Inhouse-2015

Raman Research Institute

(15th - 17th, April)

Organising committee

Core organising committee

Abir Sarkar
Anirudh Reddy S.
Debsankar Banerjee
Deepak Gupta
Karamveer Kaur
Kartick C. Sarkar
Kumar Shivam
Meera Thomas
Nafisa Aftab
Niranjan M.
Priyanka Singh
Raj Hossain
Raviranjan Kumar
Sushil Dubey

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Time Table of RRI Inhouse Meeting – 2015

(15TH to 17TH April)

Time	Name	Title
		15.04.2015
09:50 AM		**Inauguration of the Inhouse**
Morning session	Chair:	Sadiq Rangwala
10:00 AM	Ravi Subrahmanyan	Detection of radio signatures of cosmic baryon evolution
10:20 AM	Nagaraj M. N.	Open Access initiatives in Physics: use and its impact
10:40 AM	Urbasi Sinha	On the superposition principle in interference experiments
11:00 AM		**Tea Break**
11:30AM	Sanjay Kumar Behera	Falling Ball Experiments on aging Laponite colloidal suspensions
11:50 AM	Viral Parekh	Exploring Diffuse Radio Sources in MWA continuum survey
12:10 PM	Debadrita Ghosh	Single photon sources in our lab
12:30 PM		**Lunch Break**
02:00 PM		Poster viewing session
03:30 PM		**Tea Break**
Afternoon session	Chair:	Ramesh Balasubramanyam
04:00 PM	Saurabh Singh	Precision receiver for detection of redshifted 21cm signal from the Epoch of Reionization
04:20 PM	Sumati Surya	Discreteness and Causality: a potent spacetime mix
04:40 PM	Meera Thomas	Lamellar Phase in a cationic surfactant-water system induced by a polyelectolyte

		16.04.2015
Morning session	Chair:	Joseph Samuel
10:00AM	Nazma Islam	Orbital Evolution of eclipsing High Mass X-Ray Binary 4U 1700-37
10:20 AM	Samim Ali	Microstructures and yielding of gel networks of charged anisotropic colloidal particles in aqueous suspensions
10:40 AM	Ashutosh Singh	Manipulation of Entanglement Sudden Death
11:00 AM		**Tea Break**
11:30 AM	Debasish Saha	Is the secondary Relaxation process of the aging colloidal glasses of Laponite,a Johari-Goldstein Beta Relaxation process?
11:50 AM	Saurabh Paul	21 cm Epoch of Reionization and foregrounds study with MWA
12:10 PM	Andal Narayanan	Weak value amplification in resonance fluorescence
12:30 PM		**Lunch Break**
Afternoon session	Chair:	Pramod Pullarkat
02:00 PM	Karthik H. S.	Joint Measurability , Steering and Entropic Uncertainty
02:20 PM	Sushil Dubey	Mechanical Responses of Neurons
02:40 PM	Avinash Deshpande	Manifestations of collimated particle beams from pulsars
03:00 PM		Poster viewing session

03:30 PM		**Tea Break**
04:00 PM	Priyanka Singh	A cross-correlation study of circumgalactic medium
04:20 PM	D. Vijayaraghavan	Self-Assembled ordering of single-walled carbon nanotubes in a lyotropic liquid
04:40 PM	Rishin P. V.	X-Ray Polarimetery: Experiments at RRI

		17.04.2015
Morning session	Chair:	Biman Nath
10:00 AM	Gopala Krishna M. R.	POLIX (Thomson X-Ray Polarimeter): Signal Processing
10:20 AM	Sandeep Kumar	Dispersion of Zero-, One-and Two-dimensional Nanoparticles in the Supramolecular Order of Discotic Liquid Crystals
10:40 AM	Abir Sarkar	How late can the Dark Matter form in our universe?
11:00 AM		**Tea Break**
11:30 AM	Renu V.	Design of a compact cone plate rheometer for studying cell detachment dynamics and cyto-skeletal reorganization
11:50 AM	Mayuri S. Rao	On the detection of spectral ripples fron the Recombination epoch
12:10 PM	Kumar Shivam	Coarse Quantum Measurement
12:30 PM		**Lunch Break**
Afternoon session	Chair:	Hema Ramachandran
02:00 PM	Kartick C. Sarkar	Effect of hot halo gas on supernovae driven outflows from massive spiral galaxies
02:20 PM	Madhukar S.	Membrane tubulation through in-plane lipid specificity
02:40 PM		Vote of Thanks
03:00 PM		**Tea Break**
03:30 PM - 04:30 PM		**Open house:** Topic: Chair: Ranjini Bandopadhyay

Cultural evening at 07:00 pm and **Banquet** at 08:00 pm On the library block terrace.

Talks

Detection of radio signatures of cosmic baryon evolution

Ravi Subrahmanyan*

* rsubrahm@rri.res.in

Authors:

Abstracts: Thermal evolution in baryons through recombination and till the end of reionization adds spectral distortions to the cosmic microwave background. I will first describe the nature of the distortions expected and then introduce the variety of efforts in our lab at RRI that are looking at the systems and science associated with the problem

Open access initiatives in Physics: use and its impact

Nagaraj M N*

* nagaraj@rri.res.in

Authors: Nagaraj M N

Abstracts: Open access (OA) for scholarly communication has given free access to scientific literature on web. Due to tremendous developments in Information Communication and Technology and rising cost of publishing led to emergence of open access (OA) movement as an alternative model for accessing scholarly journals during late 1990. Since then several initiatives have taken both nationally and internationally. To support OA movement authors started self-archiving on their personal

web site or on subject based repositories like arXiv. Library and Information professionals initiated institutional repository. Commercial publishers also started publishing paid open access journals for which authors contributed. Because of all these, several open access initiatives has emerged. In the present study author will be discussing way to analyse usage of open access initiatives in physics and its impact.

