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The ideal tearing mode: 2D MHD simulations in the linear and nonlinear regimes

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We present compressible, resistive MHD numerical simulations of the linear and nonlinear evolution of the tearing instability, for both Harris sheet and force-free initial equilibrium configurations. We analyze the behavior of a current sheet with aspect ratio $S^{1/3}$, where S is the Lundquist number. This scaling has been recently recognized to be the threshold for fast reconnection occurring on the ideal Alfvenic timescale, with a maximum growth rate that becomes asymptotically independent on S. Our simulations clearly confirm that the tearing instability maximum growth rate and the full dispersion relation are exactly those predicted by the linear theory, at least for the values of S explored here. In the nonlinear stage, we notice the rapid onset and subsequent coalescence of plasmoids, as observed in previous simulations of the Sweet-Parker reconnection scenario. These findings strongly support the idea that in a fully dynamic regime, as soon as current sheets develop and reach the critical threshold in their aspect ratio of $S^{1/3}$ (occurring well before the Sweet-Parker configuration is able to form), the tearing mode is able to trigger fast reconnection and plasmoids formation on Alfvenic timescales, as required to explain the violent flare activity often observed in solar and astrophysical plasmas.