



HAL
open science

Improving the Detectability of Faint Emissions with MAVEN IUVS Echelle: Applications to Deuterium Lyman- and the D/H Ratio

Majd Mayyasi, John Clarke, Dolon Bhattacharyya, Jean-Yves Chaufray, Jean-Loup Bertaux, Nicholas Schneider

► **To cite this version:**

Majd Mayyasi, John Clarke, Dolon Bhattacharyya, Jean-Yves Chaufray, Jean-Loup Bertaux, et al.. Improving the Detectability of Faint Emissions with MAVEN IUVS Echelle: Applications to Deuterium Lyman- and the D/H Ratio. EPSC-DPS Joint Meeting 2019, Sep 2019, Geneva, Switzerland. pp.EPSC-DPS2019-1030-1. insu-04450767

HAL Id: insu-04450767

<https://insu.hal.science/insu-04450767>

Submitted on 10 Feb 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Improving the Detectability of Faint Emissions with MAVEN IUVS Echelle: Applications to Deuterium Lyman- α and the D/H Ratio

Majd Mayyasi (1), John Clarke (1,2) Dolon Bhattacharyya (1) Jean-Yves Chaufray (3) Jean-Loup Bertaux (3) Nicholas Schneider (4) and the IUVS team.
(1) Center of Space Physics, Boston University, Boston, MA, USA (majdm@bu.edu), (2) Department of Astronomy, Boston University, Boston, MA, USA (3) LATMOS-IPSL, CNRS, Guyancourt, France. (4) LASP, Boulder, CO, USA.

Abstract

The Mars Atmosphere and Volatile Evolution (MAVEN) mission's Imaging Ultraviolet Spectrograph (IUVS) high resolution echelle channel can resolve observations of hydrogen and deuterium Lyman- α as well as O triplet FUV emissions. D Lyman- α is too faint to be measured above the detector noise level when Mars is far from perihelion. Lessons learned from 5 years of IUVS echelle observations have been applied to produce a new data reduction pipeline in which the faint D emission can be better resolved.

1. Introduction

The MAVEN IUVS echelle is designed to optimize observations of resonantly scattered D and H Lyman- α , O triplet and forbidden doublet emission lines [1]. In the ~5 years that MAVEN has been orbiting Mars, the background noise level of the echelle detector was found to limit the detectability of faint emissions to times when they are bright. For deuterium Lyman- α , this brightening has been observed to be around perihelion [2,3]. At remaining seasons, the data reduction pipeline developed for signal retrieval showed D brightness levels to drop to the background noise level [4].

A new data reduction pipeline has been developed to optimize the signal retrieval for faint emissions in the MAVEN IUVS echelle observations. The new

pipeline includes a new calibration using simultaneous IUVS and Hubble Space Telescope observations. The results of the new data reduction pipeline are compared to the previous one to show higher accuracy retrieval of faint emissions [Fig. 1].

H Lyman- α is an optically thick emission that is relatively bright at Mars for most MAVEN observational conditions. Improving the accuracy of MAVEN's D Lyman- α emission retrievals along with the H Lyman- α measurements can provide improved constraints for radiative transfer models to use in order to generate the abundances of D and H in the upper atmosphere of Mars. With D and H densities, the D/H ratio can be determined to provide estimates of water escape flux from Mars – a primary objective of the MAVEN mission [5].

2. Figures

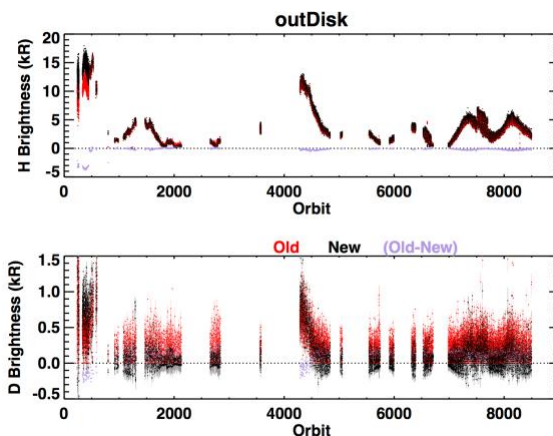


Figure 1: A comparison of old (red), new (black) and the difference between old and new (purple) data reduction pipelines for the MAVEN IUVS Echelle channel. The H Lyman- α brightness (top) varies minimally while the D Lyman- α brightness (bottom) shows more pronounced variations. The new pipeline more clearly portrays the variability as well as reliability of faint emissions.

References

- [1] McClintock, W. et al. (2015), The imaging ultraviolet spectrograph (IUVS) for the MAVEN mission, *Sp. Sc. Rev.*, 195, 75-124.

[2] Clarke, J. T. et al., (2017). Variability of D and H in the martian upper atmosphere observed with the MAVEN IUVS echelle channel, *JGR*, 122.

[3] Mayyasi, M. et al. (2019). Seasonal variability of deuterium in the upper atmosphere of Mars, *JGR*, 124, 2152-2164.

[4] Mayyasi, M. et al (2017). IUVS echelle-mode observations of the interplanetary hydrogen: Standard for calibration and reference for cavity variations between Earth and Mars during MAVEN cruise, *JGR*, 122.

[5] Jakosky, B., et al. (2015). MAVEN explores the martian upper atmosphere, *Science*, 350, 6261, 643.