Interaction of Fast Ions with Coupled Kink and Tearing Mode in NSTX

J. Yang, M. Podestà, and E.D. Fredrickson (Princeton Plasma Physics Laboratory)

The interaction of coupled kink and tearing modes with energetic particles is analyzed in NSTX. One aspect of the interaction is the coupled kink and tearing modes causing the fast ion transport [1]. The Kick model [2] is used to simulate the neutron rates considering the fast ion dynamics in the perturbed magnetic fields created by the modes, which is in good agreement with the measurement. A further analysis shows that (a) a transport channel may be formed to transport fast ions in the core to the edge via interaction with the core kink and the off axis tearing modes, and (b) the modes stop growing at the threshold for orbit stochasticization, and (c) there is an energy transfer between energetic particles and the modes. Another aspect of the interaction of the interaction is the fast ions affecting the stability of the coupled kink and tearing modes. The tearing mode stability index Δ' is calculated using the 1-D eigenvalue model, the bootstrap current is calculated using TRANSP [3] NCLASS module [4], and fast ion parameters are calculated using Kick model, to provide the preliminary results of the tearing mode stability analysis using the modified Rutherford equation with the correction for the energetic particles. The results show that by adjusting the coefficients in the modified Rutherford equation, considering the theoretical predictions of the effect of fast ions on the mode stability, it is possible to simulate the island growth in good agreement to the measurement. In the future, the results from both aspects of the interaction will be compared to the M3D-C1 (K) [5] calculations, which is a 3D MHD code that allows the simultaneous consideration of kink and tearing modes.

This manuscript is based upon work supported by the U.S. Department of Energy, Office of Science, and Office of Fusion Energy Sciences, and has been authored by Princeton University under Contract Number DEAC02-09CH11466 with the U.S. Department of Energy.

[1] Yang *et al.*, Plasma Phys. Control. Fusion **63** 045003 (2021).

[2] Podestà *et al.*, Plasma Phys. Control. Fusion **56** 055063 (2014).

[3] TRANSP [computer software] (http://doi.org/10.11578/dc.20180627.4).

[4] Houlberg *et al*., Phys. Plasmas **4** 3230 (1997).

[5] Breslau *et al*., Phys. Plasmas **16** 092503 (2009).