On the Superposition principle in interference experiments

Urbasi Sinha*

* usinha@rri.res.in

Authors:

Abstracts: In a double slit interference experiment, the wave function at the screen with both slits open is not exactly equal to the sum of the wave functions with the slits individually open one at a time. The three scenarios represent three different boundary conditions and as such, the superposition principle should not be applicable. However, most well-known text books in quantum mechanics implicitly and/or explicitly use this assumption that is only approximately true. In this talk, I will discuss recent results [1] in which we have used the Feynman Path Integral formalism to quantify contributions from non-classical paths in quantum interference experiments that provide a measurable deviation from a naive application of the superposition principle. A direct experimental demonstration for the existence of these non-classical paths is difficult to present. We find that contributions from such paths can be significant and we propose simple three-slit interference experiments [2] to directly confirm their existence. I will also describe more recent work [3] in which we have gained an analytical handle on the problem. I will end with showing some results from ongoing experiments

in my lab which are aimed at testing these theories. More details about the experimental results can be found in the posters being presented by Debadrita Ghosh and Rengaraj Aparijathan.

1. R.Sawant, J.Samuel, A.Sinha, S.Sinha and U.Sinha, Phys.Rev.Lett, 113 120406, 2014.
2. U.Sinha, C.Couteau, T.Jennewein, R.Laflamme and G.Weihs Science 329 418 - 421, 2010
3. A.Sinha, A.H.Vijay and U.Sinha, arXiv:1412.2198

Falling ball experiments on aging Laponite colloidal suspensions

Sanjay Kumar Behera*

* sanjay@rri.res.in

Authors: Sanjay Kumar Behera, Debasish Saha, and Ranjini Bandyopadhyay

Abstracts: The falling of an object through a non-Newtonian aging suspensions leads to very interesting manifestations of Stokesian flows without any terminal velocity. We have performed falling ball experiments on aging colloidal suspensions of Laponite. Balls with different sizes are dropped into the suspensions having different initial states of structure. An increase of velocity of the ball as it gets deeper into the fluid is observed. This increment is more pronounced for larger balls and for lower aging or waiting times of the suspensions. A simple rheological model is constructed to explain the experimental results by taking into account (i) the restructuring and destructuring processes and (ii) the dependence of the viscosity of the suspensions on structure parameter and shear rate.

Exploring diffuse radio sources in MWA continuum survey

Viral Parekh*

* viral@rri.res.in

Authors: Viral Parekh, Prof. K.S. Dwarakanath

Abstracts: Galaxy clusters are the most massive bound and quasi-relaxed objects in the Universe and are ideal laboratories to study the formation and evolution of large scale cosmic structure. Clusters are widespread in the sky, and it would seem that they represent the unit of matter, or building brick, from which the Universe is assembled. Detailed knowledge of galaxy clusters has been obtained in recent years as the result of advancement of observational instruments. It is of great interest to astronomers to observe galaxy clusters in various wavelengths, from radio to gamma ray, to address the key questions related to formation and evolution of galaxy clusters. It is important to investigate the role of non-thermal emission from galaxy clusters, to characterise the physical description of the ICM (Intra-cluster Medium). Radio observations provide detailed evidence for these phenomena in terms of wide diffuse synchrotron sources (for example, radio halos, relics and mini-halos), which are closely associated with the ICM rather than individual galaxies within a cluster. In this talk, we will present the recent advancement of low-frequency observation with current instruments such as the MWA (Murchison Widefield Array) to search for these components in ongoing survey. We will also discuss the importance of complementary low-frequency observation with the GMRT to understand these sources.

Single Photon Sources in our Lab

Debadrita Ghosh*

* debadritaghosh2013@gmail.com

Authors: Debadrita Ghosh and Urbasi Sinha

Abstracts: Single photon sources are ubiquitous in experiments which deal with the foundations of quantum mechanics, quantum information and quantum communication. In this talk I will demonstrate the principles behind a single photon source and means of characterizing such a source. We have developed the technology of building single photon sources in the Quantum Information and Computing lab at RRI. In this talk I will mainly focus on the experimental realization of different types of photon sources in our lab.

Precision receiver for detection of redshifted 21cm signal from the Epoch of Reionization

Saurabh Singh*

* saurabh.ascan@gmail.com

Authors: Saurabh Singh, Ravi Subrahmanyan, N.Udaya Shankar

Abstracts: Red shifted 21 cm from the Epoch of Reionization is one of the key tools to study first stars and galaxies. It is technologically challenging to achieve the high dynamic range required to detect this signal of a few mK in the presence of bright galactic and extragalactic foregrounds. In this presentation, we discuss the system architecture developed by us for the detection of global redshifted 21 cm signal in the frequency range 40-250 MHz using a broadband precision spectrometer and a frequency independent disk-cone antenna. The present system measures differential temperature between the antenna

and a known reference load. Bandpass calibration is achieved by coupling a switched noise source into the signal path. Another dedicated noise diode is used to make in-situ measurement of antenna impedance and its mismatch to free space. We have carried out extensive laboratory tests to estimate the performance of the system and Monte Carlo simulations to study the effectiveness of the data analysis methods adopted for the detection. We demonstrate that the system is capable of detecting signals of a few mK. Our approach to data analysis and preliminary results from the site characterization will also be presented.

Discreteness and Causality: a potent spacetime mix

Sumati Surya*

* ssurya@rri.res.in

Authors:

Abstracts: The two cornerstones of the causal-set-approach to quantum gravity are discreteness and causality. I will describe how these two basic principles can be used to capture the essential features of the spacetime continuum. The latter is replaced by a partially ordered set, or causal set, whose dynamics should generate, for example, the initial conditions for our universe. I will state some interesting recent results in this direction.

