Chandra Observations of the N66/NGC 346 region of the SMC: addendum

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1 Introduction

This addition to the main report contains preliminary results from the analysis of the available *HST* observations of NGC 346 in the Hα line, plus a small comment on an energy-coded image of the SNR.

2 *HST* Observations

Two *HST* WFPC2 observations of the N66/NGC 346 region in the nebular lines are available from the STSci archives. They were taken on 1998 Sept. 27 and 2000 August 7 for the programs 6540 and 8196, respectively. HD 5980 is centered on the PC in the observations from program 6540, while program 8196 shows an area situated further south. We focused mainly on the observations made through the $F656N$ filter for 2070s (Prop 6540) and 2400s (Prop 8196). This filter, centered at 6563.7 Å with a FWHM of 21.4 Å, include the Hα line and the neighboring [N II] lines, but we will neglect here the [N II] contamination.

The calibrated WFPC2 images were produced by the standard *HST* pipeline. We process them further with IRAF and STSDAS routines. The images of each program were combined to remove cosmic rays and to produce a total-exposure map. Following the procedures for narrow-band WFPC2 photometry[1], images were first divided by their total exposure time, and then multiplied by the PHOTFLAM parameter of the header, in order to get flux densities. To obtain fluxes, we multiplied the flux densities by the filter rectangular width calculated with SYNPHOT, 28.3 Å for the $F656N$ filter.

Figs. 1a, 1b and 2 show the Hα images of the two regions, while Figs. 3 and 4 show the same images superimposed on the contours of the X-ray emission seen by *Chandra*.

3 SNR 0057-7226

The first *HST* observation, presented in Figs. 1a and b, shows the close neighborhood of HD 5980. The star is surrounded by a bright arc to the west and it lies in a region with suppressed surface brightness. Only part of the N66 nebula is seen in this observation, and a close-up on it reveals interesting structures. Two Hα bright spherical 'blobs' of about 4 and 7$''$ in radius (i.e., 1 and 2 pc at an assumed distance of 59 kpc) are spotted near the edge of the WFPC2. Between them, large filaments and dust lanes are present. An additional dust lane crosses the larger and brighter 'blob', which look very similar to the N11A (LMC) or N81 (SMC) studied recently by Heydari-Malayeri *et al.* (2001). These compact H II regions could thus be star-forming regions, where the massive stars are still in their cocoon.

[1] available at http://www.stsci.edu/instruments/wfpc2/Wfpc2_faq/wfpc2_nrw_phot_faq.html

Although SNR 0057-7226 is clearly visible on the X-ray data, it does not appear clearly on the Hα images (see Fig. 4), even with the *HST* resolution. An arc of enhanced X-ray emission was seen some 10$''$ south-west of HD 5980, and we already noticed a bright arc surrounding HD 5980 in the Hα images. However, the Hα arc is at a distance of 30$''$ from HD 5980. Even if we take into account the positional errors, there is no way to reconcile these two arcs and we can therefore conclude that they belongs to two distinct features. An arc with lower X-ray emission was also spotted in the X-ray images some 30$''$ south-east of HD 5980. Again, it does not correspond to any particular structure in the Hα data.

A lot of filamentary structures - generally indicative of a SNR (Chen et al. 2000) - are seen throughout the field, but are not limited to the X-ray location of the SNR[2]. One particular filament, bright and visible near the coordinates 00 59 36 -72 11 10, is the only feature which corresponds to the SNR's edge. There are no other obvious feature associated with the SNR.

The other field comprises only a small part of the N66 nebula at its northern edge (see Fig. 2). Two bright stars are visible at coordinates 00 59 23 -72 14 23 and 00 59 31 -72 15 46, corresponding to the stars SkKM 187 and 188, respectively. None of these stars are detected in the X-ray image. The Hα emission coming from the nebula does not seem associated either with any of the X-ray emission.

To analyse more deeply the relations between X-ray and nebular emissions, we need accurate observations in a complete set of filters. Ratio maps could only then be computed and compared to the X-ray images.

3.1 RGB image of the SNR 0057-7226

Fig. 5 shows a color image of the SNR. The red, green and blue colors correspond to the 0.3-0.9 keV, 0.9-1.2 keV and 1.2-2.0 keV energy bands, respectively. This image is complementary to the temperature map presented in the main report. The only obvious trend is the softness of the NE extension of the SNR. The bright arc surrounding HD 5980 does not even possess the same color - i.e., hardness - along its whole length. We do not confirm here that the inner regions are hotter - thus harder - than the rest of the SNR.

