DPP12-2012-001556

Abstract for an Invited Paper
for the DPP12 Meeting of
the American Physical Society

Demonstration of Anisotropic Fluid Closure Capturing the Kinetic Structure of Magnetic Reconnection[1]

OBIOMA OHIA, MIT

Magnetic reconnection in collisionless plasmas plays an important role in space and laboratory plasmas. Allowing magnetic stress to be reduced by a rearrangement of magnetic line topology, this process is often accompanied by a large release of magnetic field energy, which can heat the plasma, drive large scale flows, or accelerate particles. Reconnection has been widely studied through fluid models and kinetic simulations. While two-fluid models often reproduce the fast reconnection that is observed in nature and seen in kinetic simulations, it is found that the structure surrounding the electron diffusion region and the electron current layer differ vastly between fluid models and kinetic simulations [1]. Recently, using an adiabatic solution of the Vlasov equation, a new fluid closure has been obtained for electrons that relate parallel and perpendicular pressures to the density and magnetic field [2]. Here we present the results of fluid simulation, developed using the HiFi framework [3], that implements new equations of state for guide-field reconnection. The new fluid closure accurately accounts for the anisotropic electron pressure that builds in the reconnection region due to electric and magnetic trapping of electrons. In contrast to previous fluid models, our fluid simulation reproduces the detailed reconnection region as observed in fully kinetic simulations [4]. We hereby demonstrate that the new fluid closure self-consistently captures all the physics relevant to the structure of the reconnection region, providing a gateway to a renewed and deeper theoretical understanding for reconnection in weakly collisional regimes.

[1] Daughton W et al., Phys. Plasmas 13, 072101 (2006).
[2] Le A et al., Phys. Rev. Lett. 102, 085001 (2009).
[3] Lukin VS, Linton MG, Nonlinear Proc. Geoph. 18, 871 (2011).
[4] Ohia O, et al., Phys. Rev. Lett. In Press (2012).

[1]This work was supported by NASA Grant NNX10AL11G.