Bimodal electron energy distribution observed by sounding rocket in the Sq current focus

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“S-310-44” sounding rocket experiment was conducted on January 15, 2016 to investigate electron heating and anomalous phenomena occurring in the Sq current focus. A total of 5 instruments to measure electron energy distribution, electric field, magnetic field, and plasma wave were installed on this rocket to observe key parameters for elucidating the physical process responsible for the electron heating. We reported last year that the electron temperature was observed to be about 200 K larger than the background temperature at 100-110 km altitude in the Sq current focus. In this presentation, we will talk about a result of our recent analysis on the electron energy distribution obtained during the rocket flight.
Fast Langmuir Probe (FLP), which is one of the onboard instruments, is capable of measuring electron energy distribution with a cylindrical probe based on Druyvesteyn method. In this measurement, it is possible to estimate electron energy distribution from the second derivative of the probe current with respect to the applied voltage once the space potential can be determined on the rocket. The space potential corresponds to the voltage where the second derivative of the probe current has a sharp minimum.
The FLP Data obtained in the region below 100 km altitude show ordinary energy distribution of ionospheric electrons by which the electron temperature and density are calculated from the gradient in the electron deceleration region and the space potential. In contrast, it becomes difficult to determine a position of the space potential in the altitude range between 100 and 110 km. Moreover, bimodal peaks in the second derivative are found to exist in the higher energy from the space potential above 110 km altitude. A possible cause of such bimodal energy distribution will be 1) Bi-Maxwellian energy distribution with two different temperatures, 2) Electron temperature anisotropy, and 3) Two distributions consisting of stational ionospheric electrons and higher energy electrons coming from different altitude. In addition, another characteristics of the observed energy distribution is that the peak height of the second derivative has a periodic variation according to the phase of rocket spin, which may be related to the cause of such a distribution. We also need to discuss a causal relationship between the high electron temperature in 100 –110 km altitudes and these higher-energy electrons. In this talk, we will present the latest result of our analysis of the electron energy distribution.

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