References

[1] Chen, C.-H. R., Chu, Y.-H., Gruendl, R.A., & Points, S.D. 2000, AJ, 119, 1317

[2] Heydari-Malayeri, M., Charmandaris, V., Deharveng, L., Rosa, M. R., Schaerer, D., & Zinnecker, H. 2001, A&A, 372, 527

[2] although this is not clearly seen in the figures presented here

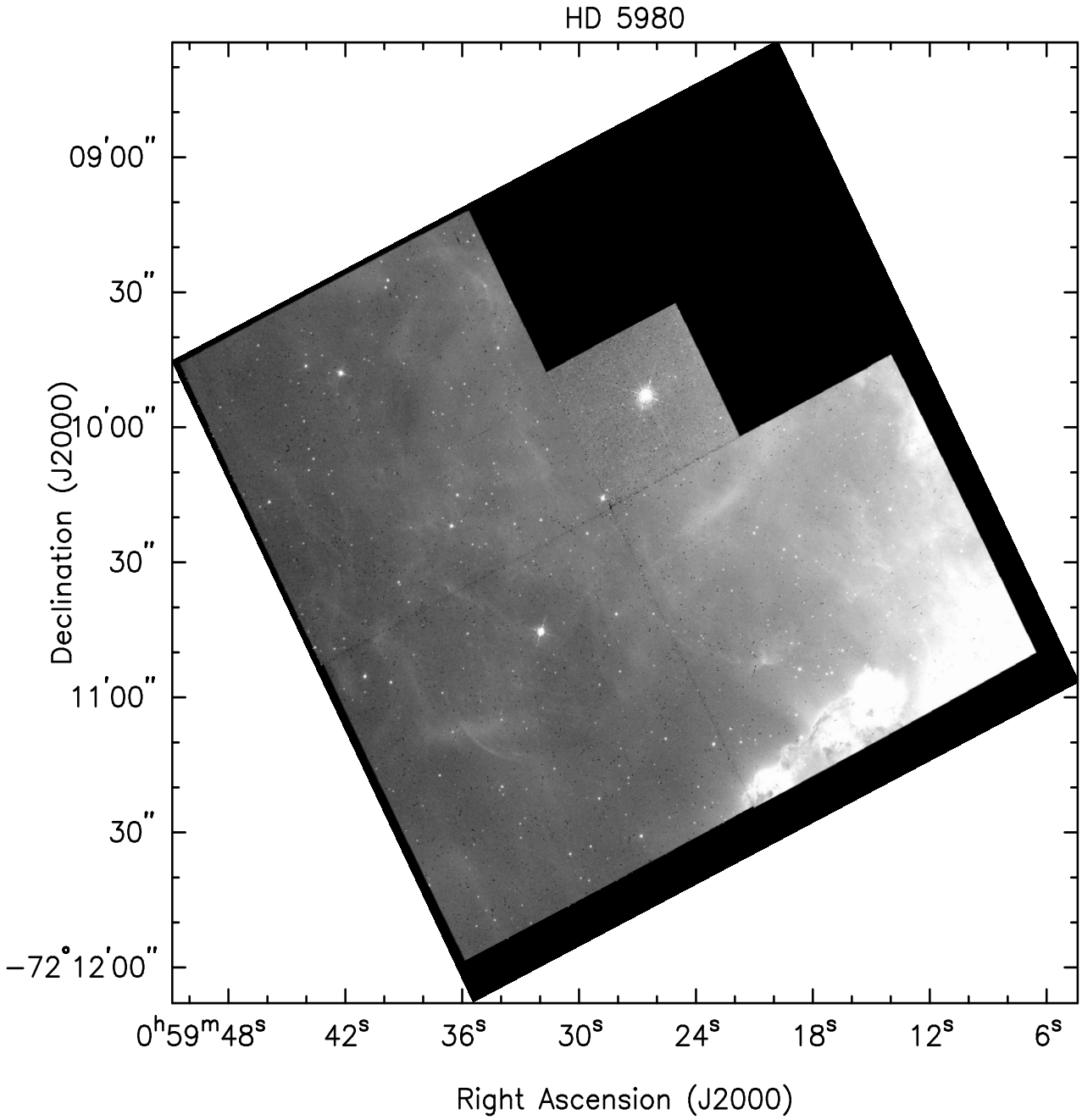

Figure 1: a. *HST* WFPC2 Hα data of the area surrounding HD 5980 (which is the star at the PC's center).

