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Final Report on Contract #: NAG5-2691
Title: Origin of the Galactic Disk 6.7 kev Line Emission

The goal of this program was to determine if the extended FeXXV 6.7 kev line emission reported by Yamauchi and Koyama (1993, Ap. J., 404, 620; and Ap. J., 405, 268) might possibly be produced and confined by the hot, wind-shocked bubbles believed to accompany UC HII regions. Our initial calculations based on stellar wind theory and the distribution of UC HII regions indicated that this might be a viable explanation for the FeXXV line emission. In the meantime, we have obtained ASCA X-ray images and spectra of the cluster of UC HII regions in the W3 complex, reduced the data, and published the results (Hofner and Churchwell 1997, Ap. J. Lett., 486, L39). The main results of this study are as follows:

1) FeXXV is detected in the W3 complex (see Fig. 4a), but at a level that could only explain a small fraction of the galactic disk emission if all UC HII regions emit at about the same intensity as the W3 complex.
2) Two X-ray sources are detected in W3 (see Fig. 2). W3-X1 coincides with the radio image of this region, but W3-X2 has no radio, optical, or infrared counterpart.
3) There is no evidençe for variability of W3-X1 during the period of observations (~40,000 sec).
4) The X-ray spectrum of W3-X1 has no emission shortward of 1 kev, it peaks at ~2 kev and show significant emission out to ~6 kev (see Fig. 4). No individual lines are resolved. There is currently no generally accepted theory for <u>extended</u> hard X-ray emission in HII regions. Perhaps the most significant discovery of this program has been the detection of extended hard X-rays and the realization that some entirely new processes must be invoked to understand this.
5) A minimum χ^2 fit of the spectrum implies a H absorbing column of $N_H \approx 2.1x10^{22}$ cm^{-2}, a temperature of the emitting plasma of $7x10^7$ K, and a luminosity of $\approx 10^{33}$ erg/s.

Due to the interesting results obtained from our observations of the W3 complex, we have submitted a follow-up proposal to observe two more massive star formation regions to confirm that the results found in W3 are representative. We believe this has been a very successful program and the support from NASA has been well spent.

Sincerely,

Ed Churchwell

Ed Churchwell

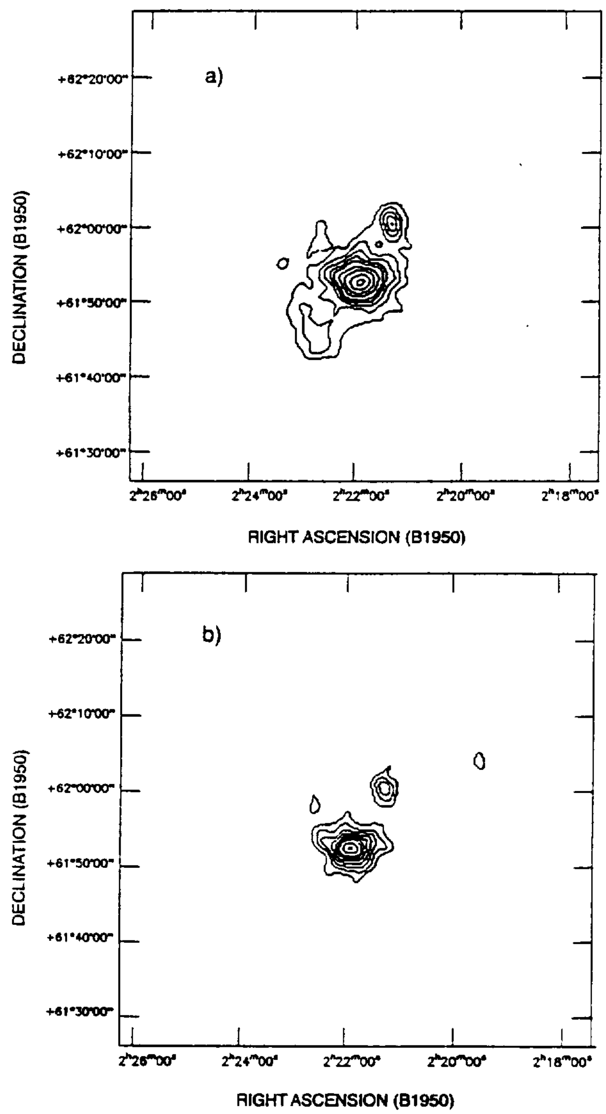

FIG. 2.—GIS3 images of W3 (background inclusive). All counts within the full energy range of 0.7–10 keV are shown in (*a*). Contour levels are 3, 4, 5, 6, 7, 9, 11, 14, and 17 counts pixel^{-1}. All counts within the hard energy range 4–10 keV are shown in (*b*). Contour levels are 3, 4, 5, 6, 7, 8, 9, 11, and 13 counts pixel^{-1}. Both images have been smoothed with a Gaussian of width 0\!'8.

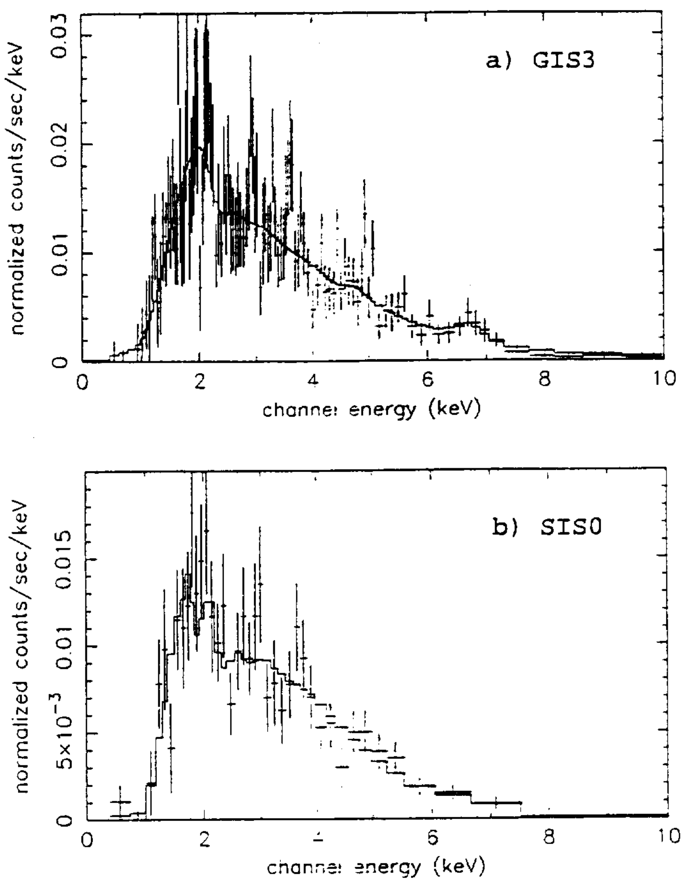

FIG. 4.—X-ray spectra of the W3 core region: (*a*) the GIS3 spectrum and (*b*) the SIS0 spectrum. Both spectra have been binned such that each spectral bin contains a minimum of 20 counts. The extraction regions were 6′ for the GIS and 4′ for the SIS detectors. The solid line in both panels shows the best-fit RS models for each detector. Note the weak Fe XXV line around 6.7 keV in the GIS3 spectrum.