Turbulence suppression and transition phenomena in Tokamak plasmas

M Romanelli[1], A. Thyagaraja[1], C. Bourdelle[2], C. Roach[1], F. Crisanti[3]

[1]EURATOM/UKAEA, Culham Science Centre, Abingdon, Oxon UK, OX14 3DB
[2]Association EURATOM-CEA, CEA Cadarache, 13108 Saint Paul lez Durance, France
[3]ENEA Associazione Euratom, V E. Fermi 45, 00044, Frascati, Italy

Transition phenomena in Tokamak plasmas, such as the formation of transport barriers, are often thought to be triggered and sustained by local suppression of the turbulence. In this paper we analyse the relevance of three physics mechanisms that lead to suppression of trapped electron mode (TEM) and Ion temperature Gradient mode (ITG) turbulence in JET-like plasmas: 1) steep density gradients in collisional plasmas, 2) the presence of a high beta fast ion population, and 3) the interaction of micro turbulence with tearing modes and other MHD instabilities.

The linear stability of dissipative drift electrostatic modes has been studied numerically with an extended version of the gyrokinetic code Kinezero including a modified Krook collision operator to account for collisional effects on the trapped electron response. Further the critical density and temperature gradients for ion gradient driven modes and trapped electron modes have been computed for different values of collisionality. It is found that for JET-like plasma parameters an increase of density gradient destabilizes the TEM and cannot be invoked as a mechanism that sustains the barrier. The role of fast particles on the linear stability of ITG and TEM has been investigated by carrying out a microstability analysis of JET discharge #59137 and accounting for the effect a Maxwellian population of supra thermal ions.

Finally, the interaction of fluid ITG and tearing modes has been investigated using a two fluid global nonlinear electromagnetic code (CUTIE) evolving plasma fields on spatial scales ranging from the ion Larmor radius up to the machine size: For JET-like conditions large scale tearing modes near resonant magnetic surfaces stabilize the small scale fluctuations and lead to the formation and sustainment of steep temperature and density gradients.

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