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

Makoto Wakabayashi[1]; Takayuki Ono[1]

[1] Department of Astronomy and Geophysics, Tohoku Univ.

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., Oya and Obayashi, 1967]. 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., Wakabayashi et al., 2005; Wakabayashi and Ono, 2005]. In recent years, it was reported that the sporadic-E layers have inner irregularity of plasma density due to the Kelvin-Helmholtz instability [Bernhardt, 2002] or sporadic-E instability [Tsunoda and Cosgrove, 2004], or the atmospheric gravity waves [Onoma et al., 2005].

However, time resolution of the impedance probe measurement is limited as ˜500 ms because it needed the swept RF signal added to the conductor sensor. Sometimes the time resolution is too long to measure the inner structure of a sporadic-E layer within the thickness less than 1 km. In such case, Langmuir probe with DC voltage have 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 achieve high time resolution because there is another idea to determine the UHR frequency by means of phase detection. Oya and Obayashi [1967] 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 correspond to several m spatial resolution in case of on-board the sounding rocket.

As the initial step in this development, we are preparing the impedance probe system to measure the electron density distribution in the space science chamber at ISAS/JAXA. We are planning to develop the new type impedance probe through the test experiments in the chamber.