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On the collisionless magnetic reconnection rate

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Magnetic reconnection is the process whereby a change in topology of the magnetic field allows for a rapid release of magnetic energy into thermal and kinetic energy of the surrounding plasma. The magnitude of the reconnection electric field parallel to the X-line (where magnetic field lines break) not only determines the rate that reconnection proceeds, but can also be crucial for efficiently accelerating highly energetic super-thermal particles. Observations and numerical simulations reveal that essentially collisionless magnetic reconnection of a Harris-type current sheet in the steady state tends to proceed with a normalized reconnection rate (V_{in}/V_A) of order 0.1, independent of dissipation mechanism or physical model. However, the explanation of this value has remained unclear for decades. We propose a model that provides insight to this longstanding problem. The prediction from this model compares favorably to particle-in-cell simulations of magnetic reconnection in both the non-relativistic and extremely relativistic limits. These results may be important for applications to solar, magnetospheric, fusion, and astrophysical setting.

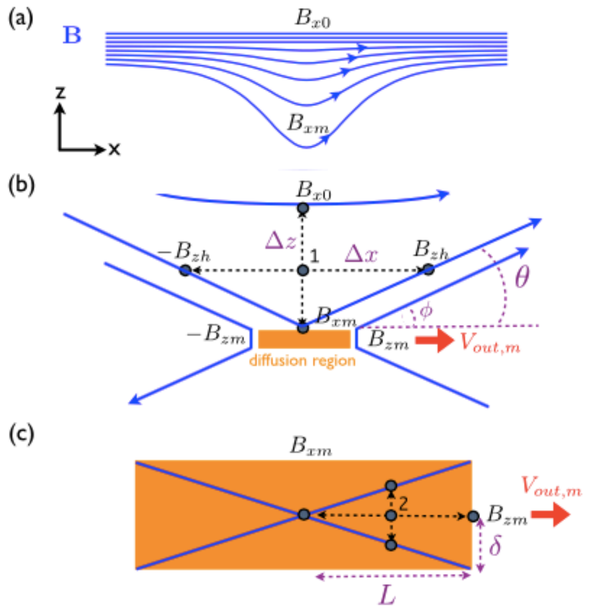

FIG. 1. (a) Sketch of magnetic field lines upstream of the diffusion region ($z > 0$). (b) Geometry of reconnection at the local scale. (c) Dimensions of the diffusion region at the microscale.

References
Yi-Hsin Liu, M. Hesse, F. Guo, W. Daughton, H. Li, P. A. Cassak and M. A. Shay, *Why does steady-state magnetic reconnection have a maximum local rate of order 0.1?*, Phys. Rev. Lett. **118**, 085101 (2017)