The phase-space complexity of nearly-reversible turbulent plasmas

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Understanding the kinetic-scale dynamics of turbulent weakly-collisional plasmas is decisive for tackling the fundamental issues of energy dissipation and plasma heating in space and astrophysical systems. As a result of the weak collisionality, kinetic-scale plasma turbulence naturally generates a large variety of non-equilibrium velocity-space structures in the plasma distribution function. Such an emerging complexity has been recently envisioned as a turbulent cascade occurring in the entire six-dimensional phase space.

Here, I will review some recent results on this topic, mainly obtained by exploiting Eulerian Hybrid Vlasov-Maxwell numerical simulations. By Hermite-decomposing the particle velocity distribution function, I will show that the Hermite spectrum of the velocity distribution function displays a broadband, power-law behavior, whose slope is in agreement with theoretical expectations [1]. The effect of the background magnetic field inducing a velocity-space spectral anisotropy, and the spatial intermittency of the velocity-space activity will be discussed as well [1,2]. Finally, I will analyze the effect of inter-particle collisions which despite being in general weak, inhibit the development of velocity-space cascade by dissipating fine velocity structures, thus restoring thermodynamic irreversibility [3].

References

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