Magnetohydrodynamic Turbulence and Its Application

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Abstract

We perform high resolution numerical simulations of compressible magnetohydrodynamic turbulence and study helical and non-helical free decay in cosmic plasma. We identify the classes of turbulence and corresponding general scaling laws. In the presence of magnetic helicity, inverse transfer from small to large scales is well known in magnetohydrodynamic turbulence and has applications in astrophysics, cosmology, and fusion plasmas. We report a similar inverse transfer even in the absence of magnetic helicity. We compute for the first time spectral energy transfer rates to show that this inverse transfer is about half as strong as with helicity, but in both cases the magnetic gain at large scales results from velocity at similar scales interacting with smaller-scale magnetic fields. This suggests that both inverse transfers are a consequence of universal mechanisms for magnetically dominated turbulence