Analysis of ELF band waves observed by SS-520-2 sounding rocket in the polar region

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SS-520-2 sounding rocket was launched from Norway Spitsbergen on Dec. 4, 2000, to observe plasma acceleration and heating phenomena in the low altitude noon cusp region. The rocket reached the altitude of 1108km, and obtained 1150sec clear observation data. We are analyzing ELF band waves observed by EFD(Electric Field Detector) onboard SS-520-2 rocket. It is considered that ion heating processes are related to low frequency electrostatic waves. Especially in the heating mechanism of heavy ions, ELF band waves, e.g. oxygen ion cyclotron waves, are expected to play an important role. EFD is a subsystem of PWA (Plasma Wave Analyzer), and is designed to observe DC electric fields and ELF band waves with frequencies of 0-50Hz. EFD worked properly and succeeded to obtain clear electric field data.

In this rocket experiment, since the rocket flies across the Earth's magnetic field, electric fields, which observed by the rocket, contain a strong inductive electric field component. This inductive electric field is shown as a sinusoidal wave with the frequency of 1.5Hz, which is the spin frequency of SS-520-2 rocket. According to the waveform analysis, impulsive waves are shown in almost all the observation time. These impulsive waves are generated due to the photo electron emission. In the waveform analysis, no clear ELF band waves are identified.

Next, we execute spectrum analysis of EFD data to identify ELF band waves with only small amplitudes. In the spectrum data of EFD, strong harmonics due to the photo electron emission are observed. In addition, weak ELF band waves with a wide frequency range about 20-30Hz are identified. The amplitudes of these ELF band waves are less than those of the harmonics due to the photo electron emission. But these ELF band waves are identified to be not natural waves but calculation noises generated by Fourier Transformation of the photo emission pulses.

As a result, no clear ELF band waves are observed in all the observation time. This is because, SS-520-2 rocket did not fly across the noon cusp region, and observed no ion heating phenomena in this experiment. ELF band waves, e.g. oxygen ion cyclotron waves, are excited in local, therefore, these waves cannot propagate in a long distance. This is another reason why no ELF band waves observed in this rocket experiment.

This study demonstrated that it is very critical to remove the influence of the photo electron emission in analyzing ELF band waves observed by a rocket. On the other hand, the spiky pulses due to the photo electron emission shows very unique characteristics. Their widths and amplitudes gradually change in time. This indicates that the characteristics of photo emission pulses are strongly influenced by the local plasma environment, e.g. the electron temperature and density. In other words, we can estimate the local plasma environment by analyzing characteristics of the spiky pulses of photo electron emissions.