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Local energy transfer rate and kinetic signatures in solar wind turbulence

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The transfer of energy from large to small scales in space turbulence is an important ingredient of the longstanding question about the mechanism of the interplanetary plasma heating. Statistical analysis in the context of magnetohydrodynamic (MHD) turbulence provided evidence that the total transported energy is compatible with the observed heating of the solar wind as it expands in the heliosphere. However, in order to understand which processes contribute to the plasma heating, it is necessary to have a local description of the energy flux across scales. To this aim, we propose a proxy of the scale-dependent, local energy transfer that includes magnetic, velocity and cross-helicity terms, and is based on the third-order moment scaling law for MHD turbulence. Data from Helios 2 are used to determine the statistical properties of such a proxy in comparison with the magnetic and velocity fields PVI, and the correlation with local solar wind heating is pointed out. MMS data are used to study the correlation with kinetic-scale features, as for example the temperature anisotropy, the heat flux, the agyrothropy of the pressure tensor, and the deviation form Maxwellian. A comparison with hybrid direct numerical simulations of the Vlasov-Maxwell system, including alpha particles, is also performed.

The good correlation between the turbulent local energy flux and the indicators of kinetic processes found in the data and in the simulations suggests an important role played by this proxy in the study of plasma energy dissipation.