Decaying Magnetized Turbulence in the Taylor-Green Vortex*

Forrest W. Glines [a], Philipp Grete [b] and Brian W. O'Shea [a]

(a) Department of Physics and Astronomy and Department of Computational Mathematics, Science and Engineering Michigan State University (glinesfo@msu.edu, oshea@msu.edu)
(b) Department of Physics and Astronomy, Michigan State University (pgrete@pa.msu.edu)

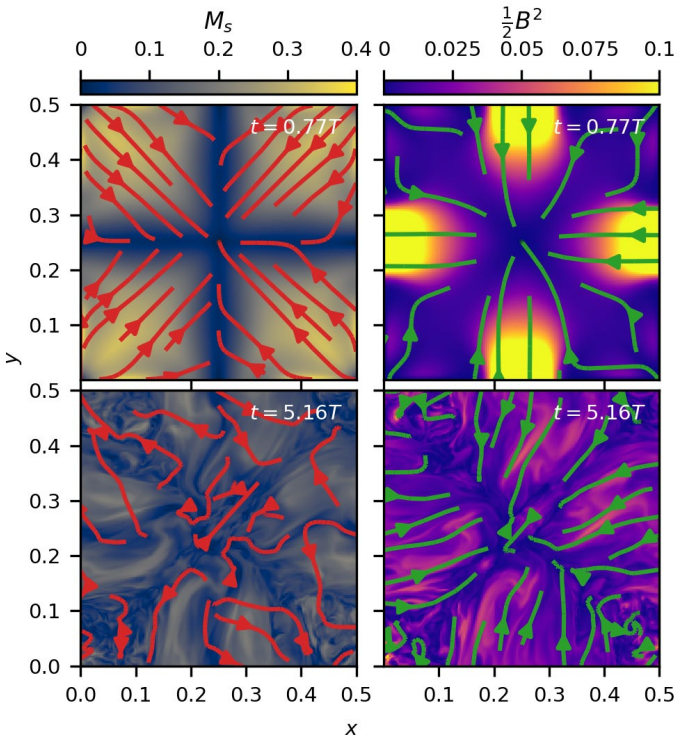

Figure 1 - Mach number with flow direction (*right)* and magnetic energy with magnetic fields (*left*) at early times (*top*) and late times (*bottom*) through a slice in the *xy*-plane of a simulated mangetized Taylor-Green vortex.

Magnetized turbulence in terrestrial and astrophysical plasmas mediates an exchange of magnetic, kinetic, and thermal energies between different length scales. Capturing these energy exchanges is essential for high fidelity numerical plasma simulations. Accurately modeling magnetic turbulence in simulations requires high temporal and spatial resolutions even in idealized systems. For the purpose of studying the formation of magnetized turbulence, we ran high resolution simulations of the magnetized Taylor-Green vortex: a system where magnetized turbulence develops from a decaying flow without an external driving force [1]. We found that regardless of initial field strength, magnetic energy came to dominate over kinetic energy in all cases. Magnetic fields also played a vital role in facilitating energy exchange from large scale kinetic energy to magnetic energy on much smaller scales, which has not been apparent in previous studies on driven magnetized turbulence. This contributed to a flatter magnetic and kinetic energy spectra after evolving for several dynamical times with more energy at smaller length scales. In general, we found magnetic fields to be essential to the behavior of the turbulence.

* Work supported by Blue Waters at the National Center for Scientific Computing and the Michigan Institute for Plasma Science and Engineering.

References

[1] F. W. Glines, P. Grete, and B. W. O'Shea, *submitted to Phys. Rev. E.* (2020) https://arxiv.org/abs/2009.01331