Development of wideband impedance probe for measurement of the ion composition in the ionosphere and magnetosphere

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The performance of new wideband impedance probe system for observation of the ionospheric ion composition have been evaluated in the plasma chamber. Measurement system of Number density of Electron with Impedance probe (NEI) were developed by Oya [1966], and successfully utilized for many sounding rockets and spacecrafts such as Denpa, Taiyo, Jikiken, Hinotori, Ohzora, and Akebono [e.g. Wakabayashi et al., 2013]. NEI measures the equivalent capacitance of the probe immersed in the magnetized plasma. By applying RF signal to the probe, we can identify the minimum of equivalent capacitance at upper hybrid resonance (UHR) frequency. The frequency of RF signal is swept from 100 kHz to 25 MHz, in order to cover the UHR frequency range in the Earth’ s ionosphere. We can obtain accurate electron number density from the measured UHR frequency. NEI data obtained in several previous ionospheric sounding rockets are provided via DARTS maintained by JAXA/ISAS (https://www.darts.isas.jaxa.jp/ stp/rocket/index.html.en).
The effective capacitance of the probe in the magnetized plasma shows minimum not only at UHR frequency but also at another resonance frequency: Lower hybrid resonance (LHR). By measurement of LHR frequency, we can derive effective mass of ionospheric plasma and determine the ionospheric ion compositions. Since LHR frequency is about several kHz in the Earth's ionosphere, we have to extend the lower limit frequency of the current impedance probe system to 100 Hz.
The measurements of UHR frequency by NEI can be tested in the chamber experiments. However, due to high ion collision frequency in the chamber, it is difficult to demonstrate the measurements of LHR frequency by wideband NEI. So, the tests of the wideband NEI have to be performed in the ionosphere, where ion collision frequency is ~100 Hz, through the sounding rocket experiments. Wideband NEI will be installed on SS-520-3 and S-520-32 sounding rockets.
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