

Development of ionization gauge for a study of the upper atmosphere

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In the Earth's atmosphere above 70 km, a part of the neutral atmosphere is ionized by various ionization processes. Since the electromagnetic force acts on the charged particles, the neutrals and plasmas mostly move in the different directions, but momentum is transferred each other due to collisions between these particles. It is thought that this momentum transport plays an important role in phenomena in this region. Thus, it is important to measure the neutral density and wind, which determine the momentum of the neutral particles, to understand these phenomena.

In this study, we try to develop an instrument to measure density of the neutral atmosphere and neutral wind in the lower thermosphere, assuming that it is installed on the sounding rocket. Specifically, we aim for the development of the ionization gauge which can be used for a pressure up to 10^{-4} Pa corresponding to that at 150 km altitude. Ionization gauge "MG-2F" made by Canon Anelva is considered as a candidate of applicable element.

In order to design the optimum structure to install MG-2F in measurement, we are considering a simulation of flow around the ionization gauge using the DSMC (Direct Simulation Monte Carlo) method which can simulate rarefied gas flows. In low pressure and large mean free path region (e.g. lower thermosphere), Navier-Stokes equation is not valid because the flow cannot be treated as continuum. The DSMC method can simulate the rarefied gas flows through the calculation of motion and collision of sample particles.

We are now considering availability of the DSMC method and MG-2F for pressure measurement in the thermosphere. First, we demonstrate the upper atmosphere environment using the vacuum chamber in which wind is induced due to pressure difference. The pressure distribution around the wind flows is measured by MG-2F. Then, the flows around the experimental system are simulated by using the DSMC method. Validity of the DSMC method on the design of the ionization gauge will be discussed by comparison between the result of simulation and experiment.

Keywords: Ionization gauge, Sounding rocket, DSMC method