Fast ion effects on the magnetic islands in a tokamak

V. Y. Savin[1, 2], S. V. Konovalov[1]

[1]*National Research Center «Kurchatov institute», Moscow, Russian Federation*

[2]*National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), Moscow, Russian Federation*

It is known that the presence of helical perturbations that violate the axial symmetry of the magnetic field of a tokamak leads to the formation of magnetic islands with a width $\Delta_m \sim \sqrt{\tilde{B}}$, as well as to a change in the drift trajectories of charged particles, coupled with their radial redistribution and/or additional losses. In this case, according to [1], the drift trajectories of fast ions, characterized by a significant deviation from the magnetic surfaces, λ, are more stable to helical perturbations of the magnetic field than magnetic surfaces. In turn, the perturbation of the drift motion of fast ions leads to the appearance of a helical current perturbation capable of both facilitating and preventing the growth of the magnetic island. In the present paper, we consider both the case $\lambda > \Delta_m$ [2], when the helical current perturbation is due to the compensating electron drift, $V_E \sim [\tilde{E} \times \boldsymbol{B}]$, and the inverse, $\lambda < \Delta_m$ [3], when the current perturbation is associated with the oscillations of the longitudinal velocity of fast ions. In the first case, the performed analytical calculations show that the contribution from fast ions to the generalized Rutherford equation for the evolution of the magnetic island width, in contrast to [2], is proportional to the difference $\Delta_h \sim (\omega - \omega_{*h})$, where ω is the island rotation frequency, and ω_{*h} is the drift diamagnetic frequency of the fast ions. Numerical simulations of drift trajectories of the fast ions in the second case demonstrate that, in contrast to [3], the stabilizing (destabilizing) effect of the fast ion beam directed co- (contra-) the plasma current also occurs with a uniform density profile of fast ions.

References:

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