Solitary Structures of Boundary Layer Waves: Observations and theoretical models

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Abstract:

Boundary layers occurring in space plasmas can support a wide spectrum of plasma waves over a frequency range of a few mHz to 100 kHz and beyond. Polar Cap Boundary Layer (PCBL) waves are ELF/VLF electric and magnetic waves detected on field lines just adjacent to the polar cap. These waves are spiky, and their frequency dependence and intensities are quite similar to those of magnetopause boundary layer waves. It is speculated that PCBL waves are on the low latitude boundary layer (LLBL) magnetic field lines, but at lower altitudes. Intense PCBL waves are present at this location essentially all (96%) of the time. The most intense waves are detected coincident with the field-aligned currents. The wave intensities in electric and magnetic components follow power laws approximately. High resolution wave magnetic component data show "magnetic noise bursts", Alfvén waves, and large amplitude (~ ±14 nT peak-to-peak) obliquely propagating proton cyclotron waves. On the other hand, high resolution data of the electric component indicates three types of intense electric signals , namely, solitary structures (with bipolar, monopolar and offset bipolar pulses), lower hybrid waves, and narrow-band waves near electron plasma frequency (most likely the upper hybrid resonance waves due to their perpendicular polarization). Solitary electrostatic structures have been observed on auroral zone field lines at various altitudes ranging from close to the ionosphere, to magnetopause low-latitude boundary layer (LLBL) and cusp on the dayside, and to plasma sheet boundary layer on the nightside. Various theoretical models based on solitons/double layers, BGK modes or phase space holes, and simulation of beam driven instabilities, will be discussed to explain the characteristics of these solitary structures.

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