Impact of trapped particles on the plasma sheath around infinitely-long electron-emitting objects in Maxwellian plasmas

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The response of a collisionless, unmagnetised, Maxwellian plasma to the presence of an external electron-emitting object is a phenomenon appearing in many interesting applications. Emissive probes, charging of dust grains and current exchange at the cathodic segment of low work-function electrodynamic tethers (LWTs) are just a few examples. Simulation tools are essential to address the properties of the sheath and calculate macroscopic quantities such as collected and emitted currents, or the charge of the object. For infinitely long cylinders, stationary Eulerian Vlasov solvers based on Orbital Motion Theory (OMT) have been implemented successfully for this purpose [1]. However, stationary codes cannot provide the population of trapped particles that might arise during charging transients, and this population is typically neglected. Nonetheless, it was shown by using a non-stationary eulerian Vlasov-Poisson solver that trapped particles modify the steady-state structure of the sheath around the cylinder [2]. The present work expands the latter analysis to include electron emission. In particular, the impact of the trapped population on the Space Charge Limited (SCL) emission regime is investigated. The latter can have an important influence on the charging of an object and, under such circumstances, commonly implemented theoretical descriptions such as the Orbital Motion Limited (OML) theory become grossly inaccurate [3]. Results from a novel semi-Lagrangian Vlasov-Poisson solver are compared with a stationary Eulerian solver and verified against a well-tested PIC code for curvilinear geometries [4].

References

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