Lamellar phase in a cationic surfactant-water system induced by a polyelectrolyte

Meera Thomas*

* meerathomas@rri.res.in

Authors: Meera Thomas, V. A. Raghunathan

Abstracts: Polyelectrolytes can strongly interact with oppositely charged micelles in aqueous systems which can result in phase separation. Liquid - liquid phase separation is called coacervation and liquid- solid phase separation is called precipitation. In the former case the system separates into two immiscible coexisting liquid phases. Using X-Ray diffraction studies and Polarizing Optical Microscope studies, the effect of the polyelectrolyte (Poly Acrylic Acid - Sodium salt (PAANa)) on the cationic surfactant (Didodecyl Dimethyl Ammonium Chloride (DDAC)) in water was studied. It was found that it forms a lamellar phase coexisting with an isotropic aqueous phase. This system exhibits both a collapsed lamellar phase and also a swollen lamellar phase. We study the dependence of the phase behaviour of the system on the concentration of the surfactant, concentration of salt, molecular weight of the polyelectrolyte, weight ratios of polyelectrolyte to surfactant etc. Doing further studies we also try to understand the underlying reason for the observed swelling.

Orbital evolution of the eclipsing High Mass X-ray binary 4U 1700-37

Nazma Islam*

* nazma@rri.res.in

Authors: Nazma Islam and Biswajit Paul

Abstracts: The high mass X-ray binary 4U 1700-37 is an eclipsing system with orbital period of 3.412 days. The orbital period decay in this system is necessarily determined from the eclipse timing measurements due to lack of pulsations from this system. We have used the previous Uhuru, Copernicus, EXOSAT, Granat/Watch and BATSE observations of 4U 1700-37 together with long term light-curves of 4U 1700-37 obtained from all sky monitors RXTE-ASM, SWIFT-BAT and MAXI, as well as few eclipses observations by RXTE-PCA, to obtain the long term orbital evolution of the system. We then investigated the role of stellar wind driven angular momentum loss as well as tidal interactions between the binary components in the slow rate of the orbital evolution of this system.

Microstructures and yielding of gel networks of charged anisotropic colloidal particles in aqueous suspensions

Samim Ali*

* samim@rri.res.in

Authors: Samim Ali, Ranjini Bandyopadhyay

Abstracts: Colloidal suspensions of charged anisotropic clay particles exhibit non-ergodic kinetically arrested states ranging from soft glassy phase dominated by interparticle repulsions to colloidal gels produced by salt induced attractive interactions.

These classes of materials have very crucial technological applications due to their interesting rheological properties. This work, in particular, investigates the attraction induced morphological changes in fractal gel structures of highly concentrated viscoelastic gels and their macroscopic mechanical response in non-linear rheological experiments. We find that dynamical yield stress of these gels increases monotonically upto a peak value at a critical salt concentration Ccs and then decreases with the further increase in interparticle attractive interactions induced by salt. The energy dissipation in plastic rearrangements during yielding transition also shows a discontinuity at Ccs. These results indicate a transition of fractal gel networks of individual particles to a new gel build up from individual clusters that are connected by weak bonds to form a new volume spanning network. We further verify this prediction of morphological changes of gel microstructures by imaging of the gels in vitrified state using scanning electron microscopy.

Manipulation of Entanglement Sudden Death

Ashutosh Singh*

* ashutoshs@rri.res.in

Authors: Ashutosh Singh, Siva Pradyumna, Urbasi Sinha (Unpublished)

Abstracts: Entanglement and quantum superposition are the two most counter-intuitive traits of quantum mechanics that distinguishes it from the classical world. Entanglement is a non-local correlation shared between quantum systems. Alike classical correlations, quantum correlations also decay with time due to noises present in the environment and it is almost impossible to isolate qubits (quantum bit: a two level quantum system) from the environment. Therefore, decay of the correlation shared by quantum systems is almost unavoidable. We

will present brief literature overview of the phenomenon called "Entanglement Sudden Death (ESD)"; when bipartite entanglement goes to zero at finite time in presence of noises, which causes individual qubits to decohere asymptotically at $t \to \infty$. We will also discuss the experimental demonstration of ESD and the possibility of manipulation of the ESD experimentally and our calculations and proposal in this direction.

Is the secondary relaxation process of the aging colloidal glasses of Laponite, a Johari-Goldstein β-relaxation process ?

Debasish Saha*

* debasish@rri.res.in

Authors: Debasish Saha, Yogesh M. Joshi (Department of Chemical Engineering, Indian Institute of Technology Kanpur, Kanpur 208016, India) and Ranjini Bandyopadhyay

Abstracts: A universal secondary relaxation process known as the Johari-Goldstein (JG) β-relaxation process, involving all parts of the molecule, appears in glass formers, including molecular glasses, metallic glasses, polymers and plastic crystals. The J-G β-relaxation mode is particularly important in glassy systems because of its very close relationship with the α-relaxation process. However, the absence of J-G β-relaxation mode in the colloidal glasses, raises questions regarding its universality. In the present work, we compare the β-relaxation process of the colloidal suspensions of Laponite (a synthetic clay and a model glass former) with the J-G β-relaxation process of the molecular glasses. Our experimental observations suggest the presence of an analogous J-G β-relaxation mode for soft colloidal suspensions of Laponite.

