



Mars' atmosphere well protected from the solar wind

Despite the absence of a global Earth-like magnetic dipole, the Martian atmosphere is well protected from the effects of the solar wind on ion escape from the planet. New research shows this using measurements from the Swedish particle instrument ASPERA-3 on the Mars Express spacecraft. The results have recently been presented in a doctoral thesis by Robin Ramstad, Swedish Institute of Space Physics and Umeå University, Sweden.

Present-day Mars is a cold and dry planet with less than 1% of Earth's atmospheric pressure at the surface. However many geological features indicate the planet had an active hydrological cycle about 3-4 billion years ago. An active hydrological cycle would have required a warmer climate in the planet's early history and therefore a thicker atmosphere, one capable of creating a strong greenhouse effect.

A common hypothesis maintains that the solar wind over time has eroded the early Martian atmosphere, causing the greenhouse effect, and thus the hydrological cycle, to collapse. Unlike Earth, Mars has no global magnetic dipole, but the solar wind instead induces currents in the ionized upper atmosphere (the ionosphere), creating an induced magnetosphere.

"It has long been thought that this induced magnetosphere is insufficient to protect the Martian atmosphere," says Robin Ramstad. "However our measurements show something different."

The Swedish-led ion mass analyser on Mars Express has been measuring the ion escape from Mars since 2004. In his research, Robin Ramstad has combined and compared measurements of the ion escape under varying solar wind conditions and levels of ionizing solar radiation, so-called extreme ultraviolet (EUV) radiation. The results show that the solar wind has a comparatively small effect on the ion escape rate, which instead mainly depends on the EUV radiation. This has a large effect on estimations of the total amount of atmosphere that has escaped to space.

"Despite stronger solar wind and EUV-radiation levels under the early Sun, ion escape can not explain more than 0.006 bar of atmospheric pressure lost over the course of 3.9 billion years," says Robin Ramstad. "Even our upper estimate, 0.01 bar, is an insignificant amount in comparison to the atmosphere required to maintain a sufficiently strong greenhouse effect, about 1 bar or more according to climate models."

The results presented in the thesis show that a stronger solar wind mainly accelerates particles already escaping the planet's gravity, but does not increase the ion escape rate. Contrary to previous assumptions, the induced magnetosphere is also shown to protect the bulk of the Martian ionosphere from solar wind energy transfer. Robin Ramstad is from Västerås in Sweden and has a Master of Science degree in Engineering Physics from Luleå University of Technology.
Thesis defence

On Friday 8 December 2017 Robin Ramstad of the Swedish Institute of Space Physics in Kiruna and Umeå University will defend his PhD thesis entitled Ion escape from Mars: measurements in the present to understand the past. The thesis defence will take place at 9 am in the Aula at the Swedish Institute of Space Physics in Kiruna.

The faculty opponent is Assoc. Prof. David Brain, Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, USA. The candidate's supervisors are Prof. Stas Barabash and Assoc. Prof. Yoshifumi Futaana at the Swedish Institute of Space Physics, Kiruna.

More information:

Robin Ramstad, Swedish Institute of Space Physics, robin@irf.se, tel. +46-980-79115

Rick McGregor, Information Officer, Swedish Institute of Space Physics, rick@irf.se, tel. +46-980-79178

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URL zur Pressemitteilung: <http://Information about the defence and a link to the thesis:>
<http://urn.kb.se/resolve?urn=urn:nbn:se:umu:diva-141892>

URL zur Pressemitteilung: <http://IRF's Mars Express web page:> http://www.irf.se/link/MEX_press

URL zur Pressemitteilung: <http://AGU Editor's Highlight of Robin Ramstad's GRL paper:>
<https://eos.org/editor-highlights/where-did-the-water-go-on-mars>