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Magnetospheric Multiscale Observation of Plasma Velocity-Space Cascade

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Plasma turbulence is investigated using unprecedented high-resolution ion velocity distribution measurements by the Magnetospheric Multiscale mission (MMS) in the Earth's magnetosheath. This novel observation of a highly structured particle distribution suggests a cascadelike process in velocity space, as supported by Vlasov simulations. This complex velocity space structure is investigated using a three-dimensional Hermite transform, revealing, for the first time in observational data, a power-law distribution of moments. In analogy to hydrodynamics, a Kolmogorov approach leads directly to a range of predictions for this phase-space transport. The scaling theory is found to be in agreement with observations. The combined use of state-of-the-art MMS data sets, simulations, novel implementation of a Hermite transform method, and scaling theory of the velocity cascade opens new pathways to the understanding of plasma turbulence and the crucial velocity space features that lead to dissipation in plasmas.

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