A NEW DISTANCE DETERMINATION TO THE CYGNUS LOOP

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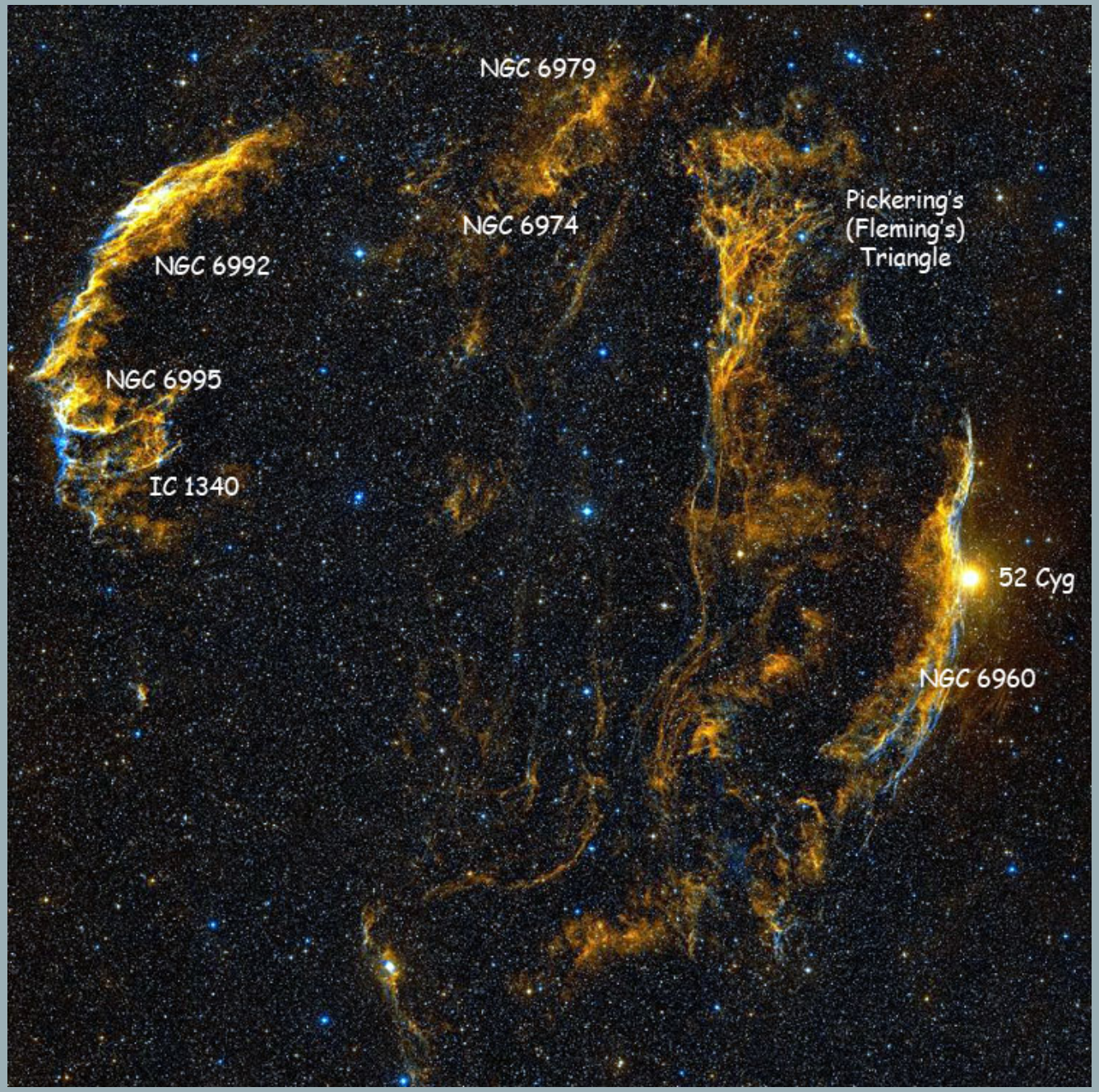
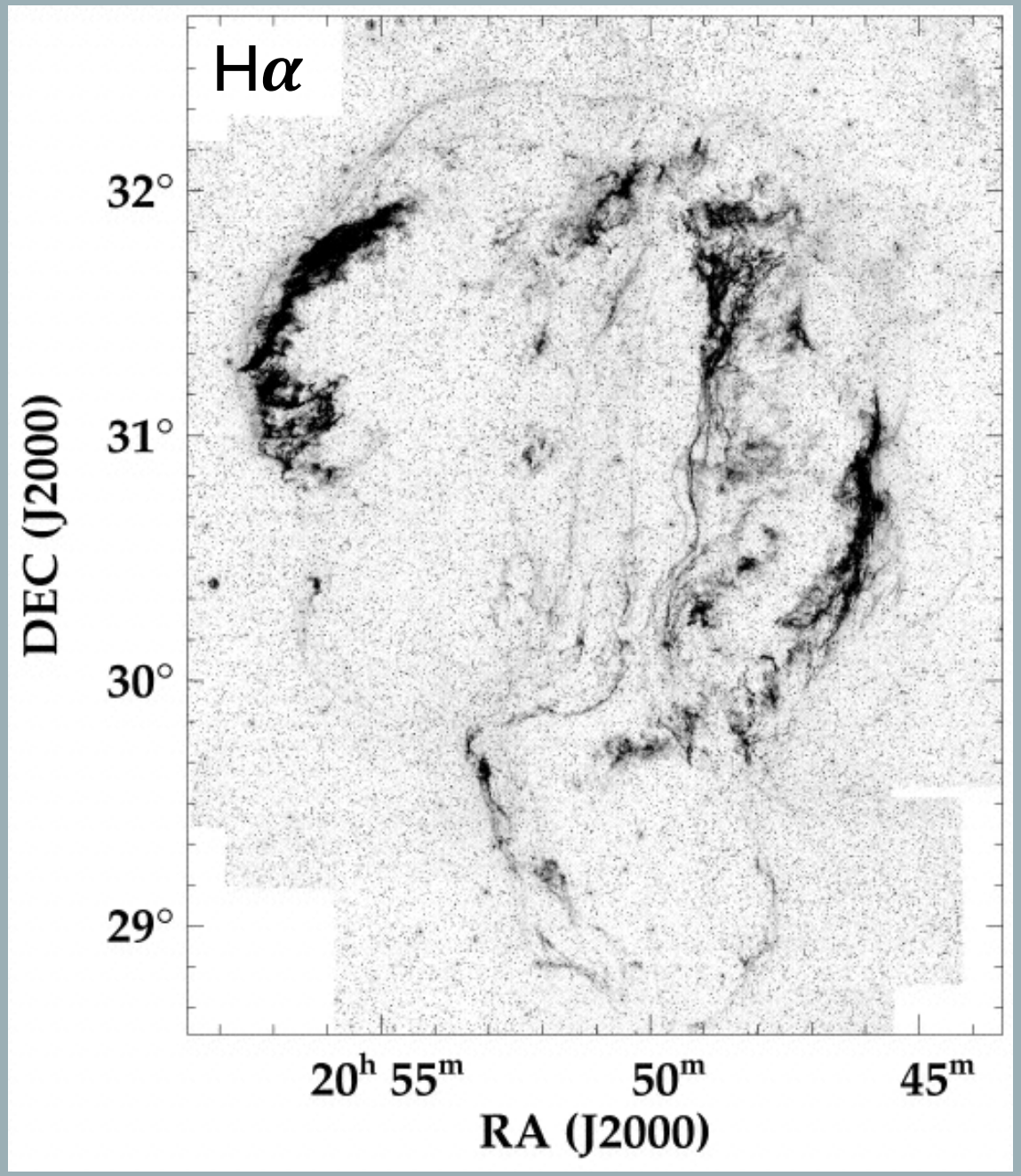
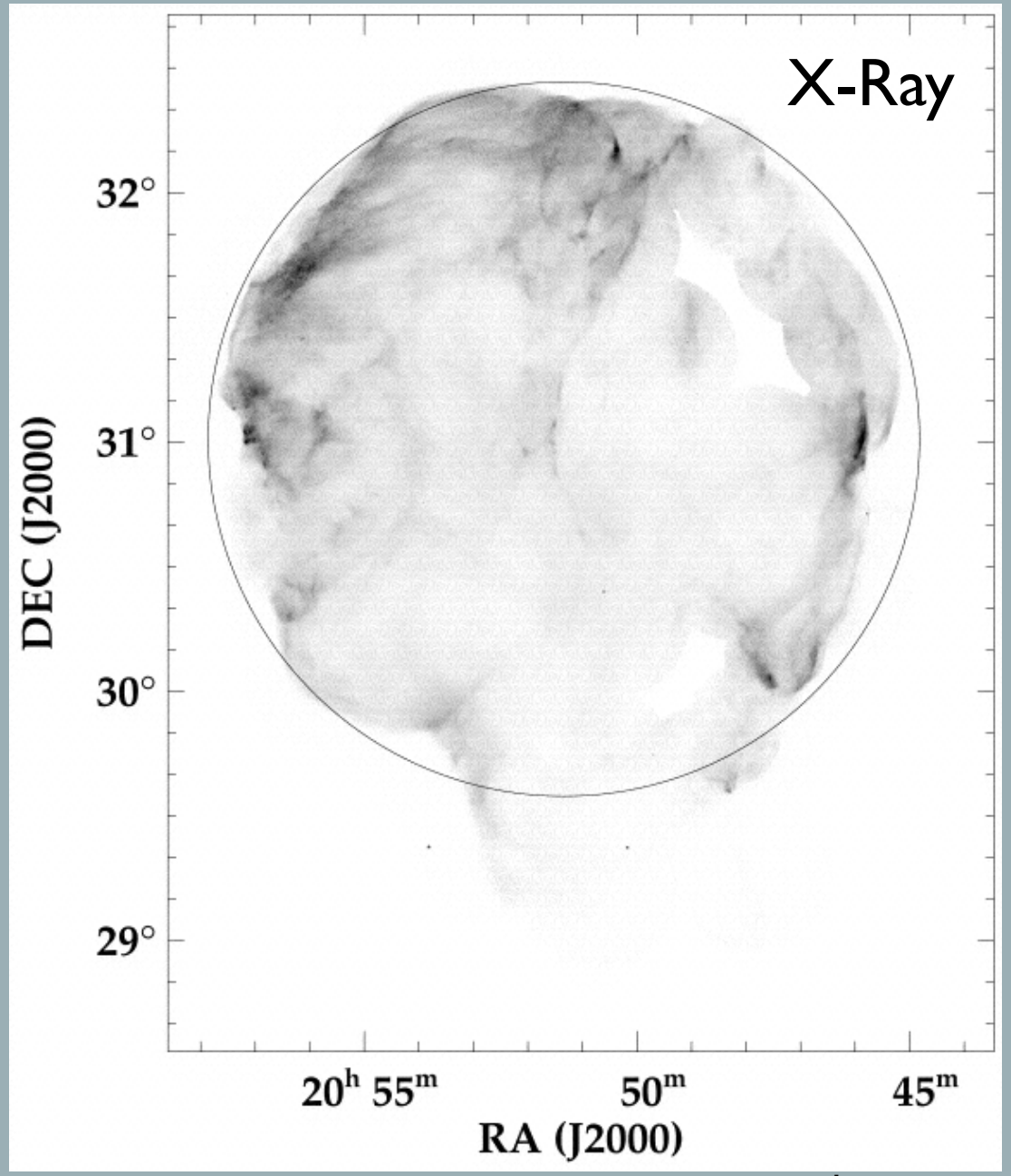
10/06/2016



