MAVEN IUVS Remote Sensing Highlights Relevant to Upcoming TGO Observations

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Introduction: The Mars Atmosphere and Volatile EvolutioN (MAVEN) mission's Imaging Ultraviolet Spectrograph (IUVS) observes Mars in the far and mid ultraviolet (110-340 nm), investigating lower and upper atmospheric structure and indirectly probing neutral atmospheric escape [1]. The instrument is among the most powerful spectrographs sent to another planet, with several key capabilities: separate Far-UV & Mid-UV channels for stray light control; a high-resolution echelle mode to resolve deuterium and hydrogen emission; internal instrument pointing and scanning capabilities to allow complete mapping and nearly continuous operation; and optimization for airglow studies. After two Earth years in orbit (one Mars year), IUVS has assembled a large quantity of data and provided insights on present-day processes at Mars including dayglow, nightglow, aurora, meteor showers, clouds, and solar-planetary interactions. In this presentation, we will highlight key results obtained by IUVS, including: (1) mapping of thermospheric composition, structure, and variability; (2) long-term tracking of H escape, O escape, and D/H ratios, and (3) detection and mapping of diffuse auroral emission. We will present an overview of these results and a discussion of their implications for upcoming TGO observations of the middle atmosphere.

Thermospheric variability:

IUVS observes the Mars thermosphere throughout the FUV and MUV, producing a rich spectrum at a range of upper atmospheric altitudes (Figure 1). From these spectra, altitude profiles of individual emissions (Figure 2) can be extracted and analyzed to reveal thermospheric scale heights, temperatures, and peak altitudes [2]. Variability in these quantities is tied to thermospheric heating by solar EUV and to dust influences from the lower atmosphere. Combining TGO and IUVS observations will lead to improved climatology of the middle and upper atmosphere.

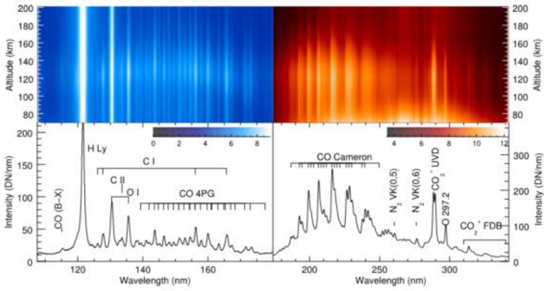

Figure 1: IUVS spectra in the FUV and MUV.

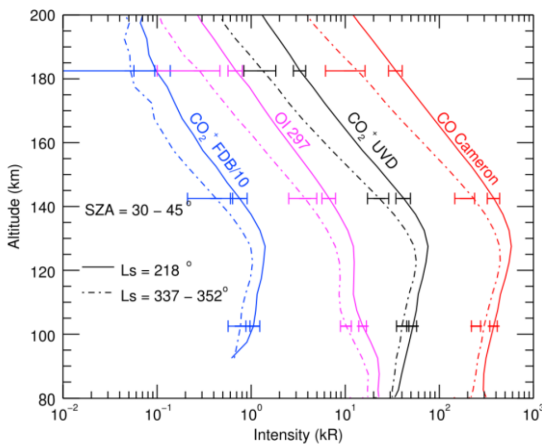

Figure 2: Altitude profiles of thermospheric emissions for two time periods, revealing variability in peak altitudes and scale heights.

H escape, O escape and D/H:

IUVS altitude profiles of H and O emission in the Mars corona can be used to constrain escape of these species. H coronal profiles are shown in Figure 1, with parameters inferred from these profiles shown in Table 1. Escape is highly variable with season, likely owing to increased transport of water from the lower to the middle atmosphere [3]. TGO may be able to observe enhanced water or intermediate species on their way to escaping as H. In addition, IUVS makes mesurements of thermospheric D/H using a dedicated echelle channel [4], which can be compared with HDO/H2O measurements made by TGO at lower altitudes.

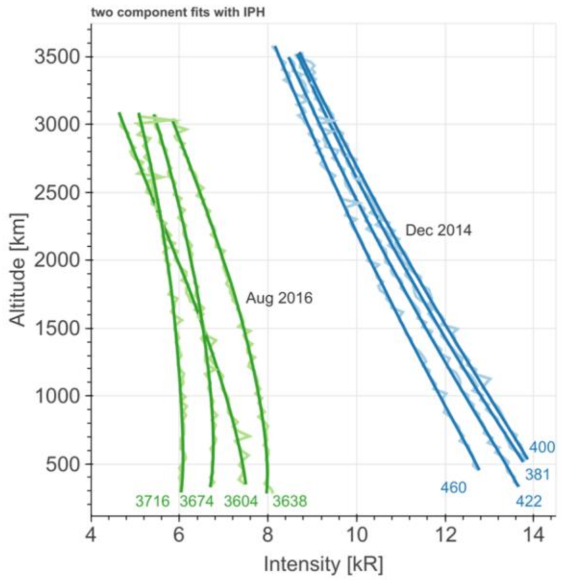

Figure 3: IUVS H Lyman Alpha brightness profiles from 2014 December (blue) and 2016 August (green). Lighter lines show observed brightnesses with darker colors indicating model fits.

Table 1: Best fit parameters for IUVS observations, including best-fit escape fluxes for H

Cal factor: 0.79 **IPH 1: 510 R** **IPH 2: 392 R**

	Ls	Exobase Density [10^6/ cc]	Exobase Temp. [K]	Total H Escape Flux [10^8/cm^2/s]	Component 2 density [10^3/cc]	Component 2 temperature [K]
Orbit 381	**250**	0.77	231	**8.15**	3.83	408
400	**252**	1.86	181	**4.06**	3.28	335
422	**254**	1.42	188	**4.07**	3.74	299
460	**259**	1.36	189	**4.14**	4.52	327
3604	**198**	0.11	254	**2.12**	2.32	392
3638	**202**	0.28	204	**1.76**	2.97	437
3674	**206**	1.15	148	**0.95**	3.17	444
3716	**210**	0.51	177	**1.22**	3.74	366

Diffuse aurora:

IUVS occasionally observes emissions characteristic of dayglow on the nightside of the planet, which we interpret as discrete or diffuse aurora [5]. While IUVS observations of this aurora are limited to the UV, visible and infrared counterparts should exist, which may be observable by TGO.

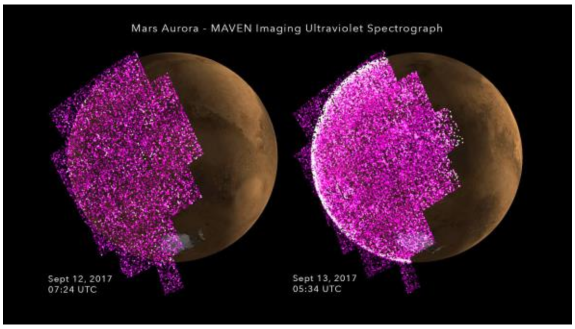

Figure 4: Observations of Mars aurora from IUVS apoapsis. During particularly strong solar events, the entire nightside emits ultraviolet aurora, which should be detectable simultaneously in the visible and infrared.

References:

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