

Full particle-in-cell simulation on the dynamics of electrons for charge neutralization of a local ion engine beam

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By performing full particle simulations, we have been studying the transient response of electrons emitted for the charge neutralization of a local ion beam originated from an ion engine which is one of the electric propulsion systems. From a macroscopic point of view, ion beam emitted from an ion engine is overall neutralized with thermal electrons emitted from a neutralizer attached next to the engine. In the vicinity of the engine where the emitted electrons are mixed into the ion beam, however, the mixing process of electrons are not so obvious because of large difference of dynamics between electrons and ions. A heavy ion beam basically propagates away from the engine and forms a positive potential region with respect to the background. Electrons emitted for the neutralizer are electrically attracted or accelerated to the core of the ion beam and some of them which has lower energy than the ion beam potential are reflected back to the opposite direction at the beam front. They are also reflected at the engine exit and propagate in the forward direction. In other words, electrons moves along the ion beam with a multi-streaming structure in the beam region. Since the locations of the electron emitter and the ion beam exit are different, the above-mentioned electron motion is also observed in the direction of the beam diameter. We will report the detailed analysis of the electron dynamics in the local beam region and discuss the effect on the spacecraft environment.

Keywords: ion engine, PIC simulation, charge neutralization, electron dynamics