Investigation of the trigger mechanism in the explosive nonlinear growth of the Double Tearing Mode

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Internal Transport Barriers (ITBs) are believed to be a key for the achievement of a better confinement of plasma inside tokamaks. Such ITBs are occasionally formed in a nonmonotonic safety factor q profile, which however leads to MHD instabilities such as the Double Tearing Mode (DTM). In the DTM, two rational surfaces coexist, leading to the formation of magnetic islands on each tearing layers. Depending on the distance between those layers, the DTM behaves either as a Kink mode (1/3 regime) or as a Tearing mode (3/5) [1]. In between those two regimes, it has been previously found that the DTM exhibits a prominent explosive dynamics leading to a full reconnection with an enhanced growth rate [2] [3]. Such a reconnection process has also drawn some attention in astrophysical plasmas as a solution for the explosive dynamics of solar flares [4]. However, a proper explanation for the triggering mechanism leading to the nonlinear abrupt growth has not yet been given.

Here, we investigate such a trigger mechanism based on numerical simulations of the DTM in slab geometry by solving the 2-field reduced MHD equations. It is proposed that the fast growth is due to a secondary instability. We check the evolution of such a new perturbation assuming a quasi-steady state equilibrium, which consists in the developed magnetic islands with flow. It is found that the more deformed the magnetic structure is by the interaction of the two islands on each rational surfaces, the bigger the growth rate of the secondary instability is. Furthermore, we observe that high mode numbers play an important role in the dynamics of the nonlinear growth of the DTM. Future work will include a modulational instability approach to characterize the interaction between the background tearing mode and the new instability.

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