低温高密度プラズマシート形成の統計解析

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Statistical study on the formation of the cold dense plasma sheet

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It is well known that the plasma sheet becomes cold and dense under northward IMF conditions although its formation mechanism is still under debate. Two major candidates, (1) high latitude reconnections in both hemispheres which capture magnetosheath plasmas on the closed field lines (double lobe reconnection) and (2) effective diffusive transport of magnetosheath plasma induced by the Kelvin-Helmholtz instability at the flank magnetopause, have been discussed to explain the formation of the cold dense plasma sheet. Although these two mechanisms have been both supported by observations as well simulation results, their relative importance in the formation of the cold dense plasma sheet is so far unclear.

We statistically studied the velocity distributions of both ions and electrons in the cold dense plasma sheet observed by the Geotail spacecraft throughout its long observation period. Velocity distributions of plasmas posses the memory of mixing and transport processes which plasmas have experienced. We quantitatively investigated the properties of the cold dense plasma sheet by fitting the observed velocity distributions to a single/multi-component Maxwellian. We found that a sharp boundary exists between the hot tenuous plasma sheet and the cold dense plasma sheet. The cold dense plasma sheet is characterized by the existence of a cold component which is completely different from the velocity distributions in the hot tenuous plasma sheet. A dawn-dusk asymmetry of a hot component in the cold dense plasma sheet supports the scenario that the hot component which originates in the hot tenuous plasma sheet is supplied by the gradient/curvature drift. There is also a dawn-dusk asymmetry that a cold component of both ions and electrons in the dawn-side cold dense plasma sheet has higher temperature compared to that in the dusk. The contribution of the double lobe reconnection and the Kelvin-Helmholtz instability is discussed based on these results.