EMIRATES MARS ULTRAVIOLET SPECTROMETER'S OBSERVATION OF ARGON IN THE MARTIAN THERMOSPHERE.

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Introduction:

The Emirates Mars Mission (EMM) has been launched to Space on July 20, 2020, arriving at Mars Orbit on February 9, 2021 and commencing its Science phase on May 23rd, 2021. EMM explores the dynamics of the Martian atmosphere on a global scale while sampling contemporaneously both diurnal and seasonal timescales. EMM has three instruments: Emirates eXploration Imager (EXI), Emirates Mars InfraRed Spectrometer (EMIRS), and Emirates Mars Ultraviolet Spectrometer (EMUS) [1]. The EMUS instrument is a far ultraviolet imaging spectrometer that is designed to determine the abundance and spatial variability of key neutral species in the thermosphere and the three-dimensional structure and variability of key species in the exosphere [2].

Argon is a photochemically inert gas with molecular weight of 40 g/mol - close to CO_2's 44 g/mol. Therefore, the Ar/CO_2 ratio in the upper atmosphere can offer a measure of transport from the lower atmosphere. EMUS provides us with unique information of Argon globally; observing two Argon emission lines, Ar I 104.8 nm and Ar I 106.6 nm, as seen in the spectrum below.

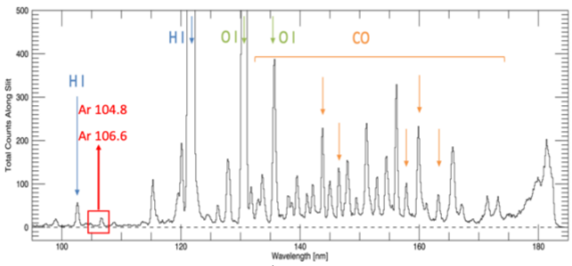


Figure 1: EMUS spectrum of the Mars disk during transition phase.

This work will showcase how the brightness of the Argon emission lines vary with different factors, such as solar longitude (Ls), emission angle (EA), and solar zenith angle (SZA). In addition, we will be comparing what we have obtained from EMUS with results from past missions.

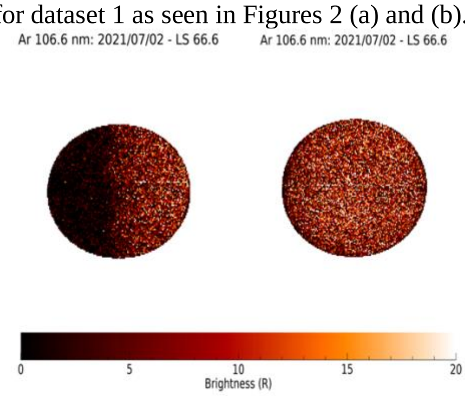
Datasets Specifications:

We will be utilizing data captured through EMUS' observation strategy 1 (OS1), which performs two swaths focusing on Thermosphere of Mars [100-200 km]. Until recently, EMUS observations have occurred during low solar activity. This presentation's results utilize the following datasets:

- Dataset 1: Two cases observed on 2021/07/02 at Ls ~66.5°, the first taken at around the subsolar point and the second at the dusk terminator.
- Dataset 2: One case observed on 2021/12/24 at Ls 146.8° close to subsolar point.

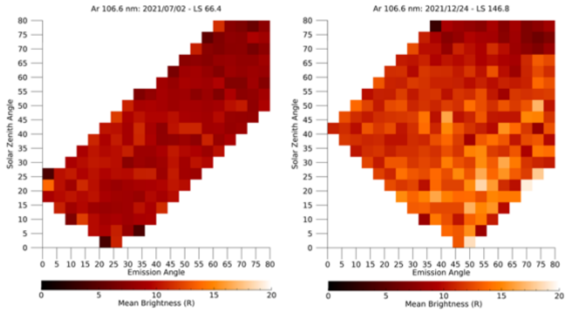
Results:

We have produced disk images of Ar 106.6 nm from two different viewpoints – the dusk terminator (a dayside/nightside viewing) and at the subsolar point for dataset 1 as seen in Figures 2 (a) and (b).

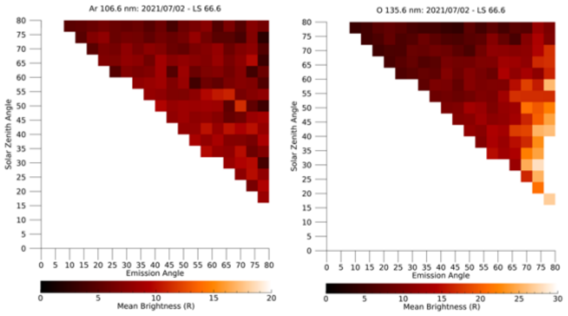


Figures 2 (a) & (b): Disk images taken from dusk terminator and subsolar point.

To understand the distribution of brightness thoroughly we've created heatmaps of average brightness with respect to SZA and EA. The heatmaps seen in Figures 3 (a) & (b) showcase that the distribution of Argon across EA seems flat with no clear pattern displaying optically thick behavior - unlike what has been reported in literature [3]. We also notice the dimming of brightness of Ar 106.6 nm at higher SZA, indicating a geometry effect due to the reduction in solar irradiance. We will also be exploring whether other factors such as latitude and local time may contribute to this behavior.



Figures 3 (a) & (b): Distribution of Ar 106.6 nm with respect to SZA and EA in dataset 1 & 2 at the subsolar point.



Figures 4 (a) & (b): Distribution of Ar 106.6 nm and O 135.6 nm at dusk terminator with respect to SZA and EA in dataset 1.

Further investigating our hypothesis that Ar 106.6 nm is optically thick, we compare the results with oxygen 135.6 nm, an optically thin emission, observed at the same orbit. As seen in the heatmap of oxygen 135.6 nm Figure 4 (b) there is a clear pattern where brightness increases with EA, expected from an optically thin emission. Meanwhile, Ar 106.6 nm in Figure 4 (a) appears flat, indicating optical thickness.

Comparison with Previous Observations:

We have compared the values obtained from EMUS with values found from the Hopkins Ultraviolet Telescope (HUT) and the Far Ultraviolet Spectroscopic Explorer (FUSE). As seen in Table 1, values from EMUS are within the value range detected by HUT, both observed at solar min and. similar Ls. FUSE values are higher when compared to EMUS, but that is expected since they were detected during solar min.

Date	Instrument	Average Disk Brightness (R) Ar 106.6 nm	Ar 104.8 nm	Solar Activity	Ls
Mar 12, 1995	HUT [4]	5 ± 2	2.4 ± 1.0	Min	70
July 2, 2021	EMUS	9.1	3.8	Min	66.4
May 12, 2001	FUSE [3]	21.8 ± 0.28	6.36 ± 0.15	Mean	160
Dec 24, 2021	EMUS	11.5	4.5	Min	146.8

Table 1: Argon values from EMUS compared with HUT and FUSE.

Future Work:

We are working on further understanding the variation of Argon brightness with latitude, local time and additional solar longitude. Furthermore, we will be using data observed through EMUS' observation strategy 2 (OS2), which scans both the disk and inner corona using three swaths. We will be ultimately comparing the results from both (OS1) and (OS2).

References:

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