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# Rheometry experiment of an electric field sensor for plasma wave observation

Tomohiko Imachi* (1), Satoshi Yagitani(1), Mistunori Ozaki(1), Ryoichi Higashi(2), and Yutaro Yokoyama(1)
(1) Kanazawa University, Kanazawa 920-1192, Japan, e-mail: imachi@imc.kanazawa-u.ac.jp
(2) Ishikawa National Institute of Technology; e-mail: higashi@ishikawa-nct.ac.jp

Observation of plasma waves is an important subject of a spacecraft observation. The waveforms of electromagnetic field observed by sensors aboard a spacecraft are converted to electric voltage and is sent to the Earth as a set of digital data. Therefore, to know the exact intensity of the electromagnetic field, an accurate calibration of the sensor is required. However, it is difficult to acquire the characteristics of an electric sensor in a ground test. For observation of the electric field component of the wave, a dipole antenna using a pair of wires (a wire antenna) is often used, and since the sensitivity must be assured at frequency of several kHz or below for plasma wave observation, the total length of the wire is very large, ranging from tens of meters to 100 m. The size of wire and the difficulty of reproduction for the space plasma environment make the ground test hard.

In this study, we try to clarify the characteristics of an electric wire antenna aboard a scientific spacecraft at low frequencies. In order to study the transition of the effective lengths of the wire antennas, we performed a rheometry experiment [1]. In this experiment, a signal is applied to two electrodes placed in parallel in water so that a quasi-static electric field is generated between the electrodes. This field is considered as the electric field component of an electromagnetic wave and is received by an antenna whose output voltage is measured. The important point of this experiment is measurement in the water. In the air, the impedance between the elements of a dipole antenna is very large in the quasi-static frequency range because the impedance is a series of capacitors, and the measurement using a voltage meter is difficult. On the other hand, in the case of water, the conductivity of water makes the antenna impedance low and a voltage meter can be used at low frequencies.

In our present research, we applied this experiment to simple structured antennas which have insulators or metal mesh sleeves, and we made a theoretical analysis which can explain the result of the experiment by using equivalent circuits [2]. Currently, we are working on experiments about a total environment of a spacecraft which contains the spacecraft body and deployed structures (e.g. solar panels). We will report the results of the experiment and theoretical analysis of electric field measurement performance under the effect of the spacecraft structure.

1. T. Imachi, et al., “Rheometry Experiment for a Wire Antenna Aboard Spacecraft at Low Frequencies,” *IEICE Trans.*, Vol. J89-B, No. 4, April 2006, pp. 552–559.

2. T. Kita, T. Imachi, S. Yagitani, M. Ozaki, R. Higashi, and F. Kondo, "Rheometry experiment of advanced wire antennas aboard scientific satellite," *Proc. 32nd URSI General Assembly and Scientific Symposium (URSI GASS 2017),* 1 page, Montreal, Canada, August 19-26, 2017.