Electron-Ion Hybrid Instability in a Quasi-Static Near-Earth Dipolarization Front

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The stability of the a quasi-static near-earth dipolarization front (DF) is investigated with a two-dimensional electromagnetic particle-in-cell (PIC) model. The DF is characterized by a boundary layer with thickness on the kinetic scale, in which ions can be regarded as unmagnetized and electrons magnetized in the time scale of the intermediate-frequency waves of interest. The inhomogeneous earthward ambipolar electric field and the self-consistent normal magnetic field drive highly sheared electron flow in the dawn-dusk direction, which can then trigger the electron-ion hybrid (EIH) instability. The instability can generate broadband lower hybrid waves in the DF frame, which relaxes the velocity shear through dissipation and is capable of transverse ion heating. The dispersion relation from the simulation results are consistent with linear theoretical predictions. The density gradient is maintained as the instability grows while the velocity shear is depleted, which leads to saturation with an increased width of the DF layer. It is also found that as the plasma beta increases, the dominant wave mode shifts to longer wavelength and becomes increasingly electromagnetic. When there is a finite parallel wavenumber, the perturbation is found more electromagnetic compared to that in the transverse plane. Comparison of simulation results with in-situ satellite observations are also discussed. The velocity shear driven EIH instability is suggested to account for the broadband spectrum that has been widely observed at the DF. Although the waves are electromagnetic most of the power is concentrated in the electrostatic limit. This study provides a new insight on the particle energization at the DF and highlights the role of velocity shear.