

§19. Effects of the Current Density on the Ion Temperature Gradient Modes

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The Instabilities in plasma, including the ITG mode, should be affected by the current density. Although many physics of the ITG mode have widely studied, the dependence of ITG mode stability on the current density parameter is still poorly understood. Furthermore, the current density or safety factor can be controlled by some experimental techniques, such as the neutral beam injection. Thus, it is necessary as well as meaningful to study the dependence of ITG mode stability on the current density or safety factor. To study the effect of current density or safety factor on the ITG modes, a local fluid model for the ITG instability is derived from the Braginskii MHD equations, including the parametric dependence on the parallel current. It is generally held that the profile of current density or safety factor, such as reversed magnetic shear, has an important role in forming electron thermal transport barrier. For simplicity, however, the local fluid approximation without magnetic shear is employed. In addition, the circular geometry is considered. Different from the two-point correlation equations, Braginskii MHD equations can not include the $E \times B$ shearing rate, nor yet in the present model. Nevertheless, it is expected that the present results based on MHD fluid theory still provide both

qualitative understanding and useful physical picture of the ITG mode's parametric dependence on the parallel current or safety factor.

In contrast to the finite Larmor radius effect, the current density effect suppresses the ITG mode with small wavenumber k_{\perp} as well as large wavenumber k_{\parallel} . In addition, the effect of the safety factor q or J_{\parallel} on the critical stability thresholds for the ITG mode are studied. For the present model, the parameter $\eta_i = d \ln T_i / d \ln n$ has the two critical values, which are determined by the growth rate $\gamma = 0$. For the typical parameter ranges of tokamaks, one critical stable condition can be realized when the parameter ϵ_n is large enough. However, the other stable region can be reached only when the safety factor is very large. Qualitatively, the present results are in agreement with the experimental observations on the MHD instabilities and in ion core transport barrier.

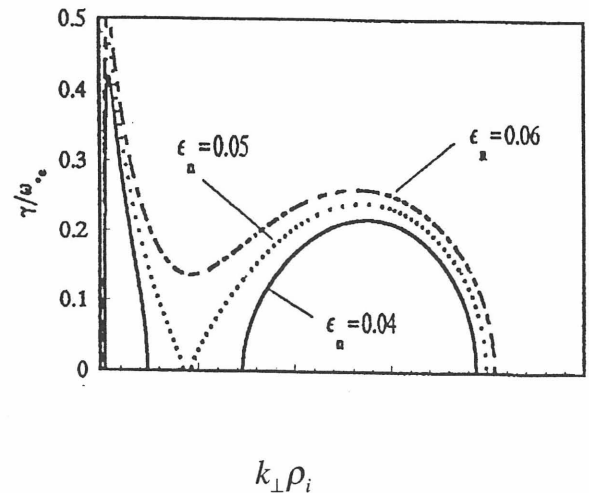


Fig. 1 Normalized growth rate versus $k_{\perp}\rho_i$ for different ϵ_n when $q = 1.5$. a) $\epsilon_n = 0.04$ (solid), b) 0.05(dotted) and c) 0.06(dashed).