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The effect of the motional electric field on the ion dynamics around the Martian magnetosphere

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The Martian planetary plasma interacts directly with the solar wind plasma because of the absence the strong intrinsic dipole magnetic field. The purpose of this study is to reveal physical mechanisms at the interaction region, which plays an important role for the planetary atmosphere escape processes. Due to the weak magnetic field in the interaction region, a typical Larmor radius of oxygen is 3000~ 4000 km, which is comparable to the spatial scale of the interaction region. This means that the ion particle motions are important to understand the physical mechanism at the interaction region. The particle motion is asymmetric to the convection electric field. Here we discuss physical mechanisms at the interaction region considering the direction of the motional electric field by using plasma moment data recorded by Mars Express/ASPERA-3 experiment. The spatial distribution of the plasma number density was statistically plotted in the induced electric field reference frame. The altitude of the solar wind induced boundary is 800 km higher in the dayside upward electric field hemisphere (UEFH), where Em is upward from Sun-Mars line, than that in the opposite hemisphere. The altitude depends on the angle between the Em orientation and the positional vector of the observation point. In the nightside, the boundary width in the UEFH is broad, where the solar wind number density changes gradually. In the opposite hemisphere, there exists a sharp boundary layer where the density quickly changes as the spacecraft goes close to the Mars-Sun line. It is also found that the position of the penetration boundary depends on the energy of the solar wind proton. In the nightside UEFH, the solar wind proton with lower energy (less than 1keV) can penetrate closer to the Sun-Mars line than that with higher energy.
It is evident from this analysis that the structure of the boundary region is asymmetric depending on the induced electric field. This result is consistent with many previous simulation studies which clearly show that momentum exchange occurs between the solar wind and the ionospheric plasma. Based on the result of our analysis, it is studied how plasma mechanisms is affected by the particle motion taking attention on the momentum exchange.

Keywords: Mars, ionosphere, electric field, solar wind