Two types of PSBL ion beams observed by Geotail: Their relation to low frequency electromagnetic waves and cold ion energization

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The plasma sheet boundary layer (PSBL) in the Earth's magnetotail is a region where hot plasma in the plasma sheet borders on the cold lobe plasma. Plasma in PSBL often consists of counter streaming ion and/or electron beam components generated from the nightside reconnection site. Although this beam component is considered to be a main energy source of broadband low-frequency waves in PSBL, the mechanism responsible for generation of low-frequency waves is not identified. On one hand, it is often seen that cold ions from the lobe are accelerated gradually up to the plasma sheet energies in PSBL [Hirahara et al., 1994]. There are many candidates for the heating mechanisms such as interaction with the electrostatic [e.g., Dusenbery and Lyons, 1989] or electromagnetic waves [e.g., Gary and Winske, 1990]. However, contribution of these electrostatic and electromagnetic instabilities to the acceleration and heating of these cold ions still remains to be understood.

It is a purpose of this study to clarify the causal relation of the ion beams, waves and cold ion energization in PSBL. Using high-sampling (16 Hz) magnetic field (MGF) and 12-s low-energy particle (LEP) data of Geotail, here we investigate characteristics of low-frequency (10 mHz to 1 Hz) electromagnetic waves and their relation to changes in ion distribution functions in PSBL. Two types of the PSBL crossings are analyzed in detail: During the periods of enhanced auroral activities with southward IMF, a collimated freshly injected earthward beam is observed together with the large-amplitude electromagnetic waves having a peak around 25 mHz (1/10 of the local ion cyclotron frequency). Cold ions are energized during the same period. Before the disturbed period, however, we observed counter-streaming thermalized beams with neither cold ion energization nor significant wave activities in the low frequency range. The themalized beams may be generated from the distant magnetotail and have undergone thermalization before reaching the Geotail position of X~-30 Re. These observations suggest that fresh beams from the near-Earth neutral line (NENL) play an important role in the cold ion energization. In addition to event studies, relations between low-frequency waves and properties of ion distribution functions in PSBL are investigated statistically. On the basis of statistical results, we discuss generation mechanism of the low-frequency waves and their effects on ion heating in PSBL.

References:
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