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Strong magnetohydrodynamic turbulence with cross helicity[1]

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Magnetohydrodynamics (MHD) is invoked to model different turbulent phenomena in magnetized plasmas. For instance, the energy spectrum of velocity and magnetic fluctuations in the solar wind obeys a power law spanning a broad range of scales, which has been associated to an inertial range of incompressible MHD turbulence. In addition to the total energy, ideal MHD equations conserve cross helicity which also undergoes a turbulent cascade to small scales. However, most of the current understanding of MHD turbulence is limited to the zero cross helicity case. Cross helicity quantifies the energy imbalance in Alfvénic fluctuations oppositely moving along the background magnetic field. Although it is well established that turbulence in the solar wind is dominated by fluctuations moving away from the sun, only in recent years there have been an increased interest in addressing the role of cross helicity in MHD turbulence. Moreover, numerical simulations have also revealed the fundamental role that cross helicity plays in the turbulent cascade. In this talk, we present results from high resolution numerical simulations of steady-state incompressible MHD turbulence, with and without cross helicity. We show that in the zero cross helicity case the configuration space spontaneously develops regions of positive and negative cross-helicity. The obtained scaling of the energy spectrum ($E^{\pm}$) of fluctuations moving in opposite directions is consistent with simulations of incompressible MHD *without* cross-helicity by other groups. When cross helicity is injected, E^+ and E^- maintain the same inertial range scaling, but with differing amplitudes depending on the amount of injected cross-helicity. It is argued that in each of these correlated regions of *imbalance*, the scaling of E^+ and E^- is the same. When the total energy spectrum $E^+ + E^-$ is averaged over those regions, the inertial range scaling is the same regardless of the amount of cross helicity in the system.

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