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Intermittent Energy Dissipation in Magnetohydrodynamic Turbulence: Applications to the Solar Corona and Solar Wind

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Energy dissipation is highly intermittent in large-scale turbulent plasmas, being localized in space and in time. This intermittency is manifest by the presence of coherent structures such as current (and vorticity) sheets, which account for a large fraction of the overall energy dissipation and may serve as sites for magnetic reconnection and particle acceleration. The statistical analysis of these dissipative structures is a robust and informative methodology for probing the underlying dynamics, both in numerical simulations and in observations. In this talk, the statistical properties of current sheets in numerical simulations of driven magnetohydrodynamic (MHD) turbulence are described, including recent results obtained from applying new methods for characterizing their morphology. Instantaneously, the overall energy dissipation is found to be evenly spread among current sheets spanning a continuum of energy dissipation rates and inertial-range sizes, while their thicknesses are localized deep inside the dissipation range. The temporal dynamics are then investigated by tracking the current sheets in time and considering the statistics of the resulting four-dimensional spatiotemporal structures, which correspond to dissipative events or flares in astrophysical systems. These dissipative events are found to exhibit robust power-law distributions and scaling relations, and are often highly complex, long-lived, and weakly asymmetric in time. Based on the distribution for their dissipated energies, the strongest dissipative events are found to dominate the overall energy dissipation in the system. These results are compared to the observed statistics of solar flares, and some possible implications for the solar wind are also described.