Young Physicists' Meet 2018
Abstract Book

Day 1, Tuesday 24^{th} April, 2018

Session 1

Time: 10:00 AM - 10:30 AM

Hot Nuclear matter in strong magnetic field.

Speaker: Manu Kurian.

The prime focus is to understand the impact of strong magnetic field created in the relativistic heavy-ion collisions to the QCD matter. Realizing, hot QCD medium in the strong magnetic field as an effective grand canonical system in terms of the modified quark, anti-quark and gluonic degrees of freedom, the thermodynamics has been studied. Furthermore, setting up and effective kinetic theory in the presence of the magnetic field with appropriate particle distributions and non-trivial dispersions would be another interesting direction where the prime interest lies. We study the temperature dependence of longitudinal electrical conductivity and bulk viscosity of the hot QCD medium in the presence of the strong magnetic field. The formulation is done within the framework of the effective fugacity quasi-particle model where the medium interactions are incorporated through the effective fugacity.

Time: 10:30 AM - 11:00 AM

Effect of the Magnetic field on Dilepton Production.

Speaker: Balbeer Singh.

We study the effect of magnetic field on the dilepton production. We take the effect of magnetic field on the fermion propagator and calculate the photon polarization tensor $\Pi_{\mu\nu}$. We derive the general expression for $\Pi_{\mu\nu}$ in the weak field limit and estimate the two-point current-current correlator. Since the magnetic field rapidly decreases with time so it is expected to be much lower in the QGP phase. We focus on the soft photons and work in the limit of zero photon momentum to estimate the dilepton production. This is important as soft photons have a major contribution from the thermal medium and thus the dilepton production can provide us with useful information about the medium properties, such as the existence of magnetic field. The effect of constituent quark mass is also included. In addition, we estimate the production rate with transverse momenta which is related to the flow v_2 for the dilepton produced.

Session 2

Time: 11:30 AM - 12:00 PM

Black hole entropy production and transport coefficients

Speaker: Fairoos C.

TBA

Time: 12:00 PM - 12:30 PM

Effective description of plasmons in the hot QCD/QGP medium.

Speaker: Mohd. Yousuf Jamal.

TBA

Session 3

Time: 2:00 PM - 2:30 PM

TBA.

Speaker: Aman Abhishek.

Time: 2:30 PM - 3:00 PM

High-Fidelity interpolation of Compact binary Coalescence (CBC) waveform using radial basis functions.

Speaker: Ayatri Singha.

Development of a computationally efficient numerical framework to perform parameter estimation for reconstructing compact-binary gravitational wave sources is crucial. Evaluating the posterior probability density function of the source parameters (component masses, sky location, distance from the source etc.) requires computing the millions of waveforms over the parameter space. The computational cost of parameter estimation is thus, dominated by waveform generation and scales linearly with the number of waveforms. The evaluation of posterior probability involves integration over likelihood times prior. Hence to get posterior probability using MCMC or Nested sampling, one needs to compute likelihood for a large number of points which requires the generation of a large number of waveforms. To get rid of the problem, one can use interpolated waveform instead of generating the waveforms at each point. Construction of the GW waveforms at an arbitrary position using different interpolation scheme has already proposed. But all the existing interpolation schemes are done by distributing input points over a regular grid. But for higher dimension as the number of input data points increases as a power of dimensionality, hence these interpolations need a large number of waveforms generated at these input points. In this project, we have proposed a numerical 2D interpolation scheme in chirp mass and symmetric mass ratio (M, Îů) parameter space using radial basis function (suitable for random template points) with template points chosen randomly. Here we are going to decompose the waveform as the linear combination of the coefficients and a set of orthonormal basis which we have obtained by SVD decomposition of template matrix generated from non-spinning template bank. For any arbitrary point from the parameter space, the coefficient can be evaluated by interpolation from Radial Basis Function. We have also computed the match between the interpolated waveforms with the original one and got very high value (> 0.99) which reflects the efficiency of this interpolation scheme.

Session 4

Time: 3:30 PM - 4:00 PM

Developing an early-warning search for gravitational wave transients using Random Matrix Factorization.

Speaker: Amit Reza.

