Propagation direction of drift-tearing mode in nonlinear regime

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A new type of tearing mode which is called the neoclassical tearing mode (NTM) has been observed in low collisional plasmas even when a tearing mode is classically stable. Recently, propagation direction of the island is pointed out as one of important factors of the NTM growth[1]. However, more accurate analyses are necessary because the conventional models are valid in the limit of cold ions. The ion motion along the magnetic field line is also needed in a consistent treatment. In this research, the propagation direction of the island is investigated in two dimensional slab geometry based on a reduced two fluid model which includes both effects of ion and electron diamagnetic drifts as well as the ion parallel motion[2]. Note that the stability parameter Δ' is positive for only $m = 1$ mode and other modes are linearly stable. Therefore, we discuss the rotation frequency of $m = 1$ mode from now.

Temporal evolutions of island poloidal velocity, the electron diamagnetic velocity, the zonal flow velocity, and the sum of the electron diamagnetic and zonal flow velocities are shown in Fig.1. Note that each velocity is averaged over the flux surface. We found that the pressure is totally flattened and zonal flow is generated inside the island in saturation regime whereas residual pressure is observed in conventional models, indicating the importance of the parallel ion motion in determining the propagation direction precisely. Plotted in Fig.2 are radial structures of zonal flow potential inside the island for two viscosity cases (a) $\nu = 5 \times 10^{-6}$ and (b) $\nu = 3 \times 10^{-5}$. Two different temporal snapshots $t = 250$ (early phase of nonlinear regime) and $t = 550$ (saturation regime) are plotted for each case. The dotted line indicates the separatrix at given time. It is found that the radial mode structure turns over its function form in saturation regime when the viscosity is large.

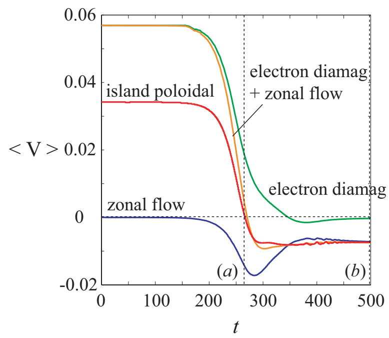

Figure 1: Temporal evolutions of island poloidal velocity and drift velocities. The electric resistivity is $\eta = 10^{-4}$ and the viscosity is $\nu = 5 \times 10^{-6}$.

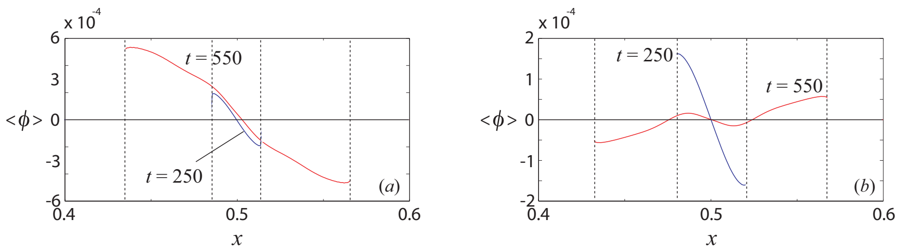

Figure 2: The radial structures of zonal flow potential inside the island for two viscosity cases (a) $\nu = 5 \times 10^{-6}$ and (b) $\nu = 3 \times 10^{-5}$ at different time $t = 250$ and $t = 550$. The electric resistivity is $\eta = 10^{-4}$.

[1] R. Fitzpatrick, and F. L. Waelbroeck, Phys. Plasmas **12** (2005) 022307

[2] R. D. Hazeltine, *et al*, Phys. Fluids 28 (1985) 2466.