The Dynamic Harris Current Sheet

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Abstract

Sheets of electric current are interwoven with the magnetic structures of space plasmas and, through their dynamics, regulate the interplay between magnetic and kinetic energy via magnetic reconnection. Harris (1962) has long served as an elegant but elementary description of such current sheets, describing how current flows freely across magnetic fields in collisionless plasmas, owing to gradients in the plasma pressure. Real current sheets are not required to form in Harris equilibrium, but plasma pinch dynamics force sheets to evolve rapidly toward the Harris equilibrium, primarily in thickness but also in shape, with overshoots, oscillations, and bifurcations. Such effects were simulated by Yoon et al. (2021,2023). Their relevance to reconnection was underscored by Moore et al. (2023), and explored by Yoon et al. (2024a and 2024b), a sample of which results are given here. They show that the fluid momentum equation is complementary to the generalized Ohm's law in describing reconnection, which is enabled and enhanced in low beta and low guide field plasma situations. The static Harris current sheet remains of fundamental importance for an introductory understanding of space plasmas, while its dynamic generalization plays an important role in the development of reconnection. This work is being extended to asymmetric cases.

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