Abstract

An important characteristic of strongly coupled dusty plasma, from the view point of collective modes excitation, is its ability to support transverse shear like modes, which are considered to be the features supported by solid media only. An understanding into the characteristics of excitation, destabilization of these modes, linear and nonlinear coupling with acoustic modes etc., in presence of various inhomogeneities, is therefore extremely important in such media. The present thesis attempts to study these features by placing it in proper perspective among other collective phenomena which are considered to be important for opening new frontiers in applied physics, modern technology, plasma processing and fusion plasmas. We elucidate a detailed analytical and numerical analysis about the stability characteristics for a class of strongly coupled dust fluid in presence of shear flow, both in Newtonian and non-Newtonian limits. The thesis highlights linear and nonlinear coupling between dust acoustic and shear mode in presence of shear flow under micro-gravity conditions. The description of the dust fluid has been made through Generalized Hydrodynamic (GH) model where strong correlation between dust grains develops on account of relaxation effects and characterized by the Maxwell relaxation time parameter. Firstly, in a Newtonian, compressible dust fluid, we found dust acoustic mode gets unstable due to shear flow only in strongly coupled limit. Secondly, in presence of vorticity fluctuations, we found acoustic and shear mode get coupled through velocity shear, which not only couples them but also drives the coupled mode to be unstable. Next, we found viscosity gradient has a modulating effect on this...
coupled mode’s instability. Thereafter, we found that these two modes also get coupled nonlinearly even in a homogeneous plasma. In connection with non-Newtonian characteristics of dust fluid, we have found that viscosity gradient leads to a novel shear driven instability in an incompressible weakly correlated dusty plasma. Inclusion of gravity triggers Rayleigh-Taylor (RT) like instability and we found that non-Newtonian characteristics of dust fluid have stabilizing effect in weakly coupled regime. Thereafter, we also found that RT modes get completely suppressed in shorter wavelength regime for a strongly correlated dust fluid.