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Comparisons of Predicted Quasi-Static Nonlinear States of Tearing Modes

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The quasi-static state of nonlinearly saturated tearing instabilities is investigated in two theoretical methods, initial value simulations and the method of integral constraints. Integral constraints on the helicity contained within regions of magnetic flux define both the axisymmetric equilibrium state and the nonlinear state of a saturated tearing instability with the imposition of current filaments on the boundary. All time dynamics of the propagation into the saturated state are ignored, and a prediction of the size of the saturated instability is obtained. Results from nonlinear initial value simulations which include all time dynamics, with viscosity and resistivity and various other physics models, are compared to this prediction. The level of conservation of the chosen helicity constraint integrals is studied temporally. The physics governing the distribution of these integral constraints is not well understood but has been shown to be critically important in the prediction of the saturated state. The predicted size of the saturated instability as a function of the linear tearing stability index delta-prime is compared between the two theoretical methods. Additionally the dependence of the saturated state on the magnetic Reynolds number S, and the Prandtl number Pr, are studied for the initial value simulations, and compared to the diffusion free method of integral constraints.

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