A Study of Nonlinear Properties of Tearing Modes

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Abstract

The main tool for this study is a numerical code which treats the plasma as an incompressible fluid of low resistivity and which utilizes simplifying assumptions on geometry. For a given set of ''almost ideal magnetohydrodynamic (MHD) constraints'' [T.H. Jensen, A.W. Leonard, R.J. La Haye, and M.S. Chu, Phys. Fluids B **3**, 1650 (1991)], the code can find equilibria which satisfy these constraints when boundary conditions and external currents are specified. Thus, given an initial MHD equilibrium (without an island), and thereby its constraints, the code can be used to find external currents needed for establishing an equilibrium with the same constraints and an island of specified width. The sign of these external currents determines whether the island would grow or shrink if the external currents were removed. Thus the code can provide information on nonlinear growth or decay, but not on the time scales involved. The two main points of the paper are (i) that the stability limit and saturated island width depend not only on the quantity Δ' [H.P. Furth, J. Killeen, and M.N. Rosenbluth, Phys. Fluids **6**, 459 (1963)] but also on the constraints imposed, and (ii) that a current density gradient at the singular surface can drive a tearing mode nonlinearly to a certain island width followed by a decrease until the island vanishes.