§25. Short Wavelength Electron Temperature Gradient Instability in Toroidal Plasmas

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Short wavelength microinstabilities with a characteristic perpendicular wavelength of the order of electron Larmor radius are much less studied than its ion counterpart since it was believed that turbulence driven by such small size microinstabilities would not be able to drive a large transport. However, nonlinear gyrokinetic simulation has shown that the turbulence driven by electron temperature gradient (ETG) instabilities can yield a large electron heat flux through radially highly elongated vortices, so called “streamers”. Experimental evidence also shows that the anomalous electron transport is governed by short wavelength turbulence with $k_{\perp}\rho_i > 1$ after the suppression of long wavelength turbulence.

The electron temperature gradient (ETG) driven mode in the very short wavelength region with $k_{\perp}\rho_i > 1$ is identified with a gyrokinetic integral equation code in toroidal plasmas. The curvature and magnetic gradient drifts, the transit effect, and finite Larmor radius effect are retained in the model for both

electrons and ions. The ballooning representation for an axisymmetric toroidal geometry with circular flux surface is employed.

Fig.1 Normalized growth rate (a) and frequency (b) vs. $k_{\perp}\rho_e$ for $\eta_e = 2.5, 2.0$ and 1.5 , respectively.

In Fig.1, this double humped growth rate of the conventional ETG and short wavelength ETG modes is attributed to the toroidal drift resonance mechanism and the nonmonotonic behavior of normalized frequency as the poloidal wavelength varies. This instability provides a possibility existence of a kind of turbulence source with very small size of cells. The wavelength of SWETG mode is too short and induced transport may be small unless the inverse cascade effect.

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