**Aurora on Mars.** N. M. Schneider¹, S.K. Jain¹, J. Deighan¹, A. Hughes², M. Chaffin¹ and the IUVS Science Team, ¹LASP, 3665 Discovery Dr., Boulder CO, 80303 (nick.schneider@lasp.colorado.edu), ²Department of Physical Sciences, Embry-Riddle Aeronautical University, Daytona Beach, FL

**Introduction:** Mars’ lack of a global magnetic field led to low expectations for auroral phenomena on the planet, but MAVEN observations have shown auroral activity to be frequent, diverse in nature, and often global in scope. Figure 1 below shows three fundamentally different types of aurora on Mars. Ironically, Mars’ lack of a global field is actually responsible for most of the activity, which leads to a new perspective for non-magnetized objects in our solar system and beyond.

Each of the three types of aurora is a tracer of a different important process involving the interaction between solar influences and the near-Mars magnetic and charged particle environment. Below we describe observations by MAVEN’s Imaging UltraViolet Spectrograph (IUVS) of the three known types of aurora and the insights they offer.

**Discrete Aurora:** Discrete auroras were detected in regions of strong crustal magnetic fields by the SPICAM instrument on the European Space Agency’s Mars Express orbiter [1,2,3]. The emission appeared in patches that were tens of kilometers across at altitudes around 130 km. Further analysis revealed a total of 20 instances of auroral patches during 10 years of intermittent SPICAM observations [4]. Auroral excitation was attributed to the precipitation of electrons, typically ~100 eV - 1 keV, most likely accelerated locally by parallel electric fields analogous to Earth’s discrete aurora [3].

MAVEN/IUVS detected discrete aurora under comparable conditions, and has obtained the first images of the phenomenon (Figure 1, center, [5]). The occurrences mapped to locations within the crustal magnetic field regions where the probability of open field lines was high. The relatively small number of detections of discrete aurora is a combination of the rarity of favorable instrument pointing and the intermittent nature of the phenomenon.

**Diffuse Aurora:** MAVEN/IUVS discovered that the entire visible nightside of Mars can be engulfed in auroral emissions [6]. Figure 1 (left) shows a detection in imaging mode. The phenomenon can also be studied in limb scan mode, which revealed that solar energetic particles penetrated down to ~60 km altitude. Contemporaneous MAVEN/SEP observations of electrons up to 200 keV confirmed the correlation with solar activity. Some diffuse aurora events have been observed to last for days during extended solar events. Particle energies appear to be high enough that crustal magnetic fields have little impact on the electrons’ access to the atmosphere.

---

**Figure 1.** Three types of aurora on Mars, as observed by the Imaging UltraViolet Spectrograph on MAVEN. Each is diagnostic of a specific interaction between solar influences and Mars’ magnetic and plasma environment.
Proton Aurora: Proton aurora is a distinct class of auroral phenomena caused by energetic protons from the solar wind precipitating into a planetary atmosphere. The defining observational signature is atomic hydrogen emissions from the precipitating particles after they are neutralized through charge exchange. Prior to MAVEN, proton aurora had only been observed at Earth.

MAVEN/IUVS discovered proton aurora by observing transient brightenings of upper atmospheric hydrogen Lyman-α emission across the Martian dayside correlated with solar wind activity [7]; Figure 1 (right). The phenomena is enhanced when the solar wind is strong and the abundance of atomic hydrogen in the corona is high. The latter circumstance occurs in southern hemisphere summer when the supply of hydrogen to the corona is higher [8]. Proton aurora appear to be the most common form occurring at Mars. A detailed analysis of proton aurora will be presented by Hughes et al. [this conference].

References: