Atmospheric Sputtering

V.I. Shematovich[1,2], F. Leblanc[3], and R.E. Johnson[4]
[1]Institute of Astronomy RAS, Moscow, Russian Federation; [2]Institute of Geophysics and Planetary Physics, University of California, Riverside, USA; [3]Service d'Aeronomie du CNRS, Verrieres Le Buisson, France;
[4]Engineering Physics, University of Virginia, Charlottesville, USA

The flow of solar wind and local pick-up ions onto the Martian exobase can affect the long-term evolution of the atmosphere, a process often referred to as atmospheric sputtering (*Johnson* 1990, 1994). Solar forcing via both atmospheric sputtering and UV absorption forms a hot oxygen corona. This corona, in turn, alters the incoming solar plasma by *mass loading* the solar wind with newly created ions and by *charge exchange* collisions. Mars-Express observations (*Lundin et al*. 2004) show that the incident plasma penetrates deeply into the Mars atmosphere: e.g., keV O^+ found at 300 km are of exospheric origin accelerated by the interplanetary magnetic fields. Therefore, acceleration processes might also occur deep into the ionosphere with the planetary wind from the dayside region sweeping tailward at altitudes as low as 270 km. Pick-up ions following the field lines that are draped across Mars can either be swept away or re-impact the atmosphere with energies up to ~1 keV. Through momentum transfer collisions they can energize other atoms and molecules enhancing escape and populating the hot corona (*Luhmann and Kozyra* 1991; *Luhmann et al*. 1992; *Johnson and Luhmann* 1998). Unlike dissociative recombination, sputtering is non-selective and can, in principle, eject all particles that are present at the Martian exobase: C, O, CO, N, N_2 and CO_2 (*Leblanc and Johnson* 2002). In the present epoch, the sputter loss rate of O and CO_2 has been estimated to range from 3×10^{23} to 4.7×10^{24} atoms/s (*Chassefiere and Leblanc* 2004). This is smaller than the nonthermal escape of oxygen due to exothermic chemistry but may dominate the carbon loss. Modeling also suggests that atmospheric sputtering could have dominated in earlier epochs (*Leblanc and Johnson* 2001, 2002).

The physical and chemical processes leading to the formation, kinetics, and transport of suprathermal O atoms in the corona will be described. This is a computationally challenging non-linear problem. On one hand, the chemistry induced by the UV and the atmospheric sputtering cause the formation of an extended corona (*Krestyanikova and Shematovich* 2005, 2006). On the other hand, pick-up-ion formation in this corona leads to escape and enhanced atmospheric loss. This feedback process is critical in determining atmospheric loss in earlier epochs (*Johnson and Luhmann* 1998). The affect on the loss rate of the uncertainties in the energy spectra of ionospheric pick-up ions and our knowledge of the differential energy transfer cross sections will be discussed.

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