§13. Nonlocal Stability Analysis of Microinstabilities —Integral Eigenmode Equation Formalism—

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Analytical methods such as WKB method associated with both differential equation and integral equation in wave number space (k-space) and numerical analysis with gyrokinetic integral equation are reviewed in the 5th APFA Conference in Jedu island in Korea. In the last year's report, we briefly surveyed the discussions associated with WKB analysis in different two approaches on the basis of the differential equation and the integral equation in k-space.

Much of the success in the classification and understanding of microinstabilities has come from local theories where an expansion is made in a small parameter such as ion Larmor radius normalized to density scale length. With higher density and higher temperature plasmas, however, the ion Larmor radius is no longer a small fraction of the density scale length. Finite plasma size with strong inhomogeneity also introduces boundary conditions, which affect the eigenvalues and eigenfunctions, which are allowable. In these strong inhomogeneous plasmas, a complicated stability characteristic is found, with the fundamental radial eigenmode not always the unstable mode. Also, the growth rate is not always small compared with the real part of the frequency. A systematic approach to these problems is based on numerical integration of integral equations. Although extensive work has been done on conventional temperature gradient (ITG and ETG) modes, the ITG and ETG modes in the short wavelength region (so called SWITG and SWETG, respectively) have not been investigated in detail. To study these topics, the ballooning representation for an axisymmetric toroidal geometry with circular flux surface is employed. Also, the $s-\alpha$ equilibrium model is applied. The magnetic curvature, gradient drift, transit effect and finite Larmor radius effect are all retained. Since we consider the dynamics of low frequency electromagnetic perturbation in low beta plasmas, we employ the following coupled equations, namely, Poisson's equation, the parallel component of Ampere's law and the gyrokinetic equation in ballooning space. Finally, we obtained coupled integral eigenmode equation for ϕ, $A_{//}$. These coupled equation are solved numerically with the gyrokinetic integral equation code HD7.

References

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