Automatic detection of Lower Cutoff frequencies of Continuum Radiation from Plasma Wave Dynamic Spectra Observed with GEOTAIL

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The PWI(Plasma Wave Instruments) onboard GEOTAIL observes plasma waves in the Magnetosphere. However, plasma densities estimated by LEP or CPI is not always reliable depending on the satellite location. Therefore, SFA observations are expected as a proxy of the plasma density detector. One of the plasma waves, Continuum Radiation, is considered that the frequency of its lower cutoff corresponds to the local plasma frequency in the vicinity of satellite. Thus we can estimate plasma densities using the plasma wave dynamic spectra. Herein we apply a new technique to the SFA data of the Continuum Radiation. We select several events in which the lower cutoff of Continuum Radiation is successfully detected and demonstrate the results.

Plasma density is one of the significant parameters for magnetospheric physics. The LEP and CPI onboard GEOTAIL observes plasma density in the Magnetosphere. However, these parameters are not always reliable, depending on the satellite location. Therefore, SFA observations are expected as a proxy of the plasma density detector. One of the plasma waves, Continuum Radiation, is considered that the frequency of its lower cutoff corresponds to the local plasma frequency in the vicinity of satellite. In the present study, we attempt to detect the lower cutoff frequency of Continuum Radiation automatically.

Herein we apply our new technique to GEOTAIL/SFA data. We process SFA data on STARS(Solar-Terrestrial Analysis and Reference System) developed in Ehime University. First of all, we load SFA data observed by GEOTAIL spacecraft on the STARS. Usually the SFA data contain spike noises, which must be removed before detections. A 2-D filter is used for this noise reduction. This filter is effective because it does not erase real edge of continuum Radiation. The cutoff frequencies are usually detected in band3 (1.57kHz-12.5kHz) or band4 (12.5kHz-100kHz). The present detecting process is composed of two steps: The first step is to detect the frequencies which obviously indicate the cutoffs. We make use of Langmuir Wave or point any obvious frequency on the SFA plot by hand. L.W. is known as a good indicator of the local plasma frequency. We often find the L.W. easily on the SFA dynamic spectrum plots since it has very conspicuous graphical patterns. Frequency and Time duration of L.W. spectrum to be detected are over 24 seconds and over 2.05 kHz. This duration is so wide that L.W. spectrum is never removed through the noise-canceling procedure. Automatic detection of L.W. frequencies is relatively easy. If we find no L.W. in the given SFA plot, we have another way for the detection: Users obtain obvious frequency by clicking mouse button on the cutoff frequency on SFA color plot. The second step is to obtain time-dependent cutoff lines. Here we assume that the cutoff frequency does not drastically change within a short time period. SFA spectrum is given in every 8 seconds and the possible maximum plasma frequency shift within 8 second is 21.875kHz. It is not difficult to find the cutoff frequency which is situated within 21.875kHz. We set a threshold and binarize the SFA data. We then move this threshold back and forth and find a most preferable frequency as a cutoff. Note that the cutoff is essentially on the continuous in the time direction (along X axis). Finally, detected lower cutoff frequencies of C.R. are drawn on SFA color plot on the STARS.

We present our new method and demonstrate how wonderfully the lower cutoffs of Continuum Radiation are automatically detected.