keV ELECTRON MICROBURSTS ABOVE AURORAL ARCS

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Abstract: Electron microbursts in the energy range less than 10 keV were directly observed at local night by a S-310JA rocket launched into a corona-type aurora from Syowa Station, Antarctica. Microbursts occurred in trains, and had an average duration of 0.1 second. The flux increase ranged from a factor of two to ten.

1. Introduction

Electron spectrometers (ESM) using magnetic analyzers and channeltrons were flown on board two S-310JA rockets (Nos. 5 and 6) into the corona-type aurora at Syowa Station in 1978. Electron fluxes in the energy range of 1-$\sim$10-keV were successfully measured at small (ESM-Z) and $\sim$90° (ESM-H) pitch angles. The description of ESM instruments and the general results of data analysis are presented elsewhere (KAYA and MATSUMOTO, 1978; KAYA *et al.*, 1981).

In this experiment, periodic rapid variations in electron flux were observed on JA-5 ESM-Z data while JA-5 ESM-H and JA-6 data did not show such variations. These variations could be identified as "Microbursts". This paper reports the phenomenon of low energy electron microburst measured with the ESM-Z on board the S-310JA-5 rocket.

2. Observation and Results

S-310JA-5 rocket was launched into an auroral arc from Syowa Station during the pre-stage period of a substorm at 2256:50 UT on June 10, 1978. The rocket was directed to the geomagnetic north and reached a peak altitude of 226 km ($t=236$ s). Measurements were made at altitudes above 130 km using a pair of ESM's (ESM-Z and ESM-H). The ESM-Z was set parallel and the ESM-H was set perpendicular to the rocket axis which is oriented nearly in the direction of the geomagnetic field lines

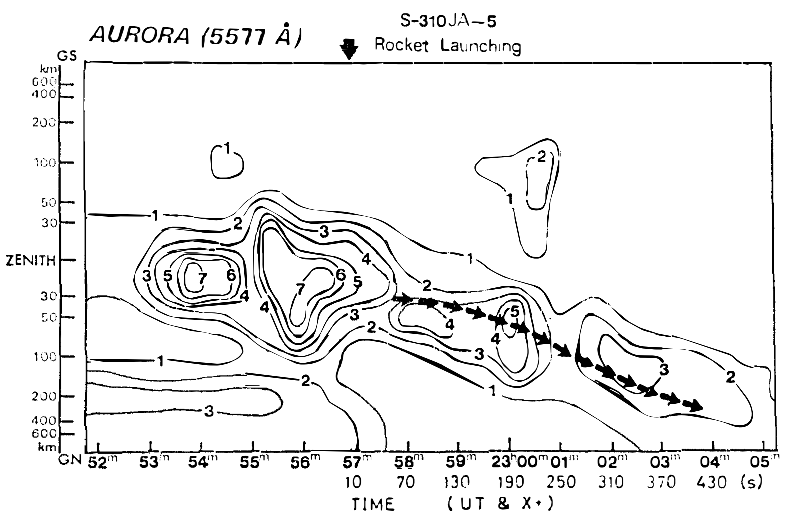

Fig. 1. The S-310JA-5 rocket trajectory projected along the geomagnetic field lines at the 100 km height with a contour map of the auroral intensity at 5577 Å (after Prof. T. Hirasawa).

