Improving MAVEN-IUVS Lyman-Alpha Apoapsis Images

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Mars in the Past

- Liquid water
- Terrestrial rivers
- Fluvial activity

Eberswalde Crater, Mars, as imaged by Mars Global Surveyor.
Mars in the Past

Aqueous mineral locations on the surface of Mars, from the review by Ehlmann and Edwards (2014)
Present-day Mars

- H at Mars H Corona is moving fast due to its light mass, therefore, escaping its gravity.
- H is derived from lower atmospheric water.
- The loss of H from Mars is capable of drying and oxidizing the planet.
UV light from the sun is absorbed and re-emitted by the $2 \rightarrow 1$ jump of an electron in a hydrogen atom, releasing the Lyman-alpha glow.
**Background: Apoapsis Maps**

- **IUV Spectograph**
- Detect various wavelengths: second order FUV (110-190 nm) and first order MUV (180-340 nm).
Instrument: IUVS Data Processing

IUVS instrument image taken at LASP (McClintock et al.)
Instrument: Image on Detector

- Light in each of the imaging pixels is dispersed in wavelength to form a 2-D image on the detector.
Data Processing for H Corona

1. Raw Data Measurements [DN]
2. Calibrated Spectra [kR/nm]
3. Summed into specific spectral features [kR]
4. Projected into H corona images
Research Focus: Apoapse

Observations

• 2D images of the whole of Mars disk using the scan mirrors and motion of the spacecraft.
Research Focus: Apoapse

Observations

Problem #1

Appropriate detection of Lyman-alpha

Problem #2

Background Subtraction

Problem #3

Correct for the lines
Step One: Detection of Lyman-Alpha

Problem #1
First Step of Data Processing
First Step to Data Improvement

Before

After
Results: First Step
Second Step: Background Subtraction

Observational Geometry (6500 km)

Spectral Dimension

Spatial Dimension

Large Keyhole

Small Keyhole

Air-glow slit

Credit: Justin Deighen
Second Step of Data Processing

- **FUV Data**
- **MUV**
- **1st Order MUV**
- **MUV Background**

![Graph showing FUV Data, MUV, and 1st Order MUV with MUV Background.](image-url)
Second Step of Data Processing

- Used 1\textsuperscript{st} order MUV (180-340 nm) data.
- Ran a MLR routine on 1\textsuperscript{st} order MUV and included it for background subtraction.

Red: Lyman-Alpha first step background subtraction.
Green: Lyman-alpha second-step background subtraction.
Purple: Subtracted Background
Results: Improvement of Second Step Data Processing
Third Step: Flatfield Correction

- Technique used to improve the quality of digital imaging caused by the variations of pixel-to-pixel sensitivity in the detector.
Third Step: Flatfield Correction

Observational Geometry (6500 km)

Credit: Justin Deighen
Third Step: Flatfield Correction

- Apoapse Data (10 Bins)

![Diagram showing radiances and bin numbers for flatfield correction.](image-url)
Flatfield Correction

- Periapse Data (7 Bins)

Bin Number (7 Bins for Periapse)

Radiance

Air-glow slit

Instrument look direction
Third Step: Flatfield Correction

- Small Keyhole
- Large Keyhole
- Air-glow slit

Bin Number (10 for apoapse data)
Third Step: Flatfield Correction

MUV Background Subtraction

MUV Background Subtraction & Flatfield Correction
1. Background Subtraction

2. MUV Background Subtraction

3. MUV Background Subtraction & Flatfield Correction.
Final Results
Next Steps

- Background code improvements, takes \(\sim 45\) minutes to run one orbit.
- Improve the model for the new procedure.
Implications

- Seasonal variability of H loss
- Identify proton aurora from the data.
1. Background Subtraction

2. MUV Background Subtraction

3. MUV Background Subtraction & Flatfield Correction.

Procedure Summary