

Particle-In-Cell Simulation on the Receiving Antenna Characteristics in Space Plasma Environment

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Understanding of electric field antenna characteristics (e.g., effective length and impedance) in space plasma environment is important, because calibration of electric field data obtained by scientific spacecraft should be done with the precise knowledge of such characteristics. Particularly, a strong demand arises regarding the development of a method for evaluating a modern electric field instrument including its detailed structure. However, due to complex behavior of the surrounding plasma, it is often difficult to apply theoretical approaches to the analysis of practical antenna characteristics including effects of the plasma kinetics and the complex structure of the modern electric field instrument.

In the current study, we applied the electromagnetic Particle-In-Cell (EM-PIC) plasma simulation to the complex antenna analysis in space plasma. By using the PIC modeling, we can self-consistently consider the plasma kinetics. This enables us to naturally include the effects of the inhomogeneous plasma environment such as a sheath created around the antenna. We also developed an analysis technique that directly simulates situations of ES/EM-wave reception by an antenna aboard scientific spacecraft. By using the technique, we can obtain practical data of its receiving characteristics, which will be helpful for the design of an electric antenna for future magnetospheric missions.

We started the analysis of an electric field instrument MEFISTO, which is an electric field instrument for BepiColombo/MMO. For practical analysis of receiving characteristics of MEFISTO, a static plasma environment affected by the guard electrode and the current biasing should be carefully considered in the analysis. We will report the current status of their numerical modeling and effects on the receiving characteristics of MEFISTO.