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磁化プラズマにおけるRayleigh-Taylor/Kelvin-Helmholtz不安定性に対する微視的効果の線形固有モード解析

Eigenmode analysis of small scale effects on MHD Rayleigh-Taylor/Kelvin-Helmholtz instability in magnetized plasmas

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For magnetohydrodynamic (MHD) instabilities, small scale effects like two-fluid and ion finite Larmor radius (FLR) effects may not be neglected if the wave number is large or if the scale length of equilibrium profile is small. It is known that the short wavelength modes of Rayleigh-Taylor (RT), or interchange, type instability are stabilized by these effects [1,2]. The RT instability in the presence of sheared flow is found in laboratory, space and astrophysical plasmas. The flow shear modifies the mode structure and stability criteria. Sheared flow itself can cause the so-called Kelvin-Helmholtz (KH) instability. The KH instability is also affected by the smalle scale effects when the scale length of the shear layer is small [3,4]. In this study, the small scale effects on the co-existing KH and RT instabilities are investigated by means of the linear eigenmode analysis based on the extended MHD model. The extended MHD model used in this study includes two-fluid and ion FLR effects. The two-fluid effects are introduced into the generalized Ohm's law as the Hall current and electron pressure while the ion FLR effects appears as the gyroviscosity in the equation of motion. We consider sheared flow and density gradient along the gravity perpendicular to an equilibrium magnetic field in a slab. The gravity is to model the curvature effects in a toroidal plasma. The eigenmode equations are solved numerically for smooth profiles of flow and density in finite-beta, non-isothermal plasmas with electromagnetic perturbations. These conditions are more realistic than simple models that can be studied analytically and directly compared with simulation results. The equilibrium profiles are given from the radial force balance. The two-fluid and ion FLR effects modify the equilibria as well as the stability. The dependence of the growth rate on the wave number for different values of parameters is examined to clarify those effects.

Figure 1 is a preliminary result of the eigenmode analysis of the ion FLR effects on the RT instability. The growth rate increases with the increase of the wavenumber for the small wavenumber for the both cases with and without gyroviscosity but decreases due to the gyroviscosity for large wavenumber. We will show the detailed results of the eigenmode analysis of small scale effects on the RT and KH instabilities in the poster presentation.

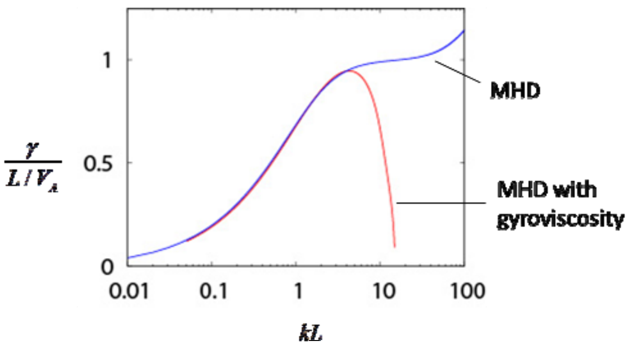

Fig1. The growth rates of the RT instability as functions of the wavenumber for MHD with and without gyroviscosity.

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