Compact-binary coalescences are an essential class of sources for the advanced-LIGO detectors. Fast and accurate waveform models are used for detection and reconstruction of the physical parameters of such systems. Improved detector sensitivity at low frequencies has resulted in a vast increase in the number of templates to cover the deemed parameter space covering target mass and spin ranges. Further, it has also led to longer template waveforms. Both of these effects amplify the computational cost of the gravitational wave searches by several orders of magnitude. Hanna, Canon et al. have shown earlier that one can use the singular value decomposition (SVD) method to deal with a large number of templates. However, performing SVD for large matrices in situ, along with filtering the data through the basis vectors and storage of many gravitational wave triggers have severe memory and logistical challenges. We investigate the application of the randomized matrix factorization method to reduce the high computational costs of such searches. Random matrix factorization is an efficient technique for the low-rank approximation of a given large template matrix by projecting the template waveforms randomly into much lower dimensional space, and QR decomposition can obtain the basis vectors of that dimension. These set of basis vectors can be used as a surrogate template to calculate the signalto-noise ratio (SNR) over a fixed region of parameter space. We demonstrate that one can factorize large template matrices using the randomized matrix factorization over a distributed memory computer architecture also. We investigate this idea to overcome time complexity and space complexity problem associated with the standard SVD method. We investigate the application of this technique to optimize the total computational and memory requirements of typical GW searches. Our approach is easily scalable and can be deployed over a distributed memory computer architecture. Observing such transients in Earth and space based electromagnetic telescopes holds enormous potential for new discoveries. Our numerical experiments indicate that the proposed new algorithm is as accurate as the standard SVD within a fixed probabilistic error bound.

Time: 4:00 PM - 4:30 PM

Designing an effectual template placement algorithm for gravitational wave searches.

Speaker: Soumen Roy.

Several gravitational wave (GW) signals from the binary neutron stars and blackholes have been detected in terrestrial broadband interferometric observatories like the Advanced LIGO and Virgo detectors. In these searches, the data is match-filtered against a set of possible template waveforms spanning a wide range of parameters. Development of efficient placement strategies for covering the search parameter space leads to computational efficiency. This is particularly important in the era of advanced detectors, where the increased bandwidth and low-frequency sensitivity of the detector have resulted in a vast increase in template bank sizes as seen in the recently concluded O1 and O2 searches. To this end, we present a new template placement algorithm that combines the robustness of the stochastic placement method along with the efficiency afforded by the use of A_n^* lattice to cover the search space. We show that the template placement is resilient to variations in the curvature of the parameter space and can deal with irregular boundaries without any explicit fine-tuning in the design. We also develop a numerical method to evaluate the metric in the space of waveform parameters, with an excellent agreement with the numerical ambiguity function. This technique is computationally efficient that can be used to compute the metric for any non-precessing waveform families. By using this metric, we construct various hybrid banks and compare them against stochastic banks. We establish that, while both are equally effective in capturing sources modelled by full *inspiral-merger-ringdown* waveform families, the new hybrid banks are significantly smaller in size and take minimal computational time for their generation.

Day 2, Wednesday 25^{th} April, 2018

Session 1

Time: 10:00 AM - 10:30 AM

Bounds on Neutrino Mass in Viscous Cosmology.

Speaker: Priyank Parashari .

It is well known that there is some discordance in the values of σ_8, the r.m.s. fluctuation of density perturbations at 8 h^{-1}Mpc scale, and H_0, the value of Hubble parameter observed today, inferred from CMB and LSS observations. It has been shown that these tensions can be resolved with the presence of viscosity of the order of $10^{-6} H_0 M_P^2$ in cold dark matter. Effective field theory of dark matter fluid on large scales also predicts the presence of viscosity of the same order. Massive neutrinos and viscosities have the similar effect on the matter power spectrum as both supress the matter power spectrum on small length scales. We show that by including the effective viscosity, which arises from summing over non linear perturbations at small length scales, We can severely constrains the cosmological bound on neutrino masses. We find that constraint on neutrino mass decreases from $\sum m_\nu \leq 0.396\,\mathrm{eV}$ (normal hierarchy) and $\sum m_\nu \leq 0.378\,\mathrm{eV}$ (inverted hierarchy) to $\sum m_\nu \leq 0.267\,\mathrm{eV}$ (normal hierarchy) and $\sum m_\nu \leq 0.146\,\mathrm{eV}$ (inverted hierarchy) in the effective viscous framework.