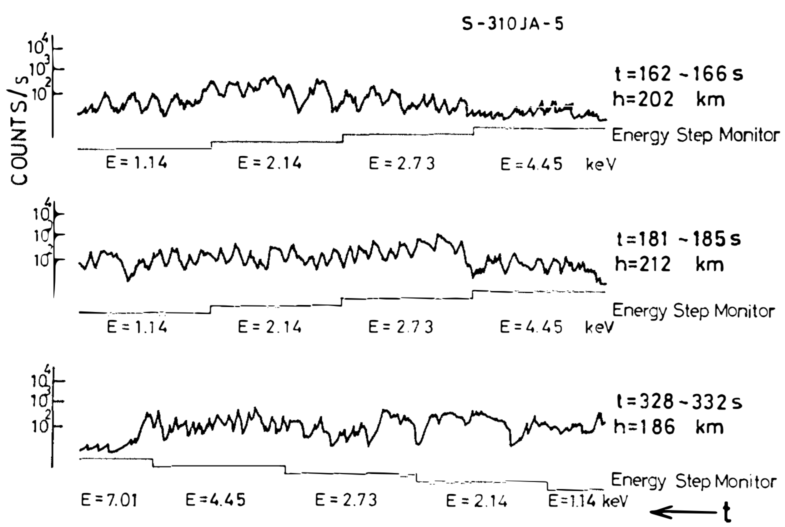

Fig. 2. Microburst structures as revealed in the ESM-Z ($\alpha = 3° \sim 34°$) data by the S-310JA-5 rocket.

during the flight. The precession and spin of the rocket resulted in the slow scanning of electron pitch angles between 3° and 34° for the ESM-Z and the fast scanning ranging from $90° \pm 3°$ to $90° \pm 34°$ for the ESM-H. Electrons having energies within five energy bands centered about 1-, 2-, 3-, 5- and 7-keV were measured with 1 second steps with the maximum measurable flux of 10^9 (/cm^2·s·sr·keV). The steps go up and down, and one cycle completes in 10 seconds including a dark count and check period. Fig. 1 shows the rocket trajectory projected along the geomagnetic field lines on the 100 km height with an average contour map of the auroral intensity in 5577 Å deduced from the all-sky photograph during the flight.

In the figure, the universal time is taken as the abscissa, and also shown is the seconds elapsed after rocket launching. The ordinate shows the horizontal distance from the zenith at the 100 km height in the geomagnetic meridian plane passing through Syowa Station. Number 5 on the contour lines shows the liminosity in kR. The electrons having energies 1-∼5-keV were present at both small and ∼90° pitch angles with the average intensity of $10^7 \sim 10^8$ (/cm^2·s·sr·keV) during the observation. In the bright region of the visible aurora, the electron fluxes having the energy around 4 keV had a strong correlation with the auroral brightness. Another significant result obtained from the experiment was periodic intensity variations of the electron flux precipitation. Examples are shown in Fig. 2, where the count rate data at three different times during the flight are reproduced. Most periodic variations continue for about 0.3∼1 s and form a kind of pulse trains. The trains sometimes encompass two or more energy ranges which, as mentioned above, are switched over every 1 second in the measurement.

3. Analysis and Discussions

The appearance of these variations is very similar to that EVANS (1967) observed at Fort Churchill in energy ranges mainly above 60 keV. As PARKS (1978) recently reviewed, these phenomena have been identified as "Microbursts" in the observation of X-ray bremstrahlung by balloon-borne equipment. Measurements of this type have generally been of an indirect nature, and direct measurements by rockets and satellites have not been so many. Moreover, the measurements have been for the energy ranges above tens of keV (O'BRIEN, 1964; OLIVEN *et al.*, 1968; LAMPTON, 1967; EVANS, 1967). CHASE (1968) tried to determine if the electron microbursts seen in high-energy electron flux also occur in less than 10 keV electron.

Four rockets were flown at Fort Churchill during particle precipitation events, three during the day and one at night. In the flight which was made during the day (1158 LT) at time of intense X-ray precipitation, electron microbursts were detected in the 80- to 320-keV range while no rapid variations occurred in the 1- to 20-keV range. In the other flights including the one which was made at night (2200 LT) into a quiet auroral arc, no rapid variations were detected.

In our experiment, the rocket JA-6 which was launched at night (0056 LT) into an intense aurora did not observe the microbursts.

It might be said that the possibility of detecting electron microbursts in less than 10-keV flux could depend on the local time, auroral activity, and the other conditions at the time of observation.

