Seminar

Institute for Plasma Research

Title : Non-inductive current drive by ETG turbulence in tokamaks and cylindrical devices

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Date : 19th December 2016 (Monday)

Time : 03.00 PM

Venue : Seminar Hall, IPR

Abstract:

Motivated by the observations and physics understanding of the phenomenon of intrinsic rotation doubts were raised on the existence of intrinsic current in tokamaks. We investigated the possibility of non-inductive intrinsic current in sheared magnetic field geometry of tokamak and in shear-less straight field line geometry of cylindrical devices like LVPD. Ohm's law is generalized to include the effect of turbulent fluctuations in mean field approach. This clearly leads to the identification of sources and the mechanisms of non-inductive current drive by ETG turbulence.

It is found that in tokamak a mean parallel electro motive force (emf) and hence a mean parallel current can be generated by 1) the divergence of residual current flux density and 2) a non-flux like turbulent source from the density and parallel electric field correlations. Both residual flux and the non-flux source requires parallel wavenumber <k_||> symmetry breaking for their survival which can be supplied by various means like mean ExB shear, turbulence intensity gradient etc. It is found that the turbulence driven current is nearly 10% of the bootstrap current and hence can have significant influence on the equilibrium current density profiles and current shear driven modes. Axisymmetric electron scale GAMs are also found to contribute to residual current flux which does not require <k_||> symmetry breaking and hence is very robust.

The parallel wave number asymmetry vanishes when magnetic shear goes to zero and hence the above mechanism does not work in straight equilibrium magnetic field line geometry. Rather it is seen that <k_y k_z> symmetry breaking can produce a residual current density flux. Possible mechanism of such a symmetry breaking is explored. It turns out that a test current shear can asymmetrize the linear growth spectrum and hence the saturated turbulence spectrum in k_y -k_z space. This produces a negative residual current density diffusivity and hence the test current shear can grow, when it overcomes the positive ambient turbulent diffusivity, via modulational instability.