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Effect of non-Maxwellian Electron Energy Distributions on Langmuir Probe Measurements and Heat Transmission in Tokamak Divertor Sheaths[1]

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Tokamak scrape-off-layers have long been analyzed and modeled with a single-fluid approach. Recent research indicates that kinetic effects in the SOL may be significant enough to challenge this approach [1]. Classical Langmuir probe interpretation is expected to be sensitive to the tail of the electron distribution and could yield results characterized by the tail population. The assessment of derived quantities, such as the sheath heat transmission coefficient, would also be affected. Non-local probe theory indicates a new interpretation method making calculation of the distribution function in the tokamak edge possible [2]. This method is applied to the divertor Langmuir probes of NSTX and non-Maxwellian distributions are found to result from the analysis. The inferred distributions contain a cool, bulk population and a hot electron tail fraction (typical $T_{hot}/T_{cool} \approx 4$) corroborating previous experiments and modeling. Determination of the sheath heat transmission coefficient with $\gamma \approx 2.5$ supports this observation. The two Langmuir interpretation methods are compared using OEDGE interpretative modeling. This fluid modeling indicates that the plasma collisionality is marginal in the NSTX SOL ($\nu_e^* < 20$) making kinetic effect probable. Candidate processes involved are 1) electron-neutral interactions, 2) non-local/gradient effects at the target plate and 3) turbulent fluctuations. The inferred distributions are compared to calculations of electron-neutral interactions, fluctuation-induced effects and PIC simulations of non-local effects.

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