The density structure of the W51 GMC

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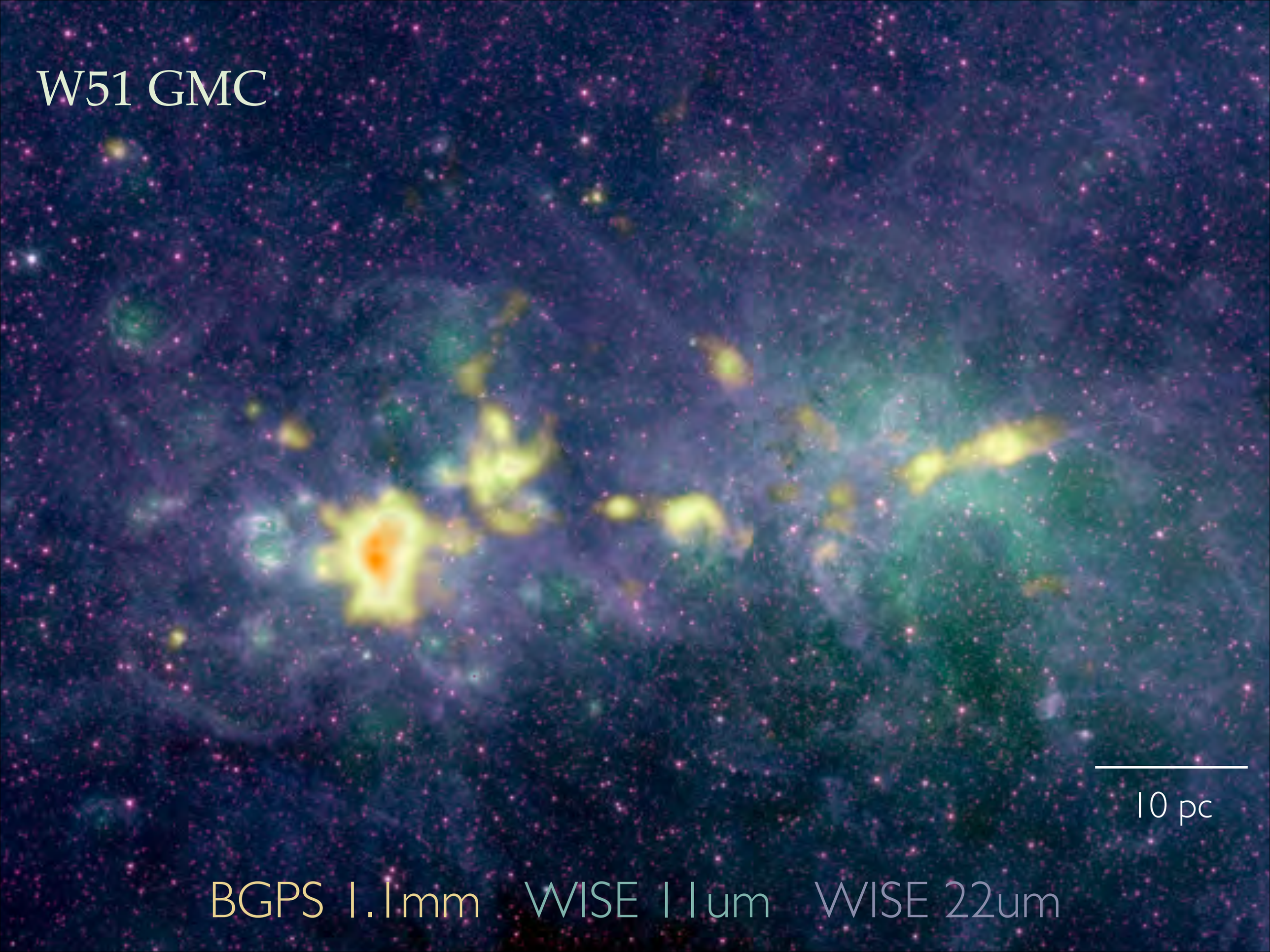
A&A 573A 106G

Cold dust does not imply cold gas
[see poster too]

H_2CO + CO can effectively provide line-of-sight geometry information & SF rate prediction

Massive stars have formed and are forming in the W51 protoclusters


W51 GMC
10 pc
BGPS 1.1mm
WISE 11um
WISE 22um

W51 GMC

7% of Galactic MSF luminosity (Urquhart et al 2014a)

10 pc

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10^6 $M_\odot$ (Carpenter & Sanders 1998)

10 pc

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W51 GMC

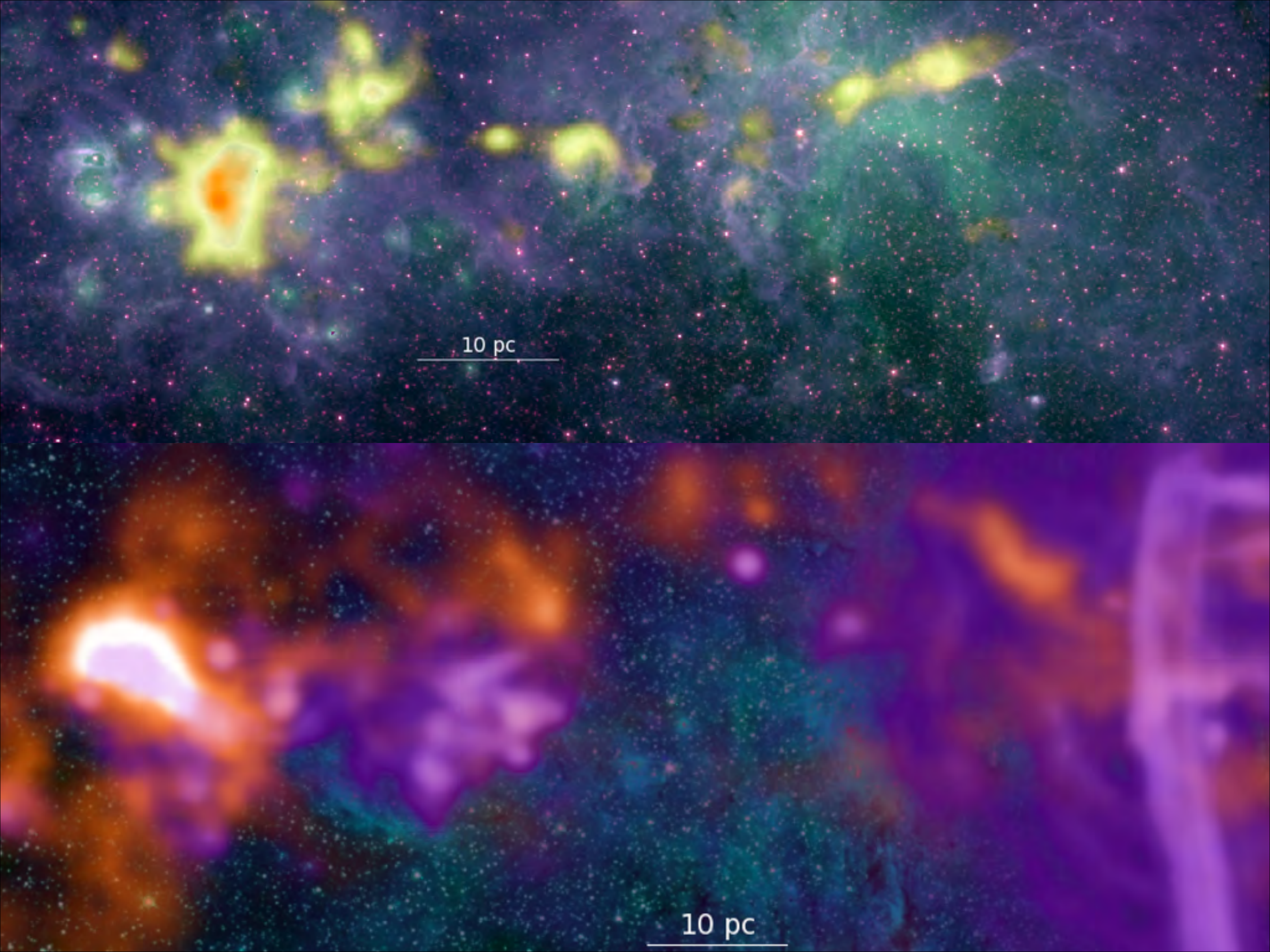
7% of Galactic MSF luminosity (Urquhart et al 2014a)

