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Nonlinear analysis of explosive growth of collisionless magnetic reconnection in the presence of the effect of finite electron temperature[1]

MAKOTO HIROTA, YUJI HATTORI, Tohoku University — Explosive behavior of collisionless magnetic reconnection is investigated by analyzing a two-fluid model that includes the effects of the electron inertia and the electron temperature (or compressibility). By micrifying both the electron skin depth d_e and the ion-sound gyroradius ρ_s such that $\rho_s = d_e < 0.01L$ (where L is the system size), a direct numerical simulation is performed to enlarge strongly nonlinear regime of a collisionless tearing instability. The nonlinear evolution is shown to be explosive when the inverse of the tearing index $1/\Delta'$ is smaller than $\rho_s = d_e$, whereas the maximum reconnection speed at the fully reconnected state does not significantly depend on the size of $\rho_s = d_e$. The singular current-vortex sheets are generated in the form of the X shape [Cafaro et al. Phys. Rev. Lett 80, 4430 (1998)]. In the explosive phase, the expansion of this X shape as well as the magnetic island occurs locally near the reconnection point. By taking an approach similar to the asymptotic matching, the dynamics of the current-vortex sheets is analyzed and the explosive reconnection speed is estimated theoretically.

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