Deep optical study of the supernova remnant G 132.7+1.3 (HB 3)

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ABSTRACT

G132.7+ 1.3 is one of the most extended supernova remnants is our Galaxy. In this work we explore its optical emission with Hα+[N II], [S II] and [O III] imaging and spectral data for its brightest filaments. Comparing our data with the properties of the SNR in other wavelengths, we find that its optical structure matches very well with this that the remnant reveals in the infrared, X-ray and the radio (330 MHz) band. We find that the detected optical emission results from shock-heated gas, being part of the SNR. Our distance and reddening calculations agree, within the errors, with those estimated from previous studies. Finally, we determine crucial physical parameters of the remnant such as the electron density of the shocked gas and the column density.

INTRODUCTION & OBSERVATIONS

G132.7+1.3 is among the largest Galactic SNRs observed so far with an angular size of 90° × 123° in 408 MHz radio maps. Adopting a distance of 2.2±0.2 kpc from HI observations, implies a physical size of 57 × 79 pc [1]. It reveals a shell morphology and has been primarily detected in radio wavelengths [2]. Further radio observations [3] clarified the SNR nature of this radio source distinguishing it from the adjacent HII region W3. Fesen et al. 1995 explored the remnant in radio wavelengths and its western structure in optical wavelengths finding that the radio and optical images are well-matched and calculated for its west filament a shock velocity ≤ 100 km s^{-1}, an upper limit for the electron density of 150 cm^{-3} and a reddening E(B-V) of 0.71 ± 0.04.
In this work, we explore its optical emission in its full extend. In particular, Hα+[N II], [S II] and [O III] emission line images are presented, which show the complete structure of this large SNR for the first time. Moreover, we present high resolution imaging and long-slit spectroscopy at multiple selected areas of the SNR. In all images presented here, North is to the top and East to the left.

