RRI In-House Meeting

29th-31st January 2014

Schedule

	Session chair	Wednesday 29/01/2014	Session chair	Thursday 30/01/2014	Session chair	Friday 31/01/2014
09:20 - 09:30		Inaugural Talk by Uday Shankar				
09:30 - 09:55	Sadiq	P K Shabeeb	K S	Madhukar S	Andal	Jaya Kumar
09:55 - 10:20	Rangwala	Nazma Islam	Dwarakanath	Jyothi S	Narayanan	Benoy Anand
10:20 - 10:45		Chaitra Hegde		Prabu Thiagaraj		Karthik H S
10:45 - 11:00				Tea		
11:00 - 11:25		Anu Renjith		Lijo T George		Ann Mary K A
11:25 - 11:50	Pratibha R	U Satya Sainadh	Supurna	Samim Ali	Hema	Mriganko M Roy
11:50 - 12:15		Meera B M	Sinha	Sujatha S	Ramachandran	Gayathri Raman
12:15 - 12:40		Jayanta Dutta		Anjan Roy		Ezhilarasi M S
12:40 - 14:00				Lunch		
14:00 - 14:25	D	Debasish Saha	Urbasi	Aru Beri	Avinash	Jagdish
14:25 - 14:50	Vijayaraghavan	Niranjan M	Sinha	D Vijayaraghavan	Deshpande	V V Prasad
14:50 - 15:15		Jake Cohen		Smijesh N		Rahul Sawant
15:15 - 15:30				Tea		
15:30 - 15:55	T N	Arnab Pal		Poster Session		Reji Philip
15:55 - 16:20	Ruckmongathan	Girish B S		Poster Session		Open House
16:20 - 16:45		Buti Suryabrahmam		Poster Session		Open House

Abstracts of Talks

(Listed according to order of talks)

Fluid - Fluid coexistence in lipid-oxysterol systems

P K Shabeeb *.

Cell membrane is a very complex system containing variety of lipids and proteins.Lipid bilayer provides the basic structure of the membrane. Lipid bilayers can exist in several different phases depending on temperature and lipid composition. Cholesterol-rich domains called "rafts" are believed to play an important role in many functions of biomembranes. To understand the formation of rafts, fluid-fluid phase separation in model lipid-sterol membranes has been studied extensively.

Giant Unilamellar Vesicles (GUVs) made up of saturated lipids and certain oxysterols have been studied.Coexistence of liquid phases in GUVs is directly observed using fluorescent microscopy . This model system has the advantage that large, micron-scale domains can be directly observed by microscopy and the miscibility transition temperatures can be measured. Phase diagrams have been constructed for various systems. Membrane multilamellae on glass substrates have also been prepared using lipids and oxysterols and coexistence of liquid phases has been observed. Structure and physical properties of the different phases are under investigation.

*shabeeb@rri.res.in

Probing the environment around GX 301-2 with MAXI

Nazma Islam*, Biswajit Paul.

GX 301-2, a bright HMXB with an orbital period of 41.5 days, exhibits

strong and stable periodic orbital intensity modulations with a strong pre-periastron flare. Several models have been proposed to explain the variation in accretion at different orbital phases, invoking accretion via stellar wind, equatorial disk, and accretion stream from the companion star. We present results from exhaustive orbital phase resolved spectroscopic measurements of GX 301-2 using data from the Gas Slit Camera onboard MAXI. Using spectroscopic analysis of the MAXI data with unprecendented orbital coverage for many orbits continuously, we have found a strong orbital dependence of the absorption column density and equivalent width of the iron emission line. The iron emission line is found to be present in all the orbital phase spectra with an equivalent width in the range of a few hundred eV to more than a keV while the absorption column density is found to vary by about a factor of 10 over the orbit. These parameters are tracers of the environment around the neutron star in GX 301-2 in different phases and are useful to examine the various models about mode of accretion onto the neutron star in GX 301-2. A very large equivalent width of the iron line along with a small value of the column density in the orbital phase range 0.10-0.30 after the periastron passage indicates presence of high density material behind the neutron star in this orbital phase range. In the energy resolved orbital light curves, we have found a low-energy component which, unlike the pre-periastron hard X-ray flare, increases gradually along with a softening of the spectrum. A soft excess is also found in the spectrum at orbital phases around the pre-periastron flare.

* nazma@rri.res.in

Tagged Particle Diffusion in a Hard Particle Single File

Chaitra Hegde* and Abhishek Dhar†.
† ICTS, Bangalore, India.

Tagged particle diffusion in one dimensional systems with no-crossing condition is studied for particles with exclusion interaction via a mapping to non-interacting systems. It is found that the mean square deviation exponent gets halved when one goes from a single particle to the corresponding interacting system. We also find exact results for diffusion in the limit of large number of particles for both finite and infinite systems.
*hegde@rri.res.in

Hydrogen bonded ionic gels for electrochemical studies

Anu Renjith* and V Lakshminarayanan.

Application oriented designer solvents such as ionic liquids are an emerging area of research. Recent entry to this class of solvents is Deep Eutectic Solvents, formed by the hydrogen bonding interaction between short chain analogues of quaternary ammonium salt (QAS) and hydrogen bond donor (HBD). In our studies, attempts were made to extend the concept of hydrogen bonding in such binary systems to higher chain homologues. Such a study involved physical characterization of their structure,composition, phase behavior etc. In addition, their utility as an effective alternative to existing ionic liquids in electrochemical studies was also explored.
A novel non-polymeric gel electrolyte was prepared from a predetermined composition of tetra butyl ammonium salt and ethylene glycol (HBD). The gel electrolyte obtained by using a preparation protocol exhibited certain unique physical properties, which were utilized for monitoring enzyme kinetics by electrochemical method. The inherent ionic conductivity of the gel measured by electrochemical impedance spectroscopy was found to vary with the progress of the enzyme-substrate reaction. Gel containing a constant amount of enzyme was allowed to react with different concentrations of substrate. Rate of the reaction was found to obey Michaelis-Menten equation. Electrochemical method employed in our studies in the gel stands out as a simple robust method to follow enzymatic reactions in a medium mimicking biological environment. Higher chain analogues (Cn=16) prepared under similar conditions displayed liquid crystalline textures in POM, which are further probed by DSC and XRD.

