Survival of 2D Turbulence in the Local Interstellar Medium

Science Question:

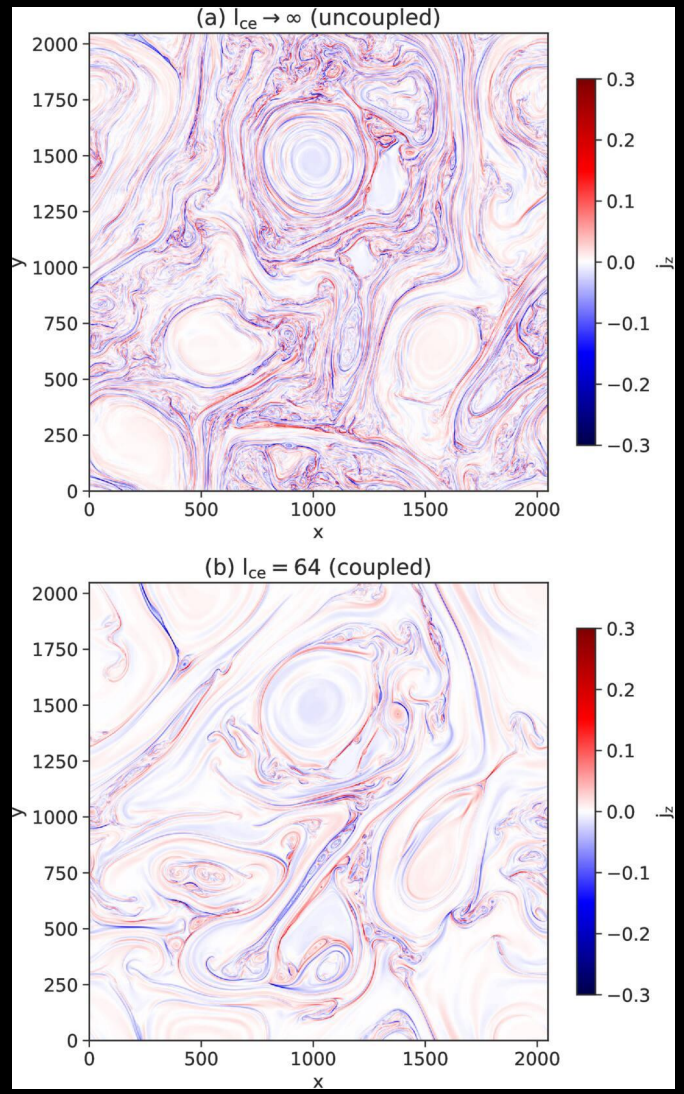
- How does 2D turbulence evolve in the interstellar medium, such as a partially ionized plasma. Is it damped by charge exchange effects as the Alfven mode?

Method:

- 2D MHD simulations coupled with a neutral fluid via charge exchange. Periodic box and spectral method.
- The initial condition is a free decay-type turbulence with uncorrelated velocity and magnetic field fluctuations.
- The background magnetic field is out-of-plane.

Key result:

- The initial velocity fluctuations are damped immediately by the neutral-drag effect, but magnetic fluctuations are not damped.
- There are large and small scale structures in the coupled case. (uncoupled case means a pure MHD turbulence.)
- Fluctuations are cascaded through magnetic reconnection, and the spectral index exhibits -7/3.



Snapshots of the current density, j_z, for (a) the uncoupled and (b) coupled case.

Nakanotani & Zank et al. *ApJL*, [2025]; DOI 10.3847/2041-8213/ae07c3