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Scaling features in the two inertial subranges of solar wind turbulence

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The scaling of turbulent fluctuations provides crucial information for the understanding of solar wind turbulence. The intermittent structures has been found to influence the scaling at the near-Earth solar wind [1,2]. However, the nature of these structures is still under debate and how they affect the higher-order scaling behaviour in the near-Sun solar wind turbulence remains to be investigated.

Here we use Parker Solar Probe (PSP) measurements in the near-Sun solar wind during its first encounter phase. We find that there are two subranges in the inertial range of solar wind turbulence. We analyze their multi-order scaling behaviours seperately. In subrange 1 at a larger scale [3], we consider the time stationarity of the magnetic field and remove the effect of convective structures based on a effective criterion. We find that the scaling indices of magnetic field show a linear dependence on the order close to IK scaling in the radial direction. The scaling displays an anisotropy: close to Kolmogorov scaling (p/3) and IK scaling (p/4) respectively with the local magnetic field perpendicular and parallel to the sampling directions.

In subrange 2 at a smaller scale [4], we identify the intermittency by partial variance of increments (PVI) method. The dependence of PVI on the scale shows subrange 2 is an intermittent domain in which the largest percentage of intermittency is 4%. We find that the multifractal scaling of the magnetic field could be predicted by the log-Poisson intermittency model with 2D sheetlike structures and a simple Kolmogorov monoscaling recovers after the removal of the intermittency. The fluctuations of the magnetic directions present similar behaviors.

The scaling behaviors and their association with the intermittent structures exist obvious differences in the two inertial subranges in the solar wind turbulence, which requires further investigations.

References

[1] Wang X., et al., The Astrophysical Journal Letters, 783, L9, (2014)
[2] Wu H., et al., The Astrophysical Journal, 892:138, (2020)
[3] Wu H.*, et al., The Astrophysical Journal, 947:45, (2023)
[4] Wu H.*, et al., The Astrophysical Journal Letters, 947, L22, (2023)