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Collisional Charging of Dust in a Collisionless Plasma Presheath
RICHARD CAMERON, MICHAEL COPPINS, Imperial College London —
Charged dust particles are commonly found near the plasma boundary, where their motion is dominated by the electrostatic presheath and sheath fields. For dust grains smaller than the typical collision lengths of the plasma, collisional effects are often ignored. In this work, Particle In Cell simulations are used to show that if a background of low-temperature neutrals is present, even infrequent charge exchange collisions cause a population of low temperature ions to develop. While of low density, these ions tend to collect in orbit around dust grains. The collection radius for this effect is also shown to be large compared to the dust grain – of order T_e/T_n dust radii (where T_e and T_n are the electron and neutral temperatures, respectively). These ions both shield the grain and, since further collisions de-orbit these ions into the grain, provide another source of current to the dust, altering its charge. We extend previous work in the bulk plasma to the presheath/sheath region, where dust is more commonly found. The presheath field causes a high flux of ions past the grain, and even grains much smaller than a Debye length can be entirely shielded by the orbiting population, completely altering their behaviour in this region of the plasma.

Richard Cameron
Imperial College London

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