Bayesian Evaluation Technique for Direction Finding Method using Spectral Matrix

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The plasma waves propagating in the Earth's magnetosphere are influenced by plasma on the propagation path in the generation and propagation process. In order to deeply understand the space plasma environment, in situ plasma wave observations by scientific satellites are indispensable. Spectral matrices which consist of cross spectra of electromagnetic field components are generally used for polarization analysis and direction finding of plasma waves. On the plasma wave experiment (PWE) aboard the ERG mission, power spectra and spectral matrices of VLF waves are generated onboard and transmitted continuously to the ground. These data are used in order to select the high-resolution waveform data to be downlinked, because they are generated intermittently and once stored on the onboard data recorder.

Conventional methods of direction-finding of VLF waves using a spectral matrix are classified as follows. One is based on the plane-wave approximation such as Means method and SVD method, and the other is the wave distribution function (WDF) method which regards observed signals as random waves. The methods for plane wave give a unique solution, and these methods have lower complexity than the WDF method. However, we must assess the validity of the approximation in advance. On the other hand, the WDF method estimates direction of arrival for multiple waves included in observed signals, and the number of the model parameters is generally more than the number of the input data components. To determine the solution uniquely, some additional assumption (model) is therefore required. So far many models have been proposed, and the estimated images are well known to be sensitive to the models.

By applying the Bayesian inference, reliability of the estimation methods can be evaluated under very weak assumption without determining the unique solution. In addition, the validity of the plane-wave approximation can be verified on the basis of the information of an observed spectral matrix. In this presentation, we introduce such evaluation techniques and tendencies of the solutions of direction finding methods.

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