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Mars UV emissions from atomic oxygen at 130.4 and 135.6 nm: MAVEN/IUVS limb observations and modeling

Birgit Ritter (1,2), Jean-Claude Gérard (1), Leo Gkouvelis (1), Benoit Hubert (1), Sonal Jain (3), and Nick Schneider (3)

(1) University of Liège, LPAP, Liège, Belgium (b.ritter@uliege.be), (2) Royal Observatory of Belgium, Brussels, Belgium, (3) LASP, University of Colorado, USA

We analyze limb observations of dayglow emissions from atomic oxygen in the Martian thermosphere. Neutral atomic oxygen is produced by photodissociation of CO_2 and supersedes CO_2 as the most abundant neutral species above 200 km and up to the lower exosphere. It plays a major role in the control of the thermal structure of the Martian atmosphere and can then be used as an indicator of the thermospheric circulation. We focus on the OI(^{3}S) and the OI(^{5}S) excited states that emit line multiplets at 130.4 nm and 135.6 nm, respectively. The Martian atmosphere is optically thick at 130.4 nm due to resonance scattering from the solar oxygen 130.4 nm line. Both oxygen emissions are furthermore produced by photoelectron impact on O and to a small fraction also by photoelectron impact on CO_2. Other processes are negligible, but absorption by CO_2 plays a major role for the observed limb peak intensities and altitudes.

The data has been collected during the last four years by the Imaging Ultraviolet Spectrograph (IUVS, McClintock et al., 2015) instrument on board the Mars Atmosphere and Volatile EvolutioN mission (MAVEN) spacecraft. IUVS is capable of observing the Martian upper atmosphere within a total spectral range of 115-340 nm and operates in limb, coronal scan and disc mode. Up to now, the observations cover two full Martian years and provide an unprecedented dataset covering various latitude and local time ranges per epoch.

We present analysis of periapsis limb observations with tangent point altitudes between 80 and 200 km using data provided by the NASA Planetary Data System (PDS). The variations of the observed limb peak intensities and altitudes of the UV emissions are investigated with respect to solar longitude, latitude and solar zenith angle. The influence of the solar flux on the intensity of the emission is shown. For specific narrow ranges of these parameters, mean limb profiles are created. We then use model atmospheres from the Mars Climate Database (MCD) and in situ solar flux data from the MAVEN Extreme Ultraviolet Monitor (EUVM, Eparvier et al., 2015) to perform Monte Carlo and for 130.4 nm additionally radiative transfer modeling for comparison with the observations.

This is the first time since the Mariner 6/7 observations in 1969 that the 135.6 nm emission at Mars is investigated and the first time that a qualitative comparison of the two oxygen emissions is performed.

References

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