Cygnus Loop
G74.0-8.5

- Also known as:
  - Veil Nebula
  - Cirrus Nebula
  - Network Nebula
- 10,000 to 20,000 years old
- 2.8 x 4 degrees
- Several components have their own designations





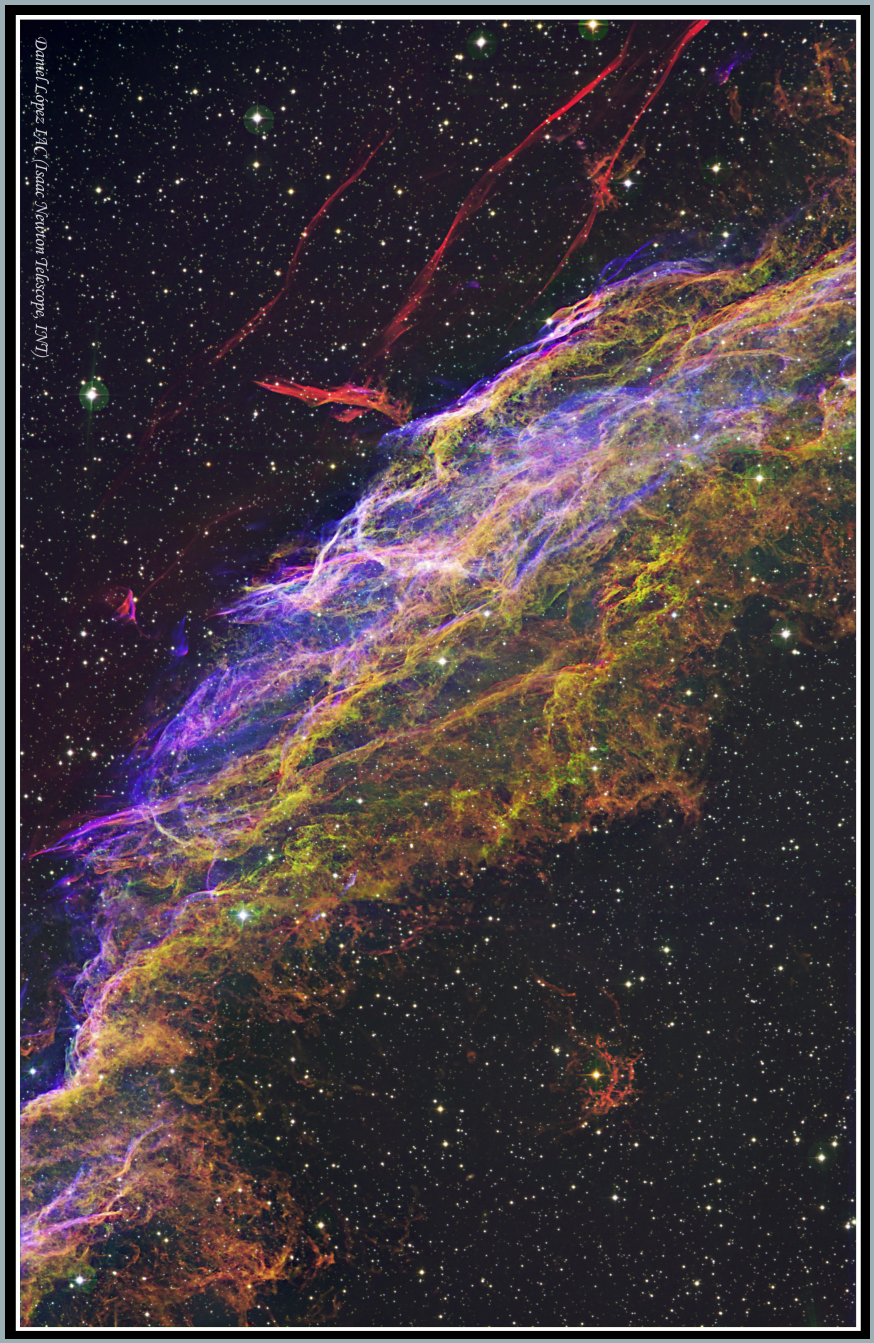
Levenson et al. 1998

Previous Distance Estimates

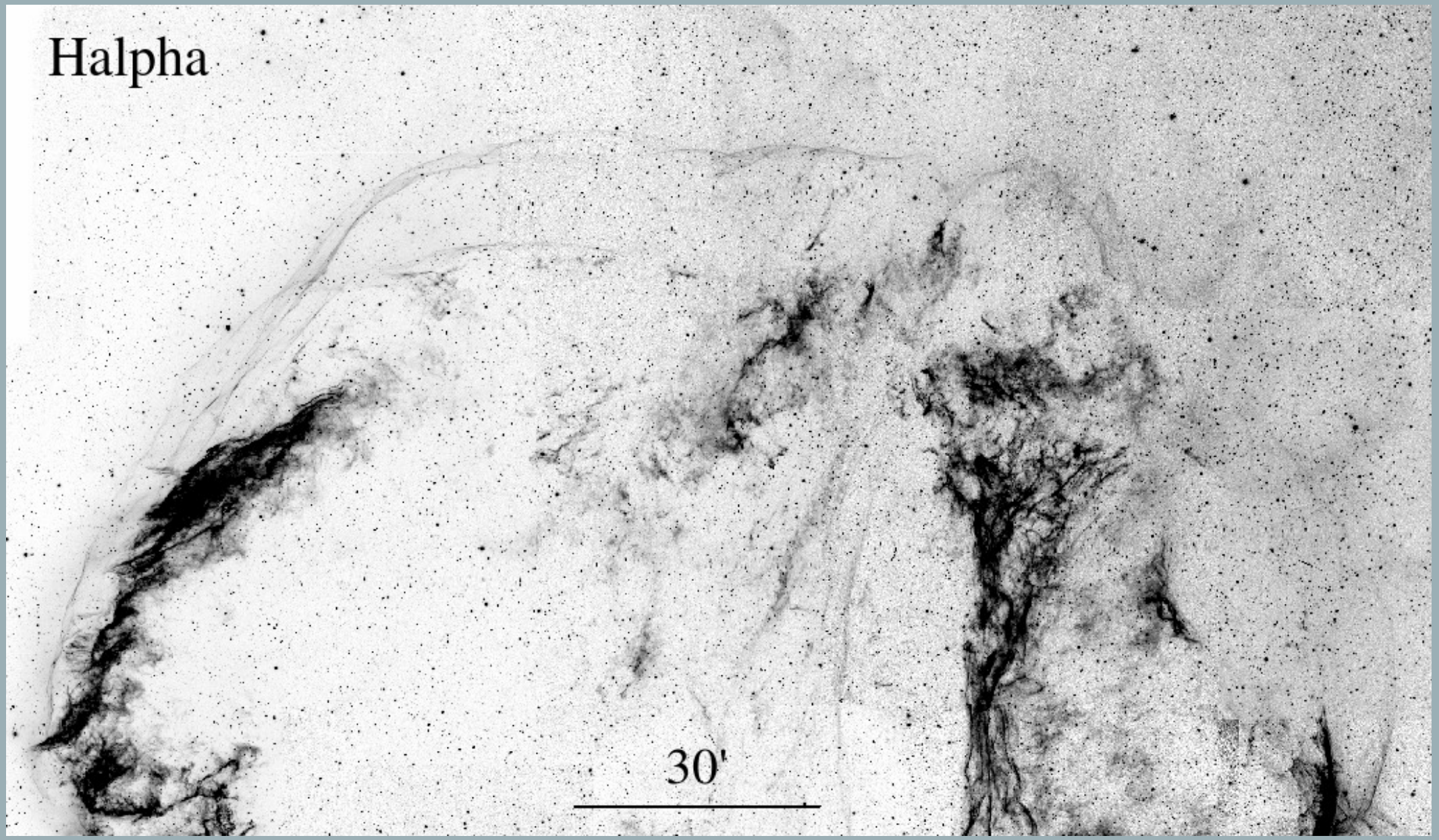
Reference	Distance Estimate (pc)	Range (pc)
Minkowski (1958)	770	
Rappaport et al. (1974)	770	470-1070
Sakhibov & Smirnov (1983)	1400	1000-1800
Braun & Strom (1986)	460	300-620
Shull & Hippelein (1991)	600	300-1200
Blair et al. (1999)	440	340-570
Blair et al. (2005)	540	460-670
Blair et al. (2009)	570	510-637
Salvesen et al. (2009)	750	>630
Medina et al. (2014)	890	790-1180