* anu@rri.res.in

Mechanical switch for quantum state transfer in cavity optomechanics

Satya Sainadh U* and Andal Narayanan.

A brief description of cavity-optomechanical systems and Dual-cavity optoelectromechanical systems (OEMS) will be presented. Dual OEMS are

those where two electromagnetic cavities are connected by a common mechanical spring. These systems have been shown to facilitate high-fidelity quantum-state transfer from one cavity to another. In this presentation, the effect of an additional mechanical mode to only one of the cavities on the fidelity of state transfer will be explained. The quantitative estimates of loss of fidelity highlight the sensitivity of a dual-cavity OEMS when it couples to additional mechanical modes. This sensitivity can be used to design an effective mechanical switch for inhibition or high-fidelity transmission of quantum states between the cavities.

*sainadh@rri.res.in

Digital Library of Raman Research Institute: An overview

B M Meera*.

Raman Research Institute Library has access to many information resources in digital format. They could be books, journals, published research papers, lectures given in various forums, photos, news paper clippings etc. Library has also built an Institutional repository called *RRI digital repository* . This was built mainly to show case the contributions of Sir C V Raman to science. However this also demonstrates the on-going research in terms of papers published by the faculty and research students. All these information resources are made accessible through RRI library home page. AN overview of different resources that are accessible through variety of portals, gate ways, repository built specially to provide easy access is discussed.

* meera@rri.res.in

Fragmentation of primordial star-forming clouds

Jayanta Dutta *, Paul Clark†, Ralf Klessen†, Biman Nath.
†ITA University of heidelberg, Germany.

The uncertainty in the 3-body H2 formation rate coefficients as well as the cosmic distribution of minihalos can significantly limit our understanding to accurately simulate the collapse of primordial cores. Here we revisit the problem to explain the fragmentation behaviour that has not been pre-

viously discussed. We investigate the gravitational collapse of halos formed in quasi-Lagrangian cosmological moving mesh code AREPO, and follow the chemical and thermal evolution of the gas particles in the modified version of GADGET-2 SPH code with different 3-body H2 formation rates. The rapid transformation from atomic to molecular hydrogen causes the gas to become chemo-thermally unstable, which triggers gravitational instability. The uncertainty in the heating and cooling rate for different 3-body H2 formation rate coefficients has important effects on the rate of collapse of the primordial clouds that fragment with different mass scales. We speculate on the implication of this difference in the resulting stellar mass function.

*jayanta@rri.res.in

Investigation of the dynamical slowing down process in soft glassy colloidal suspensions: comparisons with supercooled liquids

Debasish Saha*, Yogesh M Joshi † and Ranjini Bandyopadhyay.
† Department of Chemical Engineering, IIT Kanpur, Kanpur-208016.

The primary and secondary relaxation timescales of aging colloidal suspensions of Laponite are estimated from intensity autocorrelation functions obtained in dynamic light scattering (DLS) experiments. The dynamical slowing down of these relaxation processes are compared with observations in fragile supercooled liquids by establishing a one-to-one mapping between the waiting time since filtration of a Laponite suspension and the inverse of the temperature of a supercooled liquid that is rapidly quenched towards its glass transition temperature. New timescales associated with primary and secondary relaxation processes, such as the characteristic timescale associated with the slowdown of the secondary relaxation process and glass transition time, are extracted to describe the phenomenon of dynamical arrest in Laponite suspensions. In results that are strongly reminiscent of those extracted from supercooled liquids approaching their glass transitions, it is demonstrated that a strong coupling exists between the primary and secondary relaxation processes of aging Laponite suspensions. Furthermore, the experimental data presented here clearly demonstrates the self-similar nature of the aging dynamics of Laponite suspensions within a range of sample concentrations.

* debasish@rri.res.in

Emergent Symmetry, Colisional Trapping and Cooling of Ions

M Niranjan * and Sadiq Rangwala.

Diffusion of ions through a cloud of ultra-cold parent atoms is characterized mainly by elastic and charge exchange collisions. Charge exchange collision between a fast ion and a cold atom, leaves a cold ion and loss of atom from the trap volume. The elastic collision with cold atoms also is known to cool the ions. Competition between Coulumb repulsion between ions and slowing down of ions due to these collisions is shown numerically, to localize the ions to experimentally desirable volumes and also emergence of symmetry in spatial configuration of the ions is seen. Application of a magnetic field helps in localizing to much smaller distances and offers possibility of realizing diffusion in lower dimensions.

* niranjan@rri.res.in

X-Shaped Radio Galaxies

Jake Cohen * and Lakshmi Saripalli.

X-shaped radio galaxies (XRGs) are an anomalous, fascinating subset of radio galaxies due to their complex morphology. However, while there exist several explanations for the formation of these galaxies, insufficient research exists to provide a clear answer. The purpose of this project is to provide groundwork for a further study of XRGs at radio wavelengths by creating new, higher resolution contour maps of a large sample of potential XRGs. These radio maps allow us to identify the role of the different proposed mechanisms in forming these intriguing structures and will help to determine the merit for the further study of the galaxies.

