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Non-Gaussian probability distributions of solar wind fluctuations

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Abstract. The probability distributions of field differences <Delta>x(<tau>)=x(t+<tau>)-x(t), where the variable x(t) may denote any solar wind scalar field or vector field component at time t, have been calculated from time series of Helios data obtained in 1976 at heliocentric distances near 0.3 AU. It is found that for comparatively long time lag <tau>, ranging from a few hours to 1 day, the differences are normally distributed according to a Gaussian. For shorter time lags, of less than ten minutes, significant changes in shape are observed. The distributions are often spikier and narrower than the equivalent Gaussian distribution with the same standard deviation, and they are enhanced for large, reduced for intermediate and enhanced for very small values of <Delta>x. This result is in accordance with fluid observations and numerical simulations. Hence statistical properties are dominated at small scale <tau> by large fluctuation amplitudes that are sparsely distributed, which is direct evidence for spatial intermittency of the fluctuations. This is in agreement with results from earlier analyses of the structure functions of <Delta>x. The non-Gaussian features are differently developed for the various types of fluctuations. The relevance of these observations to the interpretation and understanding of the nature of solar wind magnetohydrodynamic (MHD) turbulence is pointed out, and contact is made with existing theoretical concepts of intermittency in fluid turbulence.

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