# Rheometry experiment of the wire antenna aboard GEOTAIL

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**ABSTRACT**

In this paper, we evaluate the effective length of a dipole in low frequency range (<MHz), making use of "Rheometry Experiment". We observe the output voltage of a small dipole antenna put into an water tank, which has a quasi-static electric field created by two electrodes at both side wall of it. The result shows that the effective length is a half of its physical length in higher frequencies (> several kHz). However, in very low frequencies(< several hundred Hz) , it approaches to the physical length, as a probe antenna.

**Effective Length of an Wire Antenna aboard a Scientific Spacecraft**

Observation of plasma waves in the space is an important subject of scientific spacecraft missions. Especially, measuring the low frequency waves, lower than a few MHz, is very important to study the space plasma environment. So far, many investigations of the characteristics of various electromagnetic sensors have been made for accurate measurements, and many methods to calibrate them have been developed. The sensor frequently used to measure the low frequency AC electric field of plasma waves is a wire antenna. It is necessary for an accurate measurement to accurately estimate the effective length of each the wire antenna, because it is closely related to the gain of the sensor, and the inaccuracy of it affects greatly to the quantitative studies of plasma waves. However, it is not easy to estimate the effective length, because the antenna structure is usually complex, and its size becomes very large to increase the sensitivity to the electric field in the low frequency.

The effective length of an ideal short wire antenna in free space is considered to be a half of its physical length when the wavelength is much longer than the antenna. So far, in most researches related to plasma waves, the effective length of a wire antenna has been assumed to be a half of its physical length. However, actual wire antennas aboard spacecrafts have complex structures such as tip mass, probes, noise reduction sleeves, a spacecraft body and so on. According to the investigation using chorus emissions observed by GEOTAIL, the effective length of each of its wire antennas has been confirmed as almost a half of its tip-to-tip length.

**Rheometry Experiment**

The purpose of this paper is to estimate the effective length of a wire antenna in space plasma. In order to estimate it, we perform "Rheometry experiment"[1]. Rheometry is an experimental method to determine the effective length of a short antenna by using a water tank. In this experiment, we generate a quasi-static electric field uniformly in the water tank. The intensity of the generated electric field is exactly known so that we can estimate the effective length of a small "scale-model" wire antenna in the water from its output voltage. It would not be possible to make such a measurement in the air, because the impedance of the antenna is very high in the quasi-static frequency range, and the voltage at the antenna terminals would be changed when a voltmeter is connected. However we can make the impedance low in the water because of water conductivity, and the electric field in the water surrounded by the air becomes homogeneous because the dielectricity of the water is much higher than that of the air. A homogeneous quasi-static electric field can be used to simulate the electromagnetic plane wave gained to the antenna.

The result shows that the effective length is a half of their physical length in higher frequencies (> several kHz). However, in very low frequencies(< several hundred Hz) , it becomes as a probe antenna, and depends on the structure of the antenna.

**REFERENCES**

[1] H. O. Rucker et al., "Cassini model rheometry", *Radio Sci., 31*, 6, pp.1299, 1996.