FINAL REPORT: NASA FUSE Cycle 3: NAG5-12210

PI. Dr. Graham M. Harper

Prepared August 1st 2004

This is the final report for the FUSE Cycle 3 program C022: NAG5-12210 [CU # 1535515] *Chromospheric Activity in Population II Giants.*

One of the mysteries of Population II giants is that they still show chromospheric emission despite their great age. The global dynamo which was active during their main-sequence lifetimes is expected to become extremely weak through magnetic rotational braking. The nature of the observed emission is not understood; although acoustic shock waves might provide the heating, acoustic waves are not predicted to drive the observed mass loss - which in turn requires the dissipation of magneto-hydrodynamic waves.

This program was designed to search for the faint stellar H Lyβ emission wings and the fluorescent Fe II and H_2 emission from one of the brightest, metal poor, Population II stars. These FUSE diagnostics, when combined with existing UV and optical spectra, help determine the major radiative cooling channels for the chromosphere. This observation was to complement that previously planned for the mildly metal deficient giant α Boo (K2 III). However, α Boo has yet to be observed with FUSE.

Program C022 was awarded 43 ksec to make FUSE observations of the single Population II red giant HD 6833 (K2 III), with the medium aperture (4x20 arcesc) (MDRS). The MDRS observation was chosen to minimize the airglow and geocoronal emission at H Lyβ in order to detect the blue-shifted H Lyβ wings, since HD 6833 is highly blue-shifted: $V_{rad} = -245\,\mathrm{km\,s^{-1}}$.

The data were retrieved from the Multimission Archive at Space Telescope and re-calibrated with the several releases of CalFUSE v2.1.6, v2.40 as well as beta-tested with v3.0.4 and v3.0.6. The observation occurred in two parts and a total of 17.5 ksec and 16.2 ksec of orbital night and day data were obtained, respectively. The spectra show no stellar signal. The observation of HD 6833 was obtained after satellite jitter information was added to the data files (i.e. after the reaction wheel failure) but before it was routinely deposited at MAST. The data for this observation were not placed in the archive, but we were eventually able to secure the data from FUSE at Johns Hopkins University. An examination of the jitter files show that the pointed was nominal, so unless the target acquisition missed the source, HD 6833 was significantly fainter than expected.

We examined HST/GHRS spectra of HD 6833 and although the Mg II h & k line emission is well exposed (from which the flux estimates for FUSE were based) observations of the

H Lyα line through the small science aperture (SSA) also show no emission. [Walter & Neff (priv. comm.) has confirmed the lack of H Lyα emission.] The HST observing sequence appears satisfactory, though it is possible that the source was missed (equivalent to the FUSE MDRS acquisition situation. So unless both HST and FUSE failed to acquire HD 6833 the stellar hydrogen emission is weaker than expected - in a metal poor star! We also examined the IUE SWP LORES spectra and the emission near 1818Å (close to well known Si II emission features) is present in both the long (SWP26429: 900 min.) and short (SWP31586: 45 min.) exposures suggesting that most of the signal in this region is likely to be an artifact of IUE spectra. Existing theoretical models from hydrodynamic models which have been proposed as a source of basal heating predict an almost constant surface flux of Mg II with metallicity. However, these model do not make specific predictions for H Lyα. The present observations show that Mg II dominates all line emission in the UV and FUV - except perhaps for H Lyα which is attenuated by the interstellar medium and cannot yet be quantified.

In summary, the non-detection of fluorescent Fe II or H_2 with FUSE in HD 6833 is a puzzle. Even though there is soke evidence that the winds of these Pop. II stars are warmer then their Pop. I counterparts, the chromospheres seem to be cooler with hydrogen being less excited. The cooling maybe dominated by metals, although much less abundant, with the electrons coming from the photoionization of these metals. To help answer this puzzle and gain a deeper insight into the Pop. II heating we have submitted a GALEX proposal to obtain deep GRISM spectra of other metal poor giants. The non-detection of HD 6833 is reported in Harper (2004).

Reference

Harper, G. M., 2004, in Cool Stars, Stellar Systems and the Sun, 13th Cambridge Workshop, ESA SP-, In Press.