PCG38-15 Room:423 Time:May 1 14:15-14:30

Characteristics of O+ velocity distributions at Venus and ion acceleration mechanisms: ASPERA-4 observations

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O^+ ion velocity distributions for high energy O^+ beams (>100 eV) around Venus are statistically studied. The study shows that O^+ acceleration is controlled by the local convection electric field produced by the local proton and local magnetic field. In the magnetosheath, velocity distributions show a trend that perpendicular velocity component shifts from initial phase of the ring distribution to the local proton velocity. This indicates that gyro motions of the pickup ion immediately collapse after pickup and the ions are incorporated into the local proton flow. The pickup ions only escape through the $+E_L$ hemisphere. In the dayside induced magnetosphere in the $+E_L$ hemisphere, measurements show a scattered velocity distribution of O^+. This velocity distribution has two ion components depending on whether their gyro radius is larger or not than the scale of the induced magnetosphere. For O^+ ions with small gyro radius (<500 km), the O^+ velocity distribution appears on the middle phase of the ring distribution. On the other hand for the O^+ ions with a large gyro radius (>500 km), the O^+ velocity distribution is similar to the one in the magnetosheath. This means that in the induced magnetosphere two types of ions are mixed up: pickup ions subject to the E x B drift and ions moving with the local proton bulk velocity. Since both ion components flow tailward, they are convected toward the nightside. In the nightside of the induced magneto- sphere, velocity distribution shows initial and last phase of the ring distributions and parallel beam (3D ring distribution). This suggests that ion pickup occurs at the center of the plasma sheet. There is no evidence of an electric potential in the plasma sheet because the O^+ parallel beam velocity is larger than the parallel velocity component of the local proton. Our result suggests that the local convection condition is rather important to discuss ion acceleration mechanisms at Venus than the solar wind condition.

Keywords: Venus, ion escape, ion acceleration, Venus Express, ASPERA