Electrostatic Solitary Waves with Oblique Potential Structure in the Upstream Region of Earth's Bow Shock

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Electrostatic solitary waves (ESW) are frequently observed in several regions of Earth's magnetosphere. Such waves are also observed in the region upstream of Earth's bow shock. These ESW are observed as disturbances of the nonthermal electrons or ions reflected by the bow shock [1]. Further, we observed ESW with oblique potential structures with respect to the ambient magnetic field in the upstream region of the Earth's bow shock. The ESW with oblique potential structures have never been observed in the foreshock, bow shock and magnetotail regions.

In order to understand these ESW, we conducted waveform analyses and statistical analyses using wave form capture onboard the Geotail spacecraft. Figure 1 shows the typical example of the bipolar pulses (shown as solid arrows) which consist of oblique potential structures. Figure 1a shows a snapshot of the parallel (upper panel) and perpendicular (lower panel) electric field waveforms with respect to the ambient magnetic field observed during the period from 19:39:57.750 UT to 19:39:57.780 UT on October 6 1997 by the Wave Form Capture (WFC) receiver of the Plasma Wave Instrument (PWI) [2] onboard the Geotail spacecraft. Bipolar pulses shown by arrows in Figure 1a are observed not only in the parallel electric field component but also in the perpendicular electric field component. Figure 1b shows a hodograph of the observed waveforms. Clearly, the bipolar pulses have oblique electric field vectors with respect to the ambient magnetic field. Thus, we conceive that the electrostatic potential structures tilt to the ambient magnetic field spatially.

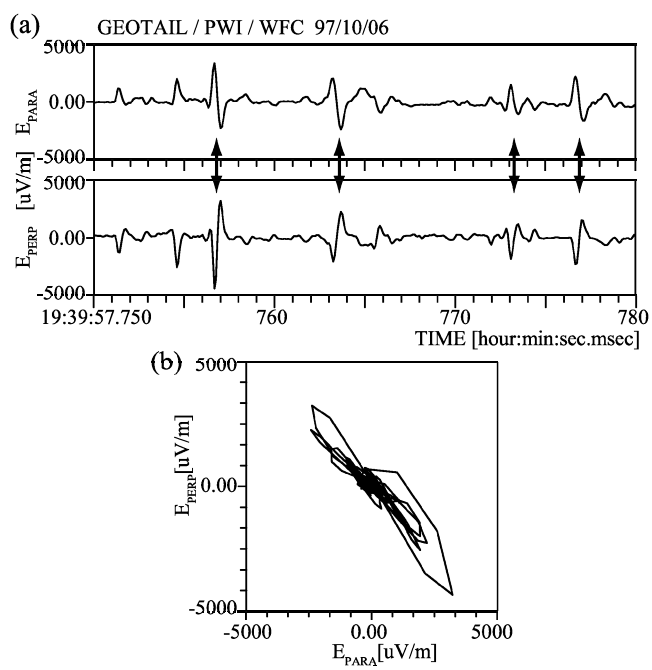

Figure 1. (a) Waveforms (a) and hodograph (b) of the electric field components observed in the upstream region of the bow shock.

Since polarizations of ESW can rapidly change with time during observation, it is not easy to compare the parameters of ESW with those of the plasma. Thus, in order to make clear the features and generation mechanism of ESW with oblique potential structures, a statistical analysis was performed of ESW observed in the upstream region of the bow shock. The results of statistical analyses show that the ESW with oblique potential structures frequently occur in the vicinity of the bow shock, and their incidence decreases with increasing distance from it. In addition, the vectors perpendicular to these oblique structures correlate with the bow shock normal. From this result, the presence of the oblique electrostatic potential structures is closely related to the configuration of Earth's bow shock. Wave features such as electric field amplitude and pulse width of these ESW are similar to the ESW which normally observed in the ion foreshock region [1]. From these results, we propose that such ESW lined up the bow shock surface excited by the two-stream instability of electrons and nonthermal ions.

In the present paper, we present observations of ESW with oblique potential structures and statistical analyses of them in the foreshock region, and discuss the propagation and generation mechanism of such oblique potential ESW.

References

1. Shin, K., H. Kojima, H. Matsumoto, T. Mukai, "Characteristics of Electrostatic Solitary Waves in the Earth's Foreshock Region: Geotail Observations," *J. Geophys. Res.*, doi:10.1029/2007JA012344, 2008 in press.

2. Matsumoto, H., et al., "Plasma wave observations with GEOTAIL spacecraft," *J. Geomag. Geoelectr*, **46**, pp. 59-95, 1994.