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Anomalous heating and plasmoid formation in pulsed power driven magnetic reconnection experiments[1]

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Magnetic reconnection is an important process occurring in various plasma environments, including high energy density plasmas. In this talk we will present results from a recently developed magnetic reconnection platform driven by the MAGPIE pulsed power generator (1 MA, 250 ns) at Imperial College London [1,2]. In these experiments, supersonic, sub-Alfvénic plasma flows collide, bringing anti-parallel magnetic fields into contact and producing a well-defined, elongated reconnection layer. This layer is long-lasting (>200 ns, > 10 hydrodynamic flow times) and is diagnosed using a suite of high resolution, spatially and temporally resolved diagnostics which include laser interferometry, Thomson scattering and Faraday rotation imaging. We observe significant heating of the electrons and ions inside the reconnection layer, and calculate that the heating must occur on time-scales far faster than can be explained by classical mechanisms. Possible anomalous mechanisms include in-plane electric fields caused by two-fluid effects, and enhanced resistivity and viscosity caused by kinetic turbulence. We also observe the repeated formation of plasmoids in the reconnection layer, which are ejected outwards along the layer at super-Alfvénic velocities. The O-point magnetic field structure of these plasmoids is determined using in situ magnetic probes, and these plasmoids could also play a role in the anomalous heating of the electrons and ions. In addition, we present further modifications to this experimental platform which enable us to study asymmetric reconnection or measure the out-of-plane magnetic field inside the plasmoids.

[1] Suttle, L. G., Hare, J. D., Lebedev, S. V. (2016). Structure of a Magnetic Flux Annihilation Layer Formed by the Collision of Supersonic, Magnetized Plasma Flows. PRL, 116, 225001

[2] Hare, J. D., Suttle, L., Lebedev, S. V. (2017). Anomalous Heating and Plasmoid Formation in a Driven Magnetic Reconnection Experiment. PRL, 118, 85001

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