Multispectral analysis of the Martian dayglow from UVIS-NOMAD on board TGO

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TGO-UVIS limb observations

Since April 2019, the UVIS spectrometer on board EXOMARS-TGO has been observing the Martian dayglow between 200 and 650 nm with a spectral resolution of about 1.5 nm. The ‘nadir’ channel has been used to increase the sensitivity.

Two special pointing modes have been used:

- **Inertial limb** pointing: the line of sight keeps a fixed direction in the inertial space. The spacecraft motion along its orbit generates an ingress and an outgress limb profiles

- **Limb tracking** pointing: the line of sight remains at a quasi-fixed altitude above the surface
The $^1\text{S}$$\rightarrow$$^1\text{D}$ transition generates the green line at 557.7 nm which is conspicuous in the dayglow visible spectrum (see detector image below).

The $^1\text{D}$$\rightarrow$$^3\text{P}$ transition at 630 nm is expected to be also present, but much weaker, as the $^1\text{D}$ state has a much longer radiative lifetime and is efficiently deactivated by CO$_2$ (slide 5).
The green line dayglow is observed between 70 and 150 km together with UV emission for OI, CO and CO$_2^+$. Green line limb profiles have been collected since April 2019 2-4 times/month.
What can we learn?
- Expansion of the atmosphere (increased solar heating near perihelion, dust storms)
- Latitudinal trends
- Scale height and temperature

Aoki et al., in preparation
What can we learn?

The red line at 630 nm requires averaging of hundreds of spectra.

777 spectra have been co-added to get an OI 630-nm limb profile (red dots). The mean profile is compared with model simulations for 2 SZAs near perihelion and aphelion.

Gérard et al., GRL, 2021
Limb tracking mode: altitude of the tangent point remains quasi-constant.

**dayside**

- 110-115 km
- 71-81 km
Limb tracking observations provide latitudinal cuts of the 557.7 nm brightness at different altitudes (in this case the main ★ and secondary ● peaks)
OI green line limb tracking observations

In this case, the latitude of maximum intensity does not coincide with the smallest SZA.
The comparison with the photochemical model indicates:

- The model simulated intensities are higher than observed
- The observed brightness maximum is shifted northward relative to the model simulation

In progress
O1 green line limb tracking observations

The main source of the 557.7-nm dayglow:

\[ \text{CO}_2 + \text{UV photons} \rightarrow \text{CO} + \text{O}^{(^1\text{S})} \]

\[ \text{O}^{(^1\text{S})} \rightarrow \text{O}^{(^3\text{P})} + 557.7 \text{ nm} \]

The model predicts a smaller intensity difference between the two branches.

The same may be done for other dayglow emissions.

In progress
Conclusions

• NOMAD-UVIS limb observations have been performed successfully in a special spacecraft pointing mode since April 2019
• They have lead to the discovery of the OI 557.7 and 630 nm dayglow emissions
• The vertical distribution of their intensity is correctly predicted by photochemical model simulations
• The CO Cameron and CO$_2^+$ UV doublet and FDB bands are also observed in the near ultraviolet
• Limb tracking observations, now in progress, provide latitudinal cuts at a fixed altitude for comparison with model

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