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Numerical study of a coaxial electron sheath

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A particle-in-cell (PIC), direct simulation Monte Carlo (DSMC) simulation is presented for a coaxial low-temperature plasma. Depending on the ratio of the area of the electron collector (A_e) to ion collector (A_w), different sheath structures may form[1]. In the case of the $A_e/A_w < \sqrt{2.3 m_e/m_i}$ where m_e is and m_i are the electron and ion mass respectively, an electron sheath will be observed. Here, a collisionless electron presheath is studied in a coaxial configuration. The center conductor is held at a positive bias and the outer conductor is fixed at ground potential. A clear electron sheath configuration is found in the model when the ratio of inner conductor area to outer conductor area meets the electron sheath criteria. It was observed that the azimuthal velocity distribution function experiences a loss as electrons with near zero velocity are lost to the center electrode. Radial velocity distribution functions are mostly Maxwellian except near the positively biased electrode where a drifted Maxwellian is observed. The analysis of the electron sheath has important applications in probe theory, probe diagnostics, and electron beam devices[2]. This coaxial electron sheath problem demonstrates a fluid-like bulk plasma region and a kinetic sheath region. As such, this is an ideal problem for analyzing the transition region between the fluid and kinetic regime.

[1]S. Baalrud, et al., Phys. Plasmas, 14, 042109, 2007
[2]N. Hershkowitz, et al., US Patent num. 7398592B2, 2009.

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