Wave Particle Interactions in the Near-Earth Plasma Sheet Boundary Layer and Consequences for the Auroral Zone

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Cluster observations of the high latitude near-Earth plasma sheet boundary layer (PSBL) show well defined velocity dispersed ion structures (VDIS). A close examination of distribution functions within the VDIS show the presence of ion shell plasma distributions, which are coincident with electrostatic and electromagnetic wave emissions. The latitudes where the ion shell distributions, which have a constant drift velocity in both the parallel and transverse directions, map to the auroral zone. Shell velocity distribution functions are formed when earthward streaming ion beams originating in the deeper magnetotail PSBL are mirror reflected at low altitudes near the Earth and by magnetic moment conservation the distribution function tends to spread in perpendicular velocity space. The spread in transverse velocity space may also be enhanced by wave-particle interactions. We have examined instabilities that result from ion shell distributions like those observed by Cluster and have found using numerical simulations that a combination of lower hybrid waves and ion Bernstein modes are excited, accompanied by electron energy gain parallel to the ambient magnetic field as well as cold ion heating in both the parallel and transverse directions. The shell distribution tends to isotropize in velocity space due to the wave-particle interactions. The simulation results are in good agreement with the wave spectrum observed when ion shell distribution functions are present. Theory and observations also show that the shell distribution is only unstable when a cold ion background is present and this tends to occur when ionospheric ions are streaming away from the Earth into the PSBL, i.e., when an auroral potential drop is present at altitudes below the satellite. We will examine the role the shell driven wave-particle interactions play in plasma transport between the PSBL and auroral zone, as well as the relationship with auroral zone potential structures.