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Arbitrary-order Hilbert spectral analysis and intermittency in solar wind density fluctuations

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The properties of inertial and kinetic range solar wind turbulence have been investigated with the arbitrary-order Hilbert spectral analysis method, applied to high-resolution density measurements. Due to the small sample size, and to the presence of strong non-stationary behavior and large-scale structures, the classical structure function analysis fails to detect power law behavior in the inertial range, and may underestimate the scaling exponents. However, the Hilbert spectral method provides an optimal estimation of the scaling exponents, which have been found to be close to those for velocity fluctuations in fully developed hydrodynamic turbulence. At smaller scales, below the proton gyroscale, the system loses its intermittent multiscaling properties, and converges to a monofractal process. The resulting scaling exponents, obtained at small scales, are in good agreement with those of classical fractional Brownian motion, indicating a long term memory in the process, and the absence of correlations around the spectral break scale. These results provide important constraints on models of kinetic range turbulence in the solar wind.