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Statistics and scaling in magnetohydrodynamic turbulence

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The nonlinear cascade of energy is one of the most prominent processes in turbulent systems. The associated self-similarity of two- point statistics leads to the appearance of inertial-range scaling laws, e.g. in the energy spectrum of turbulence. The scaling exponents that are observed in experiments or direct numerical simulations allow to verify the validity of cascade phenomenologies. Currently, controversial findings have led to a confusing situation in the phenomenological understanding of nonlinear inertial-range dynamics of magnetohydrodynamic turbulence which is discussed using recent results of direct numerical simulations. A new approach for investigating turbulent nonlinear dynamics which is based on the Lagrangian description of turbulence is also presented.