Numerical study of the internal mesh structure for ion drift velocity analyzer on sounding rocket

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In the upper atmosphere (above 80 km), the neutral atmosphere and plasma coexist. The momentum transfer between the neutral atmosphere and plasma is the important process in elucidating phenomena such as ionospheric dynamo and ionospheric plasma density disturbance. However, there are very few reports on simultaneous and in-situ observation of the key parameters. Especially in the lower ionosphere where this process plays an important role, observation data is limited because satellites cannot fly for long periods of time. Therefore, in order to understand the interaction between the neutral atmosphere and plasma in the ionosphere, it is necessary to develop an analyzer that can observe the ion drift velocity.

To measure the ionospheric plasma, we are developing the ion drift velocity analyzer for sounding rocket. The analyzer is composed of a combination of RPA (Retarding Potential Analyzer) and IDM (Ion Drift Meter), which have been used for ionospheric ion observation. RPA enables ion energy analysis by applying voltage to metal mesh. In addition, the normal component of the drift velocity and the ion density and temperature can be estimated.

In the analyzer under development, the RPA section is composed of six mesh grids. The ions are accelerated or decelerated by the voltage applied to the mesh grid. Inside the RPA, it is desirable that the potential distribution between the meshes is uniform in the tangential direction. However, it is expected that this condition is not satisfied. In the case of non-uniform potential distribution, the magnitude of acceleration or deceleration differs depending on the ion trajectory, which may affect the velocity estimation error. Further, the mesh spacing and the wire diameter are directly connected to the transmittance, and the potential distribution may be non-uniform in the plane if the mesh is too coarse.

In this study, the potential distribution near the mesh grid was examined using SIMION, a software that calculates the trajectory of charged particles in the space where electromagnetic fields exist. By estimating the potential distribution, problems relating to the design of the mesh configuration can be sorted out, and the type and structure of the metal mesh suitable for the measurement can be determined. In this presentation, we will present the simulation results, the current status of mesh grid electrode design, and future work.

