EPSC Abstracts
Vol. 13, EPSC-DPS2019-1030-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

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 or 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

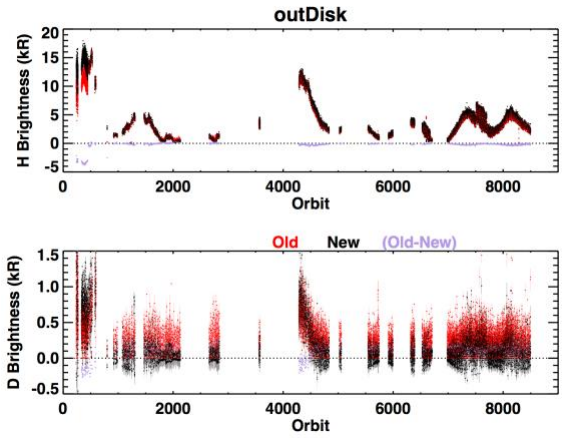

Figure 1: A comparison of old (red), new (black) and the difference between old and new (purple) data reduction pipelines for the MAVEN IUVS Echelle channel. The H Lyman-α brightness (top) varies minimally while the D Lyman-α brightness (bottom) shows more pronounced variations. The new pipeline more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