Using wavelet analysis to scale plasma fluctuations in the MHD range of solar wind turbulence seen by Parker Solar Probe

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The high Reynolds number solar wind flow provides a natural laboratory for the study of turbulence *in situ*. Parker Solar Probe provides opportunities to study how turbulence evolves in the expanding solar wind, and has to date executed nine sampling distances between 0.2 AU and 1 AU. We focus on data from the PSP/FIELDS [S D Bale *et al*., *Space Sci. Rev* **204**, 49 (2016)] and the PSP/SWEAP [J C Kasper *et al*., *Space Sci. Rev.* **204**, 131 (2016)] experiments, which provide magnetic field and plasma observations respectively at sub-second cadence. We have identified multiple intervals of uniform solar wind turbulence, selected to exclude coherent structures such as pressure pulses and current sheets, and in which the velocity of the primary proton population varies by less than 20% of its mean value. We focus on events of multiple-hour duration, which span the spectral scales from the approximately $1/f$ range at low frequencies, through the MHD inertial range of turbulence, and into the kinetic range which lies below the ion gyrofrequency. We perform a Haar wavelet decomposition [K H Kiyani *et al*., *Astrophys. J.* **763**, 10 (2012)] which provides accurate estimations of the exponents of these power-law ranges of the spectra, and of higher-order moments of the distributions of fluctuations, notably their kurtosis. This allows us to study how the spectral exponents may vary with distance from the sun and with solar wind conditions such as the plasma beta. We perform this analysis both for the vector components of the magnetic field and for its magnitude; these track Alfvénic and compressive turbulent fluctuations, respectively. At 1 AU, compressive fluctuations are known to exhibit scaling properties which differ from that of the individual magnetic field components [B Hnat *et al*., *Phys. Rev. E* **84**, 065401 (2011)]. Here we investigate this behaviour at different distances from the Sun, plasma beta, and proton density.

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