

Statistical properties of cold ion populations in the plasma sheet: GEOTAIL observations

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It is observationally known that there sometimes exists cold ion population that has density comparable to the ordinary hot plasma sheet component even in the central plasma sheet [e.g., Seki et al., 2003]. It is also reported that during extended intervals of northward IMF, plasma entry from the magnetosheath through LLBL seems to be enhanced and the ion distribution functions show the 2-composition structure in the dawn-side plasma sheet [e.g., Fujimoto et al., 1998]. These dense ions can be transported into the inner magnetosphere after a southward turning of the average IMF [e.g., Lavraud et al., 2006]. In this study, conditions for cold ion existence in the plasma sheet are investigated based on statistics of 4 years of GEOTAIL data in the central plasma sheet ($X_{GSM}=[-5, -35]$, $Y_{GSM}=[-15, 15] R_E$), aiming at getting clues to supply and transport mechanisms of these cold populations.

In order to derive density, velocity, and temperature of the cold and hot populations in the plasma sheet separately, we first carried out the 3-D shifted bi-Maxwellian fitting to the ion distribution function above 5 keV. After calculating the parameters of the hot population from the fitting result, contribution of the hot population is subtracted from the ion distribution function and the moment calculation is conducted over the energy range below 500 eV to derive the cold ion density. The results show that the observational probability of the cold ion population having density above 0.1 [1/cc] is about 0.25 and decreases with increasing tailward distances. In the near-Earth regions of XGSM greater than -15 RE, the probability goes up to 0.42. The observation also shows that there are two types of cold ion events in the plasma sheet: One is the detection of a dense sheath-like ion component primarily seen in the flank regions, and the other is observation of the colder component with a moderate density. The latter type of the cold population often has the velocity along the local magnetic field, which may suggest the direct supply of the ionospheric ions. The former type has properties similar to cold dense plasma sheet observations reported by previous studies, and primarily seen during/after the northward IMF periods. The existence of the cold population in the plasma sheet can lead to underestimation of high-energy ion flux, when one assumes the one component ion distribution in the plasma sheet. We will also discuss the effect of the cold ions on the magnetospheric dynamics.