

Nonlinear Interaction and Turbulent Transport in Mixed Scale MHD and ITG Fluctuations

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The physics of multi-scale turbulence in magnetic fusion plasmas has been attracted much attention recently. Different scale fluctuations, such as macro-scale MHD and microscopic ion-scale modes, may interplay each other directly or indirectly through secondarily excited zonal flow, which has been widely recognized as a stationary coherent structure. The spatio-temporal nature of such flow is important in plasma transport. In this work, the nonlinear interaction in mixed resistive kink-tearing mode (RKTm) and ion temperature gradient (ITG) driven turbulence is studied based on a 5-field gyrofluid simulation aiming to understand the underlying physical mechanisms. The spatio-temporal structure of zonal flow and the associated turbulent transport dynamics are discussed based on simulations and modeling analyses. To observe direct nonlinear interaction of multi-scale turbulence, linearly unstable RKTm and ITG modes are chosen to coexist in a sheared slab geometry through adjusting ion temperature gradient and the resistivity [1].

As a result, a robust oscillatory zonal flow with finite frequency in mixed MHD and ITG turbulence is created due to the multi-scale interaction so that the ion heat transport is not efficiently suppressed. This new characteristics is similar to the geodesic acoustic mode (GAM) dynamics in a toroidal plasma, but it is caused by the multi-scale nonlinear interaction. This implies probable degeneration of the favorable role of ITG zonal flows by MHD fluctuations.

[1] J.Q. Li, K. Uzawa, Y. Kishimoto, Y. Kouduki, N. Miyato, 22nd IAEA Fusion Energy Conference, TH/P8-18, Geneva (2008)