Numerical Simulations of Virtual Anodes in Ion Beam Emissions in Space

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Standard theories have shown that when the current density in a one-dimensional electron or ion beam exceeds a critical value, a potential hump would show up. This potential hump would behave as a virtual electrode to the beam particles. Laboratory measurements have demonstrated the existence of virtual cathodes and anodes. An ion beam would be especially susceptable to virtual anode formation because ions are slower than electrons. In this paper, we present results of parlick-in-cell simulations of ion beam emissions in space and study virtual anode formation in ion beams. The results show that a positive potential hump forms near the exit point of the beam. The hump potential is a function of the beam energy and current density as predicted. We found that the hump potential also depends sensitively on the ambient electron density and temperature, beam width, beam divergence, and spacecraft potential. The effects of electrons emitted from a neutralizer on virtual anode formation will also be discussed.