APOD: December 2009

- NGC 6992
- Taken with 2.5m INT
- Star J205601+313130
  - $20^h56^m0.935^s$ +31°31’29”.74



Daniel Lopez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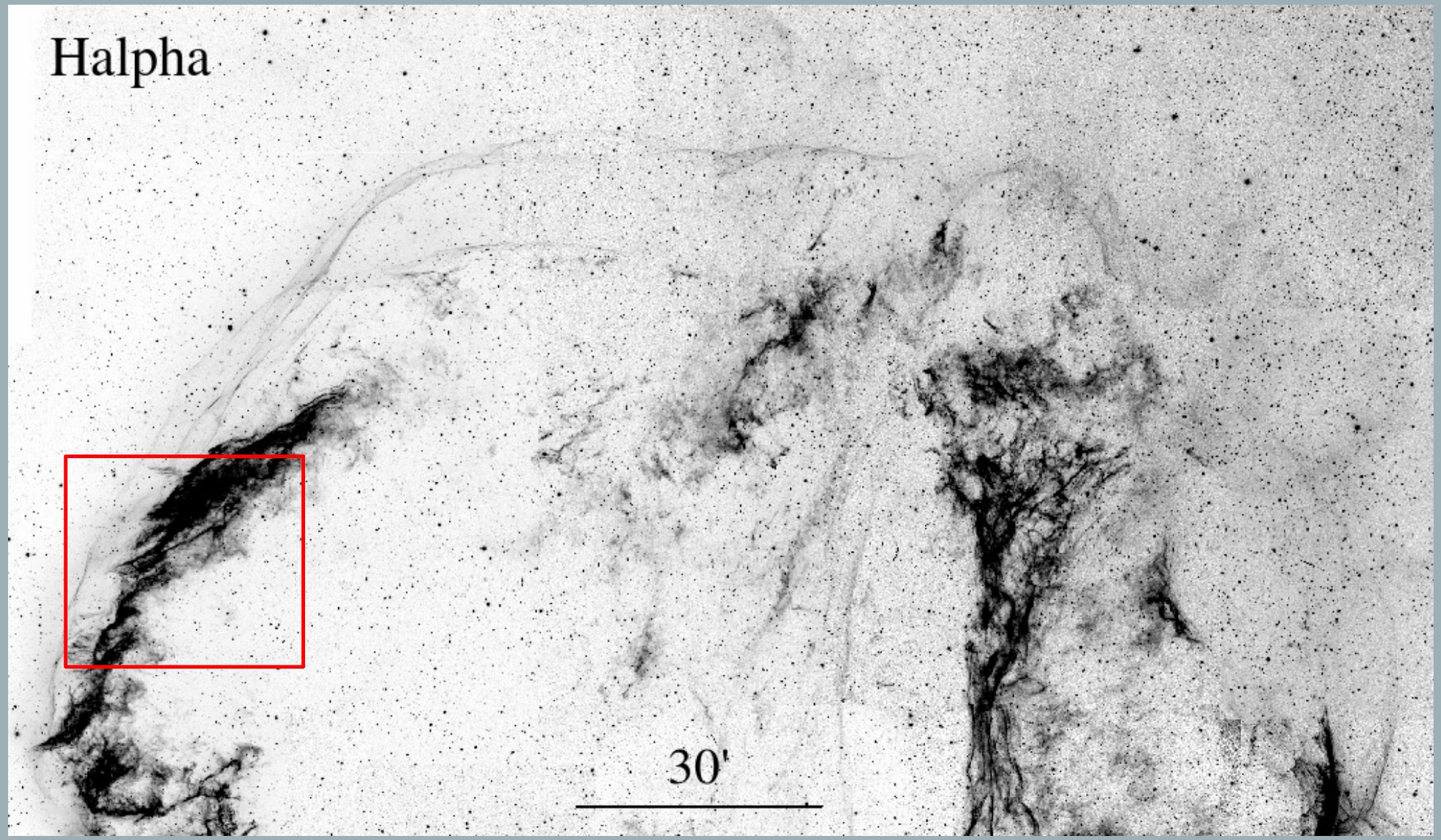