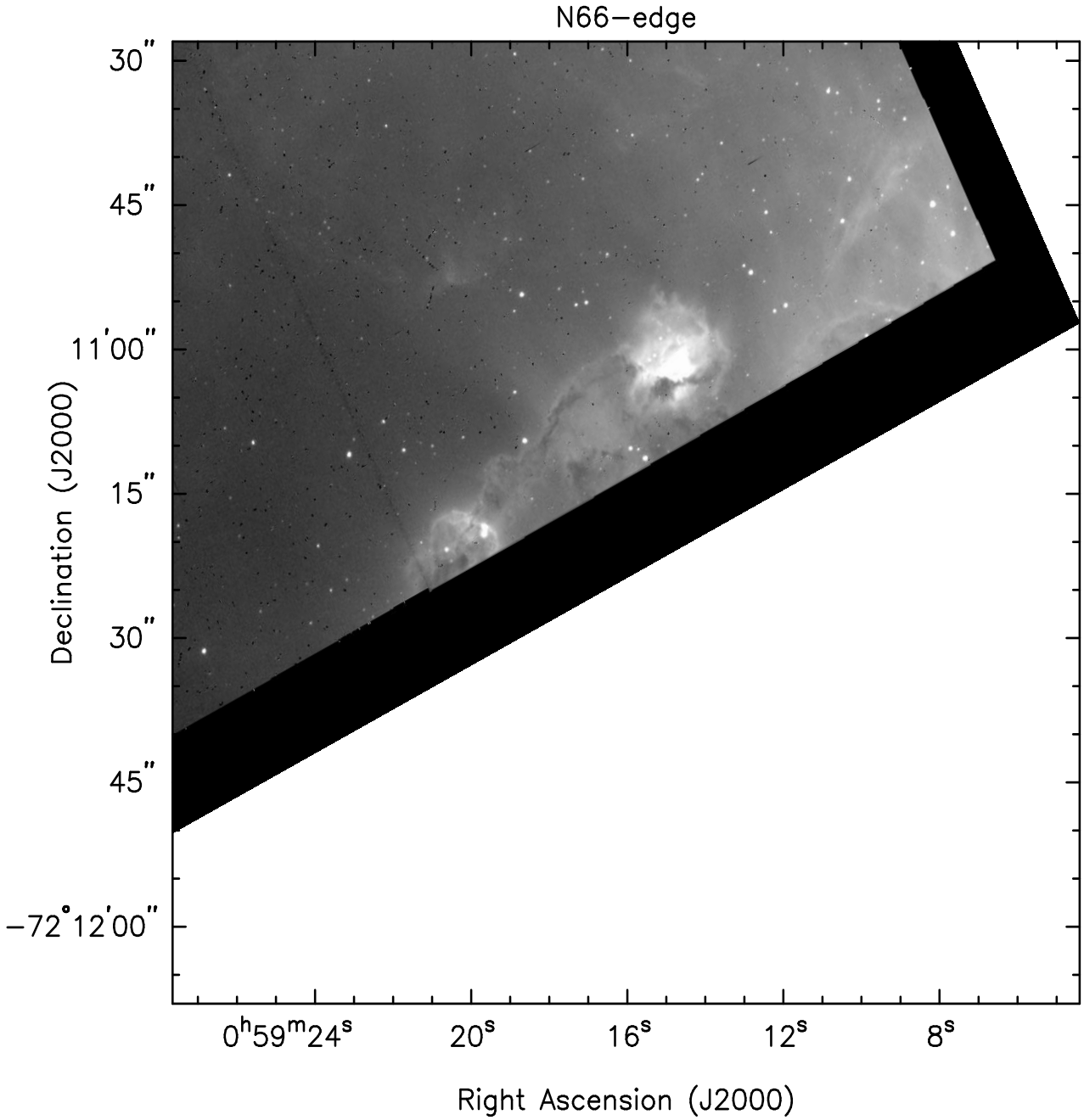

Figure 1: b. *HST* WFPC2 Hα data of the area surrounding HD 5980 : close-up on the SE edge of N66.