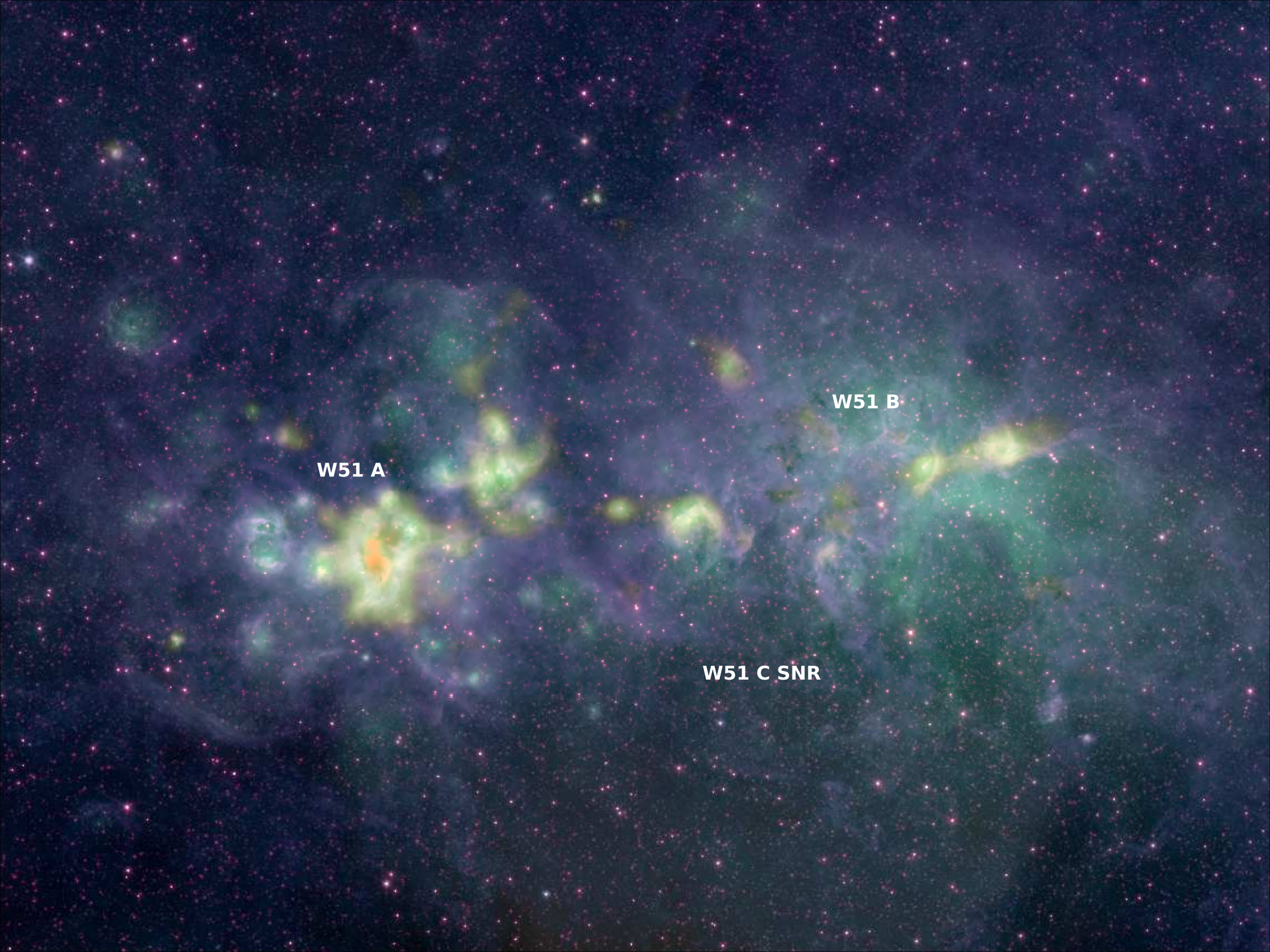
10^6 $M_\odot$ (Carpenter & Sanders 1998)

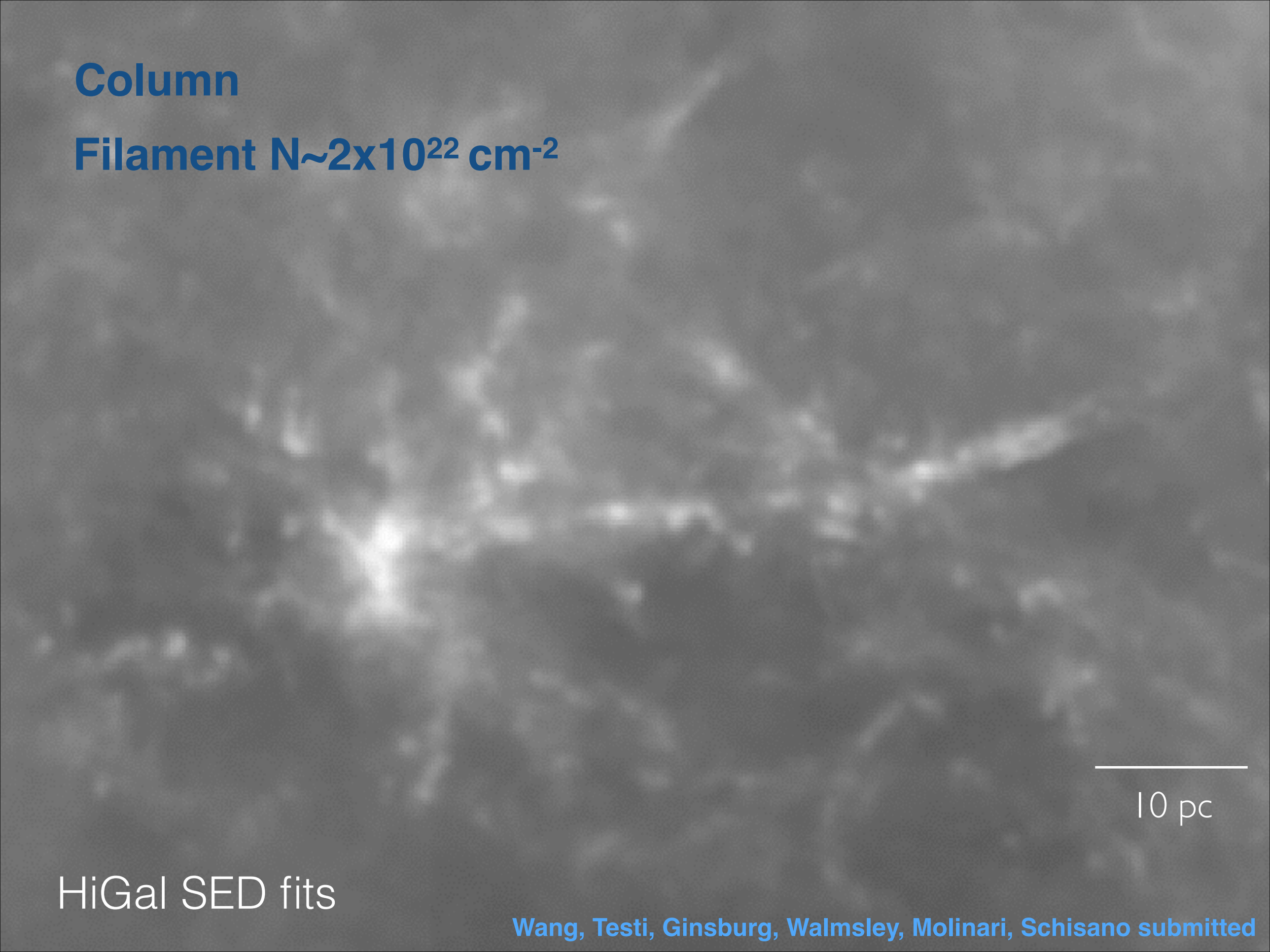
D=5.1 kpc: **closest** massive proto-cluster

