Eigenmode characteristics of drift wave instability in the presence of magnetic island in tokamak edge plasmas

S.L.Hu\textsuperscript{1}, J.Q.Li\textsuperscript{2}, H.P.Qu\textsuperscript{1}

\textsuperscript{1}Southwestern Institute of Physics, P. O. Box 432, Chengdu 610041, China
\textsuperscript{2}Graduate School of Energy Science, Kyoto University, Uji, Kyoto 611-0011, Japan

Magnetic islands, which may be excited through MHD instabilities, error fields or resonant magnetic perturbations (RMP), commonly coexist with micro-scale fluctuations in tokamak edge plasmas. Multi-scale multi-mode interaction is of key importance in controlling turbulent transport and improving confinement performance.\textsuperscript{[1]} In this work, we report on the eigenmode characteristics of drift wave fluctuations interacting with a magnetic island in tokamak edge plasmas. To focus on understanding underlying interaction mechanism, the drift wave instability with an embedded static island is simulated numerically based on so-called Hasegawa-Wakatani type turbulence model.

Simulations show that the magnetic island can couple the micro-scale fluctuation not only in the radial but also along the poloidal direction so that the zonal flow can be generated linearly through the mode coupling. The zonal flows tend to be strong as the island width increases. While small island can stabilize the drift wave through the mode coupling, which transfers the free fluctuation energy from the unstable region to the stable and damped region, large island destabilizes the drift wave robustly to form a global structure through producing a separation of rational surface. Interestingly, it is found that the global structure of drift wave in the case with large island width is mainly excited in the region between the X and O points of the magnetic island, as shown in Fig. 1(a). Such feature was analytically predicted for small island width based on kinetic theory.\textsuperscript{[2]} To understand the mechanism, a simulation model with quasi-linear flattening of the equilibrium density profile inside the corresponding island is proposed. The modeling can well reproduces the eigenmode characteristics as compared in Fig.1 (b), showing that the localization of the drift wave fluctuations is determined by the quasi-linearly flattened density profile inside the magnetic island.

![Fig. 1 Contour plots of electrostatic potential.](image)

(a) With magnetic island $w=13.11 \rho_i$

(b) No magnetic island imbedded but assuming a modeled quasi-linear flattening density profile inside the corresponding island.
