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Nonlinear Dynamics of Shear-Localized Interchange Instabilities *

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The Suydam and Mercier criteria define the instability boundary of a toroidally confined plasma for a magnetic-shear-localized ideal MHD pressure-gradient-driven interchange instability. In this work, we present the nonlinear evolution properties of these instabilities when the stability boundary is violated. For studying the nonlinear fate of the shear-localized ideal interchange mode, the nonlinear vorticity equation coupled with the ideal Ohm's law and pressure evolution equation are solved numerically for three scalar quantities, the electrostatic potential, the parallel vector potential and the perturbed pressure. The perturbed quantities are expanded in Fourier modes in y-direction. Then, each Fourier mode is evolved in both x and time where x is the direction of the equilibrium pressure gradient. The numerical results indicate that for these instabilities the magnetic perturbations play a dominant role in the nonlinear saturation. This is in contrast to the effects observed in the usual shear-free ideal interchange instability where the pressure flattening effects cause the nonlinear saturation. A current sheet/layer develops away from the mode rational surface during the nonlinear phase. The current layer moves radially outwards in time and reaches a maximum distance at the location where the radial velocity vanishes. In the region of sharp current gradient, magnetic reconnection occurs and magnetic islands forms. A discussion of the numerical results and their explanation will be presented.

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