Electron Temperature Fluctuations and Turbulent Heat Fluxes in DIII-D SOL

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Measurements of scrape-off layer (SOL) electron temperature (T_e) fluctuations and their implications on the SOL power balance in DIII-D are presented. T_e fluctuations play an important role in the tokamak SOL, being responsible for the "conductive" (due to correlated fluctuations of T_e and poloidal electric field, E_θ) part of the cross-field turbulent transport. Therefore, T_e fluctuation measurements are essential to complete the SOL power balance. In DIII-D, SOL T_e fluctuations are measured using a unique harmonic diagnostic deployed on the midplane reciprocating probe and having a bandwidth of up to 100 kHz [1]. We present an overview of T_e fluctuation properties in the SOL of low (L) and high (H) confinement discharges, over L-H transitions, and during edge localized modes (ELMs). Relative T_e fluctuation levels range from $\tilde{T}_e^{rms} / T_e = 0.1$–$0.2$ inside the last closed flux surface (LCFS) to 0.3–0.5 in the SOL of L-mode discharges, and tend to increase with the discharge density. SOL T_e fluctuations are typically quenched at L-H transition, but increase during ELMs up to $\tilde{T}_e^{rms} / T_e = 1$. Electron temperature fluctuations tend to be roughly in phase with the electron density (n_e) fluctuations. "Conductive" and "convective" (due to correlated n_e and E_θ fluctuations) components of the cross-field turbulent heat fluxes tend to be comparable near the LCFS, while in the far SOL the convective component tends to be larger. Most of the T_e fluctuation and heat flux spectral energy is below 30 kHz. Intermittent convection of plasma blobs contributes to cross-field transport of particles and heat throughout the SOL. In the near SOL, blobs produce correlated spikes in n_e, T_e, and radial velocity ($v_r = E_\theta \times B$) measured by the probe. By the time blobs reach far SOL, they cool down and correlation between n_e and T_e spikes is lost. As they cool, blobs also slow down to about half of the velocity they have near the LCFS. Cross-field heat fluxes measured near the LCFS in L-mode are in reasonable agreement with the SOL power balance.

[1] D.L. Rudakov, *et al.,* Rev. Sci. Instrum. **70**, 453 (2001).

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