10 pc

BGPS 1.1mm WISE 11um WISE 22um


10 pc
10 pc


W51 A
W51 B
W51 C SNR



HiGal SED fits

Wang, Testi, Ginsburg, Walmsley, Molinari, Schisano submitted

Temperature
18 - 32 K

10 pc

CO 3-2

T_B ~ 10 - 50 K

10 pc

Parsons et al 2012

FIR Luminosity

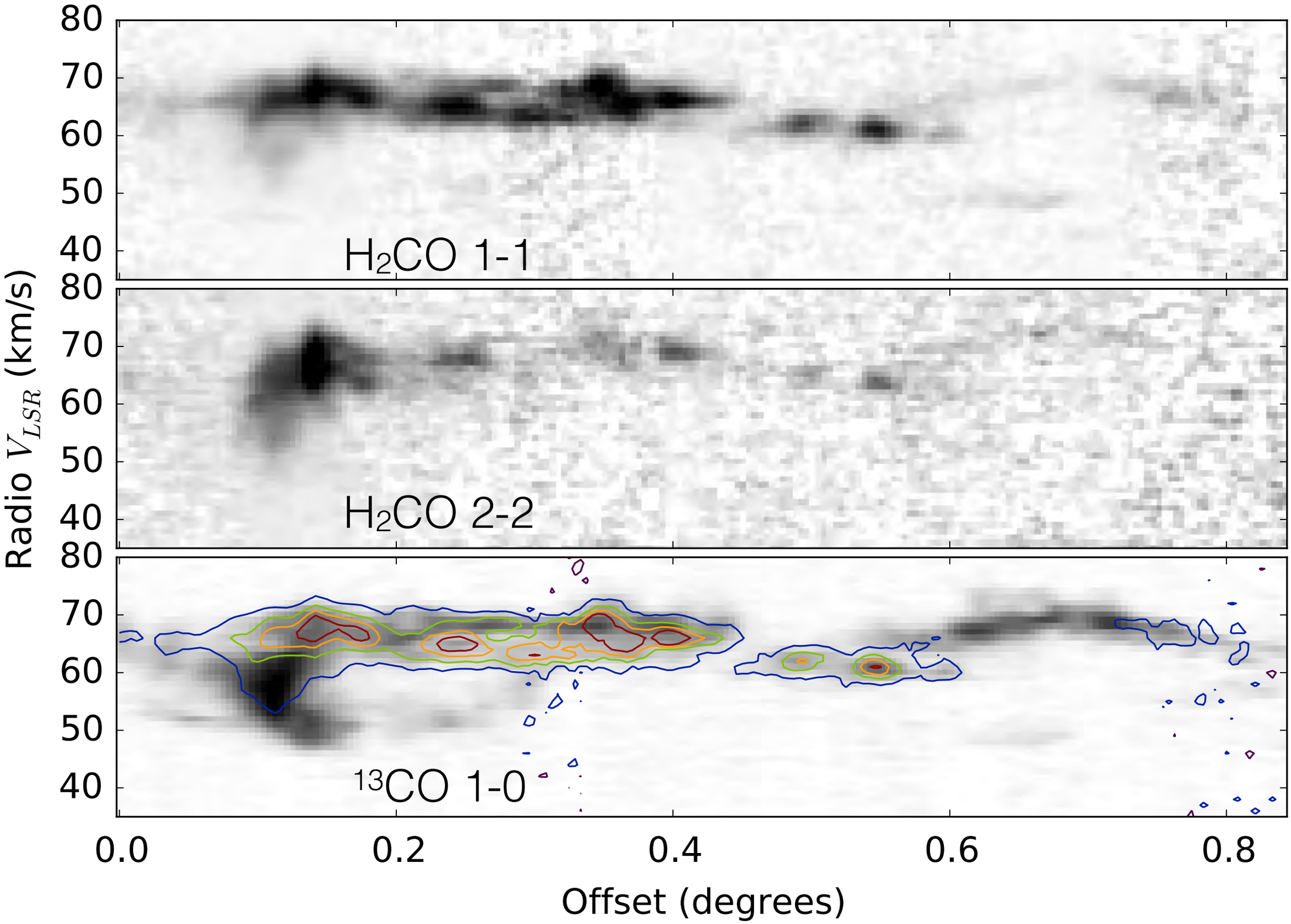
Massive Protoclusters

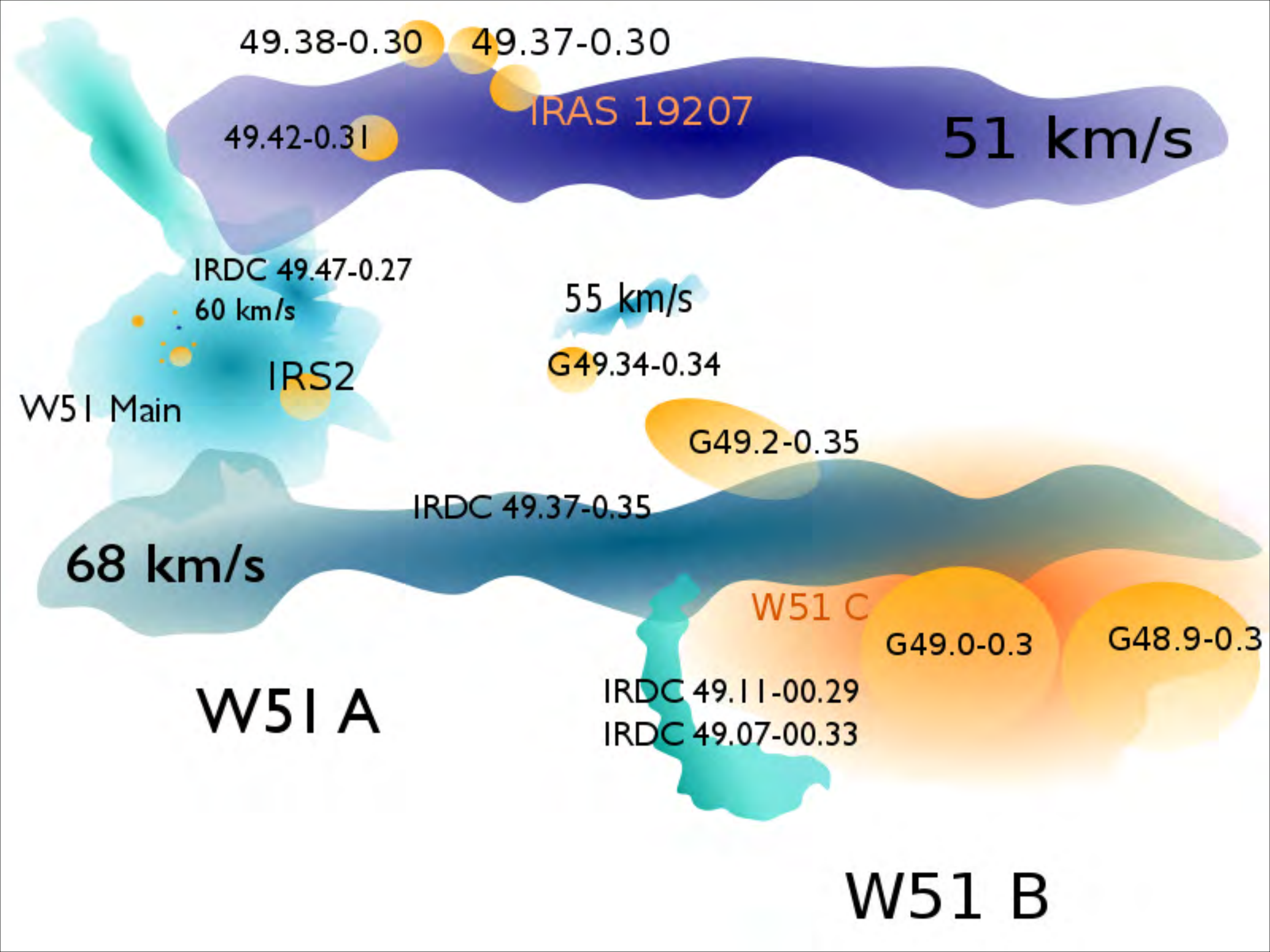
Giant HII regions

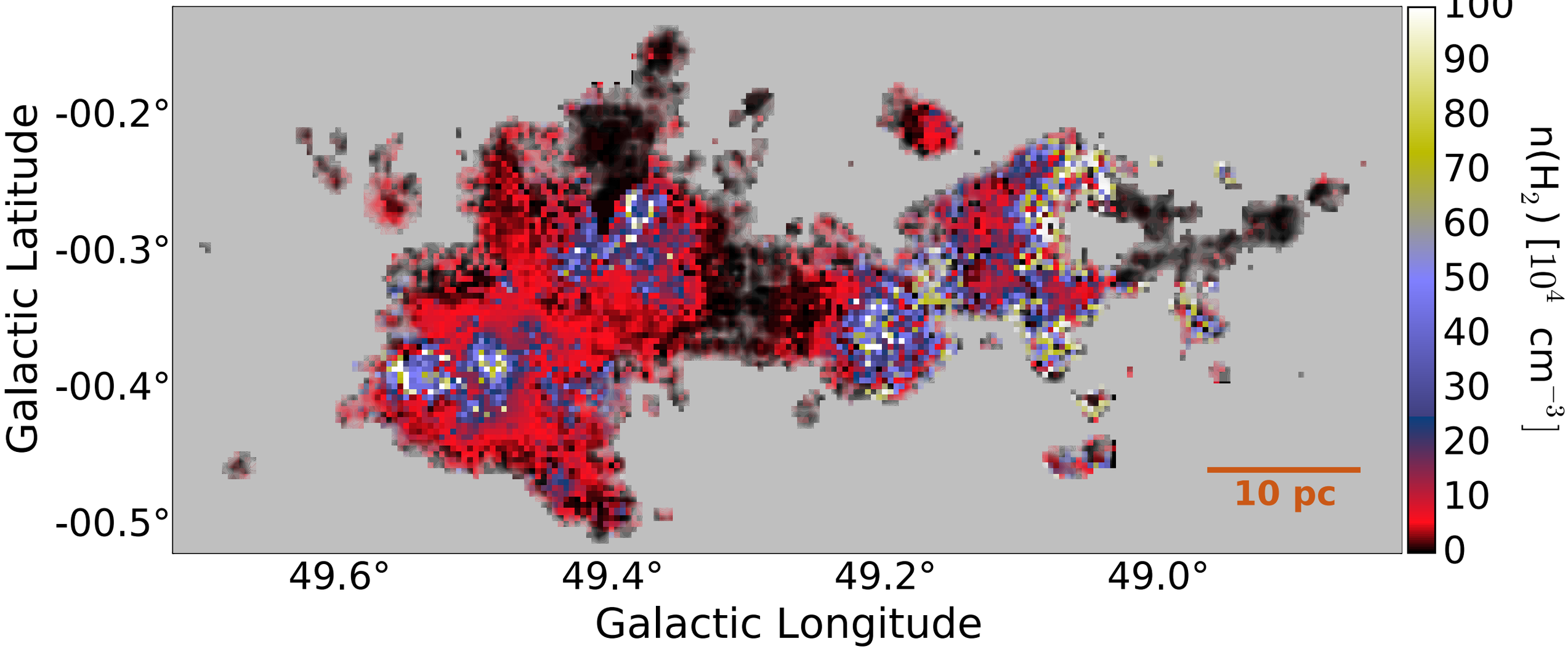
SNR interaction

~10^7 L_o

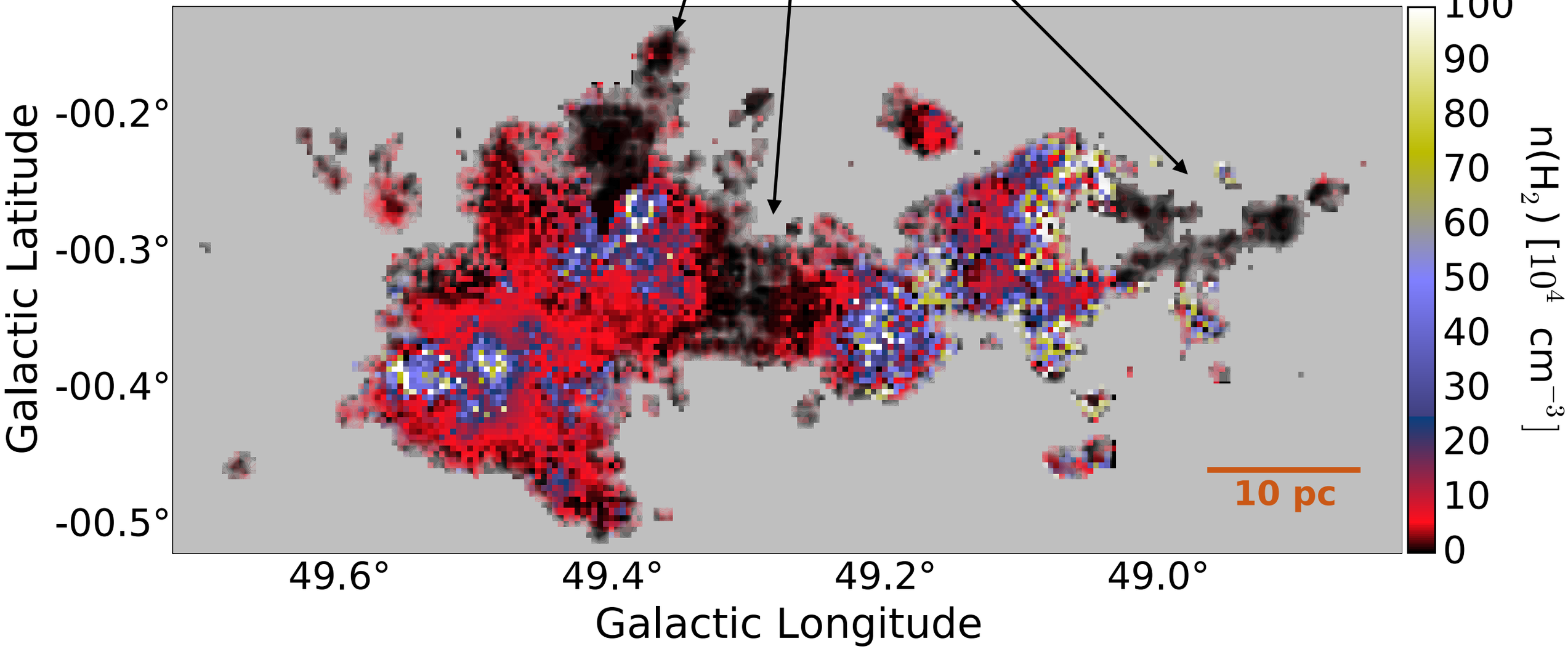
10 pc


H2CO 1-1
H2CO 2-2
13CO 1-0
Radio V_{LSR} (km/s)
Offset (degrees)
80
70
60
50
40
0.0
0.2
0.4
0.6
0.8