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21 cm Epoch of Reionization and foregrounds study with Murchison Widefield Array

Sourabh Paul*

* sourabh@rri.res.in

Authors: Sourabh Paul, Shiv K. Sethi, N. Udaya Shankar, K. S. Dwarakanath, Ravi Subrahmanyan, MWA Collaboration

Abstracts: The Detection of 21 cm emission from neutral hydrogen of EoR is a challenging task due to the weakness of the signal. This is also limited by the various foreground effects. Thus any EoR experiment involves data of long duration and statistical analysis of the data might separate the signal from various foregrounds. In this paper we present analysis results of 3, 8 and 11 hours data of EoR1 field from Murchison Widefield Array (MWA). These include the power spectra measurement of both XX and YY polarizations. One of the goals here to locate the cleaner regions to study EoR and also study the interplay between noise and foregrounds. We discuss the comparison between isolation and removal of the foreground from the data and try to infer which method leads to less contamination in the EoR window.

Weak value amplification in resonance fluorescence

Andal Narayanan*

* andal@rri.res.in

Authors:

Abstracts: The definition of measured values of an "observable" for specific initial and final states of a quantum system has

been recently expanded to include complex values. Within this regime, a weak value of an observable is defined as the first order truncated value of the observable between an initial and a final state, whenever the unitary evolution associated with the observable is (Taylor) expandable on a small parameter. Upon satisfying certain inequalities, this weak value gets amplified and the observable is said to show "weak value amplification".

In this talk, the case of resonance fluorescence from closely spaced excited atomic states will be presented for its weak value amplification effect as reported recently in an experiment (PRL Vol. 111, 023604 (2013)). An understanding of this effect from the Wigner-Weiskopff (WW) theory will be laid out. This will clarify the sense in which the weak value amplification seen in this system should be interpreted. Extensions to other systems where de-excitation to closely spaced ground states from a single excited state will also be presented to highlight the use of weak value amplification effect in atomic resonance fluorescence experiments.

Joint Measurability, Steering and Entropic Uncertainty

Karthik H S*

* karthik@rri.res.in

Authors: Karthik H S, A R Usha Devi(Dept of Physics, Bengaluru University), A K Rajagopal(Inspire Institute Inc., Alexandria, Virginia, 22303,USA; Institute of Mathematical Sciences, CIT campus, Taramani, Chennai 600113; Harish Chandra Research Institute, Chhatnag Road, Jhunsi, Allahabad 211019)

Abstracts: The notion of incompatibility of measurements in quantum theory is in stark contrast with the corresponding classical perspective, where all physical observables are jointly measurable. It is of interest to examine if the results of two

or more measurements in the quantum scenario can be perceived from a classical point of view or they still exhibit nonclassical features. Clearly, commuting observables can be measured jointly using projective valued measurements(PVM) and their statistical outcomes can be discerned classically. However, compatibility of measurements with commutativity turns out to be limited in an extended framework, where the notion of sharp PVMs of self adjoint observables gets broadened to include unsharp measurements of generalized observables constituting positive operator valued measures (POVM). There is a surge of research activity recently towards gaining new physical insights on the emergence of classical behavior via joint measurability of unsharp observables. Here, we explore the entropic uncertainty relation for a pair of discrete observables (of Alice's system) when an entangled quantum memory of Bob is restricted to record outcomes of jointly measurable POVMs only. Within the joint measurability regime, the sum of entropies associated with Alice's measurement outcomes – conditioned by the results registered at Bob's end – are constrained to obey an entropic steering inequality. In this case, Bob's non-steerability reflects itself as his inability in predicting the outcomes of Alice"s pair of non-commuting observables with better precision, even when they share an entangled state.

Mechanical Responses of Neurons

Sushil Dubey*

* dubeys@rri.res.in

Authors: Sushil Dubey, Jagruti P.(IISER, Pune), Pramod Pullarkat

Abstracts: In this talk I will describe about the response of axons under mechanical tension. We are studying the mechanical responses of neurons using home built Force Apparatus (MER) which is an optical fiber 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 responses of axonal cytoskeleton. When axon is subjected to mechanical tension it is showing the viscoelastic behavior. An appropriate explanation for this is to energy release of cytoskeletal cross-linkers. We are also looking for the stress relaxation and creep behavior of the axon. Recent results show that there is non-linear viscoelastic response when axons are pulled in stepwise fashion. Axons show a transition from a viscoelastic elongation to active contraction.

Manifestations of collimated particle beams from pulsars

Avinash Deshpande*

* desh@rri.res.in

Authors:

Abstracts: The talk will attempt to highlight different manifestations of particle beams from pulsars, and how they relate in particular to pulsar geometry, rotation history and particle energy spectrum.

A cross-correlation study of circumgalactic medium

Priyanka Singh*

* priyankas@rri.res.in

Authors: Priyanka Singh, Subhabrata Majumdar (Tata Institute of Fundamental Research, Mumbai), Biman B. Nath, Alexandre Refregier (ETH, Zurich), Joseph Silk (IAP, Paris)

Abstracts: We cross-correlate optical, Sunyaev-Zeldovich (SZ) and X-ray power spectrum of circumgalactic medium (CGM) of galaxies from current and future surveys to probe origin, distribution and other properties of CGM. We consider contribution to the SZ/Xray signal from hot gas in only those galactic halos in which the gas cooling timescale is larger than the halo destruction timescale. For flat temperature and density profiles, the SZ cross power spectrum shows fluctuations at l-values corresponding to length scales smaller than $\sim \frac{2}{3}\times$ virial radius of the galactic halo. These fluctuations depend on the steepness of the pressure profile of CGM and vanish for a sufficiently steep profile. This characteristic property of stacked SZ signal can be used to constrain the pressure profile of CGM. Similar fluctuations are also present in X-ray-galaxy cross power spectrum. However, the change in the slope of the density profile affects X-ray more as it is more sensitive to the distribution of CGM in the halo. We also discuss the detectability of SZ-galaxy and X-ray-galaxy cross power spectrum by combining SPT-DES and eROSITA-DES/eROSITA-LSST surveys respectively.

