Electron hole resistivity in space plasmas

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Abstract

Phase-space electron holes are seen in simulations, laboratory plasmas, and many regions of the Earth's space environment. We present simulations of beam plasmas showing that the generation and decay of electron holes results in a reduction of electron current, implying a parallel resistivity. This resistivity occurs in simulations where a cold electron beam is coincident with a warmer background plasma, and appears to be mediated by the generation of ion acoustic waves propagating obliquely to the magnetic field. The electron holes initially scatter electrons in the beam direction thus steepening the electron beam distribution, which launches and drives ion acoustic waves that cause resistivity and are also responsible for strong ion heating perpendicular to $\vec{B}$. Resistive effects occur in both strongly and weakly magnetized plasmas. Given that electron holes are observed in many space plasmas, these results have important implications for a number of magnetospheric and auroral ionospheric processes. For auroral plasmas, electron hole resistivity could support parallel electric fields on the order of 10 mV/m, which could account for parallel potential drops of the order of kV. The same simulations replicate a number of additional features observed in the auroral downward current region, including, ion conic distributions, electrostatic whistler waves (thought to be the source of VLF saucers). Turbulent electron hole resistivity also explains the observed non-linear relationship between downward current and potential. For the magnetopause, simulations show effective collision rates of 0.008 per ω_{pe}^{-1}, which could provide dissipation and diffusion across the boundary.

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1) URSI Commission: H Plasma Physics of the Auroral Acceleration Region

2) The paper to be presented contains new results from computer plasma simulations of electron holes. We demonstrate that under certain conditions the generation and decay of electron holes induces a parallel resistivity. This resistivity may aid diffusion and support substantial field aligned potential drops along auroral fields lines and other space plasmas.

3) This paper relates to plasma and laboratory simulations of electron holes, but has particular importance for understanding auroral ionosphere observations made by the FAST satellite.