First Results From Maven's Imaging UV Spectrograph. N.M. Schneider[1], W.E. McClintock[1] A.I.F. Stewart[1], J.Deighan[1], J.T. Clarke[2], G.M. Holsclaw[1], F. Montmessin[3], F. Lefèvre[3], J.Y. Chaufray[3], S.K. Jain[1], A. Stiepen[1], M.H. Chaffin[1], M. Crismani[1], M. Matta[2], J.S. Evans[4], M.H. Stevens[5], and B.M. Jakosky[1]
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Introduction: The Imaging Ultraviolet Spectrograph (IUVS) [1] is one of nine science instruments aboard the Mars Atmosphere and Volatile and EvolutioN (MAVEN) spacecraft which entered Mars orbit on 21 September 2014. IUVS is designed to explore the planet's upper atmosphere and ionosphere and examine their interaction with the solar wind and solar ultraviolet radiation. The instrument is one of the most powerful spectrographs sent to another planet, with several key capabilities: (1) separate Far-UV & Mid-UV channels for stray light control, (2) a high resolution echelle mode to resolve deuterium and hydrogen emission, (3) internal instrument pointing and scanning capabilities to allow complete mapping and nearly-continuous operation, and (4) optimization for airglow studies.

MAVEN Science Goals: IUVS, along with other MAVEN insturments, obtains a comprehensive picture of the current state of the Mars upper atmosphere and ionosphere and the processes that control atmospheric escape. Data returned by MAVEN will allow us to determine the role that loss of volatile species from the atmosphere to space has played in shaping the history of Mars climate, liquid water, and habitability. MAVEN is designed to answer three top-level science questions [2]:

- What is the current state of the upper atmosphere and ionosphere, and what processes control it?
- What are the rates of escape of atmospheric gases to space today and how do they relate to the underlying processes that control the upper atmosphere?
- What has been the total atmosphere loss to space through time?

IUVS Objectives: MAVEN's instrument complement answers these questions by combining observations of Mars' atmosphere and ionosphere with observations of the solar influences that control it. MAVEN has four instruments for atmospheric measurements that record atoms, molecules and ions through *in situ* measurements, probing conditions at the location of the spacecraft as it passes through the upper atmosphere. By contrast, IUVS derives atmospheric properties at a distance through spectroscopic measure- ments of UV emissions of from atmospheric gases. IUVS makes quantitative measurements of the Mars' atmosphere between altitudes of 30 and 4500 km, over all latitudes, longitudes and local times. Specifically, IUVS measures the composition and structure of the upper atmosphere by measuring:

- Thermosphere coronal profiles of neutrals (H, C, N, O, CO and N_2) and ions (C^+, CO^+_2) using limb scanning.
- Column abundance maps of H, C, N, O, CO_2, O_3 and dust in the upper atmosphere over the portion of the planetary disk that is illuminated and visible from high orbital altitudes using disk mapping.
- Coronal vertical profiles of hot species (H, D and O) using coronal scans.
- Mesosphere/thermosphere vertical profiles of CO_2 and O_3 using stellar occultations.

These observations offer three major contributions to MAVEN science: (1) making independent measurements of key properties also measured by *in situ* instruments for validation and redundancy; (2) providing the global context for *in situ* measurements taken along the spacecraft orbit, and (3) making unique measurements of atmospheric constituents and properties not possible with other instruments. Furthermore, thanks to instrument design and spacecraft accommodation, IUVS can observe Mars nearly continuously throughout the mission.

IUVS Initial Results: Each IUVS observational mode has successfully observed the spectral features and spatial distributions as intended, confirming and expanding our understanding of the Mars upper amtosphere as observed by the Mariner spacecraft and Mars Express. Initial results include

- Significant persistent structures in the thermospheric dayglow emissions, dependent primarily on solar zenith angle, along with significant variability on daily timescales;
- Nitric oxide nightglow and low-level auroral emissions of substantially greater nightside extent than seen by MEX/SPICAM;
- Confirmation of N_2 emission in the VK band, as first reported by MEX/SPICAM;
- The first vertical profiles of the D/H ratio in the atmosphere and their temporal evolution with season;

- The most complete maps and vertical profiles of H, C and O in the Mars corona (see Figure 1);
- The first global snapshot of the middle atmosphere obtained by a day-long stellar occultation campaign
- Global ozone maps spanning three months of seasonal evolution

Each of these results is described in greater detail in other papers at this conference. IUVS also observed Comet Siding Spring's hydrogen coma, and the aftermath of the associated meteor shower on Mars. These results are described further in other papers at this conference.

References: [1] McClintock, W.E. *et al*. (2014), *Space Sci. Rev*., DOI 10.1007/s11214-014-0098-7.

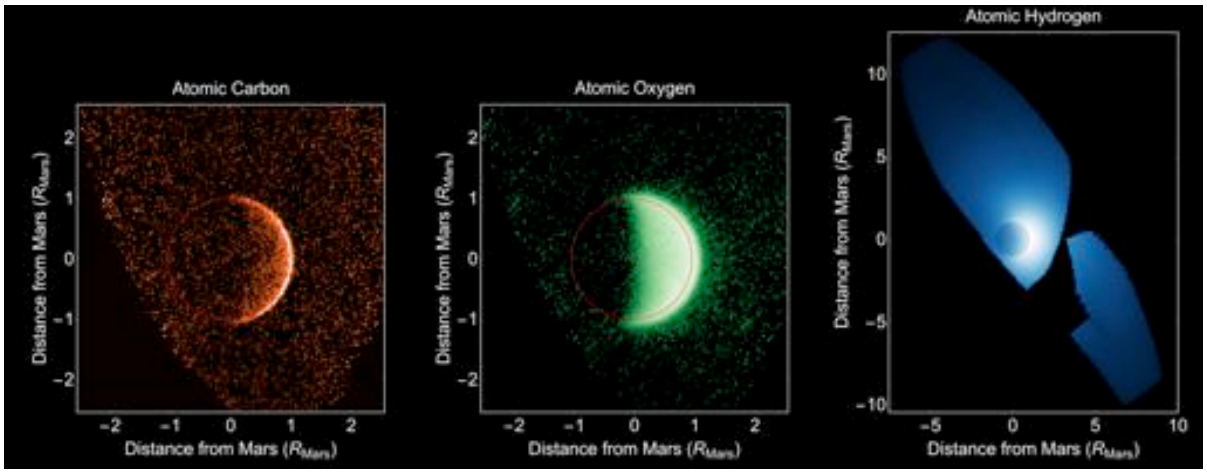

Figure 1. Three views of an escaping atmosphere, obtained by MAVEN's Imaging Ultraviolet Spectrograph. By observing all of the products of water and carbon dioxide breakdown, IUVS can characterize the processes that drive atmospheric loss on Mars.