§14. Electromagnetic Rippling Mode in Tokamak Edge Regions

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Dissipative mechanisms usually cause damping of the perturbations. However in the presence of free energy sources like inhomogeneities and currents, perturbations may become unstable even in a collisional plasma. More than three decades ago [1] , electrostatic rippling instability was studied first time in a current-carrying resistive plasma with temperature gradient. The purely growing rippling mode requires both the parallel and perpendicular wave vectors. Therefore, in a high temperature fusion plasma (> keV), it is considered that such perturbations are not important because the parallel electron thermal conduction tends to equalize the temperature and so the mode is stabilized.

However, in the edge regions, the stabilization by thermal conduction is not so large. The experimental observations of fluctuations and energy transport near the tokamak edge regions invoked the linear and nonlinear study of rippling mode and it's coupling with drift waves in sheared magnetic field [2-3].

These investigations about rippling mode have been limited to the electrostatic case only. However many experimental observations have shown the existence of low frequency electromagnetic fluctuations in the plasma edge regions. These experimental observations invoke considerable interest in an electromagnetic analysis of the rippling mode.

In the present work we have studied the electromagnetic perturbation in a current-carrying resistive plasma which can become unstable in a certain parameter regime. The dispersion relation shows that the electrostatic drift rippling mode can couple with Alfven waves in current carrying resistive plasmas (Solution 1 in Fig. 1). It is important to note that a purely growing electrostatic resistive mode can become an oscillatory instability due to the presence of pressure perturbations. The recent experiments on tokamak discharges have observed significant level of magnetic fluctuations in the edge region. Therefore we expect that the purely growing electrostatic rippling mode can turn out to be an oscillatory electromagnetic instability for relatively shorter wavelengths.

The dispersion relation also shows that the shear Alfven waves are highly damped in the low temperature edge region, even in the presence of temperature gradient and external current (Solution 2 and 3).

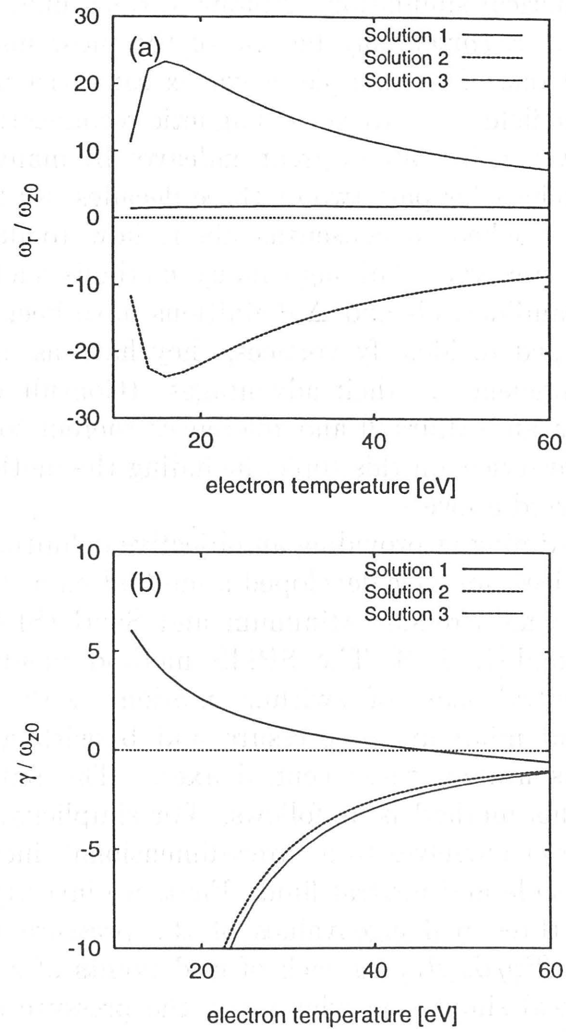

Fig. 1 : Three solutions of the dispersion relation as a function of electron temperature; (a) real frequency and (b) growth rate.

REFERENCES

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