

The results in the initial operation of the Neutral Mass and Velocity Spectrometer (NMS) onboard the CASSIOPE satellite

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We report on the results in the initial operation of the Neutral Mass and Velocity Spectrometer (NMS) instrument that is one of the Enhanced Polar Outflow Probe (e-POP) mission payloads onboard the CASSIOPE satellite. The scientific objective of the e-POP mission is to explore the escape of plasma from the polar ionosphere and the escape of neutral particles from the upper atmosphere and their interactions. The NMS instrument is expected to contribute toward a quantitative understanding of occurrence morphology of neutral particles with non-thermal velocity distributions. Therefore, NMS was developed based on a new principle, which is different from previous satellite-borne neutral mass spectrometers. The NMS instrument has an entrance aperture for incoming neutral particles is perpendicular to the ram direction of the satellite in order to take in neutral particles using the satellite velocity of 7-8 km/s. The NMS instrument consists of three parts: an ionization part, a detection part, and data processing part. The ionization part has an electrostatic thermionic electron gun to ionize the neutral particles by the electron beam. In the detection part, the ionized neutral particles are perpendicularly accelerated by the electric field for the Time of Flight (TOF) mass spectrometry, and the two-dimensional positions are detected with a Microchannel Plate (MCP) and a resistive anode. The two-dimensional position detection provides the relative velocities of neutral particles with a certain mass and the original velocity distribution is derived by subtracting the satellite velocity from the relative velocities.

In the initial operation of the satellite, though the NMS instrument had nothing wrong in the status, it was found that charged particles a few orders of magnitude more than expected were detected if the electron gun was off. At present, we suppose this can be caused by the incident neutral particles ionized by collisions with internal surfaces of the instrument. The influence of the collision in the velocity distribution measurement and the results of the analysis in the routine operation are discussed in this paper.

Keywords: neutral mass spectrometer, atmospheric escape, non-thermal velocity distribution