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Thermodynamics of the Collisional-Collisionless Phase Transition in Magnetic Reconnection JONATHAN JARA-ALMONTE, HANTAO JI, Princeton Plasma Physics Laboratory — The transition between collisional and collisionless magnetic reconnection is of critical importance in understanding how and when fast magnetic reconnection is triggered. By examining a fully kinetic simulation, it is shown that this transition may be viewed as a second-order thermodynamic phase transition that occurs when the current sheet reaches a critical temperature, $T_c = m_i\Omega_i^2\delta^2/k_B$. At the phase transition, the transport coefficients and thermodynamic properties change character, and critical behavior is identified. The high-temperature ordered phase is described by a non-zero viscous electric field, efficient thermal transport across the separatrix, and entropy production due to thermal mixing. Finally, a model for the thermodynamic collapse of an isolated Sweet-Parker current sheet is derived and it is shown that any isolated current sheet will eventually collapse down to kinetic scales, regardless of initial thickness. Implications for the onset of kinetic reconnection in both single and multi X-line scenarios is discussed.

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