R009-30
Zoom meeting D ：11/2 AM2 (10:45-12:30)
11:30-11:45

Effects of the IMF direction on ion escape mechanism from Mars under weak intrinsic magnetic field conditions

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The planetary intrinsic magnetic field is critical when considering the atmospheric escape from planets. The strength of the intrinsic magnetic field particularly affects the interaction between solar wind and terrestrial-type planets (e.g., Seki et al., 2001), and it changes the escape mechanism. The terrestrial global magnetic field has also experienced strength changes (e.g., Guyodo & Valet, 1999) and reiterated reversals over 4.6 billion years (Ga) that could have affected the surface environment of planets. It is believed that ancient Mars had a global intrinsic magnetic field of interior origin and the magnetic field decayed by ~3.9 Ga (Acuna et al., 1999). One of the pieces of evidence that ancient Mars had an intrinsic field is the existence of a "crustal magnetic field" (Acuna et al., 1999). Present-day Mars leaves the magnetism in the crust mainly in the southern hemisphere, which is called the crustal magnetic field. Sakai et al. (2018) investigated the effect of a weak intrinsic magnetic field at the Martian equatorial surface on the escape mechanism. It was shown that the existence of the weak field results in an enhancement of the ion escape rate. A parker-spiral IMF was however used in order to obtain the escape rate in this earlier study.

This paper investigates the effects of the IMF direction on the ion escape mechanism from a Mars-like planet that has a northward weak intrinsic magnetic field on the equator. The northward, southward, and Parker-spiral IMFs under present solar wind conditions are compared based on multispecies magnetohydrodynamics simulations. In the northward IMF case, molecular ions es-cape from the high-latitude lobe reconnection region, where ionospheric ions are transported up-ward along open field lines. Oxygen ions originating either in the ionosphere or oxygen corona es-cape through a broader ring-shaped region. In the southward IMF case, the escape flux of heavy ions increases significantly and has peaks around the equatorial dawn and dusk flanks. The draped IMF can penetrate into the subsolar ionosphere by erosion, and the IMF becomes mass-loaded as it is transported through the dayside ionosphere. The mass-loaded draped IMF is carried to the tail, contributing to ion escape. The escape channels in the northward and southward IMF cases are different from those in the Parker-spiral IMF case. The escape rate is the lowest in the northward IMF case and comparable in the Parker-spiral and southward IMF cases. In the northward IMF case, a weak intrinsic dipole forms a magnetosphere configuration similar to that of Earth, quenching the escape rate, while the Parker-spiral and southward IMFs cause reconnection and erosion, promoting ion escape from the upper atmosphere.

This paper also presents the dependence of the escape mechanism on the IMF clock angle be-cause the escape mechanism for the purely northward and southward IMF conditions has currently been focused.

References:

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