Properties of suprathermal electrons associated with discrete auroral arcs

K. Ogasawara, G. Livadiotis, J. M. Jahn, J. R. Sharber, J. D. Winningham[1], G. A. Grubbs, R. Michell, M. Samara[2]

[1]Southwest Research Insitute

[2]NASA/GSFC

The space-plasma particle distributions are generally not in thermal equilibrium due to their collisionless nature, and cannot be explained by only Maxwell-Boltzmann distributions. Although many theoretical studies of the auroral particle acceleration mechanisms have been based on the Maxwell-Boltzmann distributions as source plasma electron populations, their approximate distributions from observations in the plasma sheet are predominantly described by kappa distributions [e.g., Vasyliunas, 1968]. However, there are few reliable observations of electrons covering the suprathermal energy range with a single instrument due to the technical limitations of conventional detection techniques.

In this study, data from a new instrument [Ogasawara et al., 2016], dedicated to the suprathermal electrons, were analyzed to investigate the suprathermal electron properties observed in the discrete auroral arcs. Based on optical measurements, the rocket flew over the three auroral arcs, and the features of these suprathermal electrons were explained by shifted kappa distribution functions with the parameters (density, temperature, and kappa) consistent with former observations of the near-Earth tail plasma sheet: the expected source of the auroral precipitating electrons.

The statistical data analyses showed three novel features of the suprathermal electrons. First, the auroral potential drop was proportional to the inverse-square of kappa, consistent with previous theoretical investigations by Dors and Kletzing [1999]. The observed dependency was slightly stronger than their calculations, suggesting additional contribution from non-linear plasma processes. Second, the polytropic relation showed non-adiabatic (near isothermal) state of the source electrons. This can provide a restriction on the pressure balance issues in the plasma sheet convection. Third, there was a clear difference in the polytropic and the kappa index for the first arc as opposed to the second and the third arcs, suggesting different source locations in the plasma sheet for precipitating electrons that causes these near-by arcs.

[l] Dors and Kletzing, J. Geophys. Res. **104**, 6783 (1999).

[2] Vasyliunas, J. Geophys. Res. **73**, 2839 (1968).

[3] Ogasawara et al., Rev. Sci. Instrum. **87**, 053307 (2016).