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Drift waves in the turbulence of reversed field pinch plasmas[1]

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Turbulence is one of the principal mediators of energy exchange in natural and laboratory plasma settings, for example wave-particle interactions that lead to collisionless heating and acceleration. The turbulent cascade carried by Alfvenic fluctuations is especially important in magnetized plasmas, operating on a wide range of scales larger than the ion gyroradius. The MST laboratory plasma exhibits a robust turbulent cascade driven by tearing instability, which is likely connected to powerful non-collisional ion heating that is also observed. New electric and magnetic field fluctuation measurements in the plasma edge reveal a broadband cascade that is anisotropic relative to the mean B_0. Magnetic fluctuations dominate at the tearing scale, as expected, but energy equipartition is not observed at smaller scales. Instead, the kinetic energy, $\frac{1}{2}m_in_i(\tilde{E} \times B_0)^2$, begins to dominate at $k_{perp}\rho_i > 0.2$. Statistical coherency between density, parallel magnetic field, and floating potential fluctuations reveals previously unobserved features at this energy-crossing scale that are consistent with electron-branch drift waves with a phase velocity comparable to the electron drift speed. The edge region contains a strong density gradient, and either drift-Alfven coupling or unstable modes could be responsible for the excess kinetic energy. The turbulent energy rises and falls in concert with the tearing mode amplitudes, which suggests nonlinear wave coupling powers the cascade, but the coherency at small scales is more persistent than at the tearing-scale during sawtooth relaxation cycles, which suggests possible independent drift wave instability. Gradient regions are a universal feature of plasma interfaces, and similarities may be exploited to better understand turbulent dynamics in other space and laboratory plasmas, e.g., the corona-wind interface.

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