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The modulation of solar wind hydrogen deposition in the Martian atmosphere by foreshock phenomena

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Abstract

1. The neutral exosphere of Mars extends far upstream beyond the bow shock and as a result, solar wind protons can charge exchange with this neutral exosphere to produce energetic neutral atoms (ENAs). ENAs produced directly upstream of Mars will precipitate into the Martian dayside atmosphere, where some fraction can undergo a charge stripping reaction and can be observed as “penetrating protons” [1], [2], [3], [4]. Clear, quasi-periodic modulations in penetrating proton densities are observed during certain Mars Atmosphere and Volatile EvolutioN (MAVEN) periapsis passes, and we show that these modulations occur during radial IMF conditions. During such times, the region sunward of Mars is defined by quasi-parallel shock conditions, generating foreshock structures characterized by enhancements in magnetic field strength, enhancements in proton density, deceleration, and deflection of the solar wind flow. These structures are observed at time cadences equal to the modulation of penetrating proton densities at periapsis. Particle tracing simulations show that the convection of these structures with the solar wind leads to localized variations in the rate of charge exchange upstream of the shock, producing the observed temporal variations in penetrating proton densities at periapsis. The observation of modulated penetrating proton densities at periapsis can thus be used to infer the existence of radial IMF conditions upstream of the bow shock at Mars, even when MAVEN’s orbit does not sample the upstream solar wind region.

References

[1] Kallio, E. et al.: Charge exchange near Mars: The solar wind absorption and energetic neutral atom production, Journal of Geophysical Research: Space Physics, 102(A10), 22, 183-22, 197, 1997.

[2] Kallio, E. and Barabash, S.: Atmospheric effects of precipitating hydrogen atoms on the Martian atmosphere, Journal of Geophysical Research: Space Physics, 106(A1), 165-177, 2001.

[3] Halekas, J. et al.: MAVEN observations of solar wind hydrogen deposition in the atmispher of Mars, Geophysical Research Letters, 42(21), 8901-8909, 2015.

[4] Halekas, J. et al.: Seasonal variability of the hydrogen exosphere of Mars, Journal of Geophysical Research: Planets, 122(5), 901-911