Self-assembled ordering of single -walled carbon nanotubes in a lyotropic liquid crystal system

D. Vijayaraghavan*

* vijay@rri.res.in

Authors: D. Vijayaraghavan

Abstracts: We have carried out small angle X- ray scattering (SAXS) studies as a function of temperature on single-walled carbon nanotubes (SWCNTs) dispersed lyotropic liquid crystal (LLC) system consisting of 25 wt.% cetyltrimethylammonium bromide (CTAB) in water. This LLC system exhibits crystalline surfactant + water (Cr), nematic (N), hexagonal (H) and isotropic (I) phases on heating. Our SAXS pattern revealed that in the crystalline + water phase of the LLC, the doped CNTs exhibit 1-D ordering. In the nematic and hexagonal phases of the LLC, the CNTs exhibit 2-D hexagonal ordering. In the isotropic phase, there are domains of CNTs and within each domain, the nanotubes exhibit 1-D ordering. A plot of d-spacing of the CNTs as a function of temperature showed peaks at the phase transition temperatures of the LLC. We have also carried out optical birefringence and electrical conductivity measurements of the composite as a function of temperature. Interestingly, they also showed peaks at the phase transition temperatures. This indicates a correlation between the d-spacing of the CNTs and the anomalous increase in the birefringence and conductivity of the composite at the phase transition temperatures. We will also discuss our recent magnetic birefringence studies on a SWCNTs dispersed hexagonal lyotropic liquid crystal.

Reference: D. Vijayaraghavan, Self-assembled ordering of single-walled carbon nanotubes in a lyotropic liquid crystal system, Journal of Molecular Liquids, 128-132,199,2014.

X-ray Polarimetry: Experiments at RRI

Rishin P. V.*

* rishinpv@rri.res.in

Authors: Rishin P.V., Gopala Krishna M.R., Biswajit Paul, Varun, Duraichelvan R., Ateequlla C.M., Mohamed Ibrahim, Rajagopala G., Sandhya P., Mamatha T.S., Ezhilarasi M.S., Nagaraja H.N.

Abstracts: We describe two types of X-ray polarimeters being developed at RRI. The first type is based on the principle of Thomson scattering and is under development for a small satellite mission of the Indian Space Research Organisation (ISRO). Two laboratory models of this instrument have been made and tested successfully, an engineering model has been designed, fabricated and tested. Plans for space qualifications are in progress. The second type of X-ray polarimeter is based on photoelectron track in gas. This new technique is unique as it does not have loss of photons in the scattering medium and also does not require X-ray focusing optics or spin of the satellite and is therefore suitable for a small to medium sized mission. We present different aspects of the instrument design, sensitivity for polarisation measurement, current status of development and test results for the two kinds of instruments.

POLIX (Thomson X-ray Polarimeter) : Signal Processing

Gopala Krishna M R*

* gkrishna@rri.res.in

Authors: Gopala Krishna M.R., Rishin P.V., Biswajit Paul, Varun, Duraichelvan R., Ateequlla C.M., Mohamed Ibrahim,

G. Rajagopala, Sandhya P., Mamatha T.S., Ezhilarasi M.S., Nagaraja H.N.

Abstracts: We describe the Thomson X-ray polarimeter in detail. The main requirement for the X-ray polarimeter is to determine the degree and the direction of polarisation of the incoming X-ray photons impinging on the detector. This requires finding out the point of interactions of the photons in the proportional counter detectors. The position of X-ray interaction in each of the detectors is obtained by the method of charge division in a resistive anode wire. We will describe different elements of this instrument, their functions, and the test results obtained.

Dispersion of zero, one and two dimensional nano-particles in supramolecular order of discotic liquid crystals

Sandeep Kumar*

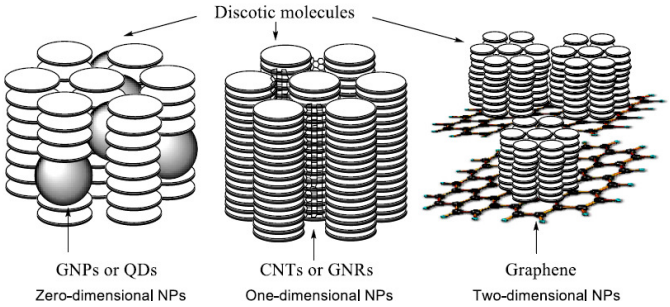
* skumar@rri.res.in

Authors: Sandeep Kumar

Abstracts: The unique geometry of columnar mesophase formed by disk shaped molecules is of great importance to study the one dimensional charge and energy migration in organized systems. There are a number of potential applications of these materials such as one dimensional conductor, photoconductor, photovoltaic solar cells light emitting diodes and gas sensors. As the conductivity along the columns in columnar mesophases has been reported to be several orders of magnitude greater than in perpendicular direction, the columns may be described as molecular wires.

On the other hand, the past decade has witnessed an explosive development in the fields of nanostructured materials, such as gold nanoparticles, quantum dots, carbon nanotubes

and graphene, due to their technological and fundamental interest. Functionalization of such nanomaterials with mesogens and their incorporation in the supramolecular order of liquid crystals is not only of basic science interest but also lead to novel materials for many device applications. With this view, we have initiated a research program to functionalize these nanomaterials with discotic as well asother molecules and disperse them in monomeric, oligomeric and polymeric discotic liquid crystals. We have observed that dispersion of such functionalized nanomaterials in columnar matrix enhance the physical properties such as, conductivity, photoconductivity, absorbance, etc., significantly.



In this talk, the design, synthesis and characterization of some electron-rich and electron-deficient discotic liquid crystals; synthesis, characterization and mesomorphic properties of functionalized nanoparticles and their insertion in the supramolecular order of discotic liquid crystals will be presented.