30'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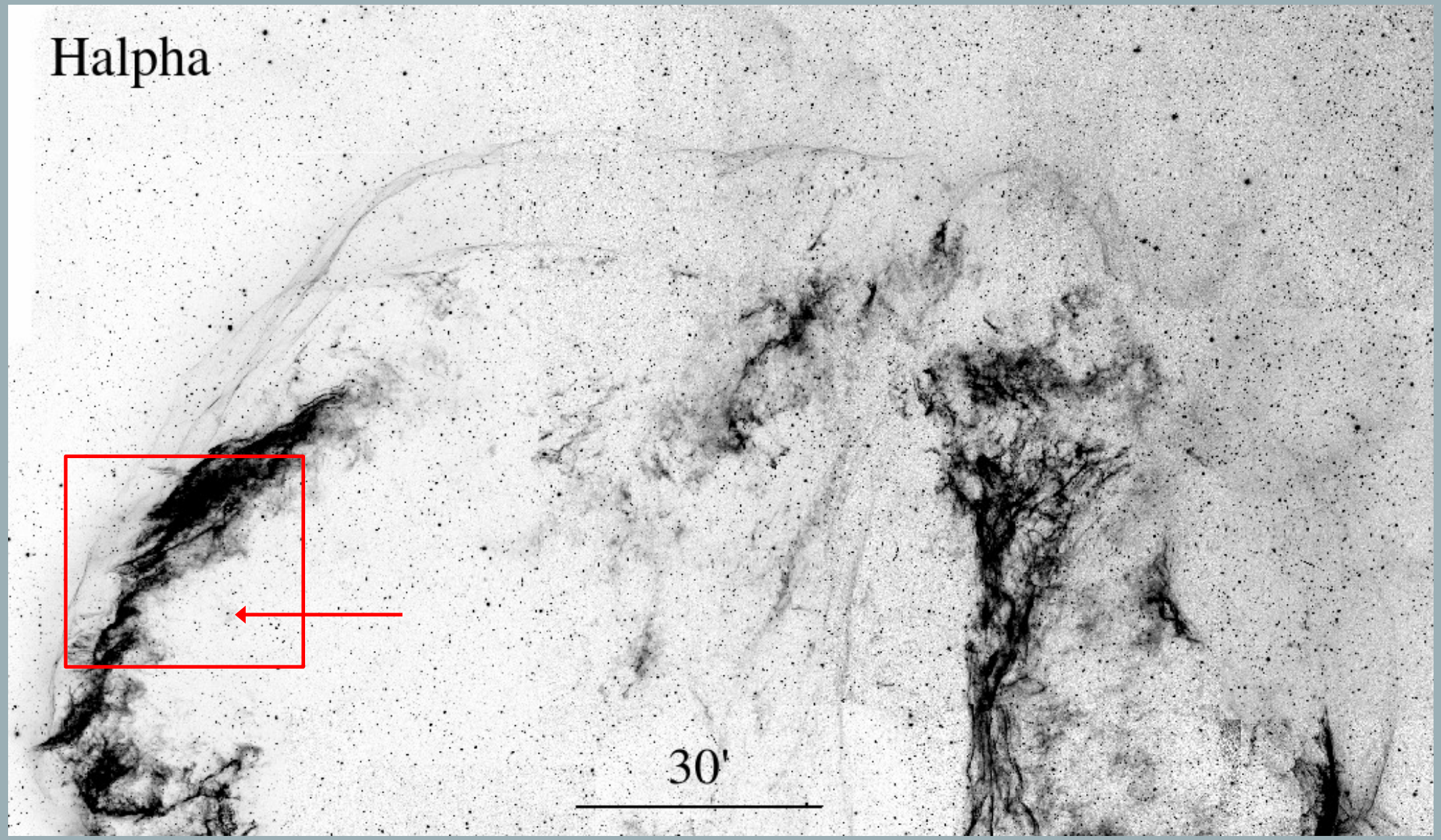
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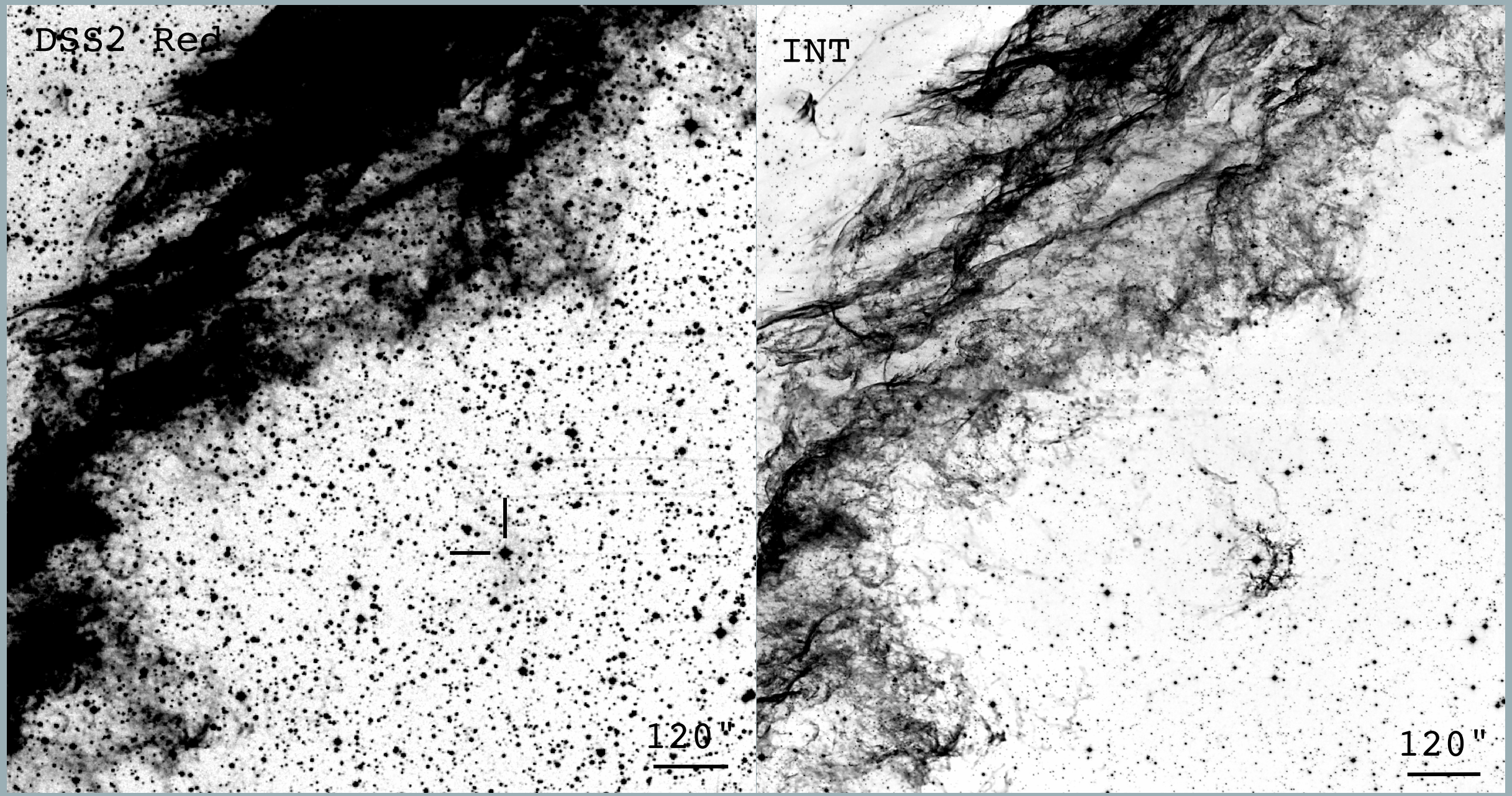
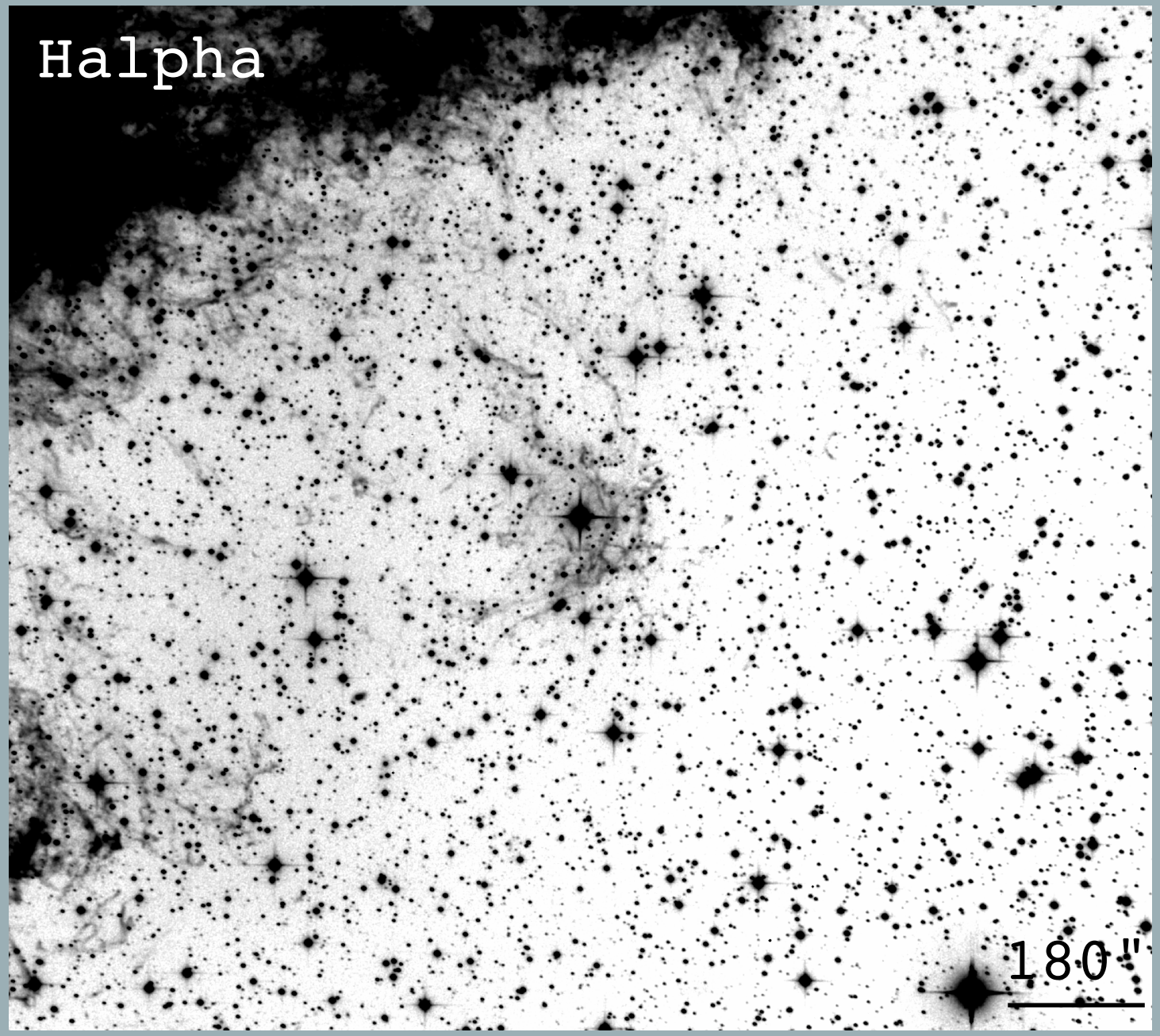

