Effects of a planetary intrinsic magnetic field on the ion loss mechanism of ancient Mars.

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Ancient Mars is thought to have had a thick atmosphere, as resent survey found the evidences that Mars had possessed liquid water in the early period. Mars has a thin atmosphere today, so there should have been some processes of removing the Martian atmosphere largely. One of the major mechanisms of the atmosphere loss is the ion loss. In ancient days, solar XUV (X-ray and extreme ultraviolet) irradiance was stronger and solar wind was denser and faster than those in present days. The ion loss from the planet might be larger under such severer solar conditions. Terada et al. (2009) investigated the ion loss from ancient Mars under ancient solar conditions using 3-D multi-species magnetohydrodynamic model and pointed out that the ion escape rate was four orders of magnitude greater than that under the present solar conditions. This study assumed that ancient Mars had no intrinsic global magnetic field, while recent observations indicate that Mars had the intrinsic magnetic field in ancient days and had lost it until now. Intrinsic magnetic field could affect the structure of the magnetic field around the planet and then the ion loss mechanism. Therefore, it is important to study the magnetic field configuration and the ion loss under extreme solar conditions and existence of the planetary intrinsic magnetic field to understand the drastic change of Martian atmosphere and climate.

We investigated the ion loss mechanism of early Martian atmosphere under strong solar conditions and weak intrinsic magnetic field using the same MHD model as Terada et al. (2009). The results show that the magnetotail near the planet has a complex structure such as triple plasma sheets due to the interaction between the interplanetary magnetic field and the intrinsic magnetic field. The escape rate of O_2^+ is higher than that with no intrinsic magnetic field, while the O^+ escape rate does not change by the existence of the weak intrinsic magnetic field. The results suggest that the intrinsic magnetic field induces escape of heavy ions from the lower ionosphere.

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