Seminar

Institute for Plasma Research

Title: Study on rotating dusty plasma equilibria and their excitations in strongly coupled quasi-localized regime

Speaker: Mr. Prince Kumar

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Date: 24th November 2023 (Friday)

Time: 10:30 AM

Venue: Seminar Hall, IPR

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Abstract: Dusty plasmas are good prototypes for the driven equilibrium states and their collective excitations. Addition of rotation and quasi-localization phases allows many more complex systems to be addressed [1, 2, 3]. The rotating dust equilibria driven in the presence of a non-uniform magnetic field are first modeled using Navior stock equations that suitably describe the non-localized phase of media [2]. Since the time scales associated with these rotating dust equilibria are assumed to be longer than the diffusion time of the underlying potential landscapes, they exhibit characteristic behavior similar to a normal fluid. The rotating dust flows generated under a variety of conditions using the fluid equations in a vorticity-stream function formulation show finite effects of the magnetic field and its gradient [2].

The subsequent part of the thesis deals with the local density fluctuations associated with the collective motion of the dust particles in stably rotating dust equilibria when they additionally experience the effects of its localized phase [1]. The spectral distribution of these fluctuations are described by more sophisticated theoretical models, such as Quasi-localized charge approximation (QLCA) rather than standard fluid equations. The QLCA model accounting for dust rotation is adopted to analyze the effects of rotation on the strongly correlated dust density fluctuations in a rotating dust cloud. When observed in a rotating frame, the dispersion relations of collective dust density fluctuations show the magnetoplasma-equivalent dispersion pattern. As the rotational frequency increases, the saturation value of the frequency in the dispersion relation decreases, and agrees closely with its weakly coupled counterpart. This linear analysis of rotating dusty plasma behaviour provides crucial insights into condition involving high magnetic fields capable of magnetizing the dust or those relevant to the laboratory rotating plasma systems producing an effective magnetization [1].

Due to the spectral domain formulation, the QLCA equations can be highly limited in treating the nonlinear excitations in the strongly coupled quasi-localized media. However, in the latter part of the thesis, these limitations are overcome by applying the equations in the spatiotemporal domain, making it easier to use them for treating the nonlinear collective perturbations [3, 4]. This has prompted theoretical advancements in understanding the properties and interactions of nonlinear lattice waves. The nonlinear QLCA model is introduced to study the effects of dust localization on nonlinear coherent structures in slowly rotating or non-rotating dust media. We have identified some of these unresolved issues which could be addressed in future works.

1. ***Prince Kumar*** *and Devendra Sharma*, *Phys. Plasmas 28, 083704 (2021)*
2. ***Prince Kumar*** *and Devendra Sharma, Phys. Plasmas 27, 063703 (2020)*
3. ***Prince Kumar*** *and Devendra Sharma, Phys. Plasmas 30, 033702 (2023)*
4. *Sandip Dalui,,* ***Prince Kumar****, and Devendra Sharma,* Physica Scripta *98.2 (2023): 025606.*