Time: 10:30 AM - 11:00 AM

Warm Inflation .

Speaker: Richa Arya .

TBA

Session 2

Time: 11:30 AM - 12:00 PM

Black Hole Topology in f(R) Metric.

Speaker: Akash K Mishra .

Hawking's topology theorem in general relativity restricts the cross-section of the event horizon of a black hole in $3+1$ dimension to be either spherical or toroidal. The toroidal case is ruled out by the topology censorship theorems. In this article, we discuss the generalization of this result to black holes in $f(R)$ gravity in $3+1$ and higher dimensions. We obtain a sufficient differential condition on the function $f'(R)$, which restricts the topology of the horizon cross-section of a black hole in $f(R)$ gravity in $3+1$ dimension to be either S^2 or $S^1 \times S^1$. We also extend the result to higher dimensional black holes and show that the same sufficient condition also restricts the sign of the Yamabe invariant of the horizon cross-section.

Time: 12:00 PM - 12:30 PM

An observational imprint of non-linear matter-gravity coupling in the speed of gravitational waves.

Speaker: Soumya Jana.

In general relativity (GR), the matter-gravity coupling is given by a proportionality relation between the stress-energy tensor and the spacetime geometry (Einstein tensor). However, theories of gravity are essentially nonlinear in nature, and therefore, the coupling to matter may also be nonlinear. Though most of the modified theories of gravity usually differ from GR in vacuum and keep the coupling to matter linear, the Eddington-inspired Born-Infeld (EiBI) gravity introduced by Bañados and Ferreira is completely opposite to them. The signature of such a nonlinear matter-gravity coupling in EiBI theory is realized by showing that the speed of gravitational waves in matter deviates from c. The effect is observable in the recently detected gravitational wave (GW) signals. An important outcome of the GW observations is that they constrain the difference between the speed of gravity and the speed of light. We use it to constrain EiBI gravity. From the time delay in arrival of gravitational wave signals at Earth-based detectors, we obtain the bound on the theory parameter κ as $|\kappa| \lesssim 10^{21}\, m^2$. Similarly, from the time delay between the signals of GW170817 and GRB 170817A, in a background Friedmann-Robertson-Walker universe, we obtain $|\kappa| \lesssim 10^{37}\, m^2$. Although the bounds on κ are weak compared to other earlier bounds from the study of neutron stars, stellar evolution, primordial nucleosynthesis, etc., our bounds are from the direct observations and thus worth noting.

Session 3

Time: 2:00 PM - 2:30 PM

EFT of large scale structure.

Speaker: Prakrut Chaubal .

Effective field theory provides a systematic framework to treat a system at long wavelength without having a complete knowledge of the behaviour of the system at short wavelengths. Applying the techniques of field theory to classical cosmological perturbations allow an improved handling of the effects of backreaction of non-linear modes on the large scale modes leading to modification of some of the most basic assumptions of ΛCDM cosmological model. We show that incorporating these corrections into standard cosmological model give a better agreement between predictions and observations of the CMB and large scale structure resulting into concordant cosmology without the need of introducing any new ad-hoc cosmological variable.

Time: 2:30 PM - 3:00 PM

Viscous Dark Energy Model.

Speaker: Arvind Kumar Mishra.

TBA

Session 4

Time: 3:30 PM - 4:00 PM

Jet Substructure at the LHC.

Speaker: Akanksha Bhardwaj.

The non-appearance of any significant excess, supporting any scenario beyond the SM (BSM), strongly motivates us to develop and apply new strategies. The powerful techniques of jet substructure are one such strategy and in many contexts takes one along untrodden paths. LHC searches have benefited immensely from developments in jet substructure techniques over the past few years and have enabled investigations of many hitherto challenging signals. In this talk, I would like to give a brief introduction to jet substructure techniques which can be applied to several unexplored parameter spaces of different BSM scenario at the LHC.

