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A quantitative, comprehensive analytical model for "fast" magnetic reconnection in Hall MHD[1]

ANDREI N. SIMAKOV, LANL

Magnetic reconnection in nature usually happens on fast (e.g. dissipation independent) time scales. While such scales have been observed computationally [1], a fundamental analytical model capable of explaining them has been lacking. Here, we propose such a quantitative model for 2D Hall MHD reconnection without a guide field. The model recovers the Sweet-Parker and the electron MHD [2] results in the appropriate limits of the ion inertial length, d_i, and is valid everywhere in between [3]. The model predicts the dissipation region aspect ratio and the reconnection rate E_z in terms of dissipation and inertial parameters, and has been found to be in excellent agreement with non-linear simulations. It confirms a number of long-standing empirical results and resolves several controversies. In particular, we find that both open X-point and elongated dissipation regions allow "fast" reconnection and that E_z depends on d_i. Moreover, when applied to electron-positron plasmas, the model demonstrates that fast dispersive waves are not instrumental for "fast" reconnection [4]. [1] J. Birn *et al.*, *J. Geophys. Res.* **106**, 3715 (2001). [2] L. Chacón, A. N. Simakov, and A. Zocco, *Phys. Rev. Lett.* **99**, 235001 (2007). [3] A. N. Simakov and L. Chacón, submitted to *Phys. Rev. Lett.* [4] L. Chacón, A. N. Simakov, V. Lukin, and A. Zocco, *Phys. Rev. Lett.* **101**, 025003 (2008).

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