*jcohen@rri.res.in

Optimization problems in Non-Equilibrium Systems

Arnab Pal *.

Recent developments in precision physics have enabled us to investigate a family of thermodynamic obeservables in small systems. However, the minimization of statistical errors in these experiments is extremely important and can be manipulated by the suitable choice of optimal protocols. We present a brief theoretical report of this analysis.

*arnab@rri.res.in

An FPGA-based multichannel recording module for coincidence-counting

B.S. Girish *, Buti Suryabrahmam, Deepak Pandey and Hema Ramachandran.

We present a compact, multichannel recording module, which can record the time-of-arrival of photons from four APDs (Avalanche Photo Diode), and carry out coincidence-counting, offline. The module, which is built around a Virtex-5 field programmable gate array (FPGA) unit, accepts pulses from APDs in transistor-transistor logic (TTL) format, and time-tags them with a timing resolution of 5 ns. To optimize the overall data rate from the module, the FPGA implements an efficient time-tagging scheme, wherein, tagging is carried out only when an output pulse from at least one of the APDs is registered. The time-tagged data is transferred to a PC through a standard Gigabit Ethernet interface, without any dead-time in data acquisition. Analysis tools, for a Linux platform, have been developed to measure the multi-fold coincidence, with the coincidence time-window ranging from a minimum of 5 ns to integral multiples of 5 ns. The data acquisition bandwidth permits scaling of the module to accept input pulses from four additional detectors.

*bsgiri@rri.res.in

Photon statistics of the fluorescence emission from a collection of ultracold atoms

Buti Suryabrahmam *, Mohamed Shafi, B S Girish, Deepak Pandey and Hema Ramachandran.

The collection of laser-cooled atoms in a Magneto-Optical Trap (MOT) is thermal, following a Maxwell-Boltzmann distribution of velocities. Fluorescence from such a collection of atoms is expected to show bunching. We irradiate a collection of rubidium atoms, cooled closed to the Doppler limit in a MOT, with coherent light from a laser, and study the intensity-intensity correlation of the scattered light in a Hanbury-Brown Twiss type of setup. While the irradiating light is coherent, with a value of the second-order correlation ($g^2(0)$) of unity, the scattered light is found to have $g^2(0) = 1.9$, close to the expected value of 2. The details of the experiments, and the trends observed in the measurement will be discussed.

*suryabrahmam@rri.res.in

Osmotic pressure and salt driven transformations in surfactant polyelectrolyte complexes

Madhukar S*.

Structural poly-morphism of two-dimensional crystals of oppositely charged linear macroions, namely DNA and self-assembled cylindrical micelles of cationic amphiphiles offer a wide degree of tunability over a range of structures.The stoichiometry of these are not limited by just charge neutrality but can be pushed to different charging limits through control of the distribution of counter- ions . Hence a variety of structures can be observed depending on the relative sizes of the particles and their charge.On the basis of the phase diagram of cetyltrimethylammonium tosylate (CTAT)-DNA complex and effect of counter ions on this [1], we have studied complexes of the shorter chain amphiphile dodecyltrimethylammonium bromide (DTAB) and DNA. The tuning of external salt concentration and osmotic pressure on structural polymorphism of DTAB- DNA complexes have been studied using small angle x-ray scattering (SAXS).

References:

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*madhukar@rri.res.in

Studying cold collisions in hybrid traps

Jyothi S *, Tridib Ray, Bhargav Ram, Arijit Sharma, Sadiq Rangwala.

An experimental system comprising spatially overlapped ion trap (Spherical Paul Trap) and an atom trap (Magneto Optical Trap) and a moderate finesse Fabry-Perot cavity around it will be discussed. The cavity serves as a tool for frequency sensitive interrogation of the species within. The ion trap consists of four wire loops and is specially designed to incorporate the MOT beams and the Fabry- Perot cavity. The system enables the study of interactions between cold atom, cold molecules, and ions in a novel way. The present experiments are carried out using Rubidium (Rb) atoms, Rb+ ions and Rb2 molecules. We demonstrate collective strong coupling of Rb atoms into the cavity. A study of the trapped Rb+ ions and its interactions with cold atoms will be discussed. I conclude with the discussion of the applicability of the system and future plans.

*jyothi@rri.res.in

Development of a full-band voltage beam forming mode for the Murchison Widefield Array Digital Receiver

T Prabu *, K S Srivani, P A Kamini, S Madhavi, A Deshpande,U Shankar N, F H Briggs† (ATNF), A Roshi‡, S M Ord§,R Bhatt N D §, S Tremblay §, S J I Oronsaye §, B Crosse §, D Pallot §, M R Gopalakrishna and other MWA builders from http://mwatelescope.org.
† ATNF.
‡NRAO.
§ICRAR.

We have developed a full bandwidth voltage beamforming mode for the Murchison Widefield Array (MWA) Digital Receiver. The digital receiver digitizes signals from 8 MWA Tiles for a band between 80 and 300 MHz. The digitized outputs are processed in the receiver using a polyphase filter bank to get 1.28 MHz wide sub-bands. During a normal operation 24 such sub-bands (correspond to a 30.72 MHz band) are selected and sent out for processing in an FX correlator. To facilitate sensitive targeted searches and fast transient observations with MWA, the digital receiver is enhanced to form a new mode where a voltage beam is formed across the 80 to 300 MHz band. The digital receiver's data path and the firmware logic are enhanced to achieve this mode. The enhanced receiver can phase and combine the full-band signals from 8 MWA tiles to form a station vide voltage beam. Now the beamformer mode of the digital receiver is developed and the new functionalities are being tested in the lab. The proposed talk is aimed at providing a brief introduction to the digital receiver, details of the full-band beam forming mode architecture, constraints considered in the design, test results, future plans and an update on current status.

