EPSC Abstracts
Vol. 7 EPSC2012-102 2012
European Planetary Science Congress 2012


# Auroral plasma acceleration processes at Mars

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## Abstract

Following the first Mars Express (MEX) findings of auroral plasma acceleration above Martian magnetic anomalies[1, 2], a more detailed analysis is carried out regarding the physical processes that leads to plasma acceleration, and how they connect to the dynamo-, and energy source regions. The ultimate energy source for Martian plasma acceleration is the solar wind. The question is, by what mechanisms is solar wind energy and momentum transferred into the magnetic flux tubes that connect to Martian magnetic anomalies? What are the key plasma acceleration processes that lead to aurora and the associated ionospheric plasma outflow from Mars?

The experimental setup on MEX limits our capability to carry out "auroral physics" at Mars. However, with knowledge acquired from the Earth, we may draw some analogies with terrestrial auroral physics. Using the limited data set available, consisting of primarily ASPERA and MARSIS data, an interesting picture of aurora at Mars emerges.

There are some strong similarities between accelerated/heated electrons and ions in the nightside high altitude region above Mars and the electron/ion acceleration above Terrestrial discrete aurora. Nearly monoenergetic downgoing electrons are observed in conjunction with nearly monoenergetic upgoing ions. Monoenergetic counterstreaming ions and electrons is the signature of plasma acceleration in quasi-static electric fields. However, compared to the Earth's aurora, with auroral process guided by a dipole field, aurora at Mars is expected to form complex patterns in the multipole environment governed by the Martian crustal magnetic field regions. Moreover, temporal/spatial scales are different at Mars. It is therefore of interest to mention another common characteristics that exist for Earth and Mars, plasma acceleration by waves. Low-frequency, Alfvén, waves is a very powerful means of plasma acceleration in the Earth's magnetosphere. Low-frequency waves associated with plasma acceleration processes, are also identified at Mars [3, 4]. Indeed, low-frequency waves generated in the magnetosheath, are omnipresent in the Martian plasma environment, down to the low-altitude ionosphere.

## References

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