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Exact Time Dependent Solutions of the Magnetic Merging Problem

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Two families of exact time dependent solutions of the driven magnetic reconnection problem are presented. The first family of solutions describes the self-similar merging process and clearly indicates the wave-like nature of the problem. The second family describes merging models in which the magnetic field and flow nulls are allowed to move with time. Both classes of solution extend existing 2D and 3D steady state annihilation and reconnection models into the time dependent regime and show that the energy release estimates based on the steady state models are robust to the inclusion of time dependent effects. The new models also allow a better understanding of the build-up and decay phases of the current sheet evolution. Although the solutions may be of somewhat limited practical application, they do further our understanding of the time dependent merging process and they also provide an excellent suite of test problems for numerical implementations of the MHD equations.