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Properties of the electron sheath in low temperature plasmas[1]
BENJAMIN YEE, Sandia National Laboratories, BRETT SCHEINER, SCOTT BAALRUD, University of Iowa, EDWARD BARNAT, MATTHEW HOPKINS, Sandia National Laboratories — The preponderance of sheath research has focused on ion sheaths and neglected electron sheaths in spite of their importance to Langmuir probes, microdischarges, sheath inversion, and negative ion sources. The conventional view of the electron sheath is that of a sharp transition region from the quasineutral plasma to the space charge dominated region. This view implies that only the random thermal flux of electrons crossing the electron sheath boundary is collected by the electrode. In this work, a combination of experiments, simulations, and theory is used to demonstrate that reality is considerably more complex than expected and that the physics of electron sheaths is unexpectedly rich. Advanced laser diagnostics prove the existence of a large transition region outside of the electron sheath. Simulations show that these "electron presheaths" are driven by pressure gradients rather than the electric field, and that these gradients originate from a loss cone-like truncation of the electron velocity distribution function. The electron flow driven by this pressure gradient can be sufficiently strong so as to excite instabilities in the sheath edge.

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