Geophysical Research Abstracts
Vol. 17, EGU2015-3623, 2015
EGU General Assembly 2015

Total energy cascade and residual energy in MHD turbulence: homogeneous versus expanding (solar wind) turbulence

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Standard phenomenologies of MHD turbulence generally neglect deviations from kinetic-magnetic energies equipartition. However, solar wind turbulence commonly shows a magnetic excess (or positive residual energy) in the inertial range, with a definite power-law. We report here direct MHD simulation results showing a magnetic excess, both in homogeneous and expanding turbulence, with the latter taking into account the radial flow (expanding box model or EBM). We show that the results on magnetic excess, both scaling laws and amplitude, can be interpreted as resulting from the competition between the nonlinear stretching of the magnetic field by the velocity field and the relaxation to equipartition by the linear propagation of Alfvén waves. We generalize in this way earlier results on homogeneous MHD turbulence.