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Space plasma turbulence at ion and electron scales: observations in the solar wind and Earth magnetosheath

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The solar wind is the most studied laboratory of space plasma turbulence. Here, at MHD scales, the Kolmogorov's power law $f^{-5/3}$ is observed for Alfvénic fluctuations, which dominate the turbulent spectrum. Above the spectral break in the vicinity of the ion characteristic scales, like ion cyclotron frequency f_{ci} or ion inertial length, or Larmor radius, the spectrum becomes steeper, $\sim f^{-3}$, and the level of compressible fluctuations raises. This range is usually called dissipation range of solar wind turbulence. Using Cluster Search Coil magnetometer data, we show that the statistical properties of the fluctuations above the spectral break (at $f > f_{ci}$) are inherent to an inertial and not to the dissipative range. Naturally, the following question rises: at what scales turbulent energy dissipates? Perhaps at electron scales. To verify this, we analyse the spectral shape of magnetic fluctuations at electron scales using Cluster Spectrum Analyser data (spectra from 8 Hz up to 4 kHz).

The Earth's magnetosheath is another example of magnetic turbulence in space plasmas. Here, the Kolmogorov power law at $f < f_{ci}$ is observed only in the flanks, however, the small scale inertial range, with the same spectrum as in the solar wind $\sim f^{-3}$, is generally observed. We study the anisotropy of wave vector distributions of these small scale fluctuations, using a statistical method, based on the dependence of the observed magnetic energy at a fixed frequency on the Doppler shift for different wavenumbers. Thus we show that this small scale fluctuations are dominated by 2D turbulence with wave vectors mainly perpendicular to a mean field B, $k_\perp \gg k_\|$. Such anisotropy is observed up to electron scales and it is independent on the value of plasma β, which varies in our analysis from less than 1 to about 10.