How Late can the Dark Matter form in our universe?

Abir Sarkar*

* abir@rri.res.in

Authors: Abir Sarkar, Subinoy Das, Shiv.K.Sethi

Abstracts: We put constraints on the epoch of dark matter formation for a class of non-WIMP (Weakly Interacting Massive Particle) dark matter candidates. These models allow a fraction of Cold Dark Matter (CDM) to be formed between the epoch of Big Bang Nucleosynthesis (BBN) and the matter radiation equality. We show that for such models the matter power spectra might get strong suppression even on scales that could be probed by linear perturbation theory at low redshifts. Unlike the case of Warm Dark Matter (WDM), where the mass of the dark matter particle controls the suppression scale, in Late Forming Dark Matter (LFDM) scenario, it is the redshift of the dark matter formation which determines the form of the matter power spectra. We use the Sloan Digital Sky Survey (SDSS) galaxy clustering data and the linear matter power spectrum reconstructed from the Lyman-α data to find the latest epoch of the dark matter formation in our universe. If all the observed dark matter is late forming, we find lower bounds on the redshift of dark matter formation $z_f > 1.08 \times 10^5$ at 99.73 % C.L from the SDSS data and $z_f > 9 \times 10^5$, at the same C.L, from the Lyman-α data. If only a fraction of the dark matter is late forming then we find tentative evidence of the presence of LFDM from the Lyman-α data. Upcoming data from SDSS-III/BOSS (Baryon Oscillation Spectroscopic Survey) will allow us to explore this issue in more detail.

Design of a compact cone plate rheometer for studying cell detachment dynamics and cytoskeletal reorganization

Renu V*

* renuv@ri.res.in

Authors: Renu V.,Pramod Pullarkat

Abstracts: Cell adhesion is the origin of ECM based mechanosensitivity of adherent cells and hence the biomechanical processes. Cell-substrate interactions govern shape, migration speed, proliferation rate and cell fate during cell differentiation. The term interaction here means the strength of adhesion between cell and the ECM and transmission of forces to the inside of cell from the adhesion sites. Cell experiences the mechanical forces from its surrounding and generates stress in response. The cellular response changes according to the stresses it experiences from its surrounding. Knowing the adhesion strength can help in predicting the cellular response for a given external mechanical cue. We present the design of a compact cone plate rheometer mounted on a microscope for live imaging and its use to give a measure of adhesion strength of different type of cells. The device is equally important for the studies related to cytoskeletal dynamics of a cell under shear at single cell level.

On the detection of spectral ripples from the Recombination Epoch

Mayuri Sathyanarayana Rao*

* mayuris@rri.res.in

Authors: Mayuri Sathyanarayana Rao (** Australian National University), Ravi Subrahmanyan, N Udaya Shankar, Jens

Chluba (Johns Hopkins University, Baltimore, MD 21218, USA)

Abstracts: Photons emitted during epoch of Hydrogen ($500 < z < 2000$) and Helium recombination ($1600 < z < 3500$ for HeII $\rightarrow$ HeI and $5000 < z < 8000$ for HeIII $\rightarrow$ HeII) are predicted to appear as additive spectral distortions in the Cosmic Microwave Background. Detecting the cosmological hydrogen recombination lines would provide a better understanding of the thermal and ionization history of the Universe and would provide an additional way to determine some of the key parameters of the Universe among others. In this talk I will present a feasibility study to experimentally detect these recombination lines of cosmological origin, the choice of frequency range, integration time for a ground based detection experiment. I will also present a method for foreground subtraction potentially applicable to other cosmological problems, including the epoch of reionization (EoR). I will talk about APSERa - Array of Precision Spectrometers for the Epoch of RecombinAtion, a venture to detect these cosmological recombination lines.

Coarse Quantum Measurement

Kumar Shivam*

* kshivam@rri.res.in

Authors: Anirudh Reddy, Joseph Samuel, Kumar Shivam and Supurna Sinha

Abstracts: We present an analytical study of the Quantum Measurement Process in the context of the Stern Gerlach experiment. We regard the spin of a silver atom as the quantum system and its orbital motion as the measuring apparatus. Both the system and the measuring apparatus are treated exactly and quantum mechanically using the Unitary evolution via the Schrodinger equation. We invoke the idea that the detection of the position of the silver atom is always done with bounded

resources. This results in an apparent non unitary evolution of the spin, so that a pure density matrix appears to evolve to an impure one. We conclude that the appearance or disappearance of coherence is determined by the coarseness of the detection. We concretize our ideas by proposing thought and real experiments.

Effect of hot halo gas on supernovae driven outflows from massive spiral galaxies

Kartick Chandra Sarkar*

* kcsarkar@rri.res.in

Authors: Kartick Chandra Sarkar, Biman B Nath, Prateek Sharma (IISc), Yuri Shchekinov (Southern Federal University, Rostov-on-Don, Russia)

Abstracts: Galaxies are known to form stars at a rate ranging from 0.1 to 500 $M_\odot$ yr^{-1}. The quick death of massive stars gives rise to energetic supernovae (SNe) explosions. These explosions, if strong enough, deposits energy in the surrounding medium and moves it to large distances from the galactic plane, producing galactic outflows. These outflows are crucial in galactic evolution and the enrichment of the intergalactic as well as the circum-galactic medium. However, very little is known about the dynamics and efficiency of the outflows in carrying away mass and metals in the presence of a hot gaseous medium surrounding the galaxy up to a large distance ($\sim$ 200 kpc). Using hydrodynamic simulations of Milky Way type galaxies ($M = 10^{12}$ $M_\odot$), we determine the properties of supernovae driven outflows and their effectiveness in carrying away mass from the galaxy in the presence of a hot halo gas. We find that the amount of mass outflow scales roughly linearly with the star formation rate at the galactic centre. Also, the outflows consist of multiphase gas of temperature ranging from 10^4 K to 10^7 K

but peaking roughly at 10^5 and $10^{6.5}$ K, giving rise to optical and X-ray emission respectively. We also find that because of the presence of the halo, the total mass thrown out of the galaxy is several times larger than the mass outflow estimated in optical measurements close to the galactic centre. This linkage between observed outflow rate in optical band at inner region and actual rate at the outermost region is important for cosmological simulations that do not resolve galaxies and depend on feedback prescriptions.

