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ESTIMATION METHOD OF SIGNAL INTENSITY DISTRIBUTION FOR A MULTI-SPACECRAFT RADIO INTERFEROMETER

Abstract

This presentation describes a method for estimating signal intensity distribution of an observation object, aiming for a construction of a radio interferometer composed of multiple spacecrafts.

In recent years, multi-spacecraft missions have been attracting more and more attention. One of the examples is a radio interferometer system implemented by a group of spacecrafts. However, there have been few examples of multi-spacecraft radio interferometers. In the conventional radio interferometry, distances among antennas needs to be measured with wavelength order accuracy. It is, however, difficult to precisely measure the relative positions of the spacecrafts which have relative motion to each other.

To solve this problem, we propose a new communication method to realize a radio interferometer with multiple satellites. This method assumes a group of spacecrafts consisting of multiple "Child" spacecrafts for observation and one "Parent" spacecraft for accumulation of the observation information from each "Child". In addition to the observation object, the reference signal source behind it is observed at the same time, and the phase delay due to spatial propagation is offset by passing those two signals through the same path. This makes it possible to accumulate the observation information on "Parent" in real time without accurate measurement of the relative distances among satellites.

We also establish an estimation method of the signal intensity distribution of the observation object from the observation information accumulated on "Parent". In this method, the relationships between the observation information and the signal intensity distribution are linearized to obtain a linear solution. The signal intensity distribution is corrected by applying the iterative method.

Numerical simulations are performed to verify those methods. It is assumed that a single signal source with a frequency of 10 MHz exists at a distance of 100 AU from the spacecraft group, and that the information about the relative position of the spacecraft includes an error of approximately 5% of the maximum baseline length, which is much longer than the wavelength. The position of the source is estimated based on the assumption and it is possible to estimate it even if the error is included in the information on the spacecraft positions. The precise measurement of distance as in the conventional radio interferometry is not required. Furthermore, even a complex distribution with multiple point sources can be estimated in the same way. The effectiveness of the proposed methods is shown by the simulations.