§ 21. Effects of Current Density on Ion Temperature Gradient Modes

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The ion thermal transport in tokamaks is generally anomalous, i.e. the ion thermal diffusivity is much greater than that predicted by the neoclassical theory. Among various instabilities, many experimental results are in favor of the ion temperature gradient driven (ITG) modes as a plausible candidate responsible for such an anomaly. Moreover, it is found that, in both high confinement (H) and very high confinement (VH) discharge modes the anomalous ion thermal transport remarkably reduces. In particular, the ion thermal transport barrier is observed in many tokamak discharges with reversed magnetic shear, where the ion thermal diffusivity falls below or at the neoclassical value. It is a widely accepted viewpoint that the confinement improvement in the ion thermal transport channel is mainly due to the suppression of ITG instabilities. However, in order to clarify the concrete roles of the ITG modes, the knowledge of ITG modes is still required. Hence, for many years the dependence of ITG mode stability on the various kinds of parameters has been studied by many authors, using the fluid and kinetic models in slab and toroidal geometries.

In the present study, a model for the ITG driven instability is derived from the Braginskii magnetohydrodynamic equations of ions. The heat flow of electrons carried by the current density in collision dominant plasmas is introduced into the model. It is found that, in contrast to the finite Larmor radius effect, the current density suppresses the ITG instabilities with small wavenumber $k_\perp$ as well as large wavenumber $k_{//}$. In addition, the current density effect on the critical stability thresholds for the ITG modes is studied. In Fig.1, we show the normalized growth rate γ/ω_{*e} versus $k_\perp \rho_e$. Long wavelength instabilities in the $k_\perp$ spectrum are suppressed by the q or current density effect and short wavelength instabilities are suppressed by the finite Larmor radius effect.

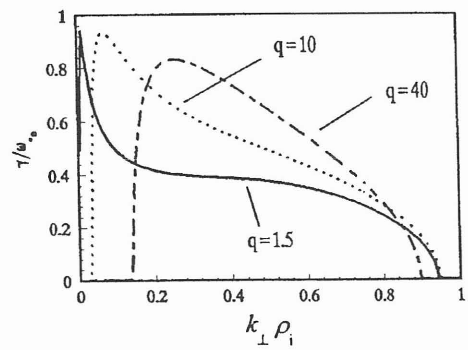

Fig. 1. γ/ω_{*e} *versus* $k_\perp \rho_i$ *for* $q=1.5$, *10, and 40 when* $k_{//}\rho_i = 0.001$, $\varepsilon_n = 0.2$, $\tau = 1, \varepsilon = 0.2$, $\eta_e = 0$, *and* $\eta_i = 1.5$.

References

1) A. K. Wang, J. Q. Dong, H. Sanuki and K. Itoh, IAEA, TH/P1-20 (2002).

2) A. K. Wang, J. Q. Dong, H. Sanuki and K. Itoh, to be published in Nuclear Fusion.