Time: 4:00 PM - 4:30 PM

Charged Higgs Discovery Prospect.

Speaker: Agvino Sarkar.

We study the collider phenomenology of charged higgs bosons $H^{\pm}$ in a model independent fashion. We classify different Beyond the Standard Model (BSM) scenarios with an extended scalar sector on the basis of the coupling properties of $H^{\pm}$: gaugophobic, leptophobic, and chromophobic.In each case both the dominant production and decay rates of $H^{\pm}$ will be different and accordingly we identify the most viable modes for a 5σdiscovery at the LHC analysis for some chosen benchmark points. Finally we translate this discovery potential in the context of a specific model, the Type II 2HDM .

Time: 4:30 PM - 5:00 PM

Quantum phases of dipolar bosons in optical lattices.

Speaker: Soumik Bandyopadhyay.

Ultracold atoms in optical lattices are excellent systems to simulate quantum effects in condensed matter systems. This is due to high controllability of system parameters and their cleanliness. These macroscopic quantum systems exhibit distinct phases depending on the system parameters, and can be steered from one phase to another by tuning one of the system parameters. This can provide deeper insights on different quantum phases and phenomena associated with quantum phase transitions. During this talk, we will discuss on some of the novel phases exhibited by strongly interacting dipolar bosonic atoms in a square optical lattice, and on the parameter regimes within which these phases can be observed.

Day 3, Thursday 26^{th} April, 2018

Session 1

Time: 10:00 AM - 10:30 AM

The 21-cm fluctuations from dark matter interactions.

Speaker: Ashish Narang.

The 21-cm electromagnetic wavelength from the hyperfine interaction in hydrogen has an important role in cosmology. This is a unique method for probing the universe prior to the star formation era. The 21-cm line or HI line refers to the electronic radiation spectral line that is created by a spin flip from ortho (J=1) to para (J=0) hydrogen which is of wavelength 21-cm (1420 MHz). When the CMB passes through a HI cloud at redshift z there will be a dip in the CMB spectrum at frequency $\frac{1420}{/}(z+1)$ MHz due to J = 0 to 1 transitions. The recent measurement by the EDGES experiment observed a dip larger than that expected from standard cosmological models. In this talk, I will explain this excess dip as a result of interaction between dark matter and HI.

Time: 10:30 AM - 11:00 AM

Halo mass function and Dark Matter properties.

Speaker: Arindham Mazumdar.

Linearized cosmological perturbation theory can describe observed CMB power-spectrum efficiently. In case of matter power spectrum cosmological perturbation theory can also generate the output from linearized theory but that cannot be matched directly with the observations. It is because the galaxy or clusters that we see today have been formed in highly non-linear process. In this talk I will describe how to connect the large scale observations with linearized perturbation theory using Halo Mass Function. I will also talk about how the properties of dark matter changes the halo mass function itself.

Session 2

Time: 11:30 AM - 12:00 PM

Dark Matter and Neutrino Mass in IDM+VLL Models.

Speaker: Soumya Sadhukhan.

We study an extension of the Inert Higgs Doublet Model (IHDM) by three copies of right handed neutrinos and heavy charged singlet vector-like leptons. The neutrino masses are generated at one loop in the scotogenic fashion. For neutral scalar dark matter of the IHDM, we particularly look into the parameter region where dark matter relic abundance is primarily governed by the inert Higgs coupling with the leptons. We also briefly discuss the collider implications of such a scenario. We also add vector-like doublet leptons and then study the effects of co-annihilation on the vector-like fermion DM.

Time: 12:00 AM - 12:30 PM

Partial mu tau symmetry and its validation at DUNE and Hyper-K.

Speaker: Kaustav Chakraborty.