*prabu@rri.res.in

MWA observations of the merging galaxy cluster Abell 3376

Lijo George *, K S Dwarakanath, Natasha Hurley-Walker† , Melanie Johnston-Hollitt ‡, Luke Hindson‡, MWA SCIENCE COMMISSIONING TEAM and MWA BUILDERS LIST.
† Curtin University.
‡ Victoria University of Wellington.

Galaxy clusters which are undergoing or have recently undergone mergers sometimes show extended, diffuse radio emission in the form of Mpc sized central halos or relics in the peripheries. Double relics are a special case of the above and consist of two relics on opposite sides of the cluster centre. They are believed to trace the outward travelling shocks generated during the merger. There have been some cases where both relics and halos have been observed in the same cluster. The method by which these halos and relics are created are still not very well understood as not all clusters showing signs of merger also host halos or relics in them. Abell 3376 ($z = 0.046, L_x = 2 \times 10^{44}$ erg/s) is one such galaxy cluster which shows two arc-like relics, 2 Mpc apart and symmetric around the X-ray centre. We present observations of the

cluster made using the Murchison Widefield Array (MWA) telescope at low frequencies (100-200 MHz) and discuss the possibility of detecting faint radio emission from the central regions of the cluster and its implications.

* lijo@rri.res.in

Rheology of aqueous suspensions of natural clay colloids: Effect of electrolytes

Samim Ali * and Ranjini Bandyopadhyay.

We use dynamic rheological measurements to examine the yielding behaviour of clay colloidal system spanning the range from soft jammed glassy aqueous suspensions dominated by inter-particle repulsion to colloidal gels produced by attractive interactions controlled by added electrolyte. The clay system shows yielding behaviour above a particular value of applied strain known as yield strain. Under both repulsive and attractive conditions, the value of yield strain decreases monotonically with the increase in particle volume fraction and attractive interaction. However, in case of gel system, the yield stress and consequently gel strength increases up to a peak value and then decreases monotonically with electrolyte concentration. This demonstrates an onset of flocculated state.

*samim@rri.res.in

RRI-BCI for SSVEP based applications

Sujatha S *, Krishnaprasad S, K B Raghavendra Rao, James Mathew, R Somashekar, Mohamed Ibrahim, Ramesh B, Hema Ramachandran.

Brain-Computer Interfaces (BCI) are devices that acquire the EEG signals of subjects and translate them to appropriate actions. One important class of signals used in BCI systems is the Steady State Visually evoked Potentials (SSVEP). As the name suggests, this component of the EEG signal is evoked in the visual cortex by an external signal that is being looked at by the subject. Recently BCI systems have become commercially available, though their cost is high. Therefore realising economical BCI is crucial for wider use by patients with motor disability to become more self-reliant. We at RRI, have been developing such an interface, end-to-end, starting from the EEG sensors, to actuating the output devices. In this poster we present the

current status of this endeavour. The developments encompass the following
i) Visual input device
ii) EEG electrode
iii) Bio-amplifier
iv) Arduino-based digitisation, parameter extraction and actuation control.

In parallel we are also developing action devices like an electric wheelchair and a robotic arm. These will later be controlled by the BCI system described above.

*sujathas@rri.res.in

Tagged particle diffusion in one-dimensional systems with Hamiltonian Dynamics

Anjan Roy*, Abhishek Dhar †, Onuttom Narayan‡, Sanjib Sabhapandit.
† ICTS, Bangalore, India.
‡ UCSC, California, USA.

Observing the dynamics of a single tagged particle in a many particle system constitute a simple way of probing the complex dynamics of an interacting many body sytem. We present our results on tagged particle diffusion in a one-dimensional gas of classical point particles evolving under Hamiltonian dynamics between fixed and periodic walls. Systems studied include equal and alternate mass hard particle gas, the harmonic chain and anharmonic chains such as Fermi-Pasta-Ulam and Lennard-Jones chains. We have studied both short time regime when the effect of boundary is not felt and the tagged particle behaves as if in an infinite system, as well as long time regime when finite size effect comes into play.

* anjanroy@rri.res.in

Torque reversals and pulse profile of the pulsar 4U 1626–67

Aru Beri*†, Chetana Jain ‡, Biswajit Paul, Harsha Raichur.
†Indian Institute of Technology, Ropar.
‡ Delhi University.

We review the pulse profile evolution of the unique accretion powered X-ray pulsar 4U 1626-67 over the last 40 years since its discovery. This pulsar showed two distinct eras of steady spin-up separated by a steady spin-down episode for about 18 years. In the present work, using data from different observatories active during each phase of spin-up and spin-down we establish a clear correlation between the accretion torque acting on this pulsar and its pulse profile. The energy resolved pulse profiles are identical in both the spin-up era and quite different in the spin-down era, specially in the low energy band. This correlation, along with the already known feature of strong Quasi Periodic Oscillations (QPO) that was present only in the spin-down era clearly establish two different accretion modes onto the neutron star which produce different pulse profiles and only one of which produces the QPOs.

* aruberi@rri.res.in

^{1}H NMR study of an aqueous surfactant solution containing single-walled carbon nanotubes Probing the association of water molecules with the self-assembled structures of carbon nanotubes

D Vijayaraghavan*.

