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Magnetic islands and neoclassical currents

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Magnetic islands generated by tearing instability can induce anomalous transport and degrade plasma confinement, especially in the tokamak experiments. Although attracting much interest in past decades, some basic physics about the distribution of various electric currents in the region of islands and the island evolution is still under debates.

Here, we discussed the neoclassical polarization current contribution to the neoclassical tearing modes (NTMs) evolution by solving the drift-kinetic equation in a so-called ion-banana-center coordinate system without the past assumption of the large island width. The corresponding results show that, when island width is comparable to finite-banana-width (FBW) of thermal ion, the neoclassical polarization current term in the equation of the island evolution is much smaller than the previously analytical expression, but matches the empirical anticipation with FBW effect included. In other words, our results suggest that the neoclassical polarization current contribution to the evolution of small islands is not strong as previous expectation and maybe insufficient to balance the driving effect from the bootstrap current perturbation. Therefore, we also investigate the bootstrap current distribution in the region of islands analytically and by GTC code. The analytical and simulation results indicate that the contribution from bootstrap current to NTM evolution is not weakened so much by so-called FBW effect. When the island width is small, the pressure gradient is not flattened inside the islands and this can really reduce the bootstrap current contribution to NTMs. These works are helpful to understand the effects of magnetic islands to the distribution of the electric currents and the evolution of the small magnetic islands.