49.38-0.30
49.37-0.30
IRAS 19207
49.42-0.31
51 km/s
IRDC 49.47-0.27
60 km/s
55 km/s
G49.34-0.34
IRS2
W51 Main
G49.2-0.35
IRDC 49.37-0.35
68 km/s
W51 C
G49.0-0.3
G48.9-0.3
IRDC 49.11-00.29
IRDC 49.07-00.33
W51 A
W51 B


-00.2°
-00.3°
-00.4°
-00.5°
Galactic Latitude
49.6°
49.4°
49.2°
49.0°
Galactic Longitude
10 pc
100
90
80
70
60
50
40
30
20
10
0
n(H$_2$) [10^4 cm^{-3}]

Low density: not much star formation



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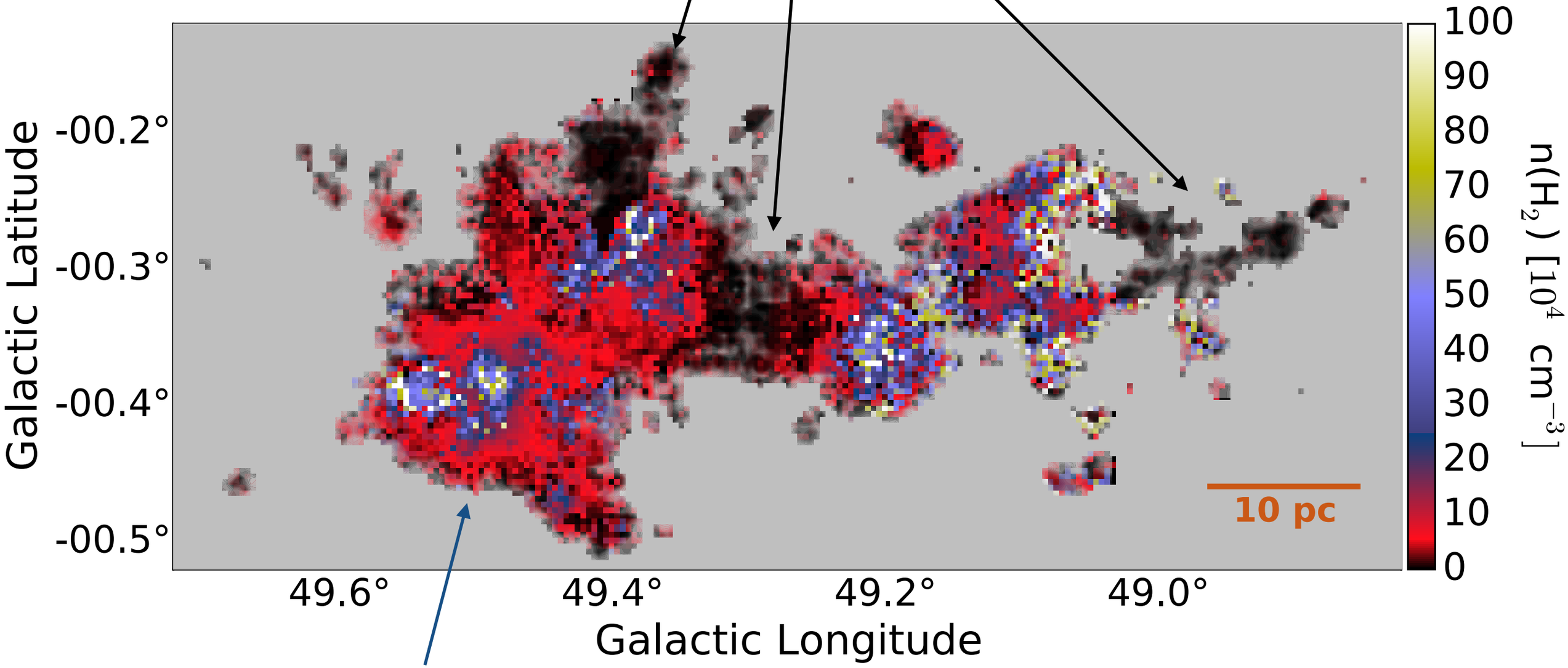
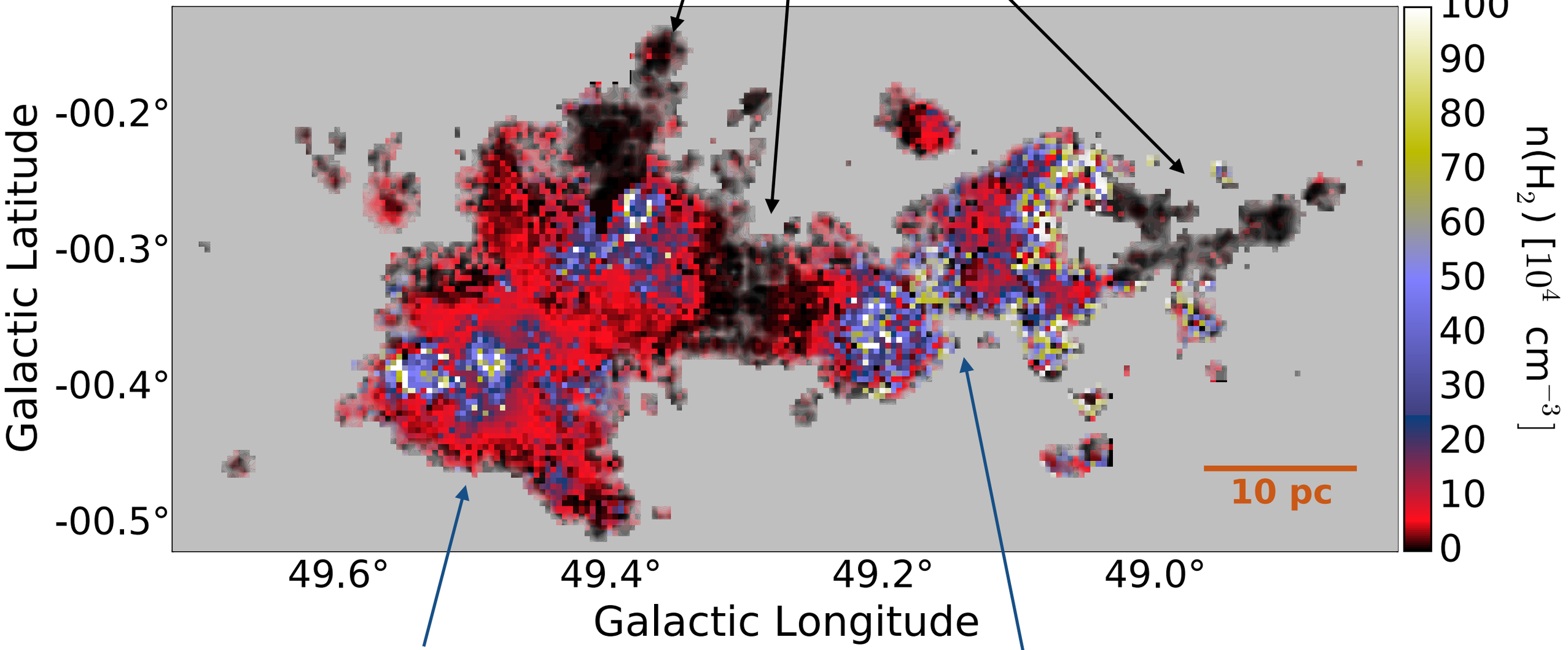


High density: lots of star formation!

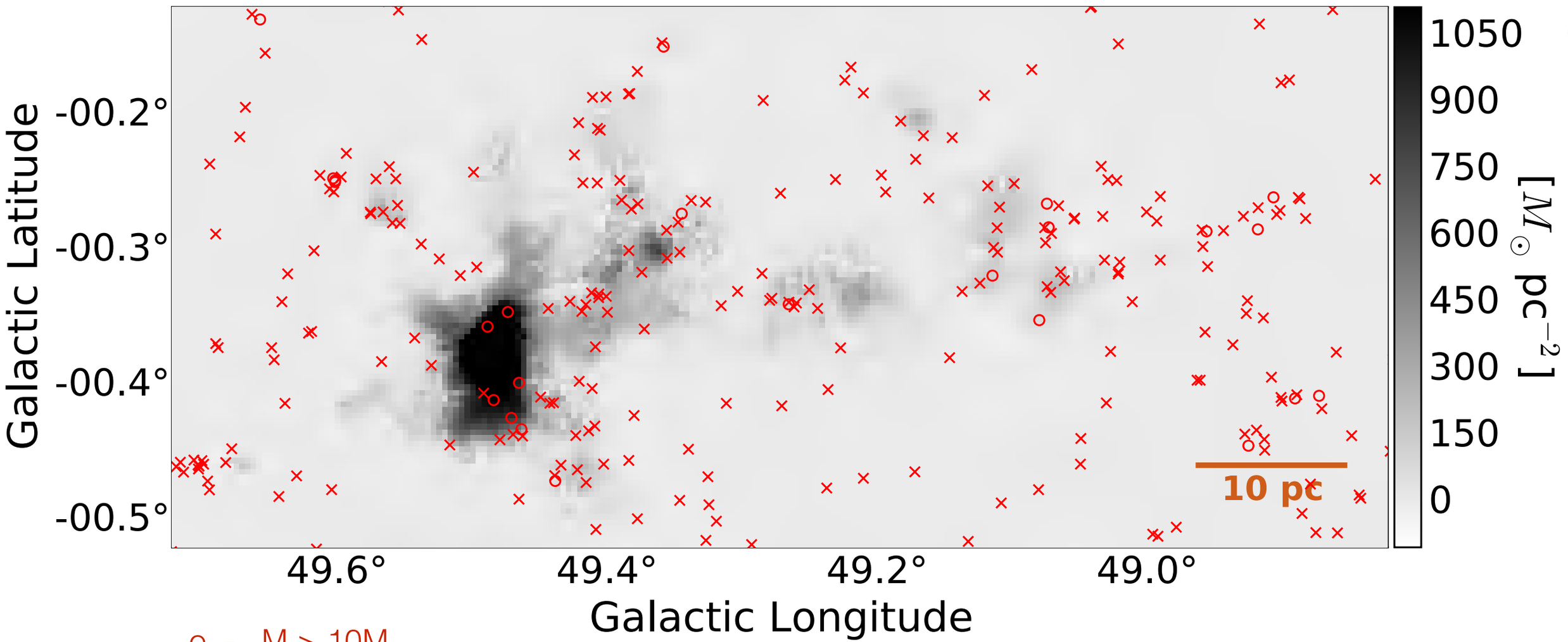
Low density: not much star formation



High density: lots of star formation!