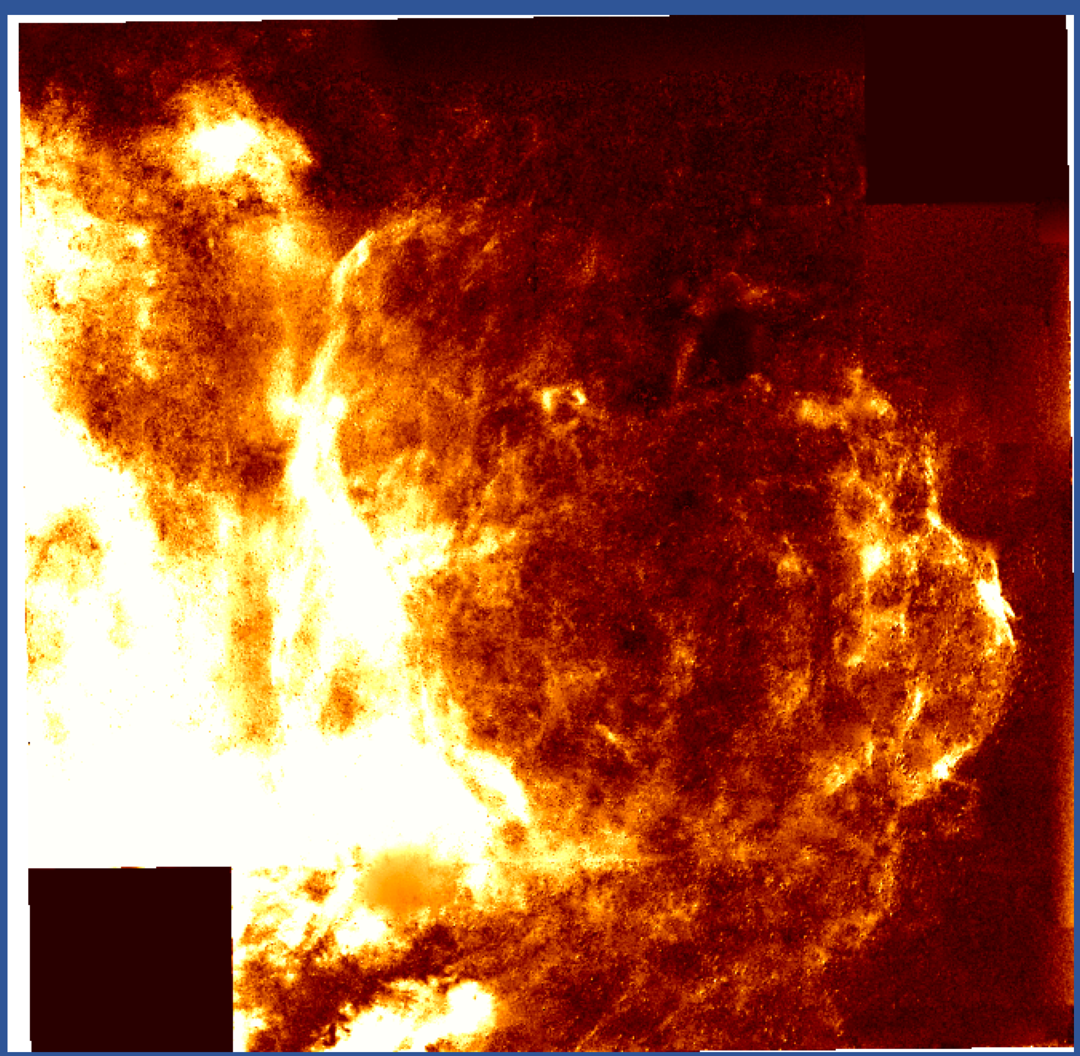

Figure 1. The continuum–subtracted mosaic of G132.7+1.3 in Hα+[N II] emission. Shadings run linearly from 0 to 801.04×10^{-17} erg s^{-1} cm^{-2} $arcsec^{-2}$).