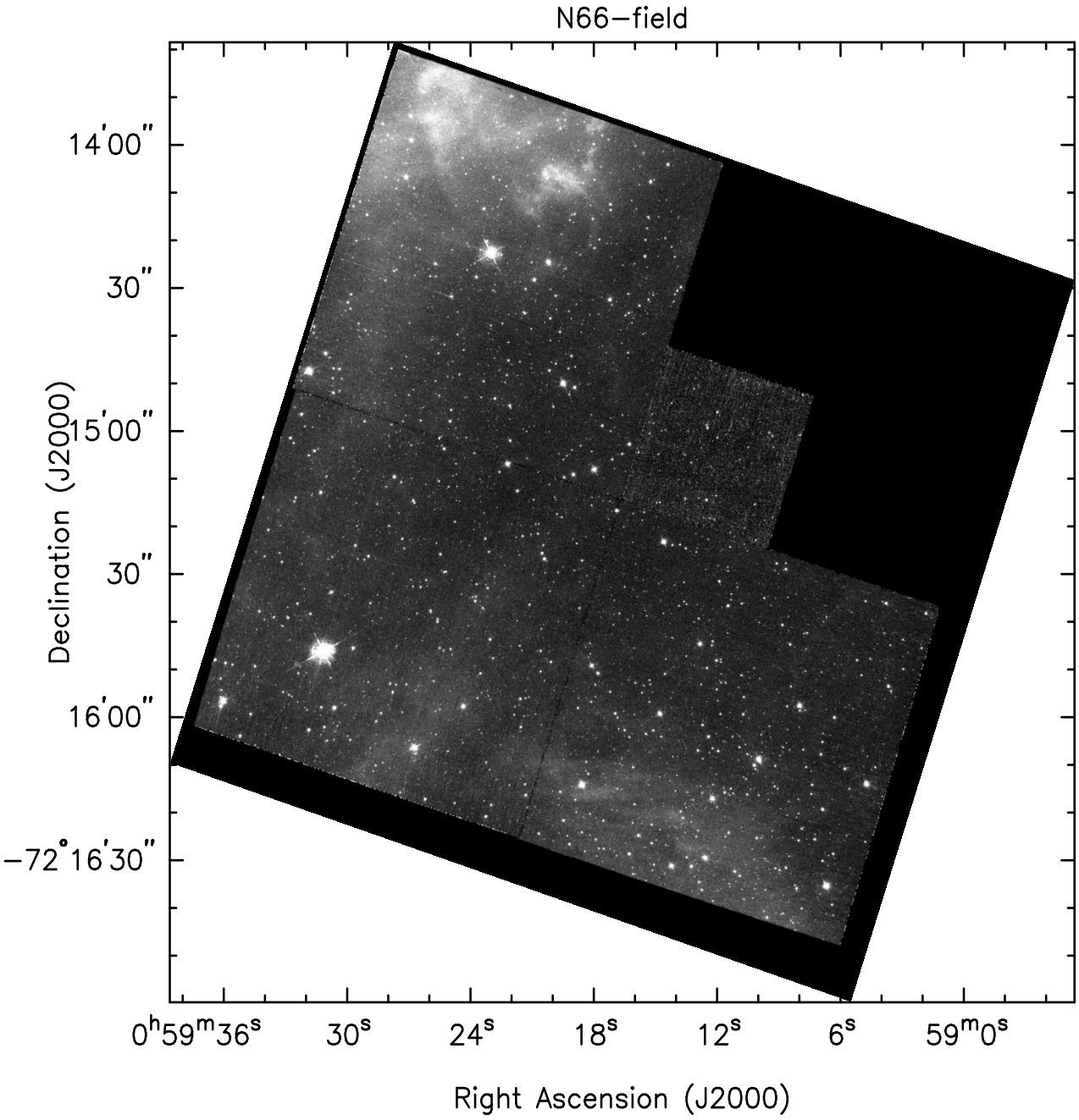

Figure 2: *HST* WFPC2 Hα data of program 8196.

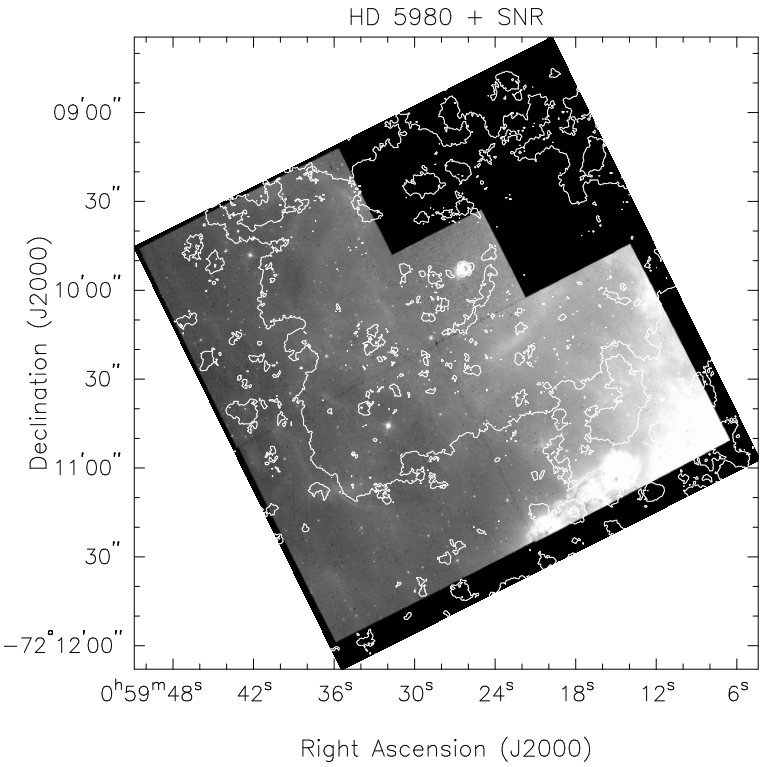

Figure 3: Same as Fig. 1, with the contours of the X-ray emission overlaid.