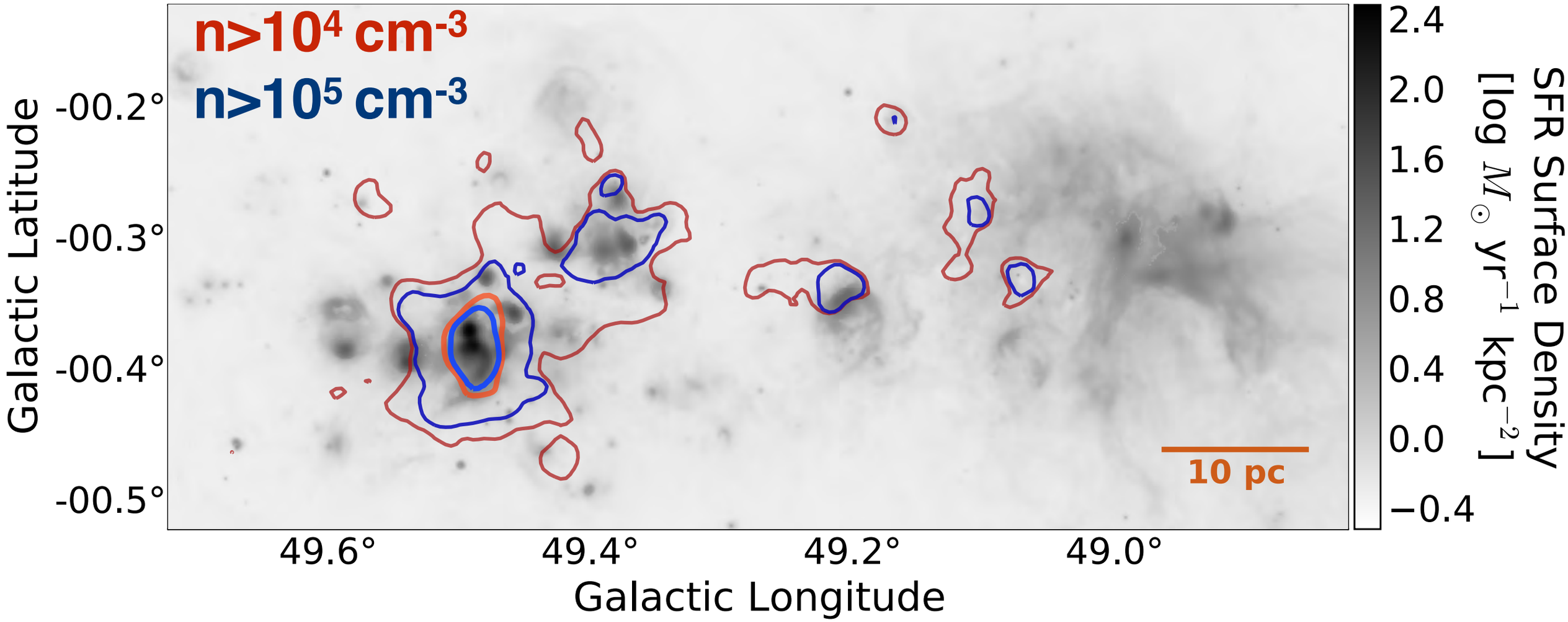
High density: no star formation?

“Star-forming gas” map:
Integrated ^{13}CO with corresponding $n(H_2) > 10^4$



Extragalactic-style “star formation map”: Only agrees above $n>10^5$ cm^{-3}

Stars formed here, but no clusters



High density gas on the edge of a supernova:
not forming many more stars

High density gas on the edge of a supernova:
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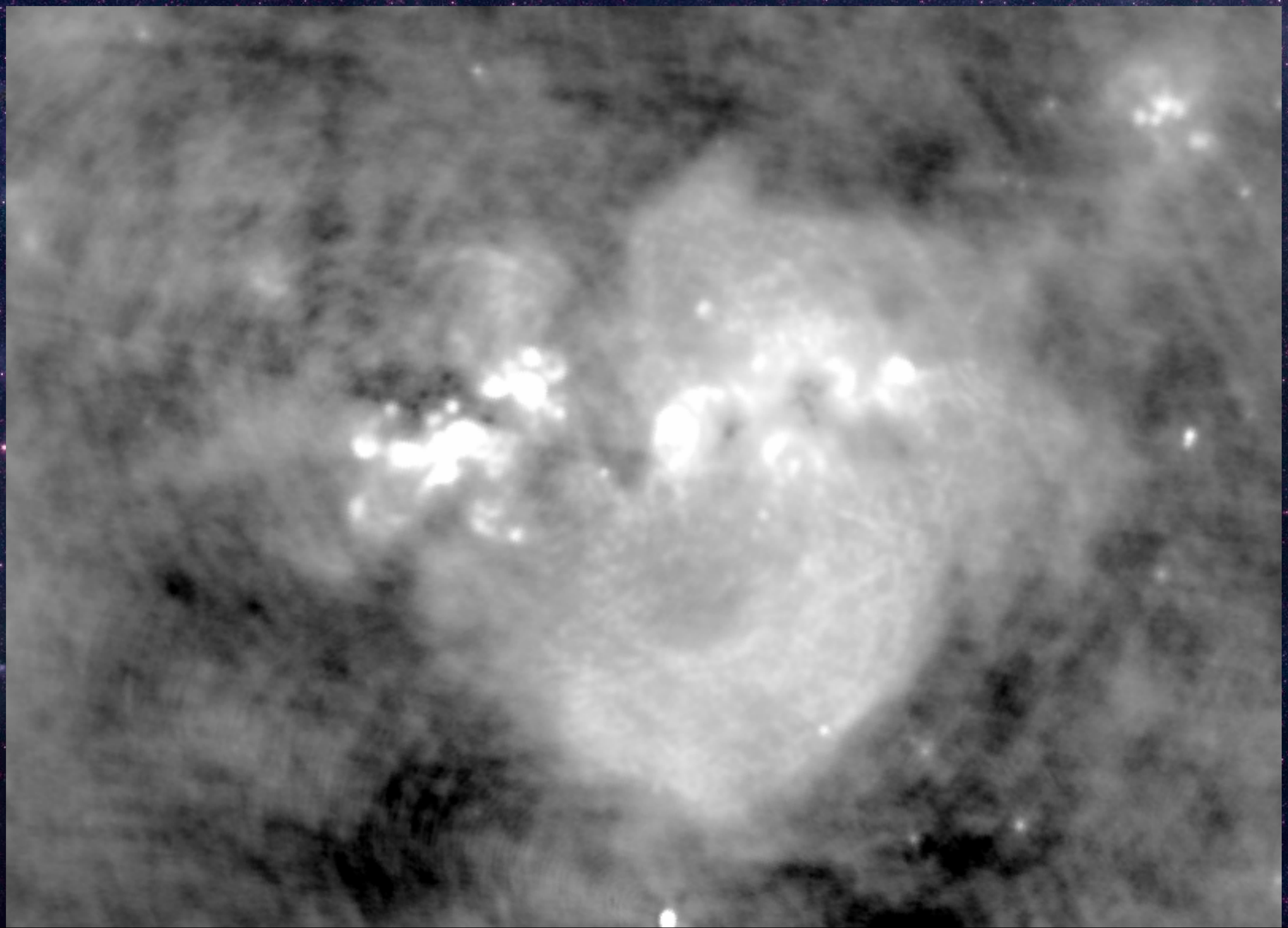
High density gas on the edge of a supernova: not forming many more stars



