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Suppression and saturation of error field-driven tearing mode for different magnetic shears in rotating plasmas

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Abstract

Boundary error field can drive the growth of the tearing mode (TM) and even cause major disruptions [1]. In the weak magnetic shear configuration, the general TM is weak and unstable with small current gradient driving [2]. In the reversed magnetic shear configuration, the large current gradient may lead to a fast growth or overlap with finite resistivity of the wall [3]. Therefore, how to suppress the driving effect of the error field on the TM for different magnetic configurations is a crucial problem in fusion plasma. In the last several decades, various suppressing mechanisms of the mode had been widely studied.

Effects of the equilibrium plasma flow on the error field-driven tearing mode have been investigated in a two-dimensional resistive magnetohydrodynamics model [4]. It is found that nonlinear suppression of the tearing mode is dominated by the interaction between the magnetic island and the error field rather than the local flow shear on rational surfaces. For a small magnetic shear case, a modest rigid flow can counteract the driving effect of the error field on the mode in the early nonlinear growth stage and transform the error field-driven mode to a general tearing mode. For a large magnetic shear case, after a fast linear growth, the tearing mode will enter a saturated process quickly before the locked mode occurs, and the mode saturation level is reduced due to the magnetic island and error field pushing each other. The threshold flow strength and its scaling analysis for the saturated modes are also given. The results will be useful for the qualitative understanding of the suppression and saturation of error field-driven tearing mode in the experiments. More realistic simulations with respect to the experimental conditions, including the three dimensional response of background plasma on resonant magnetic perturbation and the resistive wall conditions, should be carried out in future for quantitative comparison with the experiments.

References

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