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The Role of Compressibility in Intermittent Solar Wind Turbulence

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Incompressible Magnetohydrodynamics is often assumed to describe solar wind turbulence. The relevant observable in the context of turbulence is the scaling properties of fluctuations on different scales which, from in -situ plasma measurements, can be obtained from the PDF of differenced timeseries. This can be approached by scaling collapse of the PDF[1], and by generalized structure function analysis. Extended Self Similarity (ESS)- essentially normalizing one structure function by another- can extend the scaling range. We use ESS to reveal scaling in the structure functions of density fluctuations in the solar wind. Previously[2] ESS has been used to show that the scaling properties of magnetic field magnitude in the solar wind coincide with those found in the inertial range of quantities identified as passive scalars in other turbulent systems, and it was argued that in incompressible MHD turbulence, the magnetic field magnitude should also act as a passive scalar. However, we find that the scaling properties of structure functions of magnetic field magnitude, and the density are not coincident. The scaling properties of the density thus also do not coincide with that of the passive scalars. This implies that either solar wind turbulence is compressible, or that straightforward comparison of structure functions does not adequately capture its inertial range properties.

Keywords: solar wind; turbulence; intermittency

References

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