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The Onset of Fast Magnetic Reconnection: A Catastrophe Model
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The Hall MHD model produces rates of reconnection fast enough to explain observations (unattainable with the Sweet-Parker model of resistive MHD). However, there is no accepted mechanism for what triggers the sudden onset of Hall reconnection from a quiescent state. We present a model in which a decrease in the resistivity past a critical value induces a catastrophic transition from the Sweet-Parker to the Hall configuration. The crucial point is that for a wide range of resistivities, both the Sweet-Parker and Hall configurations are valid and stable, but below a critical resistivity, the Sweet-Parker solution no longer exists. This can be shown by a simple scaling analysis and we present the results of two-fluid simulations confirming the theory. The catastrophic transition occurs due to a decrease in the resistivity below the critical value due to external heating (or alternately an increase in the upstream magnetic field strength). The temperature at which this transition would occur in a solar flare is consistent with the known coronal value. The effects of a guide field will also be discussed.

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