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Study of the deuterium Lyman-alpha emission observed with the "low resolution mode"of MAVEN/IUVS

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Abstract

We studied a set of observations of the Lyman-α profile by MAVEN/IUVS using the low resolution mode. The brightness profile in the lower corona, especially the bright limb, is best reproduced with a deuterium population during the southern summer as expected from the high resolution echelle mode observations. Therefore it is possible to derive information on the atomic deuterium density at this season not only from the echelle mode but also from the coarser spectral resolution.

1. Introduction

The recent observations performed with the "echelle mode" by the Imaging Ultraviolet Spectrograph (IUVS) aboard the Mars Atmosphere and Volatile EvolutioN (MAVEN) mission indicated large deuterium brightness near Ls=270° [1]. The deuterium brightness observed at the beginning of the mission, when Mars was close to its perihelion show brightness ~ 1 kR much larger than the first deuterium detection from Earth ~ 20-50 R [2]. During this period, especially near the terminator, the Lyman-α emission observed at 121.6 nm with the "low resolution mode" present some vertical profiles that were not reproducible with models that simulated only the emission from the thermal hydrogen population [3], that are expected to dominate at the observed altitudes. In this study we investigate the possible contribution of the deuterium Lyman-α emission to explain the vertical brightness profile in these observations.

2. Observations

A vertical average of few individual profiles of the emission at 121.6 nm observed by both "low resolution mode" and the echelle mode for a very close geometry of limb observations near the terminator on the end of December 2016 (Ls ~ 285-290) is displayed on Fig. 1. This profile indicates that the strong bright limb near ~ 120 km observed with the "low resolution mode" is mainly due to the deuterium emission and consistent with the observations obtained with the echelle mode.

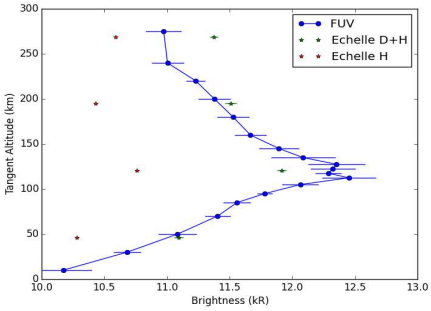

Fig. 1 Comparison between the Lyman-α average profile observed by the "low resolution mode" (blue line) and the average H (red dots) and H+D brightness profile (green dots) obtained at the same time and with similar geometry with the echelle mode.

Such bright limbs are observed systematically at other periods, where no limb observations with the echelle mode are available (from Dec 2014 to March 2015) and are not attributed to proton aurora that are observed only sporadically and characterized by short time scale increases of the brightness [4].

At other periods (for example July 2015), the deuterium emission observed with the echelle mode was much weaker [1]. The vertical profiles of the 121.6 nm brightness observed during this period with the "low resolution mode" do not present a

substantially bright limb (Fig. 2), showing correlation between the presence of a bright limb observed with the "low resolution mode" and the detection of a substantial deuterium emission with the echelle mode.

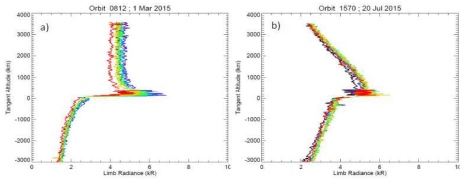

Fig. 2 Vertical profile of the 121.6 nm emission observed from the full outbound observations (disk and coronal scans) by IUVS for orbit 812. Each color represents the profile for one spatial bin. 1b) Same as figure 1a but for an orbit where no strong deuterium emission was detected with the echelle mode. The profile between 100 and 800 km is flat and doesn't present a bright limb.

3. Modeling

Hydrogen produced by the photodissociation of water vapor at ~80 km has been recently suggested to be an important source of atomic hydrogen in the Martian thermosphere near southern summer [5]. In that case, the hydrogen density profile should differ from the density profile simulated from the ionospheric H_2 + CO_2^+ only, due to a lower altitude of production. We will also present the effect on the derived D and H density profiles.

A model including both the H and D Lyman-α emissions provides a better fit to the observations in the lower corona below 500 km, as shown in Fig. 3. The relative D and H brightnesses are in reasonable agreement with the echelle brightnesses from the average profile (Fig. 1).

Therefore, it is possible to use the "low resolution mode" observations to complete the derivation of the D and H density profile near Ls= 270°.

The D and H density derived from the low resolution mode of IUVS observations and the local time variations will be presented.

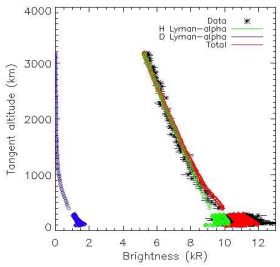

Fig. 3 Example of observed Lyman-α profile during orbit 4352 (Ls =286°, SZA ~ 84-90°) and the derived best fit, for an exospheric temperature of 200 K and an arbitrary interplanetary background of 500R.

References:

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