Geophysical Research Abstracts
Vol. 12, EGU2010-1818-1, 2010
EGU General Assembly 2010

The finite range nature of solar wind turbulence-physics of kinetic and outer scales.

Sandra Chapman
University of Warwick, Centre for Fusion, Space and Astrophysics, Physics Dept., Coventry CV4 7AL, United Kingdom (s.c.chapman@warwick.ac.uk)

Spacecraft in- situ measurements in the solar wind typically show an 'inertial range' of MHD turbulence with a power-law power spectra. Fully developed inertial range turbulence has a characteristic statistical similarity property of quantities that characterize the flow, such as the magnetic field components $B_k(t)$, so that the pth moment of fluctuations have power law dependence on scale τ such that $< |B_k(t+\tau) - B_k(t)|^p >\sim \tau^{\zeta(p)}$. The multifractal scaling of intermittent turbulence is captured in the nonlinear (concave) dependence of $\zeta(p)$ upon p.

The turbulence seen in the solar wind is however finite range. At higher frequencies a spectral break is seen around the ion-gyroscale with a subsequent steeper power-law, indicating a cross-over to spatial-temporal scales where kinetic effects become important. At lower frequencies there is an outer scale of the turbulence and a cross-over to approximately '1/f' power spectral scaling, presumably of solar origin. We will use solar wind in-situ spacecraft observations of 'quiet' stationary flow to explore to what extent these finite range properties of the turbulence are universal.

Cluster burst mode high-frequency magnetic field data (FGM and STAFF) allow us to access the kinetic scales. We examine intervals of 'quiet' flow and find statistical similarity through both the inertial and kinetic ranges, but intriguingly, the exponents $\zeta(p)$ change from nonlinear to linear dependence in p. As we cross over from the inertial to kinetic ranges of scaling, the character of the turbulence thus changes from intermittent to non-intermittent (globally scale invariant).

ULYSSES spacecraft solar polar passes at solar minimum provide in-situ observations of evolving MHD turbulence in the solar wind under ideal conditions of fast quiet flow. At the outer scale we find a generalized similarity $< |B_k(t+\tau) - B_k(t)|^p >\sim g(\tau/\tau_0)^{\zeta(p)}$. This extended or generalized similarity is a ubiquitous but not well understood feature seen in turbulence that is realized over a finite range of scales and here expresses the physics of the largest structures, that is, at the outer scale, of the evolving inertial range turbulence. We examine polar passes from the last two solar minima which in comparison show a decrease in the turbulent fluctuations of a factor of two in power. We find the same generalized scaling function $g(\tau)$ in all these observations suggesting that this may be a *universal* feature of evolving MHD turbulence.