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Seminar

Institute for Plasma Research

Title : Molecular Dynamics study of Convection Cells in 2D Yukawa liquids

Speaker: Ms. Pawandeep Kaur

Institute for Plasma Research, Gandhinagar

Date : 12th May 2022 (Thursday)

Time : 10.30 AM

Venue : Online - Join the talk:

Primary URL: https://lobby.ipr.res.in/Synopsis_Pawandeep

Secondary URL: <https://meet.google.com/wcj-uhet-jrq>

Abstract :

Equilibrium statistical mechanical systems, where many particles interact in the absence of external forces, are well understood. For example, a well known governing principle is extremization of average entropy, which leads to an accurate prediction of various equilibrium phases. However, most of the systems around us are non-equilibrium, driven-dissipative in nature, such as galaxies, stars, planets, oceans, tokamaks, coffee cups, living cells etc, which are fundamentally different from the equilibrium systems in various aspects. For example, unlike equilibrium systems, there are no obvious governing principles to predict the dynamics of such driven-dissipative systems. Interestingly, these systems usually show the emergence of a diverse variety of fascinating macroscale structures or patterns under the effect of drive and dissipative forces. In view of their ubiquity, their fundamental and technological importance, it is imperative to understand the dynamics of such far-from-equilibrium systems.

Using Yukawa liquids as a prototype, the present work is focused on understanding the dynamics of a minimal, non-equilibrium, driven-dissipative system, namely Rayleigh-Bénard (RB) convection, where a fluid layer is subjected to an external temperature gradient in the presence of downward directed external gravity, which form patterns (macroscale structures or convection cells) beyond a critical value of the applied temperature gradient. Long length scales and slow times scales inherent to Yukawa liquids make them an excellent choice to study such fluid flow phenomena at the most fundamental kinetic level.

In this Thesis, by employing classical “first principles” 2D molecular dynamics simulations, RB system of Yukawa liquids is investigated using a few thousands of particles. Several of the following non-trivial questions are addressed: Can one obtain macroscale structures or patterns in such system? If yes, is there any underlying entropic principle at microscales or macroscales (for example, Fluctuation Theorem(s))? Once macroscale structures or patterns are formed as a quasi-steady state, how is their stability affected in the presence of particle-level perturbations? What is the effect of including particle-level charge-mass inhomogeneities and dust-neutral collisions on the stability and dynamics of the macroscale fluid flow? Some of the above mentioned questions will be addressed in the synopsis talk. Furthermore, using simple convection cells at various aspect ratios as initial conditions, important insights are obtained on understanding the stability of convection cells. Several unresolved problems in this Thesis work are identified, pointing towards plausible future work. In addition to this, the possibility of realizing the present findings in Complex dusty plasma experiments, which are often modelled as systems interacting with Yukawa potential, will also be discussed.
