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Experimental Investigation of the Trigger Problem in Magnetic Reconnection[1]

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Magnetic reconnection is a fundamental process in plasma physics, which involves the often explosive release of magnetically stored energy in both space and laboratory plasmas. In order for this sudden release of energy to occur, there must be a period of slow reconnection, in which magnetic stress accumulates in the system, followed by a quick transition to fast reconnection. The question of what causes this transition is known as the “trigger problem” and is not well understood. We address the trigger problem using the Versatile Toroidal Facility (VTF) at MIT, which we operate in the strong magnetic guide field regime. The resulting reconnection occurs in spontaneous events, in which there is a transition to fast reconnection [1]. The reconnection in these events is asymmetric: it begins at one toroidal location and propagates toroidally in both directions [2]. The spontaneous onset is facilitated by an interaction between the x-line current channel and a global mode, which breaks axisymmetry. We model the onset using an empirical Ohm’s law and current continuity, which is maintained by ion polarization currents associated with the mode. The model reproduces the exponential growth of the reconnection electric field, and the model growth rate agrees well with the experimentally measured growth rate.

[1] J. Egedal et al. Phys. Rev. Lett. 98, 015003 (2007)
[2] N. Katz et al. Phys. Rev. Lett. 104, 255004 (2010)

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