Effects of the density and velocity gradients on the combination of Kelvin-Helmholtz and Rayleigh-Taylor instabilities

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Abstract

Explicit analytic formula of the linear growth rate and the frequency is derived for the combination of Kelvin-Helmholtz (KH) and Rayleigh-Taylor (RT) instabilities in fluids with continuous density and velocity profiles. It is found that the density gradient effect stabilizes the RT instability (RTI), especially for the short perturbation wavelength, while destabilizes KH instability (KHI), and the velocity gradient effect stabilizes the KH instability. The frequency of the KH instability is reduced by both the density and velocity gradients. In most cases, the integrated effect of the density and velocity gradients stabilizes the linear growth rate of the KH instability. The combination of KH and RT instabilities with continuous density and velocity profiles is analyzed according to the analytic linear growth rate formula. For the fixed acceleration and the equal scale length of the density and velocity gradients, the integrated linear growth decreases with the increased gradient scale length. On the contrary, it increases with the acceleration for the fixed scale lengths of the density and velocity gradients. Competition between the growths of the RTI and KHI plays an important role in the evolution of nonlinear RTI and material mixture driven by the RTI.

Reference:

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