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Altitude of Mars aurorae deduced from SPICAM limb detections

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Abstract

Martian aurorae have been detected with the SPICAM instrument on board Mars Express both in the nadir and the limb viewing modes. In this study, we focus on three limb detections to determine the altitudes of the auroral emissions and their intensities. We then use a model of electron transport in the Martian thermosphere based on a Monte-Carlo method to simulate and to understand the excitation processes leading to these auroral emissions.

1. Introduction

The first Martian aurora was detected by [1] with SPICAM, in a limb observation. [2] discovered several other aurorae in nadir observations and one additional limb detection. Nadir observations were studied in more details by [3]. Here, we added a third limb detection to this list, based on a search of the entire SPICAM limb observations database.

The UV aurorae observed in the Martian atmosphere include the CO ($a^3\Pi$ - $X^1\Sigma$) Cameron bands between 180 and 240 nm, the CO ($A^1\Pi$ - $X^1\Sigma^+$) Positive system (CO 4P) between 135 and 170 nm, the CO_2^+ ($B^2\Sigma_u^+$ - $X^2\Pi_g$) doublet near 289 nm, the OI multiplet at 297.2 nm and the 130.4 nm OI emission.

2. Data analysis

The altitude of the CO Cameron bands emission was found to be 137±27 km. The intensities of the auroral emissions have also been quantified. The mean intensities deduced for these emissions reach 2500 R, 500 R, 650 R, 360 R and 30 R for the CO Cameron bands, the CO Positive system, the CO_2^+, the OI multiplet at 297.2 nm and the 130.4 nm OI emission, respectively. As already noticed by [2] and [3], Mars aurorae occur at the statistical boundary of open-closed magnetic field lines, in cusp-like structures.

3. Modelling

The Monte-Carlo model of electron transport in the Martian thermosphere implemented by [4] and [5] can reproduce auroral emissions either using mono-energetic electron distributions or ASPERA-3/ELS electron energy spectra as input parameters. Results obtained with mono-energetic distributions ranging from 50 to 1000 eV simulate auroral emissions occurring between 117 and 141 km, in agreement with the observations. The model also well reproduces the observed altitudes of the aurorae with electron energy spectra measured with the ASPERA-3/ELS instrument.

4. Summary and Conclusions

Limb observations of Martian aurorae are useful to determine the intensities of the auroral emissions and their altitudes. The Monte-Carlo model of electron transport in the Martian thermosphere correctly reproduces the altitude of the aurorae but the predicted vertically integrated intensities appear to be overestimated, probably as a consequence of the inclination and curvature of the magnetic field line threading the aurora. The intensity ratio of the CO and CO_2^+ emissions is in good agreement with the limb observations though.

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