

STUDY OF THE OXYGEN DAYGLOW IN THE MARTIAN ATMOSPHERE WITH NADIR DATA OF PFS-MEX

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The photo-dissociation of CO₂ in the Martian atmosphere produces free oxygen atoms from which molecular oxygen and ozone (O₃) are formed. Ozone, which is one of the minor constituent of the Martian atmosphere, is also dissociated by solar UV light producing molecular oxygen in the O₂(a) excited state, together with a minor component of the O₂(b) and O₂(X) states. The O₂ (*a*¹Δ_g) state may be de-excited by collisions or emitting radiation. Deactivation through collision with CO₂ dominates at altitude below 20 km where the CO₂ concentration is high. The rate constant for this reaction is small ($K < 2 \cdot 10^{-20}$ cm³ molecule⁻¹ s⁻¹ [2]) and above 20 km the reaction is negligible because of the small value of $\tau K[\text{CO}_2]$, where τ is the radiative lifetime of the O₂ (*a*¹Δ_g) molecules and [CO₂] is the CO₂ concentration. Therefore, above 20 km of altitude O₂ (*a*¹Δ_g) decays emitting radiation at 1.27 μm (the so called Infrared Atmospheric System of O₂ day-glow) and at 1.58 μm. This last band should be about 45 times weaker than the band at 1.27 μm [8] and it is very difficult to observe on the dayside.

In this work we study the nadir observations of oxygen day-glow at Mars with the Planetary Fourier Spectrometer on board the Mars Express ESA mission (PFS-MEX [5]). The goal of this study is to map this glow over the planet during three Martian years. We compute the oxygen emission at 1.27 μm for the dayside observations and we take into account the correction for air mass and for the ground reflection using the formula of [6]:

$$4\pi I = \frac{4\pi I_m}{\frac{1}{\cos \psi} + \frac{2\pi r_h^2 I_c}{I_0 \cos z}} \quad (1)$$

where ψ and z are the emission and incidence angles respectively. $I_0 = 22.5$ [erg/cm² sec sr cm⁻¹] is the solar brightness at 1.27 μm [4], I_c the continuum radiation, $r_h = 1.5$ AU the heliocentric distance of Mars. Our results, essentially in agreement with similar previous results [3],[7],[1] indicate that the maximum oxygen emission occurs at equinoxes over the polar regions. An emission at middle-low latitudes is observed at the aphelion with lower values respect to the polar regions. Figure 1 shows a PFS average spectrum at the beginning of southern spring

(solar longitude [190°,200°]) at latitude range [-80°, -70°]. The main emission peak is at 7882 cm⁻¹ and at the PFS resolution many lines of the R branch (transitions with $J'=J''+1$) can be resolved. This allows us to retrieve the oxygen rotational temperature by means of the linear relation between the logarithm of the line intensity divided by the line strength factor and the energy of the upper rotational state. In fact, the emission intensity for individual lines is given by the following relation:

$$I_{em}(v) = C v^J S_J \exp(-[BJ(J+1)hc/KT])$$

where C is a constant, v is the transition frequency, S_J are the line strength factors, B is the rotational constant and J is the rotational quantum number for the emitting level. We will show the results on the rotational temperatures found with PFS nadir data.

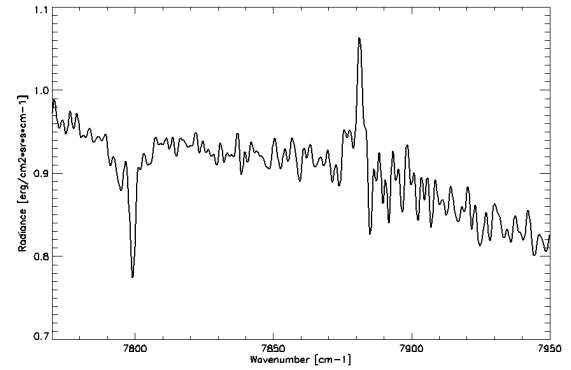


Figure 1. Average of 746 PFS spectra in the latitude range [-80°, -70°] and solar longitude range [190°, 200°].

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