Detection of Extensive Optical Emission From the Extremely Radio Faint Galactic Supernova Remnant G182.4+4.3

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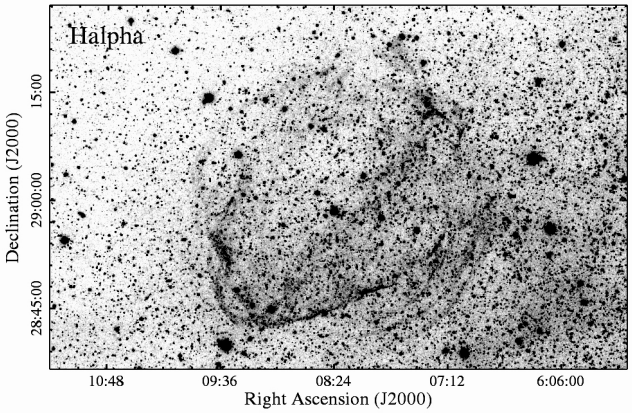
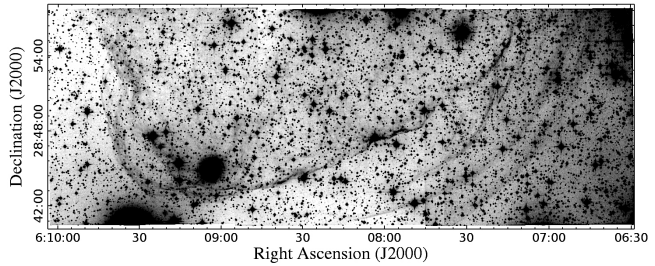
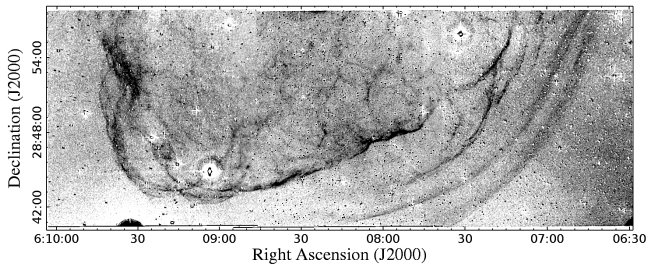


Halpha image of the radio faint SNR G182.4+4.3 showing a surprisingly extensive optical emission structure (dia ~ 43') for such a faint radio SNR. Note the unusual series of broad filaments along its southwestern limb.





Mosaics of a direct Halpha image (upper) and Halpha continuum subtracted image (lower) of G182.4+4.3's southern limb. Note the bright filaments marking the remnant's southern boundary, the numerous short curved filaments in the remnant's interior, and the unusual series of filaments situated outside the remnant's main limb farther to the southwest.

Among the faintest radio Galactic SNRs known is G182.4+4.3. It was discovered by Kothes et al. (1998) using the Effelsberg 100 m radio telescope at frequencies of 1400, 2675, 4850, and 10450 MHz. They found it to have a spectral index α = -0.42 +/- 0.10 and a polarization percentage exceeding 60% for the brightest southwestern parts of its emission shell. **They estimated a diameter of 50 arcmin, a distance of at least 3 kpc, an age of 3800 yr, and a shock velocity of 2300 km/s.**

Optical emission associated with the G182.4+4.3 was first reported by Sezer et al. (2012). Four 13.5' x 13.5' regions were imaged using on and off band Halpha and [S II] 6716,6731 filters covering portions of the remnant's center, southern, northern, and northwestern regions. These data revealed both filamentary and diffuse emission which they stated was correlated with the remnant's radio structure.
Based on finding faint associated XMM-Newton X-ray emission, they also estimated G182.4+4.3 was relatively young, just 4400 yr old assuming a distance of 3 kpc.