Membrane tubulation through in plane lipid specificity

Madhukar S*

* madhukar@rri.res.in

Authors: Madhukar S, Raghunathan V A

Abstracts: Shiga and Cholera toxins are toxins belonging to the AB5 family, consist- ing of an enzymatic A subunit and a receptor binding pentameric B subunit. On binding to the plasma membrane of the host cell these toxins are found to form tubular invaginations. Recent experiments on giant unilamellar vesicles indicate that the tubulation of the membrane occurs only with specific lipid compositions. Specifically, tubulation has been observed with lipids containing unsaturated hydrocarbon chains, but not with lipids having saturated chains.This talk will review our small angle xray scattering experiments on model mem- branes which reveal that the embedding of the toxin necessarily creates negative spontaneous curvature regions acting as a functional assembly in this process.

Posters

Superbubble: escape of ionizing photons

Arpita Roy*

* arpita@rri.res.in

Authors: Arpita Roy, Biman B. Nath, Prateek Sharma (IISc)

Abstracts: Ionizing photons are responsible for the ultraviolet background radiation and the reionization of our universe. Detailed studies suggest that the source of the ionizing photons are either the starburst galaxies or AGNs. We study the escape of ionizing photons from starburst galaxies, how dynamical evolution of superbubbles created by multiple supernovae in a star cluster affect the escape of ionizing photons, and calculate the value of escape fraction for disk galaxies with different disk parameters. We show that the ionising photons escape within a cone of $\sim 40^{\circ}$, consistent with observations of nearby galaxies. The evolution of the escape fraction with time shows that the escape fraction initially decreases as it gets absorbed in the shell and it reaches a minimum when the shell breaks out of the disk and then it starts increasing because the formation of channels and clumps in the shell of the superbubble makes it easier for the ionizing photons to escape. We then show the dependence of the time-averaged escape fraction on the gas density (in the range $1 - 300$ cm^{-3}) and disk scale height (between $1 - 300$ pc). We find that the contours of constant escape fraction in the parameter space of disk gas density and scale height roughly follows that of typical disc galaxies (disk gas density $\propto$ (scale height)$^{-2}$) for a given ISM temperature. For typical ISM parameters (temperature $\sim 7000 - 9000$ K), the escape fraction lies in the range of a few to $10(\pm 5)\%$, irrespective of galactic mass or redshift. We also discuss the possible effects of clumpiness of the ISM on the estimation of the escape fraction.

Enhancing access to audio and video collections of Raman Research Institute Library through digitization

Nagaraj M N*

* nagaraj@rri.res.in

Authors: Nagaraj, M.N and Vrinda J. Benegal

Abstracts: The digitization of library non-book materials has become essential as it enhances accessibility through internet. Library of Raman Research Institute (RRI) took digitization of audio and Video (AV) collection in the year 2000. The main objective is to enhance the access to inaccessible resources. As such retaining AV documents in their original format has problems of storage since they are vulnerable to usage and climatic changes. Due to frequent change in the physical format of AV materials, it becomes unreadable because of non-availability of reading devices. An effort has been made to show how different measures have been adopted to circumvent various problems. Initially metadata was created to provide access through library catalogue. Since, it was not enough to get full content of resources; library went for converting AV collection to CD format. CDs are very sensitive to scratches and multiuser access is restricted. To resolve these problems, library at RRI has adopted digitization of multimedia documents. This poster illustrates how digitized AV collections are showcased in RRI intranet and on the web for wider accessibility.

Dynamics and Thermalization of Ions in Linear (2k) Multi-Pole Traps

Niranjan*

* niranjan@rri.res.in

Authors: M. Niranjan* and Sadiq Rangwala

Abstracts: It has been shown that the two particle interaction energy between ions and atoms is limited by the micromotion of ions in the trap. In a higher order multi-pole trap, ions will have different dynamics and thermal properties. We study these properties to identify best trap designs for various applications. Few fundamental properties of motion in time varying potentials have been verified. These studies have been done using both analytical forms of potentials for ideal multi-pole traps and potential generated in Simion in 2D for a single Ca+ ion.

Detecting Non-classical paths in microwave based triple slot interference experiments

Rengaraj Aparajithan*

* rengaraj.aparajithan@gmail.com

Authors: Rengaraj Aparajithan, N. Udaya Shankar, Ravi Subrahmanyan, Urbasi Sinha, Raman Research Institute, Bangalore

Abstracts: Usual quantum mechanical as well as classical optics based description of a double slit interference experiment assumes an approximate form of the superposition principle wherein solutions to two different boundary conditions are incorrectly added to get a solution to a third boundary condition. The common assumption is that the solution to a wave equation for slits individually open add up to give the solution to

the situation when both are open, which is not completely correct. It has been recently shown through numerical simulations and certain analytic approximations that the naive application of the superposition principle is only approximately true. The Feynman path integral formalism has been used to illustrate the correction in terms of contributions from non-classical paths in interference experiments [1, 2] and triple slit experiments have been proposed to test for the correction [3]. In our ongoing experiment using microwave based optical tools, we are trying to explore the existence of such non-classical paths through triple slot based interference experiments. The microwave experiment, if successful in demonstrating the existence of such paths will prove that proper consideration of boundary conditions is extremely important, even for classical electromagnetic waves.

