

Development of new type impedance probe with continuous detection of the UHR frequency

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Electron density is one of the most important parameters of the space plasma to identify the characteristic frequencies, Debye length, and other physical quantities. The impedance probe is the unique method to identify the absolute value of the electron density in space plasma (e.g., [1]). Impedance probe have been used in many rockets and satellites observations such as SEEK-2 experiment which aimed to investigate the mid-latitude sporadic-E layer (e.g., [2]).

However, time resolution of the impedance probe measurement is limited as ~ 500 ms because it needed the swept RF signal added to the sensor. Sometimes the time resolution is too long to measure such an inner structure of sporadic-E layer within the thickness less than 1 km. In those cases, Langmuir probe with fixed DC voltage has been used to detect fine structures, however, this method sometimes has difficulty because the effective probe area size is depended on not only the plasma densities but also temperatures and probe potential immersed in plasma. This fact is preventing us from proper understanding of the inner structure of sporadic-E layer.

We are developing a new instrumentation of the impedance probe to realize high time resolution by means of phase detection. Oya and Obayashi [1] reported that the phase of probe signal has 90 degree displacements when the RF frequency was equal to the UHR frequency. When we take into account the phase of the probe signal, it becomes possible to detect the UHR frequency with ms order of time resolution which corresponds to the spatial resolution of several m in case of the sounding rocket experiment.

As the initial step of the development, we are preparing an impedance probe system to provide the electron density distribution in the space plasma chamber at ISAS/JAXA. We are planning to establish a new type impedance probe to be installed on-board a spacecraft.

[1] Oya, H., and T. Obayashi,: Rocket measurement of the ionospheric plasma by gyro-plasma probe, Rep. Ionos. Space Res. Japan, 21, 1-8, 1967.

[2] Wakabayashi, M., Ono, T., Mori, H., and Bernhardt, P. A.: Electron density and plasma waves in mid-latitude sporadic-E layer observed during the SEEK-2 campaign, Ann. Geophys., 23, 2335–2345, 2005.