Preliminary analysis of Martian dayglow observed by the Imaging Ultraviolet Spectrograph onboard MAVEN.

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Introduction: The Imaging Ultraviolet Spectrograph (IUVS) is one of the remote sensing instruments on the Mars Atmosphere and Volatile EvolutioN (MAVEN) spacecraft. It measures Far and middle ultraviolet emissions emanating from the Martian upper atmosphere. These emissions constitute an important diagnostic tool to study atmospheric regions, which are otherwise difficult to study. With its unique observation configuration, IUVS can measure Martian dayglow at different lighting conditions with a wide spatial and temporal coverage [1]. This study shows the preliminary analysis of Martian dayglow observed by the IUVS.

Observations: The MAVEN satellite is in an elliptical orbit with apoapsis near 6,000 km altitude and periapsis near 160 km. IUVS instrument carries two detectors: FUV detector (115-190 nm) with a spectral resolution of ~0.6 nm and MUV detector (180-340 nm) with a spectral resolution of ~1.2 nm [1]. In its limb-observing mode, IUVS measures the Martian UV airglow layer in the altitude region of 80 to 220 km with vertical resolutions of ~5 km. The data set chosen for this study span between Oct. 18, 2014 and Oct. 22, 2014 (orbits 109-128).

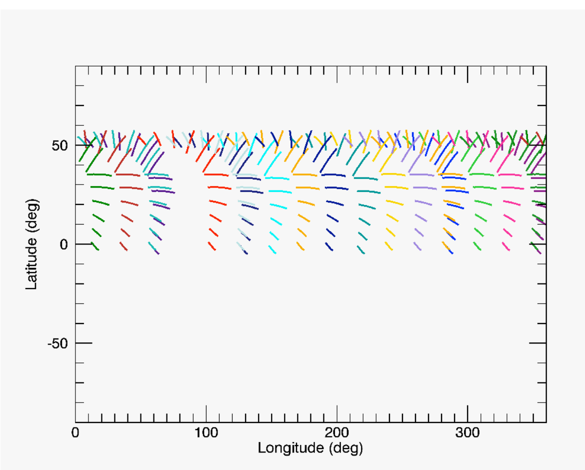

Figure 1: The tangent point of the IUVS line of sight from 19 orbits (orbits 109 to 128) plotted versus latitude and east longitude. Each color represents a single orbit.

These observations were made in the northern hemisphere. Figure 1 presents the latitude and longitude coverage of the tangent point of the IUVS line of sight, which clearly shows the wide spatial coverage of IUVS within two weeks of observations.

Figure 2 shows the detector images of MUV and FUV detectors taken during the very first observations of the Martian airglow layer. The horizontal axis represents wavelength and vertical axis depicts the altitude from 80 to 250 km. Figure 3 shows averaged spectra in the FUV and MUV observed at altitudes between 120 and 130 km during orbit 109. Martian dayglow spectra as seen by the IUVS show similar features as observed by Mariner [2-3] more than 40 years ago and recently by SPICAM onboard Mars Express [4]. Several atomic and molecular features are seen the detector images, e.g., H Lyman alpha, oxygen emissions at 130.4 and 135.6 nm, carbon emissions at 156.1 and 165.7 nm, and CO Fourth Positive bands in the FUV, and CO Cameron, CO2+ UV doublet bands in MUV, and the OI 297.2 nm line in the MUV.

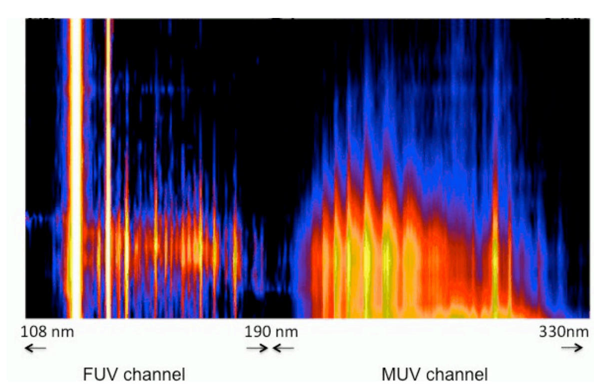

Figure 2: The IUVS detector images for single swath of orbit 113.

We have been able to identified N_2 VK band emission in the IUVS spectra [5]. Detection of these features are important and it will help us constrain the N_2 density in the atmosphere of Mars, since N_2 VK bands are mainly produced by electron impact on N_2 [6-7].

Analysis and Results: Figure 4 presents the relative brightness of CO Cameron band (180-260 nm) for single swath of orbit 109. The shape of the profile and altitude of maximum emission are consistent with the earlier measurements by Mariner and SPICAM [2-4]. Altitude profiles observed by IUVS will be used to retrieve the density of various atmospheric constituents of Mars, and the temperature of the upper thermosphere.