We have dispersed 0.1 wt% single-wall carbon nanotubes (SWCNTs) in CTAB aqueous (D_2O) solution and find interesting self assembled structures of carbon nanotubes. This system exhibits anisotropic bundle of CNT fibers, isolated but oriented CNT fibers, random network of CNT fibers with large number of nanopores, small and large aggregates of nanotubes on increasing the temperature. Our DSC thermogram of this system also showed peaks at these transition temperatures. We have carried out ^{1}H NMR study on both these binary and ternary systems. ^{1}H chemical shift of bulk water in pure CTAB solution is temperature independent. However, for the SWCNTs dispersed CTAB solution, we find that the ^{1}H chemical shift of bulk water exhibits considerable temperature dependence with discontinuous changes at the temperatures at which the nanotubes structural changes are seen. It is known that the surfactant molecules adsorb randomly on the surface of SWCNTs with no preferential arrangement of head and tail groups in stable surfactant-SWCNTs dispersions. This indicates that the hydration layer as-

sociated with both the head and tail group of CTAB molecules are in contact with the surface of the carbon nanotubes. Interestingly, we find that the temperature dependence of the difference in chemical shifts ($\delta_{CTAB+CNT} - \delta_{CTAB}$) of molecular groups of CTAB is identical to that of bulk water and both of them exhibit discontinuous changes at the transition temperatures. Considering that the difference in chemical shifts is related to the association of water molecules with the nanotubes, we infer that the manner of association of both the free water and bound water (water bound to the molecular groups of CTAB) with SWCNTs is the same and depends on the structural organization of the nanotubes/fibers. From our ^{1}H chemical shift data, we infer that, in the case of the anisotropic bundle and oriented CNT fibers of nanotubes, the water molecules are adsorbed at the outer surface of the nanotubes and in the case of random network of CNT fibers with pores, the water molecules are trapped inside the pores.

* vijay@rri.res.in

Acceleration of neutrals and ions in short-pulse (nanosecond) and ultrafast (femtosecond) laser produced plasmas

N Smijesh †, Reji Philip*.
† Laser and Nonlinear optics lab, Dept. of Physics, National Institute of Technology Calicut.

Here we investigate the spatial evolution of neutrals and ions in a laser produced Nickel plasma plume, generated by irradiating a Nickel target with 7 ns as well as 100 fs laser pulses, with nitrogen as background gas. It is found that line emission from the neutral species can be measured for greater axial distances than that from the ionized species, in the expanding plasma plume. The fast atomic species found in the emission dynamics is very probably formed by the recombination of fast ions with electrons. There are two reasons for this conjecture: firstly, the time of arrival of fast neutrals falls within the time of arrival of ions at nearby distances, and secondly, fast atomic species are absent at larger axial distances where no ionic emissions are detected. The velocities of fast neutrals and ions are found to increase with increase in laser energy. Close to the target, an acceleration of fast neutrals and ions has been measured for short-pulse LPP. Results obtained for the acceleration of ions and neutrals for both short-pulse and ultrafast

excitations are analyzed and compared.

*reji@rri.res.in

Constructing moduli space for 2D crystals using string field theory

Jaya Kumar A * and Yashodhan Hatwalne.

We explore the similarities between theory of defects in 2D crystals and Bosonic open string field theories. In this context Chern-Simmons theory is used to build a moduli space for classification of different crystal configurations. Our studies indicate that for a complete theory of elasticity one needs to go further than classical differential geometry and consider algebraic geometry techniques.

*jkumar@rri.res.in

An all-carbon solid-state optical diode

Benoy Anand *†, R Podila ‡, K Lingam‡, S R Krishnan‡, S Siva Sankara Sai †, A M Rao‡, Reji Philip.
† Sri Sathya Sai Institute of Higher Learning, Andhra Pradesh.
‡Clemson University, USA.

Nanocarbon based devices offer unprecedented prospects as an alternative to silicon nanophotonics for integrated photonic applications. A key element missing in the all-carbon o??ering of photonic devices is the optical diode which allows nonreciprocal transmission of light, similar to current ???ow in an electronic p-n junction diode, and is indispensable in integrated photonics for optical signal processing and signal isolation. Here, we report the experimental demonstration of the first all-carbon solid-state optical diode, which is based on the axially asymmetric nonlinear absorption principle. Optical nonreciprocity in transmission is achieved using a simple configuration of a saturable absorber (graphene) and a reverse saturable absorber (C60) arranged in tandem. Graphene and C60 possess contrasting electronic structures which result in characteristically different nonlinear absorption behaviors. We successfully demonstrated that these fundamental differences in

nonlinearity of carbon allotropes can be elegantly engineered to introduce a jump discontinuity in light transmission along the direction of beam propagation, to achieve optical nonreciprocity. The diode action is all-optical, polarization independent and has no phase-matching constraints. The key nonlinear parameters that determine the nonreciprocity factor can be precisely tuned by varying the number of graphene layers and concentration or thickness of C60 coating. This optical diode is versatile with a potentially large bandwidth, chemical and thermal stability and ultracompactness, and offers vast scope for cost effective large-scale integration using the existing fabrication technologies.

*anandbenoy@gmail.com

Beating Entropic Uncertainty bound with conditioned sequential measurements

Karthik H S *, A R Usha Devi†, J Prabhu Tej†,A K Rajagopal‡.
†Dept. of Physics, Bangalore University.
‡Inspire Institute Inc., Alexandria, Virginia, USA and Harish-Chandra Research Institute, Allahabad, India.

