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A Fluid Dynamic Study of Coulomb Acoustic Mode in High Density Dusty Plasmas

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Low frequency acoustic modes are well studied in dusty plasmas characterized by Havnes Paramater, P << 1 and are known as Dust Acoustic Waves (DAW). In such dusty plasmas with low dust density or P << 1, the dust charges are screened by the standard Debye shielding mechanism. However, in high dust density regimes (P > 1) such as in nano-dusty plasmas, a new kind of screening mechanism, called "Coulomb screening" becomes prevalent [1], which give rise to several interesting phenomena such as charge reduction on each dust grain. This Coulomb screening has a profound effect on the properties of acoustic modes and thus gives rise to a novel acoustic mode in dusty plasmas, which we refer to as "Coulomb Acoustic waves"[1].

Using BOUT++ framework [2], we perform numerical experiments to investigate the Coulomb Acoustic waves in high density regime of dusty plasmas [4]. For that purpose, we define an electrostatic pressure in our fluid model to capture the Coulomb screening. To benchmark our fluid code, we obtain phase velocities of DAW over a range of dust density values, which are found inline with the expected theoretical values [1] for both low as well as high dust density regimes. Figure 1 represents the density vs phase velocity curve for isothermal DAW, where the red solid line represents theoretical values and blue points represent our simulation results for system size L = 1.

In present study, we study various properties of Coulomb acoustic waves for example, the fate of such acoustic waves under various non-linear effects [3]. Furthermore, the fate of coherent structures will also be explored in Coulomb screening regime of dusty plasmas [4], the details of which will be presented.

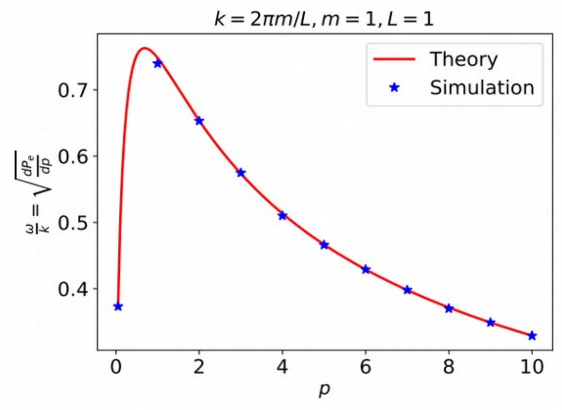

Figure 1: Phase velocity for a range of normalized dust density values obtained from our fluid simulations performed using BOUT++ framework, where P_e represents electrostatic pressure and p represents normalized dust density.

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