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MAVEN Measurements of the Ion Escape Rate from Mars

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The loss of atmospheric particles (neutral atoms, neutral molecules, ions) to space is thought to have played a role in the evolution of Martian climate over the past ∼4 billion years. Due to the lack of a global magnetic field on Mars, the solar wind has direct access to the upper layers of the Martian atmosphere, and can drive non-thermal escape of charged particles (ions) from the atmosphere. Two spacecraft (Phobos 2 and Mars Express) have previously measured escaping ions at Mars. The recently arrived MAVEN spacecraft is equipped with instruments to measure escaping ions with high time cadence and high energy and mass resolution, as well as instruments to provide contextual information about what controls the variation in escape rates.

We report on the total escape rate of heavy planetary ions from the Martian atmosphere measured by MAVEN. Heavy ions are identified in data from the SupraThermal And Thermal Ion Composition (STATIC) instrument. Rudimentary estimates of ion escape rate are obtained by summing the measured ion fluxes over a surface downstream from Mars with respect to the solar wind flow. This estimate can then be refined to account for the limited field of view of the instrument (investigation of measured particle distributions) and the limited spatial coverage of the spacecraft orbit trajectory. Variability in measured escape rates can also be grouped according to upstream conditions and the orientation of Mars (and its crustal magnetic fields) with respect to the solar wind. Important upstream drivers include the solar Extreme Ultraviolet (EUV) flux, solar wind pressure, and the interplanetary magnetic field strength and direction. These drivers are measured directly by MAVEN's EUV, SWIA, and MAG instruments.

We will provide an initial estimate of ion escape rates based on the first several months of MAVEN data. We will then report on progress to refine these estimates to correct for instrument field of view and spacecraft coverage effects, as well as the influence of external drivers. We will place these estimates in context with previously published ion escape rates, and address the implications for atmospheric loss over the history of the planet