The Uncertainty Principle marks a "classic" departure from the seemingly expected world of Classical Physics. This along with Entanglement has been the advertised features of the non-classical regime. The uncertainty principle[1,2] brings out intrinsic quantum bounds on the precision of measuring non-commuting observables. Statistical outcomes in the measurement of incompatible observables reveal a trade-off on the sum of corresponding entropies. Maassen-Uffink entropic uncertainty relation [3] constrains the sum of entropies associated with incompatible measurements. The Entropic Uncertainty Principle(EUR) in the presence of quantum memory [4] brought about a fascinating twist by showing that quantum side information, enabled due to entanglement, helps in beating the uncertainty of non-commuting observables. In this work we investigate EUR arising from sequential measurements of observables in a single quantum system and show that temporal correlations of the observables could lead to reduction of uncertainties [5]. We also obtain entropic temporal steering inequality analogous to Einstein-Podolsky-Rosen steering inequality [6]. The temporal steering inequality is

obeyed if the correlations fall within the macro realistic tenet (which implies an underlying convex product form for the probabilities associated with the sequential measurements of temporally separated observables) and could get violated in the presence of temporal correlations. Our result is thus useful in witnessing temporal correlations in a single quantum system.

References:

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* karthik@rri.res.in

Ultrafast Optical Nonlinearity in CuS nanocrystals

K A Ann Mary †, N V Unnikrishnan †, Reji Philip*.
† School of Pure & Applied Physics, Mahatma Gandhi University, Kottayam, Kerala.

In this work we report the effect of excitonic and plasmonic absorptions on the nonlinear optical properties of CuS nanocrystals, excited by laser pulses in the short-pulse (nanosecond) and ultrafast (femtosecond) excitation regimes. CuS nanocrystals are synthesized through a soft chemical route with polyvinylpyrrolidone as capping agent. Nonlinear optical absorption is measured using the open aperture Z-scan technique, employing 100 fs and 5 ns laser pulses, at 800 nm and 532 nm, respectively. Nonlinear optical absorption is found to arise from a combined action of absorption saturation, excited state absorption, and/or free carrier absorption, the rela-

tive strengths of which are different in the two excitation regimes. While the bleaching of ground state plasmon resonance enhances saturable absorption in the NIR region (880 nm), the relatively long pulse duration accounts for the higher value of effective two-photon absorption coefficient for visible (532 nm) excitation. Optical nonlinearity parameters for both excitation regimes are calculated from the experimental data using appropriate models. The high nonlinearities measured indicate that CuS nanocrystals are potential candidates for optical limiting applications in both short-pulse and ultrafast excitation regimes.

*reji@rri.res.in

The Discrete Geometry of a Small Causal Diamond

Mriganko Mrinmoy Roy *, Debdeep Sinha and Sumati Surya

In the Causal Sets approach to quantum gravity, spacetime is postulated to be fundamentally discrete, with classical gravity being recovered in the continuum limit. In [1], expressions for the scalar curvature of a small alexandrov interval as well as the time-time component of its Ricci tensor in terms of the abundances of k-element chains in the underlying causal set is obtained. A new dimension estimator (for generic curved spacetimes) is also found.
The talk will explain how contact is made between discrete geometry (the causal set) and continuum properties of the spacetime interval.

References:

1. "The Discrete Geometry of a Small Causal Diamond " - Physical Review D 87, 044046 (2013) - Mriganko Roy, Debdeep Sinha and Sumati Surya

*mriganko@rri.res.in

Optical reprocessing of Xrays in EXO 0748-676

Gayathri Raman*, Biswajit Paul.

We will present simultaneous X-ray and optical observations of the Low

Mass X-ray Binary EXO 0748-676 with the XMM Newton Observatory. The X-ray and optical light curves include intensity variations at the orbital period, as well as thermonuclear X-ray bursts.

By studying the correlated optical and X-ray bursts, we wish to further probe the structure and geometry of the compact object surroundings. The Optical Monitor and the EPIC-PN instruments aboard the XMM- Newton satellite have been used to obtain simultaneous optical and X-ray coverage of this source. The optical bursts are seen to occur after a certain time lag, which has been computed by cross correlating the X-ray and optical data. The correlations are interpreted as the result of reprocessing of X-rays into optical radiation, with a delay, owing to light travel time difference between the direct and the reprocessed emission. An optical transfer function has been constructed to model the optical photons. It consists of a time delay function and a Gaussian shaped smearing function. A fit is performed in order to obtain optimal values for the mean delay and smearing width, as a function of orbital phase.

We also present the orbital modulations of the optical light-curves with and without the thermonuclear bursts. To probe the inner accretion disk, we also explore the eclipses and dips in the lightcurves.

* graman@rri.res.in

Voice activated wheelchair

Ezhilarasi M.S*, Junaid Ahmed, Ramesh Balasubramanyam and Hema Ramachandran.

Patient assistance systems increase their self-reliance. A paraplegic(Leg-disabled) person need a wheelchair and a nurse's assistance to get around. A motorised wheelchair restores self-reliance to such a patient. But, if the disability is due to quadriplegia (neck-down paralysis), the person will not be able to drive oneself around using the standard joy-stick interface provided. This situation can be remedied by providing other interfaces such as Voice-Computer Interface (VCI) and Brain-Computer Interface (BCI). We at RRI BCI group are developing such interfaces. Currently, we have developed a robust "Voice Activated Wheelchair" which listens to specific voice commands and executes appropriate tasks. We have included proximity sensors to make the system fail-safe. For example, while the wheelchair is on the move obstacles or other persons might come in its way and the person may not be able to quickly command the chair to stop. In such situations the proximity

sensors will sense the obstacle and stop the wheelchair regardless of the prior command. Thus, our system enables patients with such disability to move around in a safe and self-reliant manner.

* arasi@rri.res.in

Diffuse Neutrino Flux from Cosmic Ray Interactions in the Milky Way

Jagdish C Joshi * and Nayantara Gupta.