DSS2 Red
120"
INT
120"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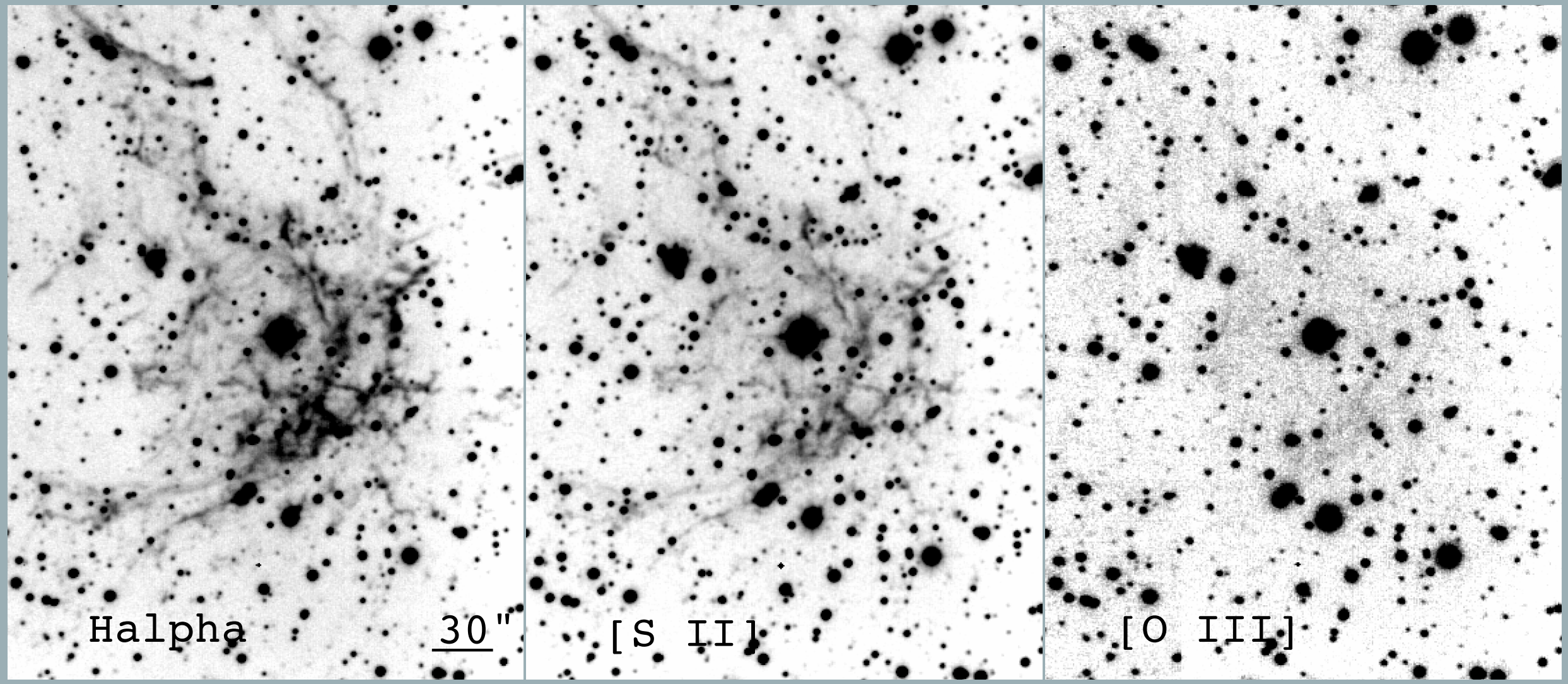
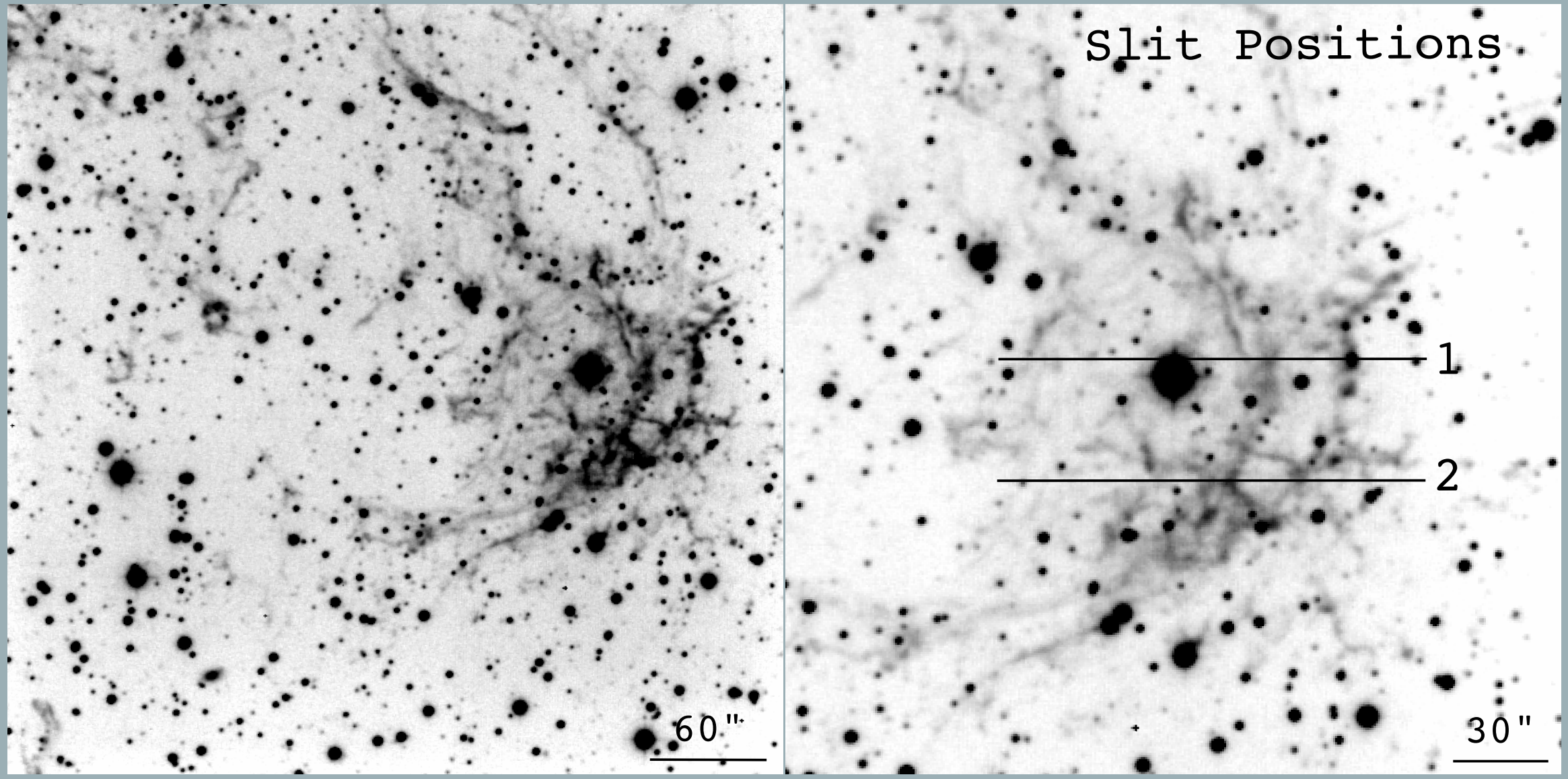
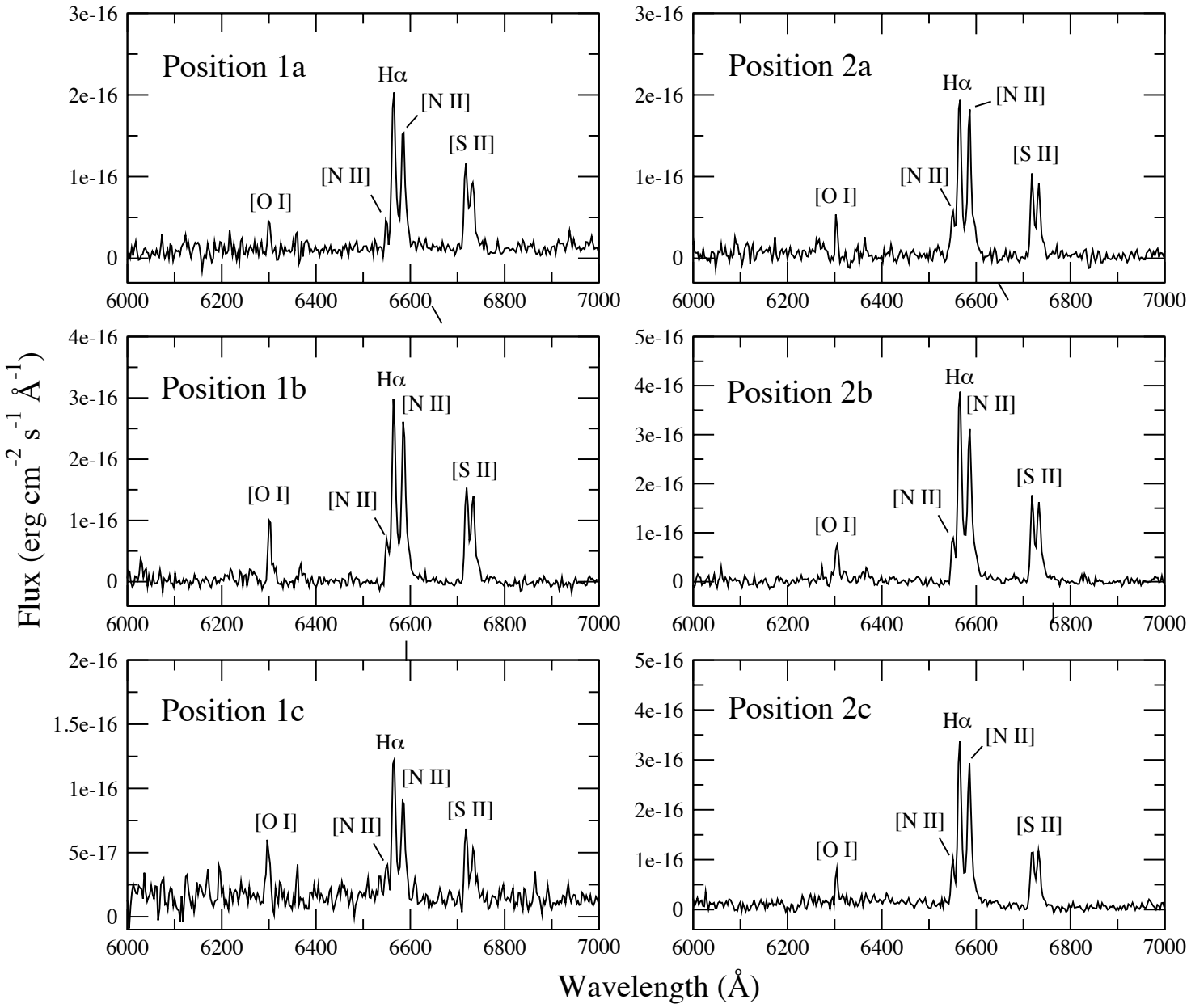
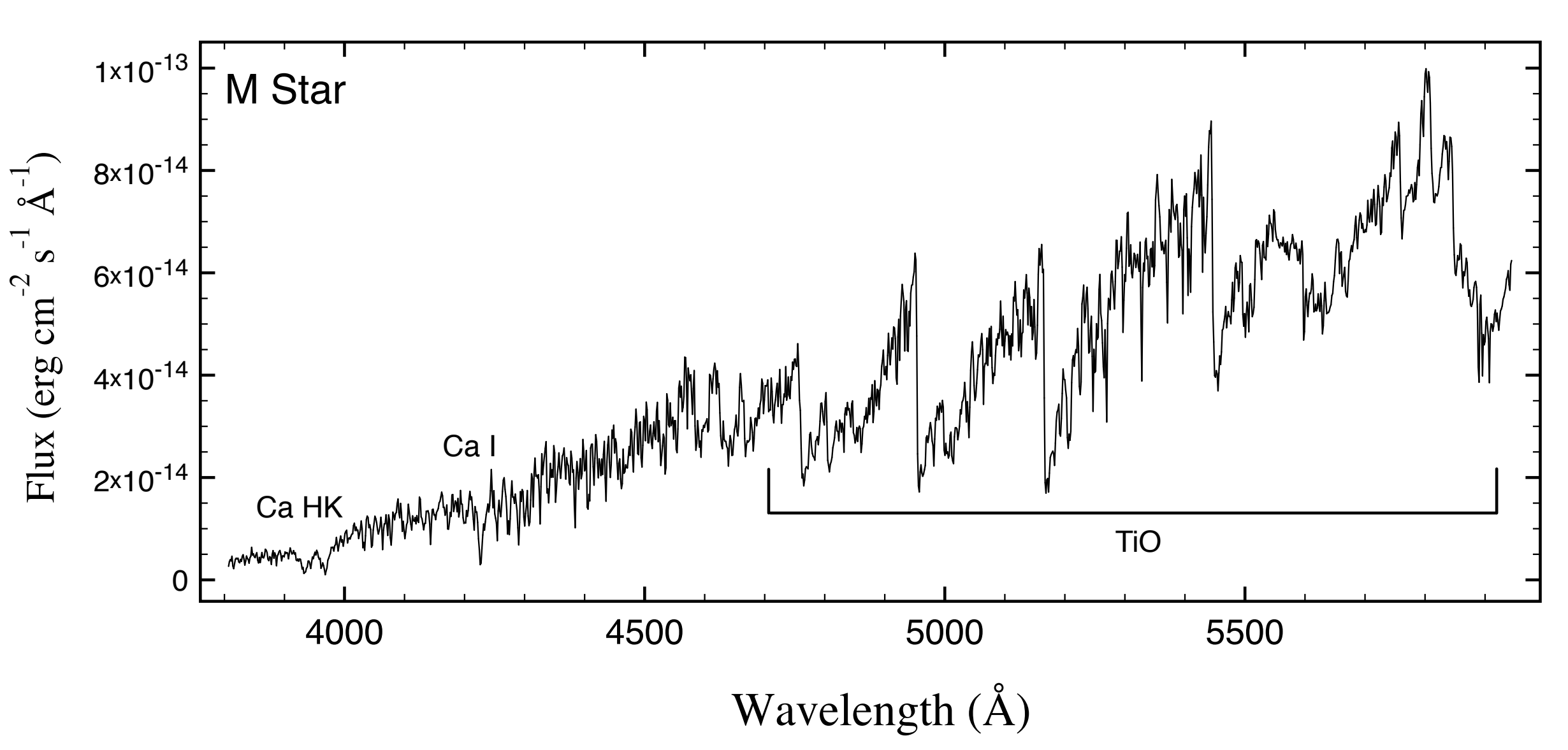
180"