Results of preliminary analysis on the microbursts are shown in Figs. 3 and 4. Bars in Fig. 3 show times at which prominent microbursts are seen on the ESM-Z

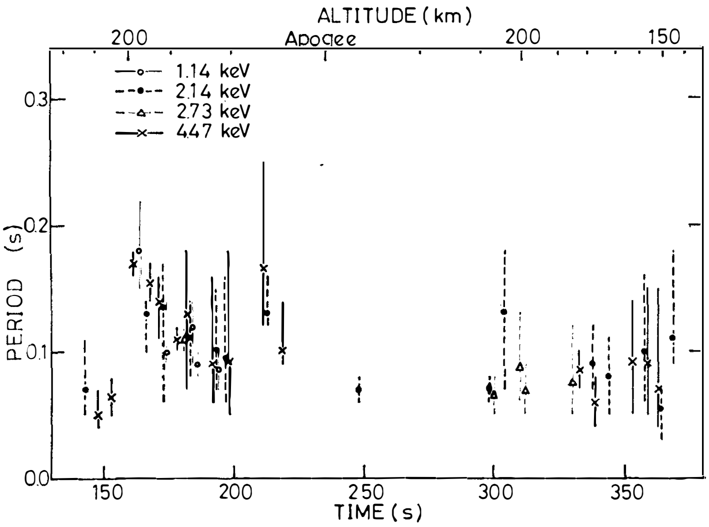

Fig. 3. Microburst events during the flight and the time range of durations of burst waveforms in the corresponding event.

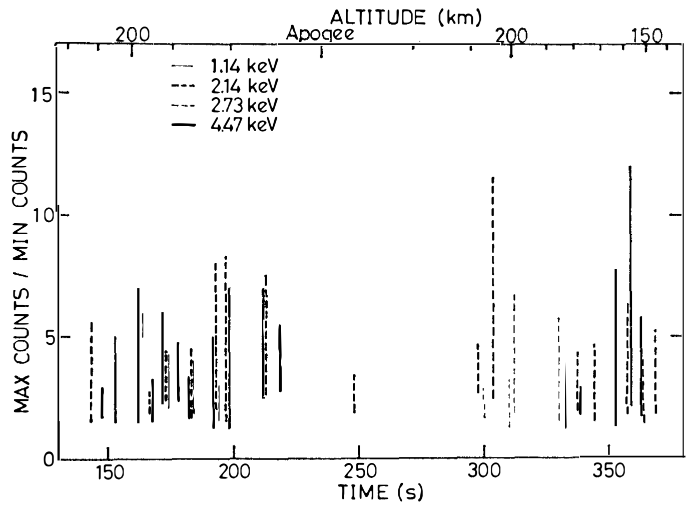

Fig. 4. Microburst events during the flight and the range of maximum and minimum count ratios in the corresponding event.

data and the time range of durations of burst waveforms in the corresponding microburst event. The durations seem to be centered around 0.1 s and this agrees with the result obtained by EVANS (1967). During time intervals $t=150\sim200$ s and $t=330\sim370$ s, the microbursts are most frequently observed. Comparing with the trajectory in Fig. 2, the rocket seems to go through the brightest regions of the aurora luminosity during the above time intervals. The microbursts are observed mainly in the energy range of $2\sim5$ keV which is most dominant in electron fluxes in the observation. The count rate in the 7 keV range is very small and periodic fluctuations are not observed.

Fig. 4 shows the range of ratios of maximum and minimum counts in burst waveforms in the individual event. The total range of the ratios is between 2 and 10. This also agrees with the past results except for the observed energy (OLIVEN *et al.*, 1968). Microbursts were not clearly observed on the ESM-H ($\alpha \approx 90°$) data as mentioned before.

The electron microbursts mentioned above were observed at local night (0156:50 LT) and this fact makes difference with that for the X-ray microbursts which have been observed at daytime (PARKS, 1978). This experiment could be the first time that the electron microbursts were directly measured in the southern hemisphere, although this might not be substantial. The velocity dispersive effect as reported by EVANS (1967) seems to be present in the form of a discrete phase shift of burst waveforms at the instant of switching of an energy step. Detailed analysis is now in process and will be reported later.

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