Cosmic rays diffuse through the interstellar medium and interact with matter and radiations as long as they are trapped in the Galactic magnetic field. The IceCube experiment has detected some TeV-PeV neutrino events whose origin is yet unknown.Assuming that at least several of these events were produced in the interactions of cosmic rays with matter, we calculate the average matter density needed to explain them for different halo sizes and shapes, we study the effect of the chemical composition ofthe cosmic rays, and we show the impact of the directional information of the neutrino events. We do not require knowledge of the cosmic ray escape time or injection for our approach. We find that it is plausible to describe the fraction of the observed neutrino events by these interactions which may be correlated with the Galactic plane.

*jagdish@rri.res.in

High Energy Tail of the Velocity Distribution of Driven Inelastic Gases

V V Prasad *, Sanjib Sabhapandit and Abhishek Dhar †.
† ICTS, Bangalore, India.

I will discuss a model of homogeneously driven dissipative system of particles characterized by only their velocities. We are interested in studying the steady state velocity distributions of this prototypical driven non-equilibrium system. Following a discrete dynamics we show that a simple Langevin driving is inefficient to model the driving, as it cannot sustain a steady state. We present an alternative model which not only solves this issue, but can

be exactly solved for the high energy tail of the velocity distribution in the steady state.

*prasadvv@rri.res.in

Theoretical models for atom cavity interactions

Rahul Sawant *, Tridib Ray and Sadiq Rangwala.

An optical cavity is a very high quality resonator. Atoms and molecules have very well defined energy levels. Depending on the structure of these energy levels the light inside the cavity gets modified and hence can give signatures of various processes happening inside the cavity. One of the long term goal is to use a cavity to detect molecules inside the cavity. As a first step we have studied theoretical models for atom cavity interactions. Especially the role of spontaneous emission in both the steady state and dynamics of cavity-atom system.

*rahuls@rri.res.in

Time-resolved emission dynamics of an ultrafast laser-produced Nickel plasma

N Smijesh †, K Chandrasekharan †, Jagdish C Joshi, Reji Philip*.
† NIT Calicut.

We present the experimental characterization and comparison of the temporal features of short-pulse (7 ns) and ultrafast (100 fs) laser produced nickel plasmas generated in a nitrogen atmosphere, expanding into ambient pressures ranging by eight orders of magnitude from 10-6 Torr to 10+2 Torr. Plume intensity rapidly increases around a pressure of 1 Torr for both excitations. Electron temperatures (Te) calculated from optical emission spectroscopy are found to be mostly uniform with ambient pressure for ultrafast excitation, whereas an enhancement is seen in the range of 10-4 to 10-3 Torr for short-pulse excitation. Time-resolved spectroscopic measurements of emission in the visible from neutral Ni (Ni I) species at 361.9 nm [$3d^9(^2D)4p \rightarrow 3d^9(^2D)4s$ transition] exhibit a single (fast) peak in ultrafast excitation and double (fast and slow) peaks in short-pulse excitation, which appear at different nanosecond time scales. These fast and slow peaks represent recombined neutrals and un-ionized neutrals present in the plasma

plume, respectively. Species velocities are determined from time of flight measurements carried out at distances of 2 mm and 4 mm respectively from the target surface, along the plume axis. Shock wave effects are found to affect the velocity in the case of short-pulse excitation. Measured velocities of the fast species indicate acceleration of the ions, caused by electrons propagating as the plume-front envelope in ultrafast excitation, and laser-plasma interaction in short-pulse excitation. These investigations provide new information on the pressure dependent temporal behavior of Ni plasmas produced by short-pulse and ultrafast laser pulses.

*reji@rri.res.in

Poster abstracts

E-books - Gearing up for the Future

Vrinda Benegal *, Geetha S, Manjunath M and Nagaraj M N.

Certainly, eBooks are part of our library and eBooks are coequal to printed books. eBooks have changed library services and have enabled academic libraries to align with the e-learning initiatives at their library. The last few years have witnessed the growth of the eBook market. The format of digital book publishing has changed existing methods of working pattern in delivering the digital library services. Many publishers have come forward to provide online books to libraries under different models. eBooks are not being used as widely and is not as popular as the E-journals but the trend is slowly catching up in our libraries also. In fact, Academic libraries are considering eBooks as a substitute over print books because of multi-user , user-friendly and 24X7 access anywhere and anytime. Here is a poster to showcase different pricing and access models of e-books from different publishers.

*vrinda@rri.res.in

Active pulsation and symmetry breaking flow in an actomyosin mesh confined within cell boundaries

Deb Sankar Banerjee * and Madan Rao.

During morphogenesis of the Drosophila embryo, the germ-band tissue gets elongated along anterior-posterior axis through irreversible and planar polarized remodeling of epithelial cell junctions called *T1 cell intercalation*. Recent experimental results from Prof. Thomas Lecuit's lab [1],[2], indicate that T1 cell intercalation is driven by pulsation of actomyosin in the interior each cell, followed by a symmetry-breaking flow towards one of the vertical junctions. This leads to a shrinkage of this junction resulting in ultimate cell intercalation. Our goal is to understand the physical processes of actomyosin

pulsation and flow and dynamics of T1 intercalation using an active hydrodynamics framework.
We understand the dynamics of pulsation and flow of actomyosin using an active elastomer model of actin filamentous meshwork interacting with myosin filaments embedded in the viscous cytosol. The actin meshwork is elastically coupled to the cell junctions via cell junction proteins. The myosin filaments bind and unbind onto the actin meshwork, and apply contractile stresses, which are resisted by the elastic coupling to the cell junction. In addition, we assume that the unbinding of myosin filaments is strain dependent [3].

