Review/Projects opted by the Post-MSc Theory Batch 2018-2019 for II and III Trimester:

1. Prof. Koushik Dutta

II Trimester: *Study of reheadting/preheating at the end of inflation*

The student is expected to review the basics of perturbative and non-perturbative mechanisms of inflaton energy density being converted to the standard model degrees of freedoms at the end of inflation.

III Trimester: *Gravitational wave production during reheating/preheating at the end of inflation*

Based on the study of the previous semester, the student is expected to study the gravitational wave production during the epoch of reheating/preheating at the end of inflation. This analysis will require numerically solving the perturbation equations for the fields in the expanding background.

Khursid Alam

2. Prof. Ambar Ghosal

Generation of nonzero neutrino mass and estimation of the Majorana phase(s) in some beyond Standard Models

Extension of the Standard $SU(2)_L \times U(1)_Y$ model through the incorporation of (i) symmetry (discrete or continuous) (ii) fermion and/or scalar field or any possible combination of them is necessary to generate light neutrino masses. In this project, after basic review of neutrino properties, we will investigate different neutrino mass generation mechanisms, such as, Type I,Type II, Type III, inverse and linear seesaw mechanisms, Zee mechanism and through higher dimensional operators. Further, we will study different models invoking above mentioned mechanisms and symmetry. Particularly, we will focus on the implication of 'Residual Symmetry' in addition to other symmetry. Next, we will estimate the Majorana phase(s) of the neutrino. Nature of the neutrino, whether Dirac or Majorana type, depends crucially on the observation of neutrinoless double beta decay event. In this project, utilising this experimental result (which provides an upper bound on the $m_{\nu ee}$ element) and other neutrino oscillation experimental data, the Majorana phases appearing in a Majorana type neutrino mass matrix will be estimated in some beyond Standard models.

Satyabrata Datta

3. Prof. M.S. Janaki

Nonlinear Waves and chaos in Plasmas

Plasma being an electrically conducting fluid, supports a large number of electromagnetic waves. WIthin the framework of the linear theory, the characteristics of these waves are studied using dispersion relations that depend on a number of parameters such as density, temperature of plasma, collisional effects, applied magnetic field and so on. The frequencies and wave numbers of these waves vary over a wide range and can be classified depending on the dynamics of ions and electrons. When the amplitude of the waves becomes large, nonlinear effects come into play. Nonlinear wave structures are ubiquitous in both space and laboratory plasmas and make appearance as solitary structures, shock waves, vortices, BGK-modes and so. Very often, interaction between various waves leads to chaotic dynamics. The scope of this review is to study some of the nonlinear dynamical features of plasma fluctuations, explore the routes to chaos and develop familiarity with some of the techniques used to study them.

Siba Prasad Acharya

4. Prof. P.K. Mohanty

II Trimester: *Exactly solvable models in equilibrium*
III Trimester: *Exactly solvable models in non-equilibrium*

Indranil Mukherjee

5. Prof. Kalpataru Pradhan

Interfacial Magnetism in Transition Metal Oxide Heterostructures

When surfaces of two transition-metal oxides (TMOs) were joined together to form an interface, new phenomena were discovered during the last decade. In some cases the phases at the interface are not even realized in the bulk of either of the TMOs which are joined together. It remains a continuing challenge to understand the physical phenomena and functional properties at the interface. Understanding the physics at interfaces will bring us closer to design new functional materials. In this project we will start with an overview of basic magnetic properties of bulk TMOs, then turns to understand the charge transfer across the interface of two TMOs and how this can be used to understand the magnetism at the interface.

Sandip Halder

6. Prof. H. Singh

Holography and the entanglement entropy in string theory

Abstract: The entanglement of states of the quantum subsystems is a well known phenomenon. In some strongly coupled critical systems it can even be studied using string theory holographic approach. The student will explore the basics of the Ryu-Takayanagi method.

Sabyasachi Maulik

Note:

- **Trimester-II: There will be a half an hour presentation of the Review/Project topic, (20-22 March 2019).**
- **Trimester-III: You have to submit a write up on the Review/Project Topic by 10th July 2019. The final presentation of the Review/Project will be held by 15th July 2019.**

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PMSc Physics (Theory)