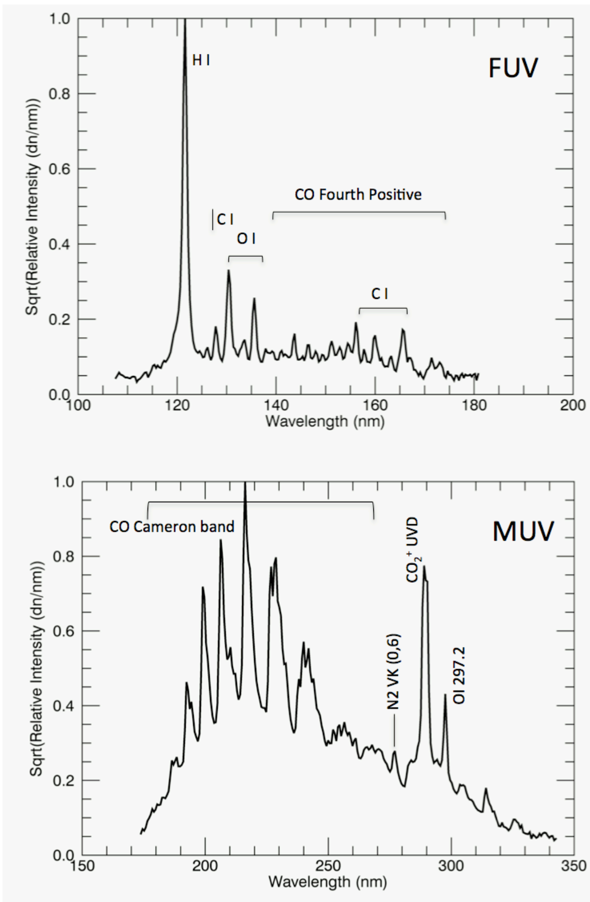

Figure 3: FUV (top panel) and MUV (bottom panel) spectrum obtained by IUVS between SZA = 70 and 35 deg. Average of 15 individual spectra obtained between 120 and 130 km.

Figure 5 shows the variation of peak intensity of CO Cameron band with solar zenith angle. The relative peak intensity at SZA = 30° is about 0.8 and it decreases to value of 0.3 at SZA = 70°. The variation with SZA closely follows cos(SZA).

Chapman layer theory also predicts a variation of peak altitude with SZA as H × ln (sec(SZA), where H is scale height of the atmosphere, but we have not seen any significant variation of altitude of peak emissions with SZA in our preliminary analysis. We have also not seen any variation in the altitude of maximum emission with the longitude.

Future Work: A detailed analysis of Martian dayglow and its variation with various physical parameters. Future work includes density retrieval of major atmospheric constituent of Mars. Scale heights and temperature of neutral upper atmosphere will be retrieved to understand the dynamics of Martian Thermosphere-Ionosphere region.

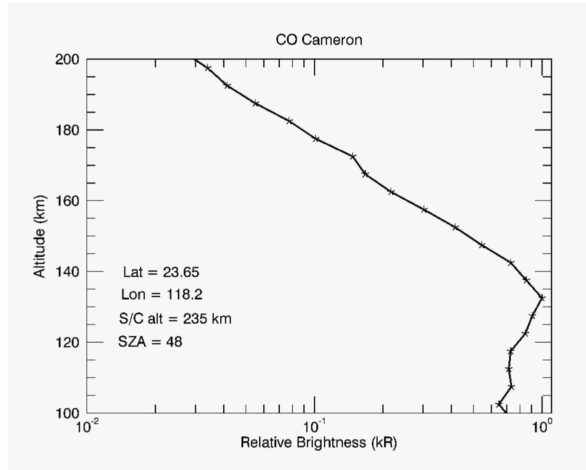

Figure 4. The altitude profile of CO Cameron band obtained from a single swath of orbit 109.

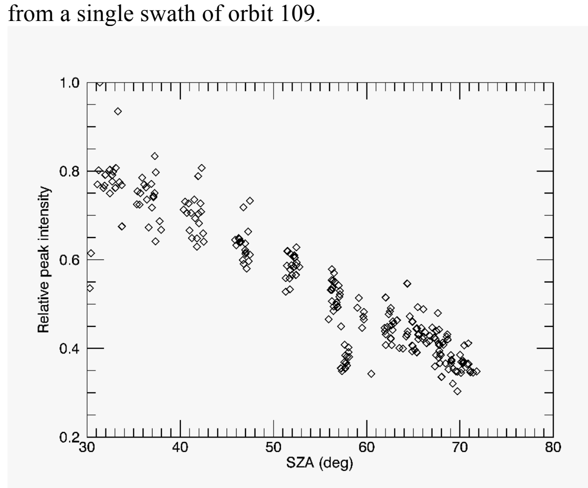

Figure 5: Relative peak intensity of CO Cameron plotted versus solar zenith angle (SZA).

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