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Scaling of forced magnetic reconnection in the Hall-MHD Taylor problem

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Two-dimensional, nonlinear Hall-MHD simulations are used to investigate the scaling of the rate of forced magnetic reconnection in the so-called Taylor problem. In this problem, a small amplitude boundary perturbation is suddenly applied to a tearing stable, slab plasma equilibrium; the perturbation being such as to drive magnetic reconnection within the plasma. This type of reconnection, which is not due to an intrinsic plasma instability, is generally known as "forced reconnection". The inclusion of the Hall term in the plasma Ohm's law is found to greatly accelerate the rate of magnetic reconnection. In the linear Hall-MHD regime, the peak reconnection rate is found to scale like $d\Psi/dt \sim d_i\,\eta^{1/3}\,\Xi_0$, where Ψ is the reconnected magnetic flux, d_i the collisionless ion skin-depth, η the resistivity, and Ξ_0 the amplitude of the boundary perturbation. In the nonlinear Hall-MHD regime, the peak reconnection rate is found to scale like $d\Psi/dt \sim d_i^{3/2}\,\Xi_0^2$.