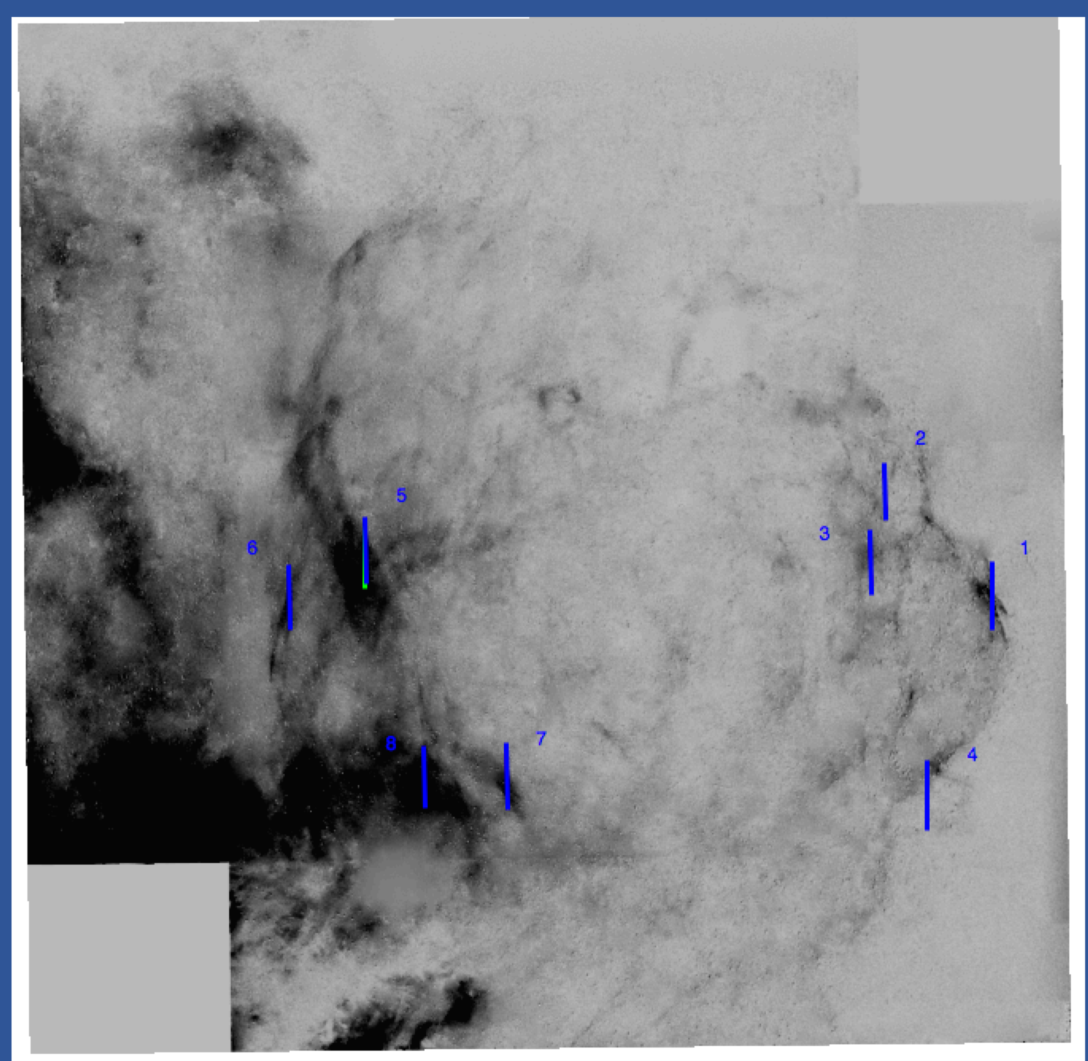

Figure 2. The continuum–subtracted image of G132.7+1.3 in [S II] emission. Shadings run linearly from 0 to 38.9×10^{-17} erg s^{-1} cm^{-2} $arcsec^{-2}$). The blue lines indicate the positions of the slits.

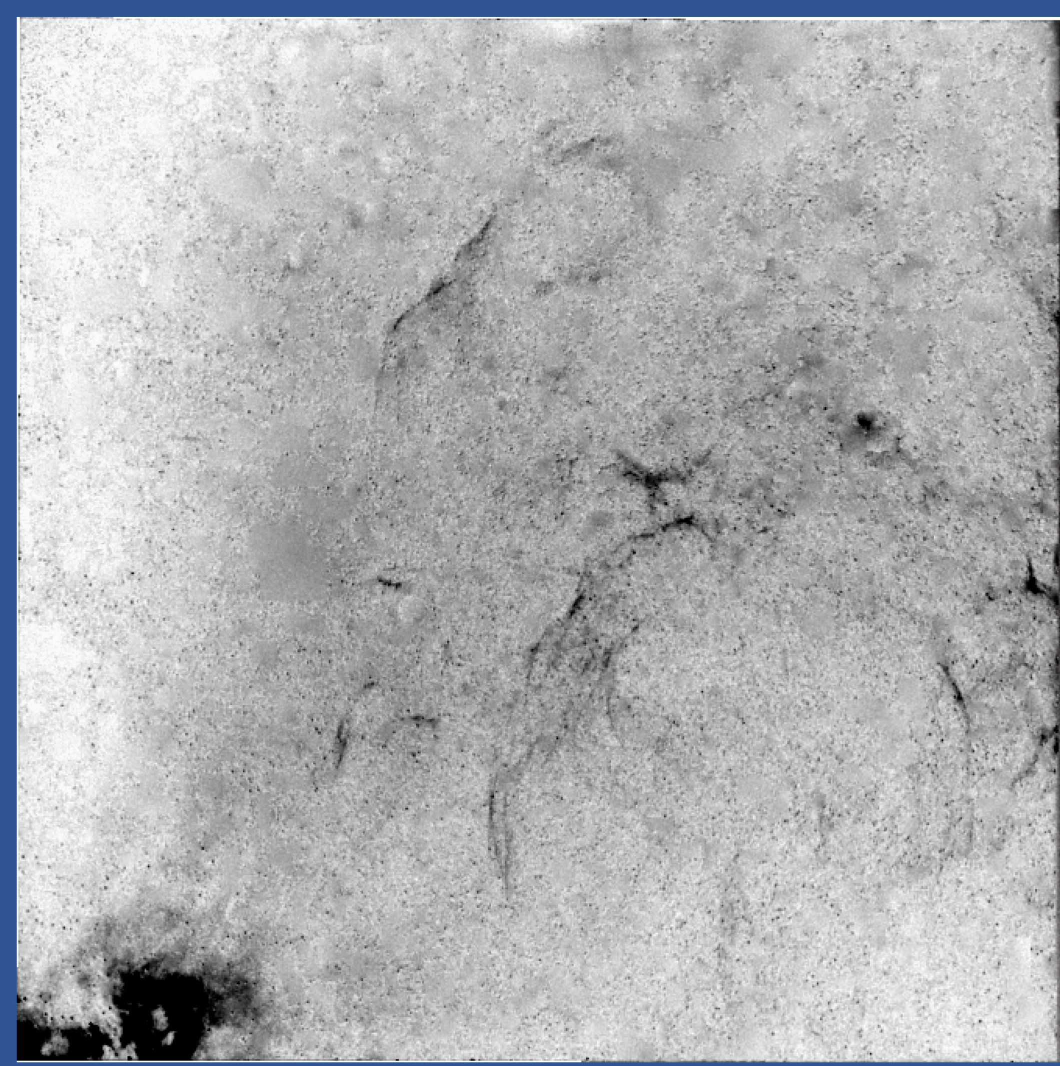

Figure 3. The continuum–subtracted image of G132.7+1.3 in [O III]. Shadings run linearly from 0 to 60.4×10^{-17} erg s^{-1} cm^{-2} $arcsec^{-2}$). This image covers only part of the SNR.

