

Evaluation of Direction Finding Methods based on Spectral Matrix

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The ERG (Arase) satellite was launched on 20 December 2016 to study acceleration and loss mechanisms of relativistic electrons in the Earth's magnetosphere. The Plasma Wave Experiment (PWE), which is one of the science instruments on board the ERG satellite, measures electric field and magnetic field. The PWE consists of three sub-systems; EFD (Electric Field Detector), OFA/WFC (Onboard Frequency Analyzer and Waveform Capture), and HFA (High Frequency Analyzer). The OFA/WFC measures electromagnetic field spectra and raw waveforms in the frequency range from few Hz to 20 kHz. The OFA produces three kind of data; OFA-SPEC (power spectrum), OFA-MATRIX (spectral matrix), and OFA-COMPLEX (complex spectrum). The OFA-MATRIX measures ensemble averaged complex cross-spectra of two electric field components, and of three magnetic field components. The OFA-COMPLEX measures instantaneous complex spectra of electric and magnetic fields. These data are produced every 8 seconds in the nominal mode, and it can be used for polarization analysis and wave propagation direction finding.

In general, spectral matrix composed by cross-spectra of observed signals is used for direction finding, and many algorithms have been proposed. For example, Means method and SVD method can be applied on the assumption that the spectral matrix is consists of a single plane wave, while wave distribution function (WDF) method is applicable even to the data in which multiple numbers of plane waves are simultaneously included. The estimation accuracy of these direction finding methods is fundamentally dominated by the average duration and the sample size of the cross-spectra. The dominant parameters therefore should be determined adequately for the reliable estimation. In order to understand the influence due to the parameters on the direction finding, we evaluated the accuracy of the estimation results of some methods with various parameters by using the PWE/WFC data. In this presentation, we introduce these results.

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