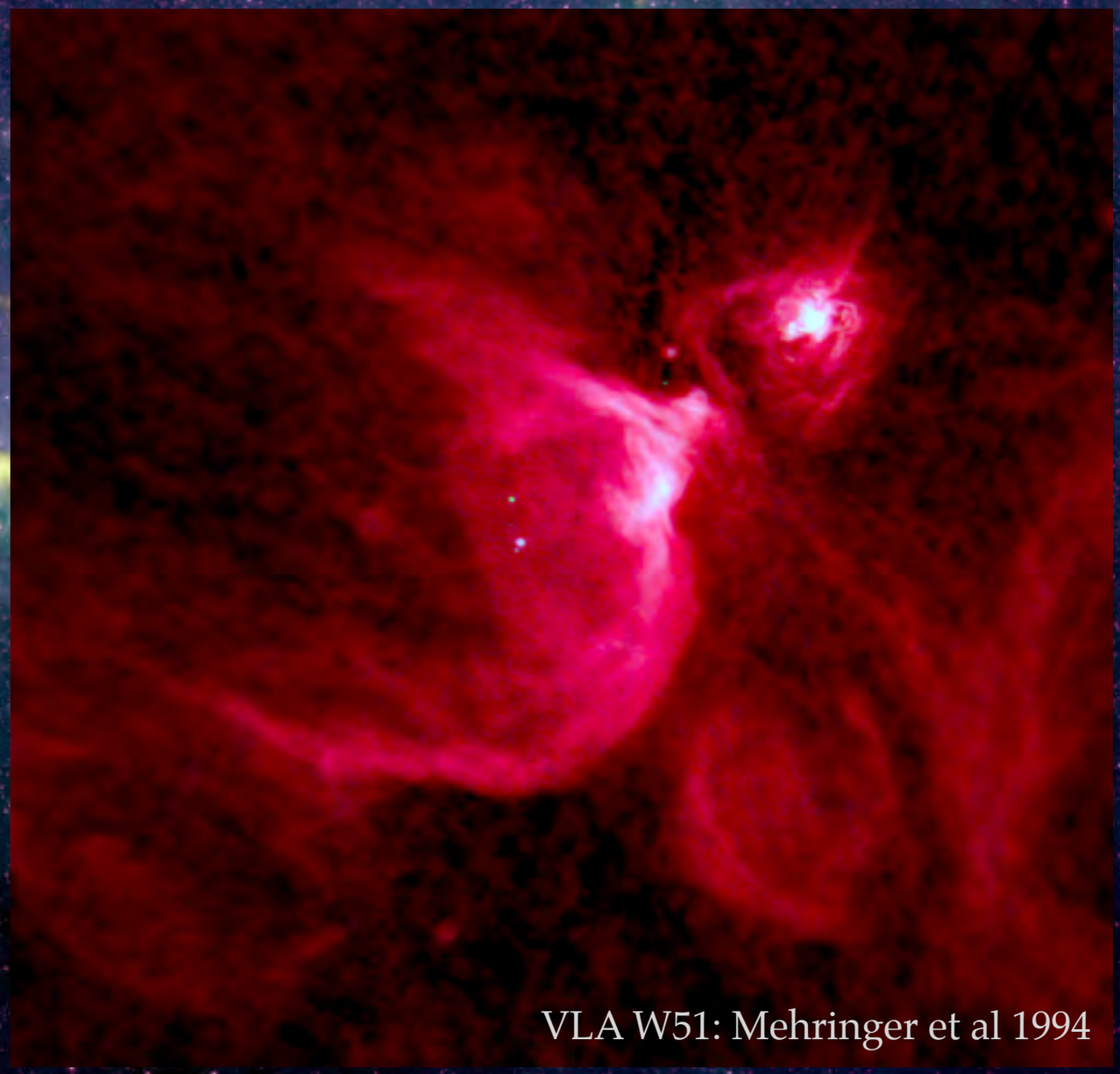
Large scale summary:

Feedback from distributed massive stars stops or slows star formation on cloud (100 pc) scales

Star formation continues in the densest gas, unaffected by feedback (so far)

W51 has not yet formed a mature, exposed massive star cluster, yet it is already the most active and luminous star-forming complex in the Galaxy.
Perhaps the clusters will end its reign?

Until then, though, we can determine what is happening in the clusters



VLA W51: Mehringer et al 1994

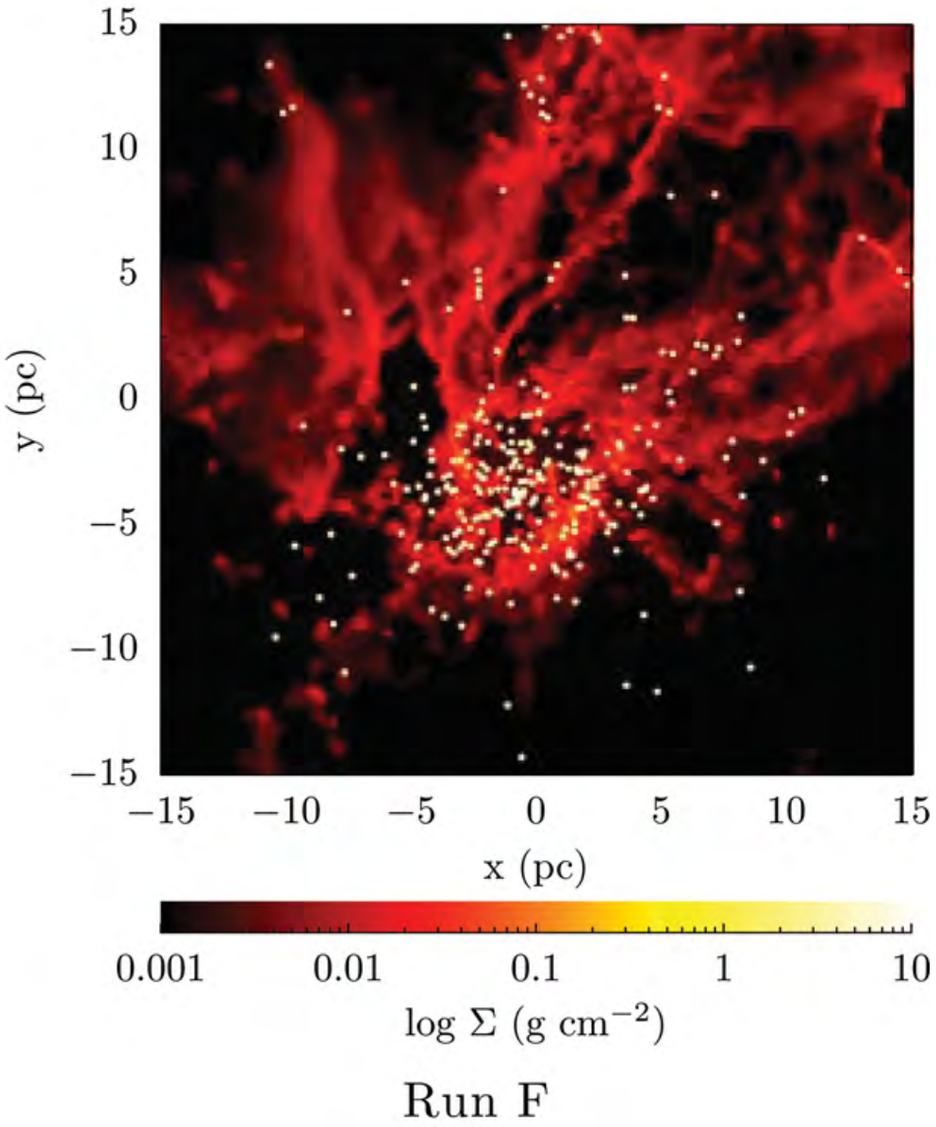
In $>10^4$ $M_\odot$, R<1 pc clusters, ionized gas remains bound

What happens in cluster-forming GMCs?

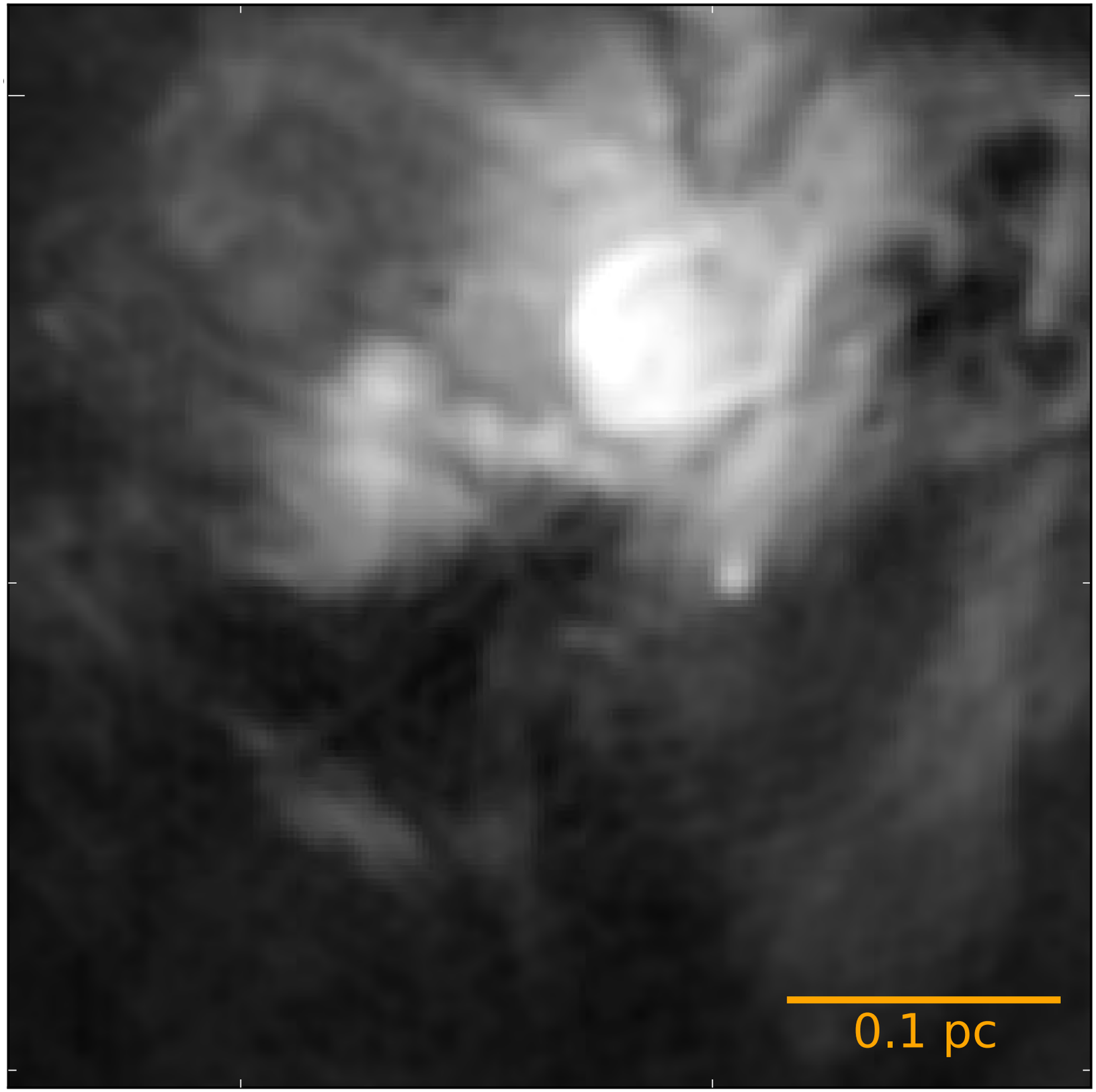
- (most) gas can't escape from proto-YMCs

- What is the final star formation efficiency? Does the gas all get consumed?