1. R.Sawant, J.Samuel, A.Sinha, S.Sinha and U.Sinha, Phys.Rev.Lett, 113 120406, 2014.
2. A.Sinha, A.H.Vijay and U.Sinha, arXiv:1412.2198
3. U.Sinha, C.Couteau, T.Jennewein, R.Laflamme and G.Weihs Science 329 418 - 421, 2010

Coarse Quantum Measurement

S Anirudh reddy*

* anirudhr@rri.res.in

Authors: Anirudh Reddy, Joseph Samuel, Kumar Shivam, Supurna Sinha

Abstracts: We present an analytical study of the Quantum Measurement Process in the context of the Stern Gerlach experiment. We regard the spin of a silver atom as the quantum system and its orbital motion as the measuring apparatus. Both the system and the measuring apparatus are treated exactly and quantum mechanically using the Unitary evolution via the Schrodinger equation. We invoke the idea that the detection

of the position of the silver atom is always done with bounded resources. This results in an apparent non unitary evolution of the spin, so that a pure density matrix appears to evolve to an impure one. We conclude that the appearance or disappearance of coherence is determined by the coarseness of the detection. We concretize our ideas by proposing thought and real experiments.

Spectral dispersion of ultrafast optical limiting in reduced Graphene Oxide

P. Sreekanth*

* sreekanthnowhere@gmail.com

Authors: P. Sreekanth, Pranitha Sankar, Priya Rose T., Reji Philip

Abstracts: We report the wavelength dispersion of ultrafast optical limiting in reduced Graphene Oxide (rGO) nanosheets, measured by the white light continuum (WLC) Z-scan technique, using ultrafast (100 fs) laser pulses. The WLC Z-scan is a much faster technique with good wavelength resolution for determining optical nonlinearities in materials, when compared to spectroscopic measurements using tunable laser sources such as optical parametric amplifiers. WLC was generated in water using focused ultrafast laser pulses (800 nm) from a Ti:Sapphire laser. rGO was synthesized by the modified Hummers method followed by hydrothermal reduction, and characterized using X-ray diffraction (XRD), UV-Vis spectroscopy, High Resolution Transmission Electron Microscopy (HRTEM), and Raman Spectroscopy. rGO has an increased crystalline nature and extended conjugation which is conducive for optical nonlinearities, which essentially arises from the sp2 and sp3 carbon sites. When the continuum passes through layers of rGO, electrons in the valence band absorb two photons each to reach the conduction

band, resulting in absorptive nonlinearity and optical limiting behaviour. We found that rGO exhibits excellent optical limiting for the entire wavelength regime investigated (400 nm-700 nm). The measured 2PA spectrum approximately follows the 1PA spectrum in shape, except for the shift in wavelength by a factor of 2. The 2PA coefficient is different for each wavelength but independent of the peak intensity. Therefore, even though the energy corresponding to each wavelength is slightly different in the WLC spectrum, it does not affect the calculation of two-photon absorption coefficients. In our case, the measured 2 PA coefficients are non-degenerate.

Role of actin in correlating cell spreading and nuclear shape

Renu V*

* renuv@ri.res.in

Authors: Renu V., Sweatavalli Raghawan, Chandrashekar Kuyyamudi,Abhijit Majumder(IIT,Bombey), Jyotsna Dhawan(Intsem NCBS, Bangalore),Pramod Pulllarkat

Abstracts: It is well known that substrate properties like stiffness and adhesivity influence stem cell morphology and differentiation. Recent experiments show that cell morphology influences nuclear geometry and hence gene expression profile. The mechanism by which surface properties regulate cell and nuclear properties is only beginning to be understood. Direct transmission of forces as well as chemical signalling is involved in this process. Here, we investigate the formal aspect by studying the correlation between cell spreading and nuclear deformation using Mesenchymal stem cells under a wide variety of conditions. It isobserved that a robust quantitative relation holds between the cell and nuclear projected areas, irrespective of how the cell area ismodified or when various cytoskeletal or nuclear

components are perturbed. By studying the role of actin stress fibers in compressing the nucleus we proposethat nuclear compression by stress fibers can lead to enhanced cell spreading due to interplay between elastic and adhesion factors. The significance of myosin-II in regulating this process is also explored. We demonstrate this effect using a simple technique to apply external compressive loads on the nucleus.

Detecting Non-classical paths in triple slit interference experiments

Debadrita Ghosh*

* debadritaghosh2013@gmail.com

Authors: Debadrita Ghosh, Urbasi Sinha

Abstracts: Usual quantum mechanical description of a double slit interference experiment assumes an approximate form of the superposition principle wherein solutions to two different boundary conditions are incorrectly added to get a solution to a third boundary condition. The common assumption is that the solution to a wave equation for slits individually open add up to give the solution to the situation when both are open, which is not completely correct. It has been recently shown through numerical simulations and certain analytic approximations that the naive application of the superposition principle is only approximately true. The Feynman path integral formalism has been used to illustrate the correction in terms of contributions from non-classical paths in quantum interference experiments [1,2] and triple slit experiments have been proposed to test for the correction.In our ongoing experiment using optical tools, we are trying to explore the existence of such non-classical paths through triple slit based interference experiments.

1.Non classical paths in quantum interference experiments, R.Sawant,

J.Samuel, A.Sinha, S.Sinha and U.Sinha, Physical Review Letters, 113, 120406, 2014.
2. On the Superposition principle in interference experiments, A.Sinha, A.H.Vijay and U.Sinha, arXiv:1412.2198.