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Solar-planetary interactions are fundamentally mediated by a variety of plasma processes that span a wide range of scales. While large scale solar wind structures govern the overall architecture of space weather, small-scale turbulent processes facilitate the transfer and dissipation of energy throughout the heliosphere. Characterizing the dynamics of these small-scale processes is therefore essential to building the predictive framework for understanding solar influence on planetary environments.

This study investigates the behavior of energy dissipation in kinetic-scale solar wind turbulence at 1 AU. Using high resolution magnetic field observations from a single Magnetospheric Multiscale Mission (MMS) spacecraft and a novel implementation of correlation function analysis, we resolve ion dissipation scale fluctuations and quantify its spatial structure. We find that turbulence at these scales exhibits pronounced anisotropies, with compressional fluctuations demonstrating shorter correlation lengths than transverse ones. In addition, we show that anisotropies within transverse fluctuations increase when the interplanetary magnetic field is nearly perpendicular to the solar wind flow and scale as approximately the inverse sine of the cone angle. This behavior indicates a prominently two-dimensional turbulent structure at ion-dissipation scales which provides insight into the nature of fluctuations and energy transfer in the solar wind.

Building on this foundation, we extend the analysis by incorporating simultaneous multipoint measurements from all four MMS spacecraft. By cross-correlating multiple observations across the constellation, we can probe into kinetic scale fluctuations without reliance on Taylor’s hypothesis. This addresses key limitations inherent to single spacecraft studies and enables a more comprehensive characterization of small-scale turbulent structure.
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Solar Infuluence on Earth and Planetary System