In this talk I will discuss about the origin, consequences and testability of a hypothesis of 'partial μ-τ' reflection symmetry, which can be obtained using discrete flavour symmetries. This symmetry predicts $|U_{\mu i}| = |U_{\tau i}|$ $(i = 1,2,3)$ for a single column of the leptonic mixing matrix U. Depending on whether this symmetry holds for the first or second column of U different correlations between θ_{23} and δ_{CP} can be obtained. We will discuss how the predictions of this symmetry compare with the allowed area in the $\sin^2\theta_{23} - \delta_{CP}$ plane as obtained from the global analysis of neutrino oscillation data. Furthermore, we study the possibility of testing these symmetries at the proposed DUNE and Hyper-Kamiokande (HK) experiments (T2HK, T2HKK), by incorporating the correlations between θ_{23} and δ_{CP} predicted by the symmetries.

Session 3

Time: 2:00 PM - 2:30 PM

Neutrino Physics and Flavor Symmetries.

Speaker: Biswajit Karmakar.

Observations of non-zero neutrino mass and large leptonic mixing have been confirmed by several neutrino experiments in the last two decades, three important issues related to neutrino physics are yet not settled. They are namely, nature of neutrinos: Dirac or Majorana, mass hierarchy of neutrinos and leptonic CP violation. Use of various flavor symmetry in this regard is quite popular as it has potential to address the unsolved phenomenons related to neutrino masses and mixing in an economic way. Models with Majorana neutrinos (via various seesaw mechanism) have been studied extensively in this regard and our aim is to explore few less traveled paths. Although negative results at $0\nu\beta\beta$ experiments do not prove that the light neutrinos are of Dirac nature, here first we propose few scenarios predicting Dirac neutrinos with correct mass and mixing. Hence we construct different seesaw models to realise light Dirac neutrinos and study their consequence within the framework of A_4 discrete flavour symmetry in our first approach. In an alternate attempt, we employ flavour symmetry in the minimal left-right symmetric theories and try to explain neutrino masses and mixing.

Time: 2:30 PM - 3:00 PM

Phenomenology of B decays.

Speaker: Bharti Kindra .

Exclusive semileptonic decays based on $b \to s$ transitions have been attracting a lot of attention as some angular observables deviate significantly from the Standard Model (SM) predictions in specific q^2 bins. B meson decays induced by other Flavor changing neutral current (FCNC), $b \to d$, can also offer a probe to test new physics with an additional sensitivity to the weak phase in Cabibo-Kobayashi-Masakawa (CKM) matrix. We provide predictions for angular observables for $b \to d$ semileptonic transitions, namely $B \to \rho \ell^+ \ell^-$, $B_s \to K^* \ell^+ \ell^-$, and their CP-conjugated modes. We also discuss finite width effects and $B^0 - \bar{B}^0$ mixing effects on the observables.

Session 4

Time: 3:30 PM - 4:00 PM

General $U(1)'$ Extensions of the Standard Model, Neutrino Mass and Fermionic Dark Matter.

Speaker: Vishnudath K.N.

We discuss a class of U(1) extensions of the standard model to which we add three extra singlet fermions in addition to the three right handed neutrinos needed for anomaly cancellation. Light neutrino masses are generated by the minimal inverse seesaw mechanism and one of the extra neutral fermions could be a dark matter candidate. We constrain the U (1) quantum numbers of the Higgs doublet and the additional scalar from vacuum stability as well as perturbativity considerations.

Time: 4:00 PM - 4:30 PM

Phenomenological aspect of Very special relativity.

Speaker: Alekha Nayak.

The special theory of relativity has been experimentally tested to unprecedented degree of accuracy. The Standard model of particle physics respects Lorentz invariance and successfully describes all particle interactions. However, it breaks several discrete symmetries such as P, T, CP or CT, which were once thought to be preserved in nature. With the violation of these discrete symmetries, it is possible that only a subgroup of the Lorentz group may be preserved in nature. The resulting framework along with translational symmetry is known as very special relativity (VSR). It turns out that this is both necessary and sufficient to explain the null result of Michelson-Morley experiment and its consequences. VSR has a preferred direction which manifestly breaks Lorentz invariance. Remarkably it provides an alternative approach for neutrino masses which does not require addition of a new fields in the Standard Model and it also conserves lepton number. We study collider and astrophysical implications of models based on VSR.

Time: 4:30 PM - 5:00 PM

Better than chi square.

Speaker: Bhavesh Chauhan.

TBA