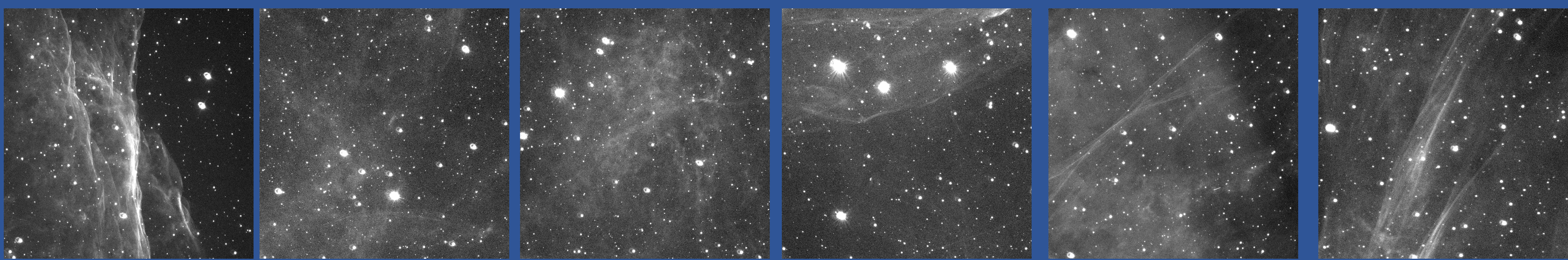

Figure 4. High resolution images of G132.7+1.3 in Hα+[N II] emission of slit positions 1-6 (from left to right). The North-East orientation is the same for all images and it can be seen on the top left image. The faint ring which appears to the north-east of all bright stars is a ghost due to the filter.

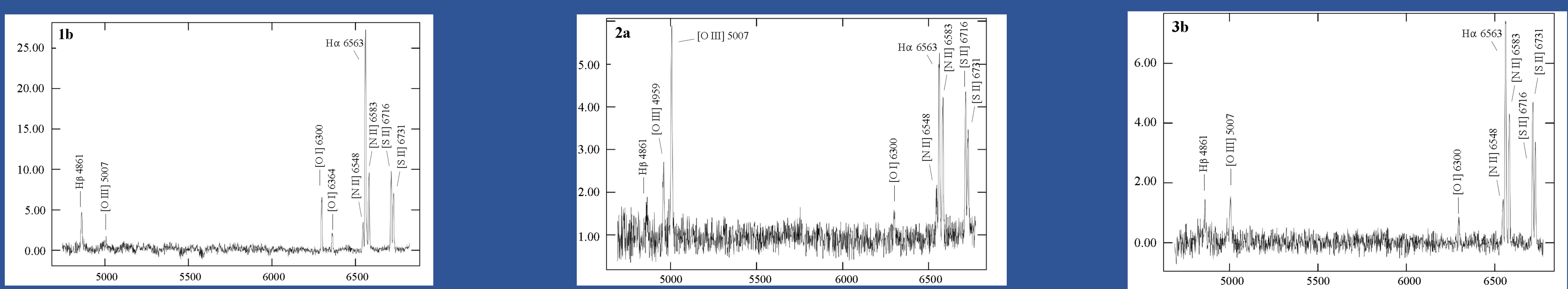

Figure 5. A sample of long–slit low resolution spectra from different positions of the observed SNR. The flux is in units of 10^{-17} erg s^{-1} cm^{-2} $arcsec^{-2}$ A^{-1}.

Preliminary Results

The composite Hα+[N II] image provides the best description of the morphology of G 132.7+01.3 in its full extend making possible the identification of all of its detailed structures. [S II] and [O III] emission has also been detected matching in shape and position that of Hα+[N II], though being more diffuse and less filamentary. Both the presence of the [O I] 6300 Å emission line and the measured [S II]/Hα > 0.4 and 0.5 < [N II]/Hα < 1 emission line ratios support the view that the detected emission originates from shock heated gas. From our spectral data we estimate the interstellar extinction being between 0.62 ± 0.22 and 2.80 ± 0.46. The distance to the remnant was estimated to be larger than 0.82 kpc and its column density greater than 3.95 x 10-21 cm^{-2}.

References

[1] Fesen et al. 1995 AJ.110.2876
[2] Brown & Hazard 1953; MNRAS.113.109
[3] Caswell 1967; MNRAS.136.11