Phase-space cascade in turbulent plasmas: observations, simulations and theory

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Plasma turbulence has been investigated using unprecedented high-resolution ion velocity distribution measurements by the Magnetospheric Multiscale mission (MMS) in the Earth's magnetosheath. This novel observation of a highly structured particle distribution suggests a cascadelike process in velocity space [1], as shown in figure 1. Complex velocity space structure is investigated using a three-dimensional Hermite transform, revealing, for the first time in observational data, a power-law distribution of moments. In analogy to hydrodynamics, a Kolmogorov approach leads directly to a range of predictions for this phase-space transport. The scaling theory is found to be in agreement with observations and new simulations. The combined use of state-of-the-art MMS data sets, novel implementation of a Hermite transform method, scaling theory of the velocity cascade and kinetic simulations opens new pathways to the understanding of plasma turbulence and the crucial velocity space features that lead to dissipation in plasmas [1, 2, 3, 4]. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 776262 (AIDA, www.aida-space.eu)

References

[1] S. Servidio, A. Chasapis, W. H. Matthaeus, D. Perrone, F. Valentini, T. N. Parashar, P. Veltri, D. Gershman, C. T. Russell, B. Giles, S. A. Fuselier, T. D. Phan and J. Burch, Physical Review Letters **119**, 205101 (2017)

[2] A. A. Schekochihin, J. T. Parker, E. G. Highcock, P. J. Dellar, W. Dorland and G. W. Hammett, J. Plasma Phys. **82**, 905820212 (2016)

[3] S. S. Cerri, M. W. Kunz and F. Califano, Astrophys. J. Lett. **856**, L13 (2018)

[4] O. Pezzi, S. Servidio, D. Perrone, F. Valentini, L. Sorriso-Valvo, A. Greco, W. H. Matthaeus and P. Veltri, Velocity-Space Cascade in Magnetized Plasmas: Numerical Simulations, Physics of Plasmas **25**, 060704 (2018)

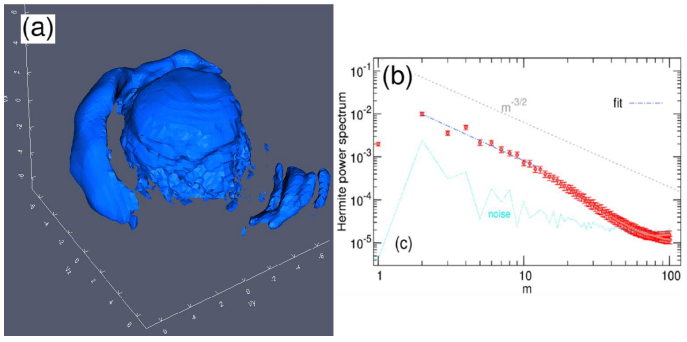

Figure 1: *(a) Example of a ion velocity distribution function, in the velocity space, as observed by the MMS spacecraft. (b) Hermite spectrum of the fluctuations in the velocity space.*