SA-I5 AAPPS-DPP2019

3rd Asia-Pacific Conference on Plasma Physics, 4-8,11.2019, Hefei, China

Inverse magnetic energy transfer through magnetic reconnection

Muni Zhou[1], Pallavi Bhat[1], Nuno F. Loureiro[1], and Dmitri A. Uzdensky[2]
[1] Plasma Science and Fusion Center, Massachusetts Institute of Technology
[2] Center for Integrated Plasma Studies, Physics Department, University of Colorado, Boulder
e-mail (speaker): munizhou@mit.edu

The process of how large-scale magnetic fields in the universe are formed is unclear. One possible mechanism is the transfer of magnetic energy from seed fields generated at kinetic scales to system scales. We investigate this inverse transfer of magnetic energy in a system of parallel current filaments (corresponding to flux ropes) as well as more generic magnetically-dominated turbulent systems. A solvable analytical model is introduced and shown to correctly capture the evolution of the main quantities of interest, as borne out by our reduced magnetohydrodynamics (RMHD) and particle-in-cell (PIC) simulations. Magnetic reconnection is identified as the key mechanism enabling the inverse transfer, and setting its properties: magnetic energy decays as $\tilde{t}^{-1}$, where $\tilde{t}$ is time normalized to the (appropriately defined) reconnection timescale; and the correlation length of the field grows as $\tilde{t}^{1/2}$. Evidence of critical balance is shown by the structure functions of magnetic field during the decay of field strength and the growth of coherent length. This quantitative description of the inverse magnetic energy transfer could improve the understanding of longstanding astrophysical problems such as galactic magnetogenesis and high-energy emission in gamma-ray bursts.

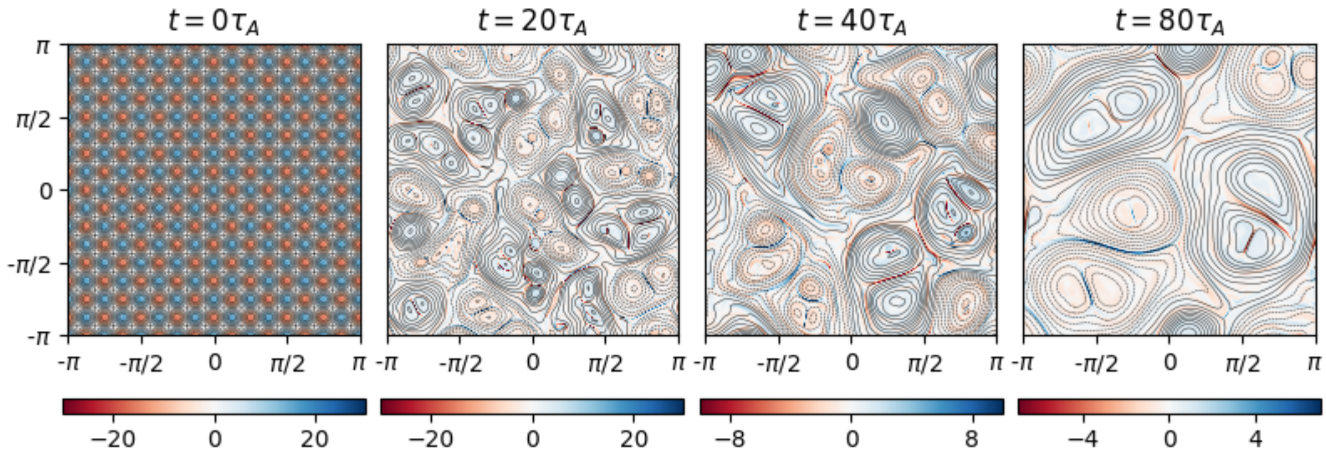

Figure 1: Current density (colors) and magnetic flux (contours) at various times for the two-dimensional RMHD simulation with the Lundquist number of initial magnetic islands S_0=1786.

Reference:
Zhou, M., Bhat, P., Loureiro, N. F., & Uzdensky, D. A. (2019). Magnetic island merger as a mechanism for inverse magnetic energy transfer. *arXiv preprint arXiv:1901.02448*.