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Plasma Turbulence in Astrophysics and in the Laboratory[1]

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Turbulence plays a critical role in plasma systems ranging from laboratory fusion experiments to astrophysics. In nearly collisionless systems, modeling this turbulence is challenging because of the kinetic nature of the dominant dissipation processes and because of the strong nonlinear interactions that control the dynamics. On the other hand, the range of spatio-temporal scales that must be simultaneously resolved is not as large as in neutral fluid turbulence. A new class of "gyrokinetic" codes developed for fusion are facilitating the exploration of plasma turbulence across a broad range of problems. In fusion applications, fluctuations driven by local pressure gradients cause energy and momentum to leak from the magnetic containers shielding hot plasma from the cold surrounding surfaces. A major surprise from the models is that transport may be dominated by self-generated, small-scale streams that convect the high temperature extended distances across the confining magnetic field. Experiments are now being carried out to search for these streams. In astrophysics an important issue is how large-scale turbulent energy is absorbed as it cascades to small spatial scales. Whether the energy is dumped into electrons or ions in accretion flows and other applications impacts both the dynamics of the system and our ability to interpret observations through measurement of radiation from distant sites throughout the universe. Results from the first self-consistent calculations of the collisionless absorption of turbulent energy cascades for astrophysical applications will be presented.

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