Current sheet break-up via fast plasmoid formation in the island coalescence problem in the high Lundquist number regime*

Enabling Predictive Extended MHD Simulations by the Development of Stable, Accurate and Scalable Computational Formulations and Solution Methods

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Abstract

Magnetic reconnection is a fundamental process whereby the sheared magnetic field topology is altered via some dissipation mechanism, resulting in a rapid conversion of magnetic field energy into plasma energy and significant plasma transport. Magnetic reconnection dominated the energetics and dynamics of most space and laboratory plasmas. However, plasmas in all the above-mentioned cases are known to have a negligible resistivity that cannot be used to explain the reconnection time-scales observed. This issue has drawn significant attention over the last 50 years [1]. Recently the break-up of Sweet-Parker current sheets into smaller plasmoids has been the subject of attention as a possible mechanism for fast reconnection in resistive MHD. Various studies, both theoretical [2] and numerical [3,4,5,6], have shown that the fast formation of small structures is not only possible, but in fact unavoidable for large enough Lundquist numbers. In this study, we have used state-of-the-art computational capabilities to perform simulations of the Fadeev island coalescence problem in the high Lundquist number regime to investigate if thin current sheets dynamically formed in this strongly non-uniformly driven problem are prone to break-up by fast plasmoid instabilities. Our numerical simulations confirm that plasmoid break-up of dynamically formed current sheets occur for $S > 10^6$.

References:

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