The role of plasma waves in Mars' atmospheric loss

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Abstract

An analysis of recent observations of plasma waves, electron fluxes, and ion fluxes in Mars' ionosphere indicates that ion heating may have had a considerable impact on Mars' atmospheric loss. We discuss two energy sources of plasma waves: the solar wind interaction with Mars and field-aligned currents in the cusps of the crustal magnetic fields. These plasma waves can damp through cyclotron resonance with the O^+ population in the ionosphere leading to substantial heating and subsequent O^+ escape. These mechanisms can support ~10^{25} atoms s^{-1} (~0.4 kg/s) O^+ outflow indicated by observations. We suggest that a stronger source of O^+ ~4 Gyr ago could support losses on the order of 100 kg/s, enough to strip Mars atmosphere or 10 m of water in a ~0.3 Gyr period. The observational evidence for ion heating is, with current data sets, largely circumstantial so we suggest needed observations.