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Neutral escape at Mars induced by the precipitation of high-energy protons and hydrogen atoms of the solar wind origin

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One of the first surprises of the NASA MAVEN mission was the observation by the SWIA instrument of a tenuous population of protons with solar wind energies travelling anti-sunward near periapsis, at altitudes of ∼150-250 km (Halekas et al., 2015). While the penetration of solar wind protons to low altitude is not completely unexpected given previous Mars Express results, this population maintains exactly the same velocity as the solar wind observed. From previous studies it was known that some fraction of the solar wind can interact with the extended corona of Mars. By charge exchange with the neutral particles in this corona, some fraction of the incoming solar wind protons can gain an electron and become an energetic neutral hydrogen atom. Once neutral, these particles penetrate through the Martian induced magnetosphere with ease, with free access to the collisional atmosphere/ionosphere.

The origin, kinetics and transport of the suprathermal O atoms in the transition region (from thermosphere to exosphere) of the Martian upper atmosphere due to the precipitation of the high-energy protons and hydrogen atoms are discussed. Kinetic energy distribution functions of suprathermal and superthermal (ENA) oxygen atoms formed in the Martian upper atmosphere were calculated using the kinetic Monte Carlo model (Shematovich et al., 2011, Shematovich, 2013) of the high-energy proton and hydrogen atom precipitation into the atmosphere. These functions allowed us: (a) to estimate the non-thermal escape rates of neutral oxygen from the Martian upper atmosphere, and (b) to compare with available MAVEN measurements of oxygen corona. Induced by precipitation the escape of hot oxygen atoms may become dominant under conditions of extreme solar events - solar flares and coronal mass ejections, - as it was shown by recent observations of the NASA MAVEN spacecraft (Jakosky et al., 2015).

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