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Critical Importance of Nonlinear Processes for the Onset of Internal Modes*

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The large scale dynamics and confinement properties of magnetically plasmas depend intimately on the behavior of macroscopic internal modes. Understanding and predicting the development of these modes into the nonlinear regime is of special importance for the design of meaningful fusion burn experiments that should operate at best close to the marginal stability of the m=1, n=1 MHD ideal mode [1].

This problem is addressed analytically in the simplest relevant framework of resistive low-beta reduced MHD equations. We present a dynamical analysis [2] that takes into account self-consistently the motion of the critical layer, in which the magnetic field reconnects, in order to describe how the m=1, n=1 resistive internal mode [3] develops in the nonlinear regime. The amplitude threshold marking the onset of strong nonlinearities due to a balance between convective and mode coupling terms is identified. We predict quantitatively the early nonlinear growth rate of the m=1, n=1 mode below this threshold. These predictions are in good agreement with the numerical results obtained by A.Y. Aydemir [4]. Most important, this approach should be generally applicable to model the early nonlinear evolution of internal toroidal modes involving more realistic (and complex) MHD sets of equations.

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[1] B. Coppi et al., paper FT/P2-10, 19th IAEA Fusion Energy Conference, Lyon (2002) (Publ. IAEA, Vienna 2002).
[2] M.-C. Firpo and B. Coppi, "Dynamical analysis of the nonlinear growth of the m=1, n=1 resistive internal mode", to appear in *Phys. Rev. Letters* (2003).
[3] B. Coppi, R. Galvão, M. N. Rosenbluth, and P. H. Rutherford, *Sov. J. Plasma Phys.* **2**, 3276 (1976); G. Ara et al., *Ann. Physics* **112**, 443 (1978).
[4] A.Y. Aydemir, *Phys. Rev. Lett.* **78**, 4406 (1997).