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Velocity shear effect on Jeans instability in a viscoelastic fluid. (English) Zbl 1480.76056

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Summary: The effect of velocity shear on Jeans instability is investigated using generalized hydrodynamic equations. The main feature of generalized hydrodynamic equation is the viscoelastic behavior. It is found that in the hydrodynamic regime ($\omega\tau_m \ll 1$, where τ_m is the viscoelastic relaxation time and ω^{-1} is the typical time scale of wave which we consider here), in absence of velocity shear Jeans instability exponentially grows. However, finite velocity shear turns the instability to oscillation with finite amplitude. The instability/oscillation is completely suppressed for small but finite value of viscosity. In the kinetic regime ($\omega\tau_m \gg 1$), viscosity plays the role of wave source instead of dissipating agent. The velocity shear coupling of this wave source reduces the amplitude of oscillations similar to the hydrodynamic regime. Apart from these two extreme regimes we have also solved the general equation in the intermediate regime where $\omega\tau_m \sim 1$. Since wave source and dissipation due to viscosity both are operative in this regime, velocity shear coupling becomes more effective to mitigate the Jeans instability. Such characteristics may exhibit themselves in a dense molecular cloud of interstellar medium.

MSC:

76E20 Stability and instability of geophysical and astrophysical flows
76A10 Viscoelastic fluids
85A30 Hydrodynamic and hydromagnetic problems in astronomy and astrophysics

Keywords:

Jeans instability; velocity shear; viscoelastic fluid model; oscillatory instability; viscosity effect

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