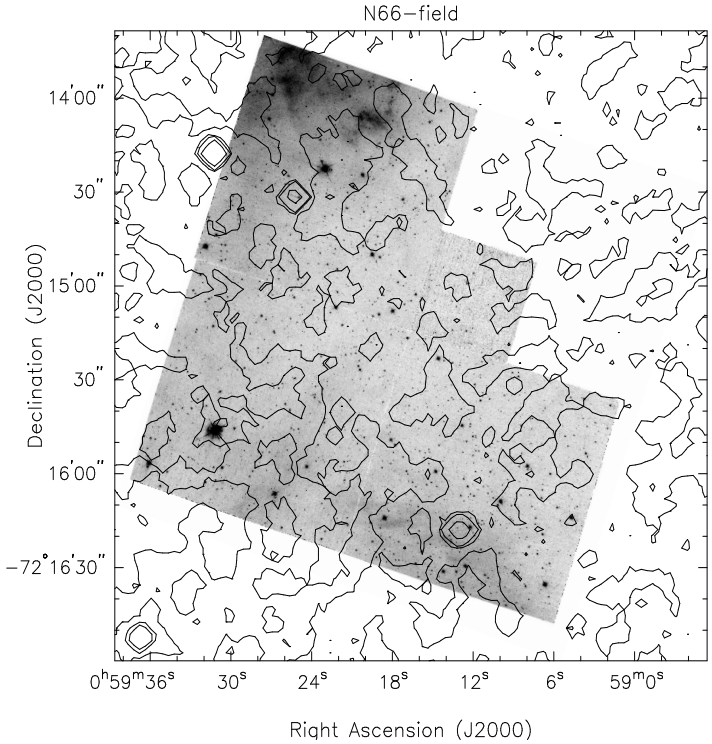

Figure 4: Same as Fig. 2, with the contours of the X-ray emission overlaid.

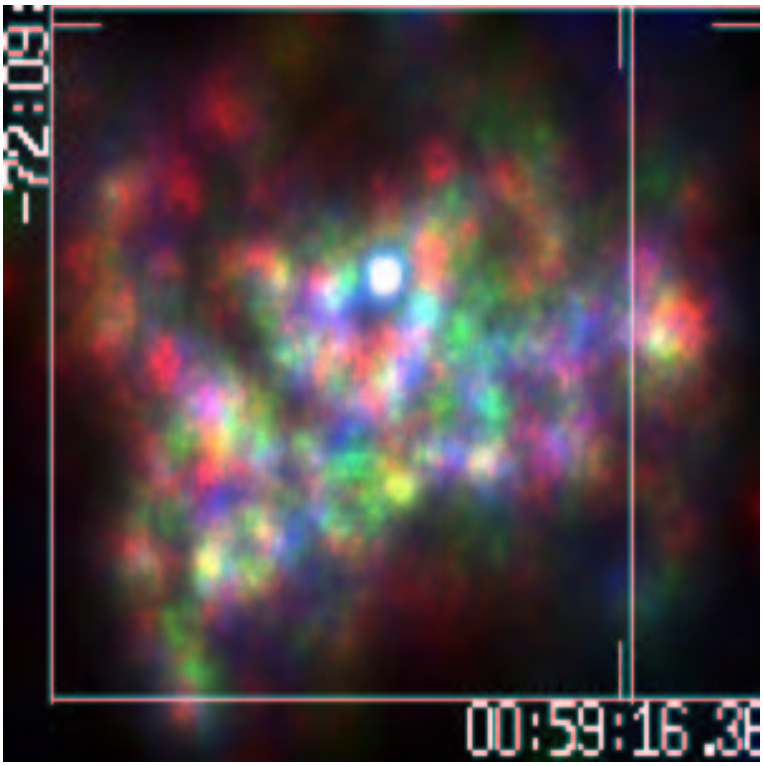

Figure 5: RGB image of the SNR, with red corresponding to the 0.3-0.9 keV energy band, green to 0.9-1.2 keV band and blue to 1.2-2.0 keV band.