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FINAL REPORT: NASA FUSE Cycle 1: NAG5-9010

PI. Dr. Graham M. Harper

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1 Final Report

This is the final report for the FUSE Cycle 1 program A100: NAG5-9010 [CU # 1532022] *FUV Spectra of Evolved Late-K and M Stars: Mass Loss revisited and Stellar Activity*

Program A100 was awarded 50 ksec of FUSE observing time. Targets α TrA (K3 II) and γ Cru (M3 III) were originally assigned 25 ksec each, to be observed in the medium aperture. Once the in-flight performance and telescope alignment problems were known, the observations were reprogrammed to optimized the scientific return of the program. α TrA was scheduled for 25 ksec observations in both the medium and large apertures. The principle aim of this program was to measure the stellar FUV line and continuum emission, in order to estimate the photoionization radiation field and to determine the level of stellar activity through the fluxes in the collisionally excited high temperature diagnostics: C III 977Å and O VI 1032,1038Å doublet. The medium aperture observations were obtained successfully while the large aperture observations were thought by Johns Hopkins University (JHU)to be lost to satellite problems. There was insufficient signal-to-noise in the medium aperture short wavelength SiC channels to do quantitative science.

The long wavelength LiF spectra are of high signal-to-noise (SN) and show pronounced emission lines near $\lambda\lambda 1100 - 1140$Å. Emission had been observed at these wavelength in low resolution and low SN ORFEUS-SPAS II spectra obtained by Dupree & Brickhouse (1998 ApJ 500, L33), however, they were unable to identify these features. One of the first problems faced in the early FUSE mission was establishing a reliable wavelength scale, especially between the different channels. With the medium aperture data in hand we decided to identify the features and thereby establish an absolute wavelength scale for the channels where the emission occurred. We first established that the emission was fluorescent, and then we constructed a fluorescent line formation model for all neutrals and singly ionized species with atomic numbers up to 28, and the H_2 molecule. We used datasets of radiative rates and energy levels which were as complete as possible and available in an electronic format (millions of transitions). We found that most, but not all, emission was from Fe II pumped by H Lyα. This is not typical fluorescence, since the emission is *shortward* of the pumping transitions near 1215.6Å. This occurs because

Final Report
Mars Data Analysis Program
NAGS-9590
Characterizing the Oxidizing Properties of Mars' Polar Regions

Amanda Hendrix (formerly at LASP, U. of Colorado, now at JPL)
Karen Simmons (LASP, U. of Colorado)

This project had two primary goals. The first was to restore and archive the Ultraviolet Spectrometer (UVS) data from the 1971 Mariner 9 (MM71) mission to Mars. The second was to use this revised data set to analyze data of Mars' polar regions to look for and map out the ozone (O_3) and hydrogen peroxide (H_2O_2) features.

Data restoration and archiving activities for this project have resulted in the restoration of 100% of the original Mariner 9 raw data set as well as many of the secondary analysis data sets. These data sets have been submitted to the Planetary Data System (PDS) Atmospheric Node, long with their PDS labels and descriptive metadata.

These data have also been placed on a new, LASP web site for easy reference and downloading (see http://lasp.colorado.edu/mariner_9_data). This allows other researchers easy access to the data for analysis and comparison.

In addition, a useful visualization and analysis tool has also been developed which allows the user to compare these Mariner 1971 Ultraviolet spectral data with several choices of related data sets: Mariner 9 images, USGS geologic data, MGS MOLA topography, Viking images (Viking MDIM) and thermal inertia data (MGS TES). (See http://lasp.colorado.edu/albatross.)

Preliminary analysis of the Mars polar data was presented in July 2000. We find, using just a subset of the entire database, relatively large amounts of ozone and small amounts of peroxide are measured at the winter pole, while relatively large amounts of hydrogen peroxide and small amounts of ozone are found at the summer pole. The ozone and peroxide are thus anti-correlated. These results were obtained using a method proven to be useful in analysis of Jupiter icy satellite data from the Galileo UVS (Hendrix *et al.*, 1999). The UVS spectra were modeled using laboratory spectra of hydrogen peroxide (Carlson *et al.*, 1999) and the ozone cross section. Varying combinations of O_3 and H_2O_2 were tried in the model to achieve the best fit to the Mars spectra. The presence of H_2O_2 at the polar cap suggests that it may also be present in the martian soil, which is

significant because Viking lander results indicate that an oxidant is likely present at the Mars surface, but so far none has been detected. The anti-correlation between Mars' ozone and hydrogen peroxide is consistent with the idea that hydrogen peroxide contributes to the destruction of ozone (Hunten, 1974), so this result is also important in understanding the CO_2-H_2O-O_3 cycle on Mars. It had been noted in early analysis of MM71 UVS data (Barth and Dick, 1974), that more ozone is present during periods of lower temperature and lower water vapor amounts. This new result indicates that the ozone amounts may have less to do with water vapor abundances than with the related H_2O_2 abundances.

The above results were obtained using data from just three MM71 orbits. These results will be expanded by analyzing the entire MM71 UVS dataset. We can now use the Albatross software (see above) to look for additional observations in regions of interest that exist in the MM71 database. This software plots the MM71 FOV onto a map of Mars for a selected latitude-longitude range. The user can then go into the database to extract the spectra for the times associated with those footprints.