Gyrokinetic turbulence: a nonlinear route to dissipation through phase space

Alexander Schekochihin
Plasma Physics, Blackett Laboratory, Imperial College, London SW7 2AZ, UK

This talk describes a conceptual framework for understanding kinetic plasma turbulence as a generalized form of energy cascade in phase space. It is emphasized that conversion of turbulent energy into thermodynamic heat is only achievable in the presence of some (possibly arbitrarily small) degree of collisionality. The smallness of the collision rate is compensated by the emergence of small-scale structure in the velocity space. For gyrokinetic turbulence, a nonlinear perpendicular phase mixing mechanism is identified and described as a turbulent cascade of entropy fluctuations simultaneously occurring in the gyrocentre space below the ion gyroscale and in velocity space. Scaling relations for the corresponding fluctuation spectra are derived. An estimate for the collisional cutoff is provided. The importance of adequately modeling and resolving collisions in gyrokinetic simulations is discussed, as well as the relevance of these results to understanding the dissipation-range turbulence in the solar wind and the electrostatic microturbulence in fusion plasmas.

References

AA Schekochihin, SC Cowley, W Dorland, GW Hammett, GG Howes, E Quataert, T Tatsuno, "Astrophysical gyrokinetics: kinetic and fluid turbulent cascades in magnetized weakly collisional plasmas," *Astrophys. J. Suppl.,* submitted (2007) [e-print arXiv:0704.0044]

AA Schekochihin, SC Cowley, W Dorland, GW Hammett, GG Howes, GG Plunk, E Quataert, and T Tatsuno, "Gyrokinetic turbulence: a nonlinear route to dissipation through phase space," *Plasma Phys. Control. Fusion,* submitted (2008) [e-print arXiv:0806.1069]