DPP17-2017-001442

Abstract for an Invited Paper
for the DPP17 Meeting of
the American Physical Society

Coupling of Shear Flows in a Cylindrical Plasma Device

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Spontaneous generation of parallel flows has been observed in a cylindrical plasma device. The mean parallel velocity shearing rate, V_z', increases as the radial gradient of the plasma density, $\nabla_r n_e$, exceeds a critical value. Correspondingly, when critical density gradient is exceeded, the parallel Reynolds power, $\mathcal{P}_{\ddagger}^{\mathcal{R}\rceil} = -\langle \sqsubseteq_{\ddagger} \rangle \nabla_{\triangledown} \langle \heartsuit\!\!\!\sqsubseteq_{\triangledown} \heartsuit\!\!\!\sqsubseteq_{\ddagger} \rangle$, increases substantially, indicating the mean parallel flow gains more energy from ambient turbulence. Meanwhile, the shearing rate of the mean azimuthal flow, V_θ', increases with the density gradient, but soon saturates when critical density gradient is exceeded. Also, the azimuthal Reynolds power, $\mathcal{P}_{\theta}^{\mathcal{R}\rceil} = -\langle \sqsubseteq_{\theta} \rangle \nabla_{\triangledown} \langle \heartsuit\!\!\!\sqsubseteq_{\triangledown} \heartsuit\!\!\!\sqsubseteq_{\theta} \rangle$, drops at higher density gradient, implying that the mean azimuthal flow gains less energy from ambient turbulence. These results suggest that the energy of azimuthal flows may be coupled to that of parallel flows through ambient turbulence. A 4-field model is employed to explain the coupling between the azimuthal flow and the parallel flow.