

Electron density perturbation near the Sq focus observed by S-310-37 sounding rocket

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The layers of anomalously high electron temperature are often observed near the Sq focus in winter hemisphere in lower E-region. Theoretical studies suggest that the electric potential near the center of the Sq focus in winter hemisphere is higher than that in summer hemisphere. The field-aligned electric field generated in lower E-region, where the electric conductivity is low compared with higher altitude, would accelerate electrons, and ambient electrons could be heated through direct collisional processes or plasma waves. The S-310-37 sounding rocket was launched to elucidate the generation mechanism of the electron temperature enhancement. Several electrostatic probes and electric field detector (EFD) were installed. Fast Langmuir Probe (FLP) and Electron Temperature Probe (TEL) were used to obtain the profiles of electron temperature and electron density with high time resolution. Fixed Bias Probe (FBP) is to detect fluctuations of electron density with high time resolution up to 800 Hz. Suprathermal Plasma Analyzer (SPA) aims to measure energy distribution function of thermal and suprathermal electrons and to verify the existence of electrons heated by accelerated electrons. EFD aims to measure three-dimensional electric field.

The rocket successfully passed near the Sq focus during the rocket upleg, and FLP and TEL identified the electron temperature enhancement around 95-100 km in altitude. Although some data were slightly contaminated or partly saturated due to unexpectedly large fluctuation of electron density, all instruments worked properly and obtained data successfully during the rocket flight. Electrostatic probes observed abrupt increase of electron density fluctuation at 95-100 km in the rocket upleg up to the rocket apogee of 138 km. According to FBP, the ratio of the fluctuated component to the background reached the maximum value 8% at 98 km. From analyses of FLP and SPA data, large fluctuation occurred at a specific rocket spin phase when the instrument faced toward the geomagnetic field which was connected to summer hemisphere. From these results, it is suggested that accelerated electrons along the geomagnetic field from summer to winter hemisphere may excite plasma waves through beam plasma instabilities, which was detected as an electron density fluctuation.

Keywords: sounding rocket, electron heating, beam plasma instability, lower E-region, electrostatic probe