Collective Behavior of strongly coupled dusty plasma

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The behavior of strongly coupled state of matter is a frontier research topic in physics. The dusty plasma medium can play a very important role in the understanding of the behavior of such a medium. Unlike other strongly coupled states of matter the dusty plasma does not require extreme conditions to be in the strong coupling regime. Furthermore, its dynamical response is within the perceptible grasp of human senses and hence no sophisticated diagnostics are required. The description of strongly coupled state of dusty plasma has often been provided by a phenomenological visco – elastic Generalized Hydrodynamic (GHD) [1] fluid models. The GHD model has successfully captured the behavior of normal modes such as dust acoustic and transverse shear modes, observed experimentally.

The paper employs the GHD model to illustrate certain other aspects of the collective behavior. For instance, it is shown that in 1-D the strongly coupled state of dusty plasma does not permit smooth Solitonic structures. Instead singular solutions are supported by the medium. In higher dimensions the growth rate of fluid instabilities such as Rayleigh Taylor and Kelvin Helmholtz are suppressed. The existence of a local elastic instability is shown which is responsible for driving turbulence even at low Reynold's number (a characteristic feature of the elastic instability). The nonlinear stage shows better mixing and transport properties. Some of the observations are reproduced by the MD (Molecular Dynamics) simulations treating the dusty plasma medium as a collection of particles interacting with Yukawa potential.

Within the GHD paradigm the dusty plasma medium takes the dual role of the fluid medium which itself is responsible for its visco – elastic properties. There can, however, be complementary parameter regimes wherein the addition of dust grains acts like elastic polymers against the background ion and electron fluid system. The Oldroyd B model [2] for the additive polymers in a fluid medium has been suitably adopted for this purpose.

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[2] S. Berti and G. Boffetta, Phys. Rev. E, **82(3)**, 036314 (2010)