- What happens at the bottom of the potential well?

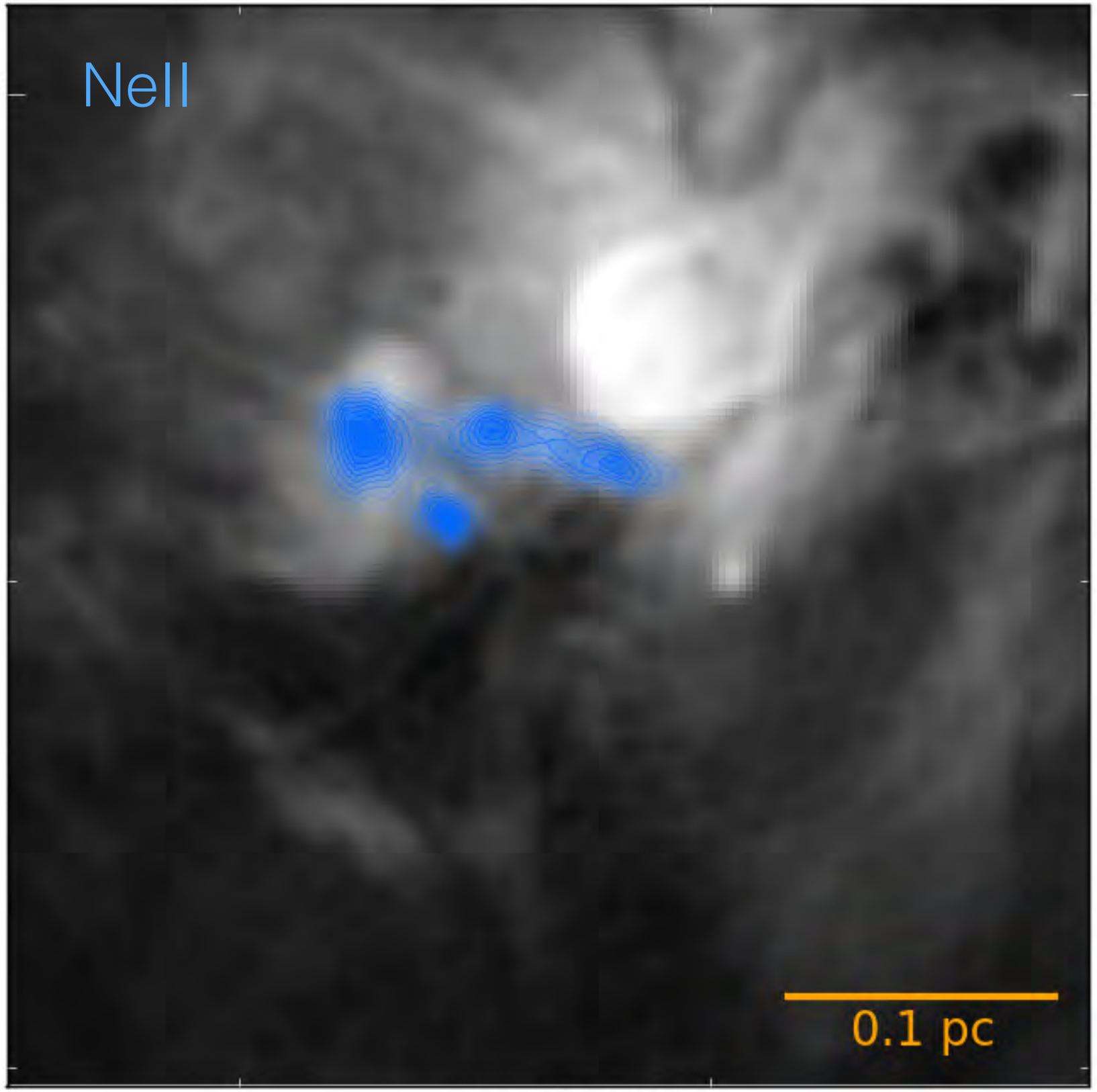


W51 IRS 2



Lacy et al 2007: 12um ionized jet?

