Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

PEM035-P05 Room: Convention Hall Time: May 25 17:15-18:45

A Mechanism of the Nonlinear Destabilization and Explosive Dynamics in the Double Tearing Mode

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Nonlinear phenomena in plasma physics have attracted much attention in the recent decades, since the increase in the power of numerical simulation has given the possibility to understand complex interactions. Among them, the rise of instabilities such as the reconnection of magnetic field lines on the surface of the Sun as well as in fusion plasma is still being under investigation. In the present work, we conducted a systematic study of an MHD instability, the Double Tearing Mode (DTM), for which two magnetic islands that exist on two distinct rational surfaces can interact with each other, giving rise to a new type of phenomenon [1].
In the DTM, a first resistive instability, scaling as a Kink mode or a Tearing mode (depending on the distance between the rational surfaces [2]) leads to the formation of two magnetic islands on each tearing layers. However, if those latter are separated by a distance for which the magnetic islands overlap with each other, the DTM exhibits a prominent explosive dynamics leading to a full reconnection with an enhanced growth rate [3],[4]. By using a numerical MHD model, the destabilization of a secondary instability in the presence of the already formed double magnetic islands is investigated. Two effects can be taken into account: the perturbation of the equilibrium current profile as well as the coupling of radial and poloidal modes. The equilibrium profile can stabilize the dynamics of the nonlinear DTM via flattening, or destabilize it via current corrugations. Radial and poloidal couplings of the other modes are also shown to affect the evolution of the DTM. Finally, analytical approach will be proposed in parallel to the numerical results.

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