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Viscoelastic and compressibility effects on single and multiple coherent structures in a strongly coupled dusty plasma

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Viscoelastic medium shows both viscous (fluid-like) and elastic (solid-like) properties. Dusty or complex plasma is an important example which behaves like viscoelastic medium with low density. When micron or sub-micron sized dust grains embedded in a traditional plasma, each dust particle acquires a highly negative charge ~10^3 e–10^4 e, where e is the absolute electronic charge because of high mobility of electrons [1]. Various properties of such medium, such as phase transition, transport, fluid instability, shear wave generation, emergence of inertial wave have been addressed [2, 3].

Strongly coupled dusty plasma can often be treated as a viscoelastic fluid that retains its memory and modelled by the generalised hydrodynamics model [4, 5]. In the present work, the effect of viscoelasticity and compressibility over a localized (or single) vortex structure and multiple rotational vortices [6, 7] in a strongly coupled viscoelastic dusty plasma medium have been studied [8]. A transverse wave is generated from the localized vortex source and the evolution time of generated waves is found to be reduced due to finite viscoelasticity and compressibility of the medium [see Figure]. We study the effect of viscoelasticity over such vortex.

In the presence of small memory, we observe Kelvin waves grow nonlinearly generating a “V” state. Then the perturbation grows and generates filamentation in the form of extended “fingers” from the patch vortex. In case of large memory, the transverse waves generated from point-like vortices form consecutive ring-like structures outside the point vortex. As time evolves, the structures propagate in radius and followed by other rings of smaller radii [8].

In this study, spatio-temporal evolution of coherent structures, vortex merger process, low and strong memory effects, role of compressibility via increasing Mach number will also be presented.

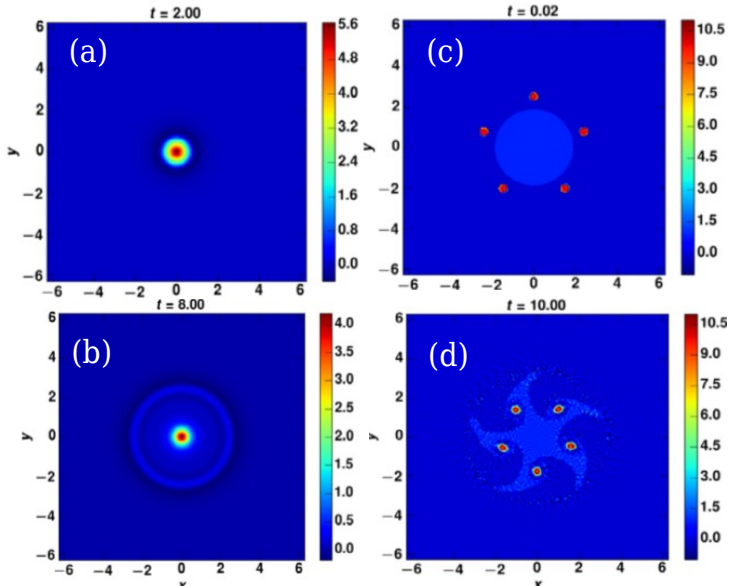

Figure: Left panel (a, b)- Generation of shear wave from Gaussian vortex source- Right panel (c, d)- Vortex merger in the presence of multiple vortex

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