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Experimental Demonstration of Resistive Electron Plasmoids in a Reconnecting Current Sheet[1]

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Magnetic reconnection is an important process occurring in nearly all magnetized plasmas that involves the complex coupling of multiple physical scales. Significant progress has been made in understanding the cross-scale physics of magnetic reconnection around localized reconnection sites, but how reconnection couples to global physics is still an open question. Recently, the spontaneous formation of plasmoids has been proposed as a mechanism for bridging widely disparate scales, thereby permitting fast reconnection in large systems. Numerous works have demonstrated the existence of collisionless plasmoids in both space and laboratory plasmas, however to-date, direct evidence for collisional plasmoids has been confined to numerical simulations and analytic theory, although remote-sensing observations of solar and fusion plasmas have provided some indirect evidence. However, it is known that many naturally occurring plasmas, such as the solar chromosphere or the interstellar medium, are both large and collisional, thus requiring collisional plasmoids. In part, the current lack of experimental or in situ observational evidence for collisional plasmoids is due to the large Lundquist numbers required for plasmoid formation within the resistive MHD framework. In this work [1], experimental evidence for resistive electron plasmoid formation during magnetic reconnection in the two-fluid regime is given. Using the Magnetic Reconnection Experiment (MRX), driven reconnection is studied in collisional current sheets wherein the electric field is balanced solely by classical Spitzer resistivity. Despite low Lundquist numbers, these collisional current sheets are observed to be unstable to the spontaneous formation of plasmoids, which is explained by the importance of electron physics when in the two-fluid regime. The number of plasmoids is observed to scale with the Lundquist number. Due to the onset of plasmoids, both the local reconnection electric field and the globally normalized reconnection rate are observed to increase above an already fast rate.

References

[1] J. Jara-Almonte *et al.*, submitted to Phys. Rev. Lett.

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