References

1)Rauzi M, Verant P, Lecuit T and Lenne PF. Nature and anisotropy of cortical forces orienting Drosophila tissue morphogenesis. Nature Cell Biology (2008) 10(12):1401-10.
2) Rauzi M, Lenne PF, Lecuit T. Planar polarized actomyosin contractile flows control epithelial junction remodelling.Nature (2010) 468, 1110-1114.
3) S. Banerjee, T.B. Liverpool and M.C. Marchetti, Generic phases of cross-linked active gels: Relaxation, oscillation and contractility, Europhysics Letters, 96, 58004 (2011).

*debsankar@rri.res.in

Light scattering from evolving, field-induced, chain-like structures formed by magnetite nanoparticles suspended in water

Madhuri Kumari *, Archana M S and Hema Ramachandran.

We report here a systematic study of light scattering from chain like structures formed in ferrofluids under the effect of uniform external magnetic field. The structures are found to be evolving with time, under constant external field. We find significant differences in the transmission and the dynamics with changes in relative orientations of the wave-vector, the magnetic field, the viscosity, the saturation magnetization and the polarization of light. These observations shed light on the underlying mechanisms, which will be discussed.

* madhuri@rri.res.in

RRI-BCI FOR SSVEP BASED APPLICATIONS

Sujatha S *, Krishnaprasad S, K B Raghavendra Rao, James Mathew, R Somashekar, Mohamed Ibrahim, Ramesh B, Hema Ramachandran.

Brain-Computer Interfaces (BCI) are devices that acquire the EEG signals of subjects and translate them to appropriate actions. One important class of signals used in BCI systems is the Steady State Visually evoked Potentials (SSVEP). As the name suggests, this component of the EEG signal is evoked in the visual cortex by an external signal that is being looked at by the subject. Recently BCI systems have become commercially available, though their cost is high. Therefore realising economical BCI is crucial for wider use by patients with motor disability to become more self-reliant. We at RRI, have been developing such an interface, end-to-end, starting from the EEG sensors, to actuating the output devices. In this poster we present the current status of this endeavour. The developments encompass the following
i) Visual input device
ii) EEG electrode
iii) Bio-amplifier
iv) Arduino-based digitisation, parameter extraction and actuation control.
In parallel we are also developing action devices like an electric wheelchair and a robotic arm. These will later be controlled by the BCI system described above.

*sujathas@rri.res.in

Active and Passive responses of axonal cytoskeleton

Sushil Dubey *, Jagruti P†, Pramod Pullarkat.
†IISER, Pune.

We are studying the mechanical responses of neurons using home built Force Apparatus (MER)which is a optical fibre based force apparatus. The mechanical properties of the axonal cytoskeleton play important role in development (growth and retraction) and in maintaining the regular cylindrical geometry of the axon. We are trying to explore the active and passive properties of axonal cytoskeleton. We are studying the mechanical response of neuronal cells subjected to tension using force apparatus (MER).When axon

is subjected to mechanical tension its showing the viscoelastic behavior. An appropriate explanation for this is to energy release of cytoskeletal crosslinkers. We are also looking for the stress relaxation and creep behavior of the axon. Recent results show that there is stress relaxation when axons are pulled in stepwise fashion. Axons show a transition from a viscoelastic elongation to active contraction, Further aim is to built a temperature control and look for the active responses (a) understand the roles played by the different cytoskeletal components, including motor proteins and MAPs in regulating the mechanical properties, and (b) in exploring the feedback mechanism that regulate tension induced growth of axons. For these, we aim to combine genetic and biochemical modifications, high resolution fluorescence microscopy, photo bleaching techniques and force measurements

*dubeys@rri.res.in

Some VSP activities at RAL

Prabu *, et al.

This poster is a compilation of some of the interestig activities being carried out by our visiting students at the Radio Astronomy Lab, and it is aimed at providing a birds eye view of the over all importance of the work and the present status. There will be many contributors to this poster.

*prabu@rri.res.in

Equilibrium, nonequilibrium and life

Chaitra hegde *.

A few observations are made about engines, dissipation, and biological machines.

*hegde@rri.res.in

App for colorblind compatible graphics design

Jaya Kumar A *.

When graphic signages or presentations are designed, people use bright colors for highlights. Usually they tend to be in red, but a color blind would

miss it completely. This is one primary reason pilots and train drivers are tested for color blindness.
We develop a quantitative method to verify that the signages are visible, indifferent of whether a person is color blind or not. The colors are calibrated to CIE Lab print standards and the corresponding metric is modified to take into account color blindness. Then the 'Delta E' values in the highlighted region is verified to be greater than a set threshold.

*jkumar@rri.res.in

Microwaves and Triple Slot

Shreya Ray *, Anjali P S, Urbasi Sinha.

A precision experiment in the microwave regime is not something you usually hear, do you? This is exactly what we are attempting! The first step in this direction involves the characterisation of certain "looped paths" whose existence is hinted at in the Feynman's Path Integral formalism, but has so far been neglected in the wave function hypotheses in slit experiments. A very simple way of measuring the contribution of these "looped paths" can be via a triple-slit experiment, or alternatively by a triple-slot experiment, quantitatively represented by a dimensionless ratio "kappa". We perform these experiments in the microwave regime using an antenna source. The dimensions involved in this unorthodox experiment are large enough to be considered macroscopic. The results can be very exciting as we look for a very small effect in the macroscopic world.

*anjali@rri.res.in

Single Photon Source

Debadrita Ghosh *, Rengaraj Aparajithan, Urbasi Sinha.

In this poster we demonstrate the principles behind a heralded single photon source. We are in the process of manufacturing one in our lab and will explain how we plan to apply them towards quantum computation and foundations research.

*debadrita@rri.res.in