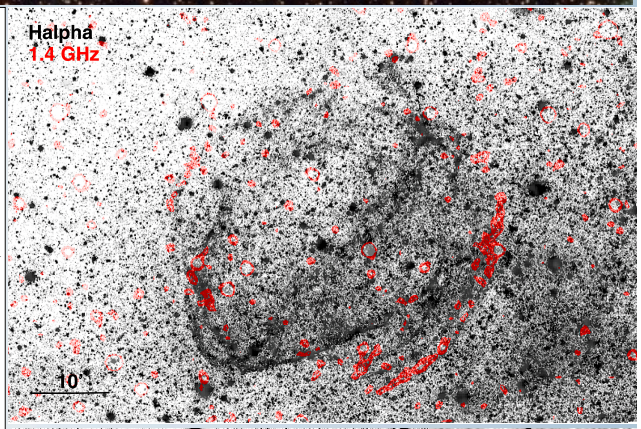
Main Results

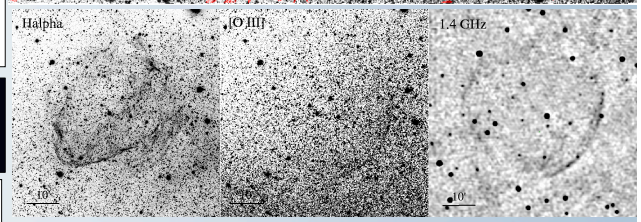
We obtained wide-field Halpha images of the extremely radio faint Galactic SNR G182.4+4.3 that reveal a far more extensive and complex emission structure then previously known, with an unusual series of broad and diffuse filaments along the remnant's southwestern limb. [O III] 5007 images revealed no appreciable remnant emission with the exception of a single filament coincident with the westernmost of the broad southwest filaments.

Low-dispersion optical spectra of several regions in the remnant's main emission structure confirm a lack of appreciable [O III] emission and indicate [S II]/Halpha line ratios of 0.73 - 1.03, consistent with a shock-heated origin. However, the near total absence of [O III] emission suggests the majority of the remnant's optical emission arises from relatively slow shocks , <70 km/s.

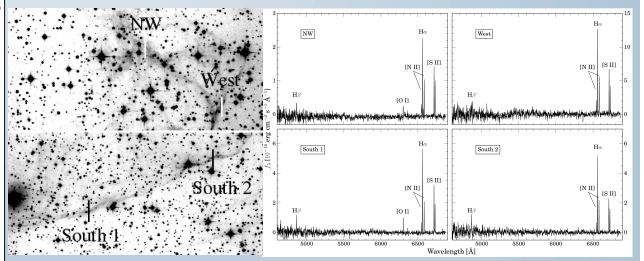
We conclude G182.4+4.2 is a fairly large remnant (d ~50 pc at 4 kpc) and much older (age ~40 kyr) supernova remnant than previously estimated. Its weak radio and X-ray emissions are related to its old age, low shock velocity, and location in a low density region some 12 kpc out from the Galactic center.

References:
Kothes, R., Furst, E., & Reich, W., 1998, Astro. & Ap, 331, 661
Sezer, A., Gok, F., & Aktekin, E., 2012, MNRAS, 427, 1168





Upper: Overlay of the NRAO VLA SKY Survey (NVSS) 1.4 GHz radio image (red) onto the Halpha image (black). Lower: Comparison of emissions from G182.4+4.3: Halpha, [O III] 5007, and 1.4 GHz. While the remnant exhibits extensive emission in Halpha, it is virtually undetectable in [O III] 5007 except for a single faint filament located near the outermost of the Halpha filaments in the southwest. This sole [O III] filament is coincident with the remnant's brightest radio feature.



Left Panel: Locations of our four slit positions. Right Panels: Low-dispersion optical spectra for the four slit positions. Note the strength of the [S II] 6716,6731 emission lines compared to that of Halpha, which is a characteristic of shocked gas. Presence of [O I] 6300 emission could only be firmly established for two of the four emission regions examined.