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Spontaneous Profile Self-Organization in a Simple Realization of Drift-Wave Turbulence[1]

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We report the observation of a net inward, up-gradient turbulent particle flux from two independent diagnostics in collisional drift-ITG plasma turbulence. At low magnetic fields (B $\leq$ 1.0 kG), particle transport is outward at all radii and the predominantly collisional electron drift wave turbulence drives a sheared ExB zonal flow. As the magnetic field is further increased (B $\geq$ 1.2 kG) the drift-waves persist, an up-gradient inward particle flux develops [1], fluctuations propagating in the ion diamagnetic drift direction develop and a pronounced steepening of the ion temperature and mean density gradients occurs. The two different types of fluctuation features modulate and compete with each other and dominate in different radial location and magnetic field region. Linear stability analyses show that a robust ITG instability is excited for these conditions. The onset of net inward flux also coincides with the development of a strong intrinsic parallel flow shear that can drive an inward pinch when it is coupled with grad-T_i. However, we find that the ITG-driven inward pinch is more dominant in our experiments. This basic experiment provides for a detailed examination of turbulent-driven particle pinches and up-gradient fluxes in the presence of multiple free-energy sources. Moreover, the coexistence and competition of DWs and ITG have been observed to influence tokamak transport and remains a topic of interest for both magnetically confined fusion plasmas and space plasma systems. A detailed experimental study complemented by theory and linear and nonlinear simulations of these experiments is used to elucidate the physics of up-gradient particle transport.

[1] L. Cui et al, Phys. Plasmas 22, 050704 (2015).

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