Effects of finite-β and plasma current on the reversed shear Alfvén eigenmode

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Global gyrokinetic particle simulations of reversed shear Alfvén eigenmode (RSAE) [1] have been successfully performed and verified using the gyrokinetic toroidal code (GTC) [2]. The damping rates measured from the antenna excitation and from the initial perturbation simulation agree very well. The RSAE excited by fast ions shows an exponential growth. The finite Larmor radius effects of the fast ions are found to significantly reduce the growth rate. With kinetic thermal ions and electron pressure, the mode frequency increases due to the elevation of the Alfvén continuum by the geodesic compressibility. The non-perturbative contributions from the fast ions and kinetic thermal ions modify the mode structure relative to the ideal magnetohydrodynamic (MHD) theory (Fig. 1) due to the breaking of radial symmetry, in qualitative agreement with XHMGC and TAEFL simulations and recent 2D imaging of RSAE mode structure in DIII-D tokamak [3]. It can be analytically calculated that the plasma equilibrium current affects the existence condition of the RSAE. The equilibrium current has been derived in the gyrokinetic formulation and shown to agree with the ideal MHD theory when appropriate approximations made. It has been implemented in the GTC and its effect on the RSAE is being studied. Study of all sorts of nonlinear effects on the RSAE is also in progress. GTC simulations of kinetic ballooning modes will also be reported.

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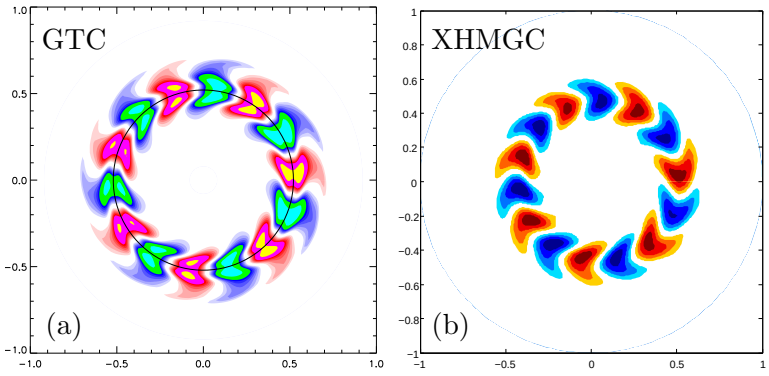

Figure 1: Poloidal contour plots of RSAE $\delta\phi$ from GTC and XHMGC simulations.

[1] W. Deng et al., Physics of Plasmas **17**, 112504 (2010).

[2] Z. Lin, T. S. Hahm, W. W. Lee, W. M. Tang, and R. B. White, Science **281**, 1835 (1998).

[3] B. J. Tobias et al., Phys. Rev. Lett. **106**, 075003 (2011).