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Reduction of bootstrap current contribution to NTM evolution

Feng Wang, Hongpeng Qu,
Southwestern Institute of Physics，China

Magnetic islands caused by tearing instability can lead to confinement degradation in tokamak plasmas. Especially, neoclassical tearing modes (NTMs) driven by the bootstrap current perturbation are very dangerous in tokamak experiments. For this reason, the better understanding of the physics of the bootstrap current contribution to NTMs is important in tokamak research.

In tokamak plasmas, if there is a large magnetic island on the rational surface, the pressure gradient inside the island can be removed and thus the bootstrap current vanishes. This bootstrap current perturbation can drive the NTMs to grow. However, when the island width is small, besides the nonlinear radial diffusion of the electrons that influence the electron bootstrap current distribution, the effects from the ion banana-orbit width or the recovery of the ion pressure gradient can also influence the bootstrap current distribution in the region of the island. These mechanisms can reduce the bootstrap current driving effect on NTM evolution and have been considered in some recent experiments [1]

In present work, we focus our attention on the distribution of the ion pressure and bootstrap current in the region of islands. The work is done by adding the magnetic island structure to a well-known gyro-kinetic particle simulation code GTC. Firstly, the dependence of ion equilibrium bootstrap current on collisionality has been calculated and compared with analytical results as benchmark [2]. Then, the distributions of ion pressure and bootstrap current are investigated in the region of islands with different width. Figures 1 and 2 show that ion pressure gradient is flat and ion bootstrap current vanishes inside the large magnetic islands, which match the analytical expect. But in the case of the small islands, ion pressure gradient and bootstrap current hardly changes compared to equilibrium state. These results verify the empirical anticipation that the bootstrap current driving contribution can be dramatically reduced by the recovery of ion pressure gradient inside the islands.

References

[1] O Sauter, R J Buttery, R Felton, et al, Plasma Phys. Control. Fusion **44,** 1999 ((2002))

[2]F. L. Hinton and R. D. Hazeltine, Rev. Mod. Phys. 48, 239 (1976)

Figure 1 Radial profile of ion pressuret with different size of magnetic island.

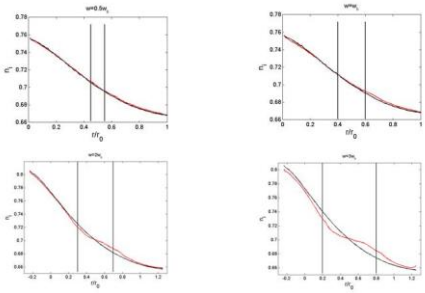

Figure 2 Radial profile of bootstrap current with different size of magnetic island.