Halpha
30"
[S II]
[O III]


60"
Slit Positions
1
2
30"


Position 1a
Position 2a
Position 1b
Position 2b
Position 1c
Position 2c
Hα
[N II]
[S II]
[O I]
Flux (erg cm^{-2} s^{-1} Å^{-1})
Wavelength (Å)


M Star
Ca HK
Ca I
TiO
1x10-13
8x10-14
6x10-14
4x10-14
2x10-14
0
4000
4500
5000
5500
Flux (erg cm-2 s-1 Å-1)
Wavelength (Å)

Mass loss in Cygnus Loop?

- M4 III

- B Mag: 13.08
- V Mag: 11.57
- K Mag: 5.83

- Distance Estimate with Vmag: 2.5 ± 0.5 kpc

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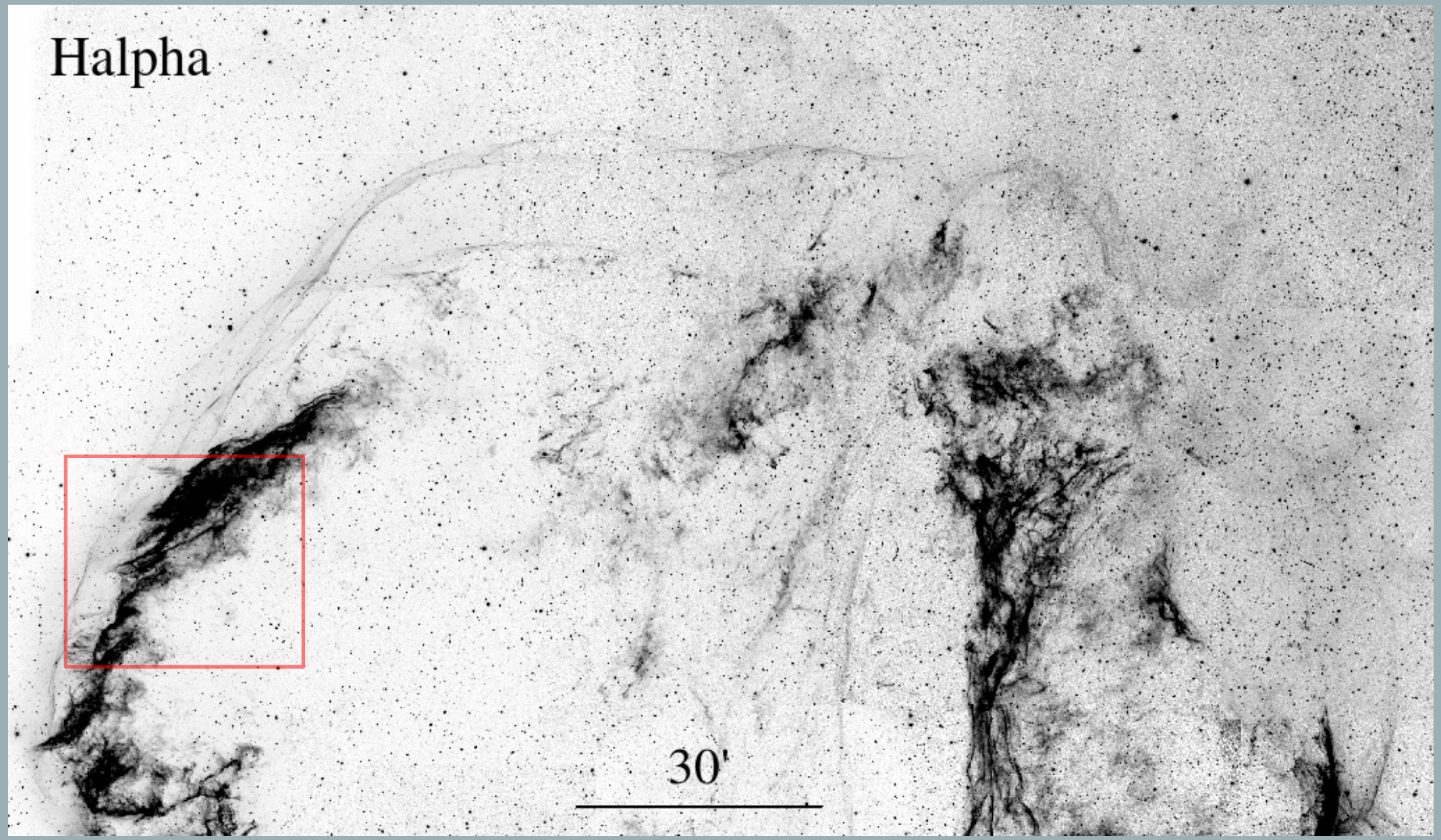
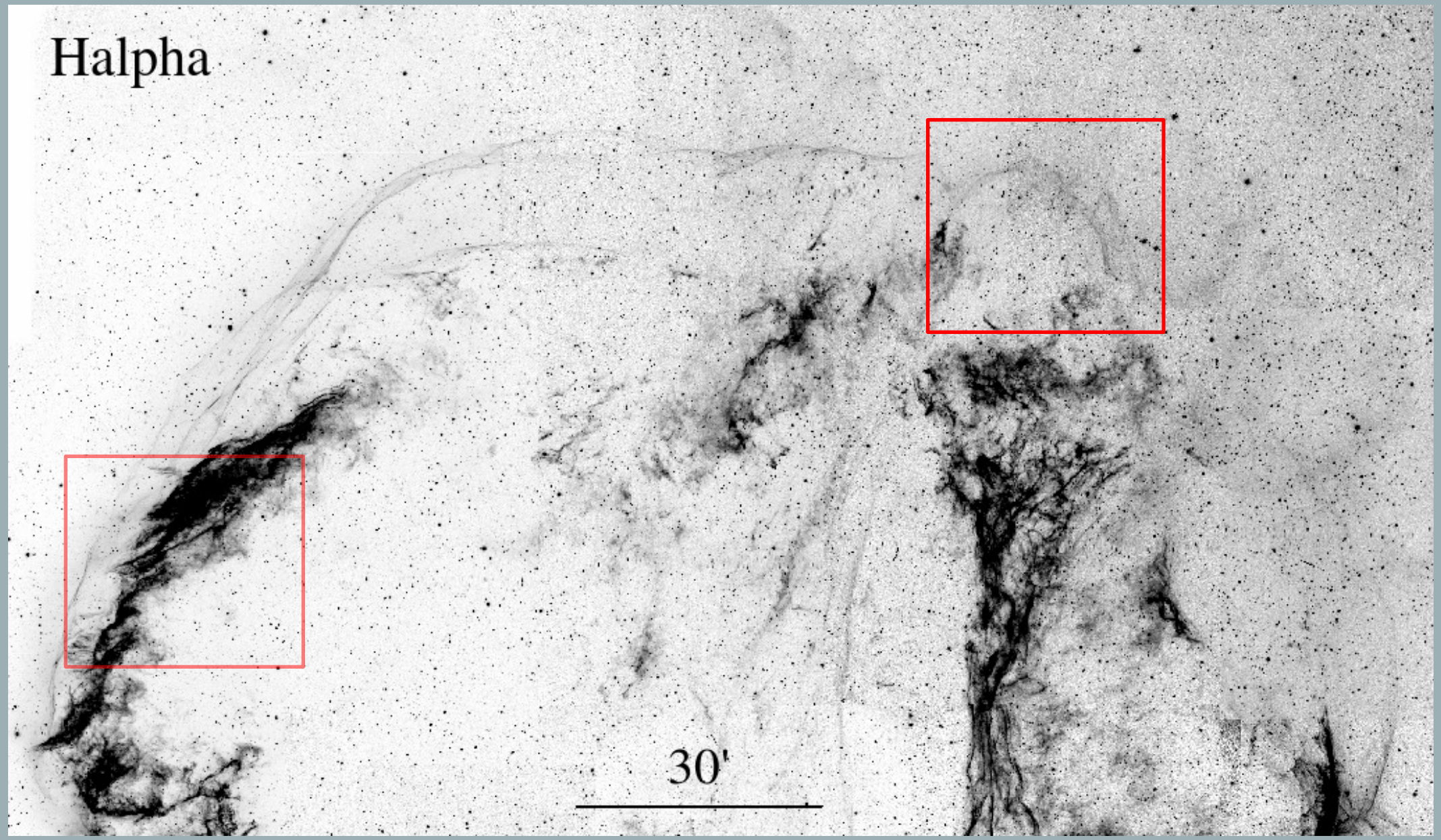
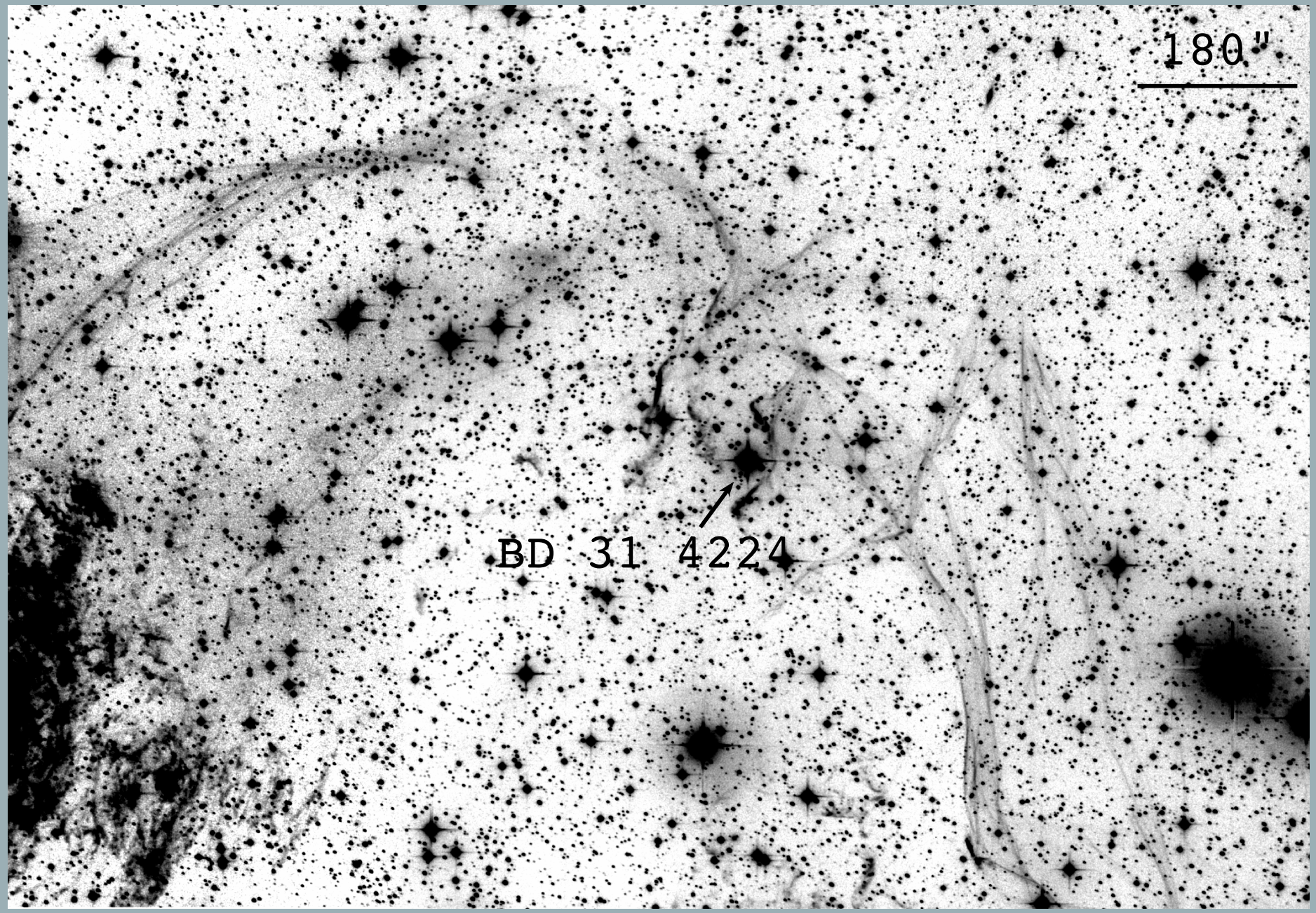
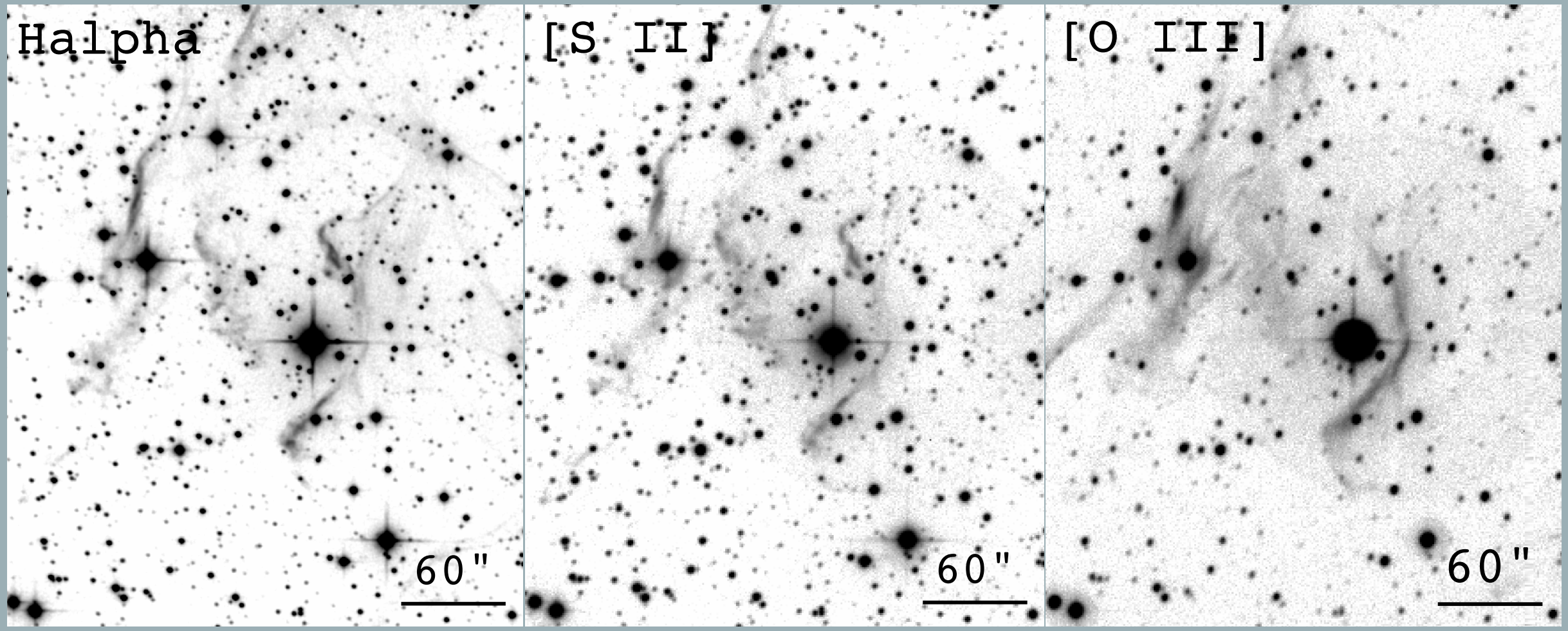
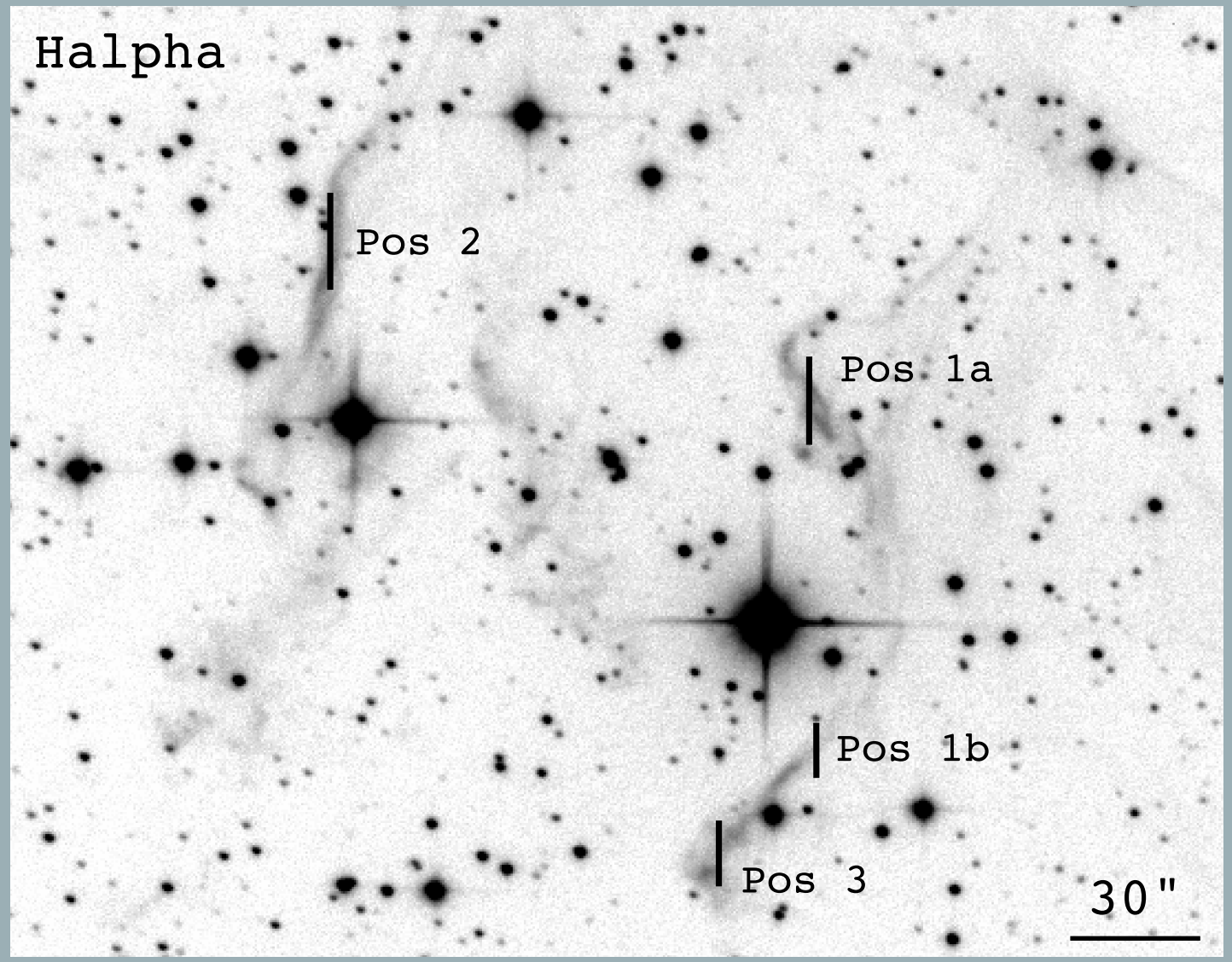
Yikes!

