MAVEN/IUVS NADIR OBSERVATIONS OF DISCRETE AURORA ON MARS: INSIGHTS INTO REGIONAL LOCAL TIME CONTROL AND MAGNETIC RECONNECTION

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Discrete aurora are sporadic ultraviolet emissions on Mars. These emissions, which occur globally and in the upper atmosphere of Mars, are strongly correlated with martian crustal magnetic field. Crustal fields on Mars form from remanent magnetism locked in the crust, and vary in strength across the disk, with the strongest fields located in the southern hemisphere

Discrete aurora on Mars was first identified by the ultraviolet spectrograph (SPICAM) on Mars Express (Bertaux et. al. 2005) which appeared as clustered, sporadic, and localized emissions in the mid-ultraviolet. Further work conducted by the SPICAM team (Leblanc et al., 2006, Leblanc et al., 2008, Gerard et al., 2015) expanded the list of detections to 19, 16 of which were identified in nadir-viewing geometry. This work showed that (1) the lifetime of discrete aurora is on the second timescale and (2) correlations between detection time and electron energy measurements (taken by the ASPERA-3 instrument aboard the Mars Express) showed that detection locations were highly correlated with locations of increased precipitating electron fluxes (Gerard et al., 2015.) These SPICAM detections were plotted on top of a global crustal field map (Brain et al., 2007) and found to be correlated with local field strengths. Analysis of precipitating electron populations with contemporaneous SPICAM aurora detection times (Brain et al., 2006, Gérard et al., 2015, Leblanc et al., 2006, Leblanc et al., 2008) with models of electron energy deposition and resultant emission altitudes (Leblanc et al., 2006, Soret et al., 2016) revealed the emission populations causing discrete aurora and altitude. These electron populations are likely between 40-200 eV and peak near 130 km altitude (Brain et al., 2006, Soret et. al. 2021.)

Later work, conducted 10 years later using MAVEN-IUVS observations, revealed the first nadir-viewing full-disk image of discrete aurora on Mars. In this work, the IUVS team identified a single orbit during the September 2017 space weather event with multiple discrete aurora emissions (Schneider et al. 2018.) Due to the lack of a large nadir-viewing dataset of detections, it remained unanswered at the time if discrete aurora were visible in other nadir-viewing observations.

Analysis of MAVEN-IUVS limb observations confirms previously reported knowledge of crustal field strength correlations with both detection location and brightness and auroral emission altitude (Schneider et. al., 2018, 2021.) This analysis also showed events mainly occurring before midnight with a preference for negative interplanetary magnetic field (IMF) clock angles in the strong crustal field region (Schneider et al., 2021.) Due to observational bias and spacecraft viewing limitations, this dataset did not have good morning coverage. It remained unanswered how local time controlled where discrete aurora occurred.

The work presented here builds off previous understanding and examines an additional seven thousand nadir-viewing observations of Mars using MAVEN-IUVS data. Previous studies using data taken by the MAVEN spacecraft has revealed hundreds of detections in limb viewing and a single detection in the nadir observations. Further analysis of all nightside MUV nadir-viewing observations taken by the MAVEN Imaging Ultraviolet Spectrograph (IUVS) instrument has revealed approximately 200 additional discrete aurora detections. While aurora occur globally and sporadically, events in the strongest crustal magnetic field regions of the Martian southern hemisphere show high repeatability. Previous work reported using IUVS limb observations (Schneider et. al., 2021) revealed detections occurring mainly before midnight; the emissions identified in the nadir dataset show detections both occurring before midnight and after midnight in the strong field region. This independent and in-depth analysis has resulted in an additional 183 detections, confirms previous understanding of discrete aurora, allows for tighter confinement on detection locations and dimensions, and reveals a previously unreported regional local time correlation of discrete aurora on Mars. The regional local time control identified in this new dataset reveals two distinct auroral event groups manifesting pre- and post-midnight in separate but adjacent locations in the strong field region (figure 1), which may be explained by magnetic field

reconnection between local crustal martian fields and the draped interplanetary magnetic field.

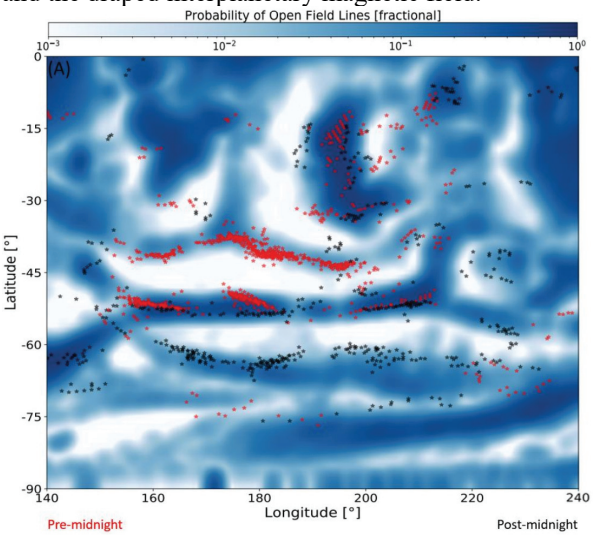

Figure 1. Locations of discrete aurora detections in the strong crustal field region organized by local time, overplotted ono a magnetic field map of Mars. The blue-white colorbar corresponds to the probability of open magnetic field lines, with dark blue being ~100 probably for open field lines and white corresponding to closed loops. Red detections correspond to pre-midnight detection locations and black to post-midnight detection locations. There is a noticeably clear distinction between pre-and-post midnight at -52° latitude and between 150° – 210° longitude. Analysis of detection frequency vs local time histograms shows that most pre-midnight detections from -35° to -52° latitude occur shortly after dusk. Post-midnight detections from -52° to -67° latitude mainly occur before dawn.