FINAL REPORT: NASA FUSE Cycle 3: NAG5-12438

Evolved Late-Type Star FUV Spectra: Mass Loss & Fluorescence
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Final Report

This is the final report for the FUSE Cycle 3 program C023: NAG5-12438 [CU # 1535942 & CU # 1536809] *Evolved Late-Type Star FUV Spectra: Mass Loss & Fluorescence*

Summary

This proposal was for a detailed analysis of the FUV photoionizing radiation that provides crucial input physics for mass loss studies, e.g., observations of the flux below 1044Å allow us to constrain the Ca II/Ca III balance and make significant progress beyond previous optical studies on stellar mass loss and circumstellar photochemistry. Our targets selection provided good spectral-type coverage required to help unravel the Ca II/Ca III balance as the mass-loss rates increase by over three orders of magnitude from K5 III to M5 III. We also explored the relationship between the FUV radiation field and other UV diagnostics to allow us to empirically estimate the FUV radiation field for the vast majority of stars which are too faint to be observed with FUSE, and to improve upon their uncertain mass-loss rates.

We proposed deep exposures of β Gru (M4.5 III), β Peg (M2.5 II-III), α Cet (M1.5 III), β And (M0 III) and λ Vel (K4 Ib) that are well studied in other spectral regions and are important for the study of mass loss. These spectra provide a valuable complement to the spectral types and evolutionary phases of the GTO targets and Cycle 1 (α TrA) and 2 (γ Cru) targets.

Observations & Data Reduction

Subsequent to the acceptance of the original proposal and target list, problems of FUSE observations at low declination led to a reprogramming of the original target lists. β Peg was replaced by a deeper exposure of M8 IIIe R Dor which is the largest star in the sky (aside from the Sun) and extends the spectral range of the sample and thus is in keeping with our original science objectives. It is also an important target as it is a transition star, i.e between normal irregular variable giants and the Mira type behavior. It also became clear that thermal alignment drifts between the four FUSE telescopes meant that the large aperture was required to optimize the probability of detecting features, such as C III 977Å in the SiC channels. Later observations were therefore obtained with the larger LWRS aperture rather than the MDRS.

The raw datasets for the stars were retrieved from the MultiMission at Space Telescope (MAST) archive and re-calibrated with different versions of the public release of CalFUSE

emission observed from non dust evolved stars to see if photodissociation if CO is the cause.

An interesting discovery in our data was the presence of O VI on the K4 Ib supergiant λ Vel. The presence of transition region material does not completely rule out the heating by acoustic wave modes (shocks), but magnetic heating is the most likely cause. This detection of the coronal proxy was published in Harper et al. (2005). A study of O VI of the giant α Tau was published previously (Ayres, Brown & Harper 2003). It appears that magnetically heated coronal plasma is more pervasive in the Hertzsprung-Russell diagram than previously thought. The study of activity levels for the sample is ongoing.

Finally, I presented a review of FUSE cool star science at the 13th Cambridge Workshop on Cool Stars, Stellar Systems and the Sun, covering the advances made in cool star astrophysics with FUSE, and advertising it's spectral and time resolving capabilities to the wider community.

Publications and Presentations Related to this Program

Ayres, T. R., Brown, A. & Harper, G. M., 2003, ApJ, 598, 610

Harper, G. M., 2004, Procs of the 13th Cambridge Workshop on Cool Stars, Stellar Systems and the Sun, 5-9 July 2004 Hamburg, Germany, ESA SP-560, p. 51

Harper, G. M., Brown, A., Bennett, P.D., Baade, R., Walder, R., & Hummel, C.A., 2005, AJ, 129, 1018

Harper, G. M., Sim, S.A., Brown, A., & Ayres, T.R., 2004, IAU Symp. 219, 651

Additional References

Harper, G. M. & Linsky, J. L., 2002, Fuse Science and Data Workshop, Baltimore, Maryland, 20-22 March 2002

Harper, G.M., Wilkinson, E., Brown, A., Jordan, C., & Linsky, J. L., 2004, ApJ, 551, 486

Wilkinson, E., Harper, G. M., Brown, A., & Herczeg, G. J,, 2002, AJ, 124, 1077