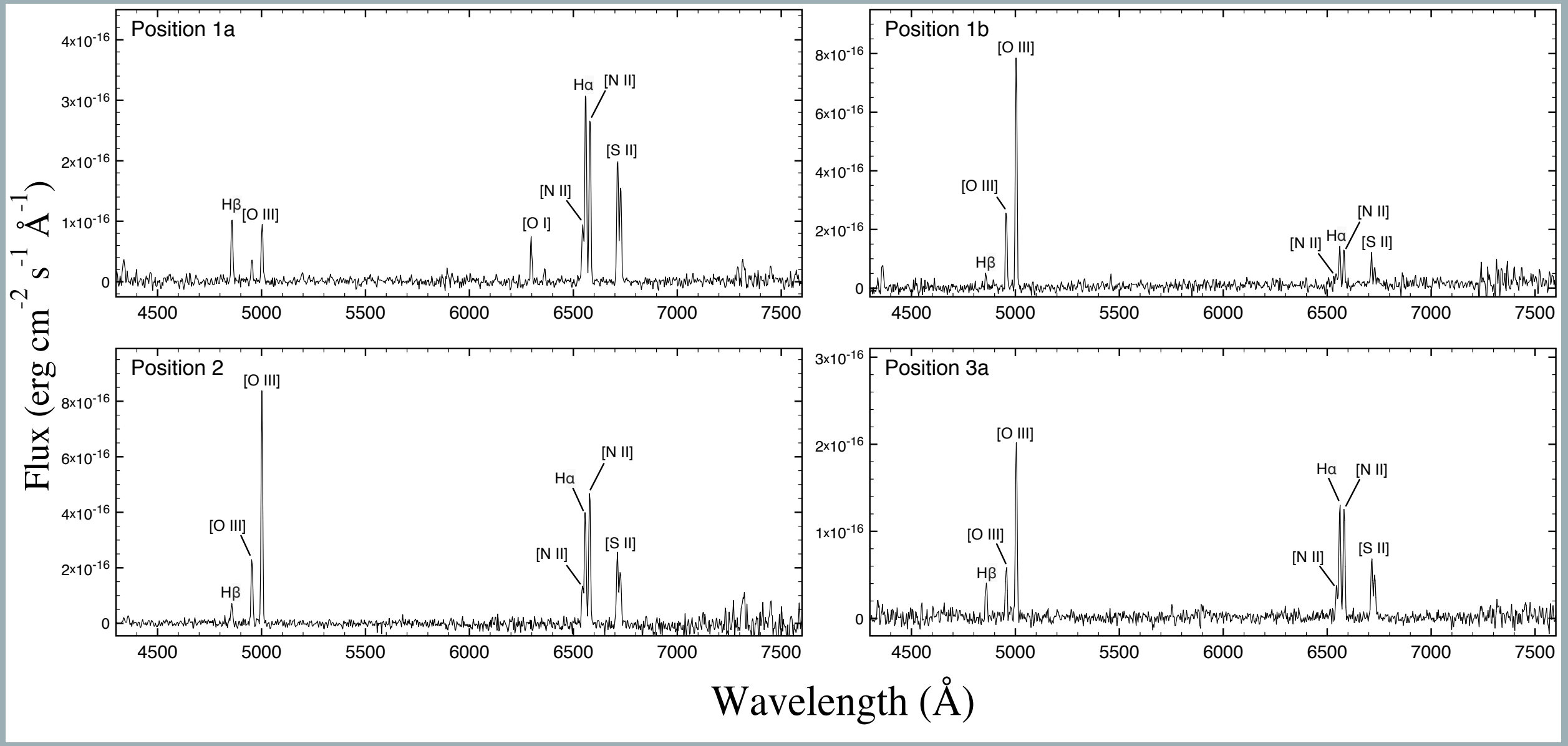

Halpha
30'

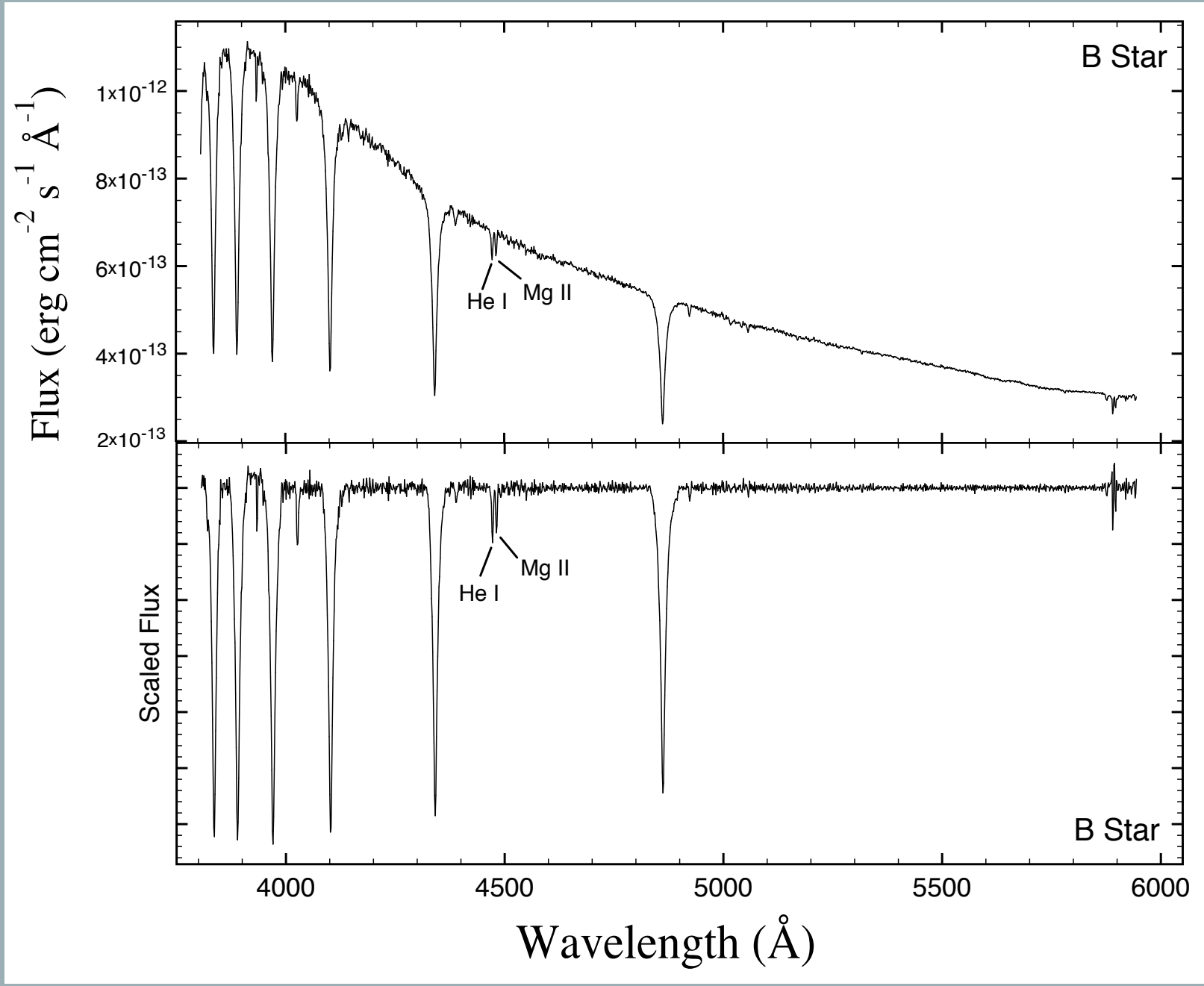

Halpha
30'


180"
BD 31 4224


Halpha
60"
[S II]
60"
[O III]
60"


Halpha
Pos 2
Pos 1a
Pos 1b
Pos 3
30"


Position 1a
Position 1b
Position 2
Position 3a
Hβ
[O III]
[O I]
[N II]
Hα
[S II]
Flux (erg cm^{-2} s^{-1} Å^{-1})
Wavelength (Å)


B Star
Flux (erg cm^{-2} s^{-1} Å^{-1})
1x10^{-12}
8x10^{-13}
6x10^{-13}
4x10^{-13}
2x10^{-13}
He I
Mg II
Scaled Flux
He I
Mg II
B Star
4000
4500
5000
5500
6000
Wavelength (Å)

BD 31 4224

- B7
- mag(V) = 9.58

- Mag(V) for B7V = -0.4
  - Distance = 960 pc

- Mag(V) for B7 IV = -1.3
  - Distance = 1.45 kpc

Conclusions

(Fesen, Black, Neustadt, Milisavljevic 2016 in prep)

- 2 stars are interacting with the Cygnus Loop
  - M4 III
    - Distance: 1.6 – 3 kpc
  - B7V/IV
    - Distance 0.95 – 1.45 kpc
- Distance to the Cygnus Loop $\geqq$1.0 kpc
- Implications
  - Diameter of ~50 pc
  - Consistent with Medina et. al. 2014 estimated velocity of ~400 km/s for the broad component of some Balmer filaments
  - Explosion energy of ~10^{51} ergs (Martinez 2011)