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Inward particle transport driven by low-frequency modes in cylindrical magnetized plasma

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Radially inward particle flux driven by fluctuations can help build transport barriers and maintain density profile in magnetic-confined plasmas. For fusion plasmas, inward turbulent transport could act as a natural fueling mechanism and transporting cold DT ions near the edge towards the core. Considering the difficulty of building fueling system for future large fusion devices, it is important to study turbulent inward transport. In a linear helicon plasma device, net radially-inward turbulent particle flux was observed. In frequency domain, the inward flux was contributed by 1 kHz coherent modes, while very low frequency components dominate outward transport. The radial evolution of particle flux Γ_r was dominated by cross-phase evolution. Fluctuation amplitudes and cross coherence do not play significant roles in the evolution of Γ_r. Turbulence energetics is analyzed to find out the energy source of the 1 kHz mode which caused inward transport, and results show that in the region where particle flux directs inwards, turbulence is obtaining energy from nonlocal turbulence spreading process. Energy transfer terms, including turbulent production power P_I, Reynold's power P_K and turbulence spreading power P_S are estimated for every radial positions. P_S dominates over other energy transfer terms, and has a significant peak where the inward flux peak locates, indicating that energy is spreading in to drive turbulence. Nonlinear kinetic energy transfer analysis in frequency domain is also estimated, and the results indicate that the 1 kHz mode gains energy through nonlinear interaction with very low frequency components with f < 0.5 kHz. Although located in a E_r shear layer, the 1 kHz mode does not belong to Kelvin-Helmhotz instability driven by flow shear but shows many common features with Reyleigh-Taylor instability.

References
[1] H. Liu, Y. Yu, C.Y. Xiao *et al*, Plasma Physics and Controlled Fusion **65,** 055017 (2023)
[2] H. Liu, S. Shinohara, Y. Yu *et al*, Journal of Instrumentation **15,** P11002 (2020)

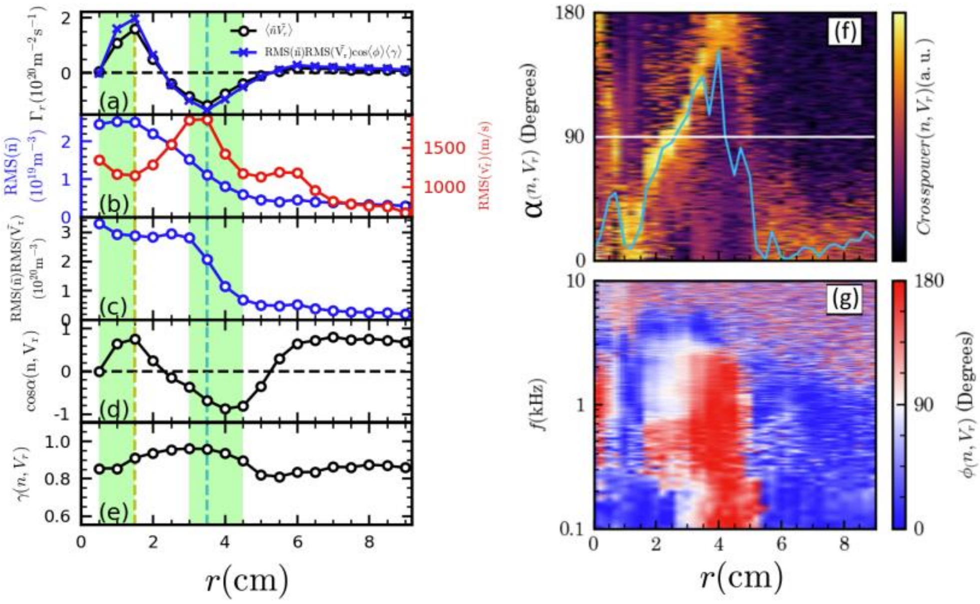

Figure 1 (a) Particle flux profile; (b) Radial profile of $\tilde{\boldsymbol{n}}_{\boldsymbol{e}}$ and $\tilde{\boldsymbol{v}}_{\boldsymbol{r}}$ amplitudes (rms); (c) Radial profile of rms roduct of $\tilde{\boldsymbol{n}}_{\boldsymbol{e}}$ and $\tilde{\boldsymbol{v}}_{\boldsymbol{r}}$; (d) Power-weighted average of cross-phase of $\tilde{\boldsymbol{n}}_{\boldsymbol{e}}$ and $\tilde{\boldsymbol{v}}_{\boldsymbol{r}}$; (e) Power-weighted average of cross-phase of $\tilde{\boldsymbol{n}}_{\boldsymbol{e}}$ and $\tilde{\boldsymbol{v}}_{\boldsymbol{r}}$; (f) Distribution of crosspower in cross-phase angles. Blue curve is the weighted average of cross-phase. (g) Distribution of cross-phase in frequencies.