Extremely high velocity, ~100 km/s



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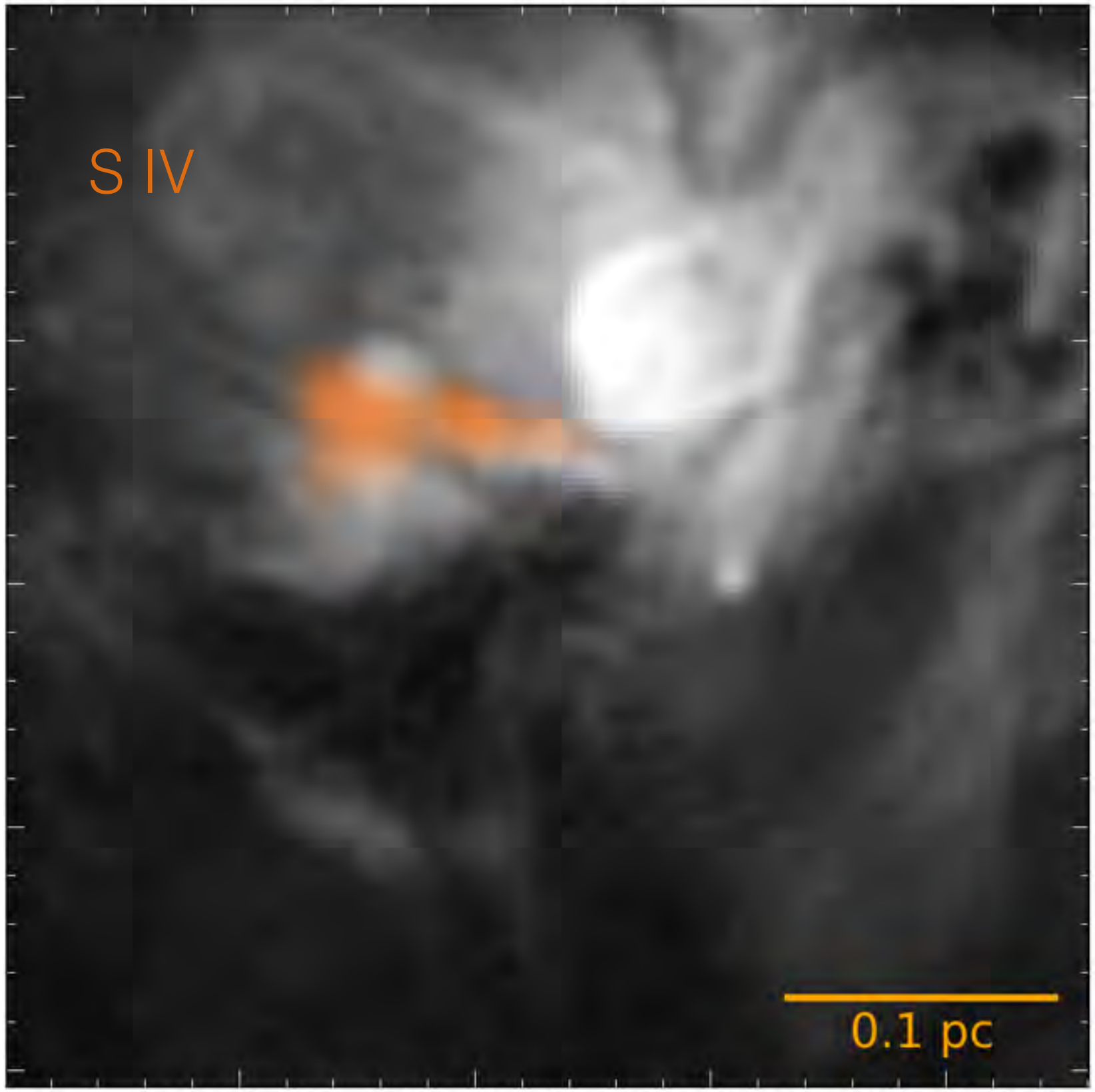
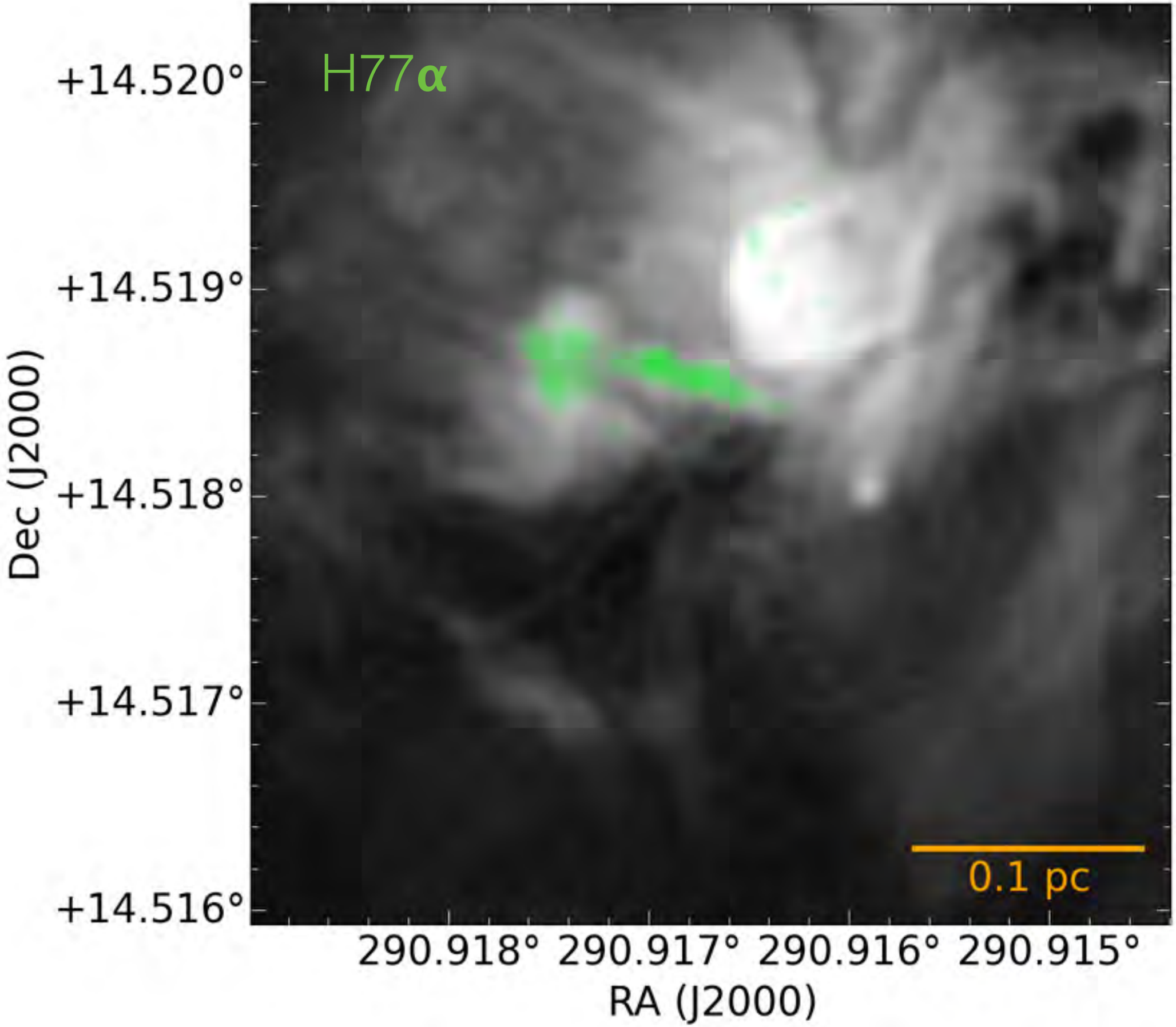
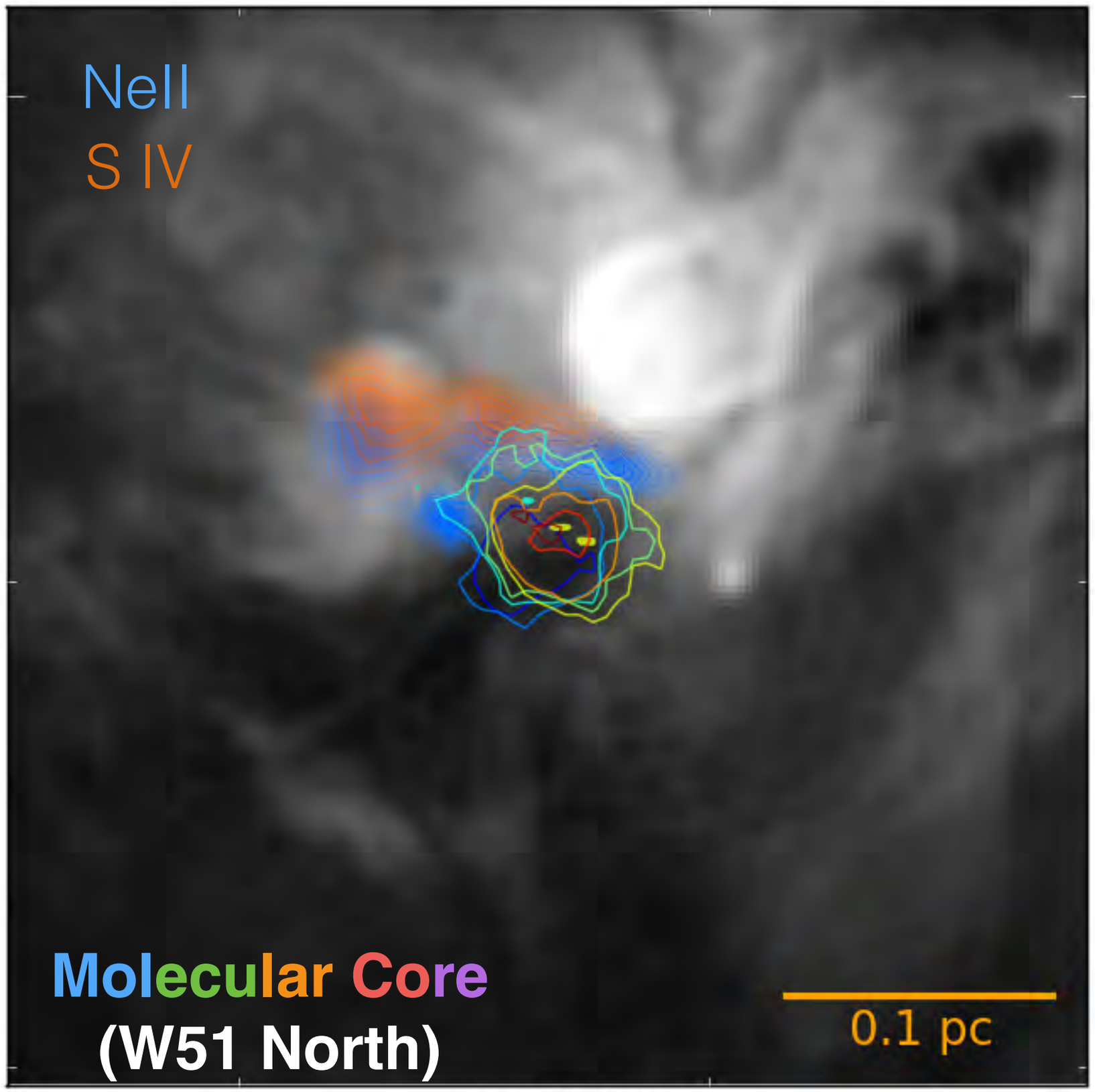
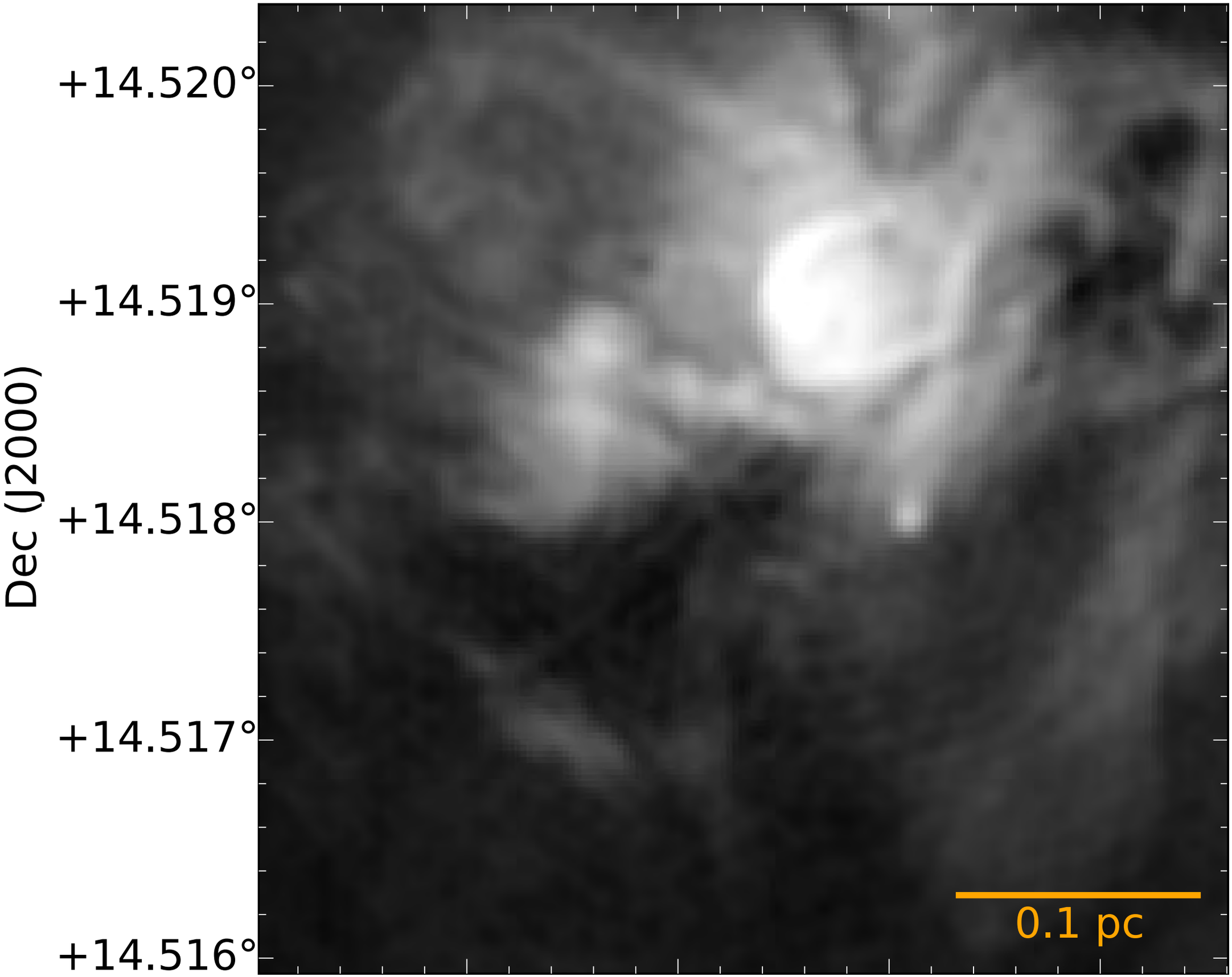



H77α
+14.520°
+14.519°
+14.518°
+14.517°
+14.516°
Dec (J2000)
0.1 pc
290.918° 290.917° 290.916° 290.915°
RA (J2000)

Zhang 1997, Zapata 2009 HOT molecular core (1500 K molecules)

Goddi 2015, Henkel 2013: High-J NH_3




+14.520°
+14.519°
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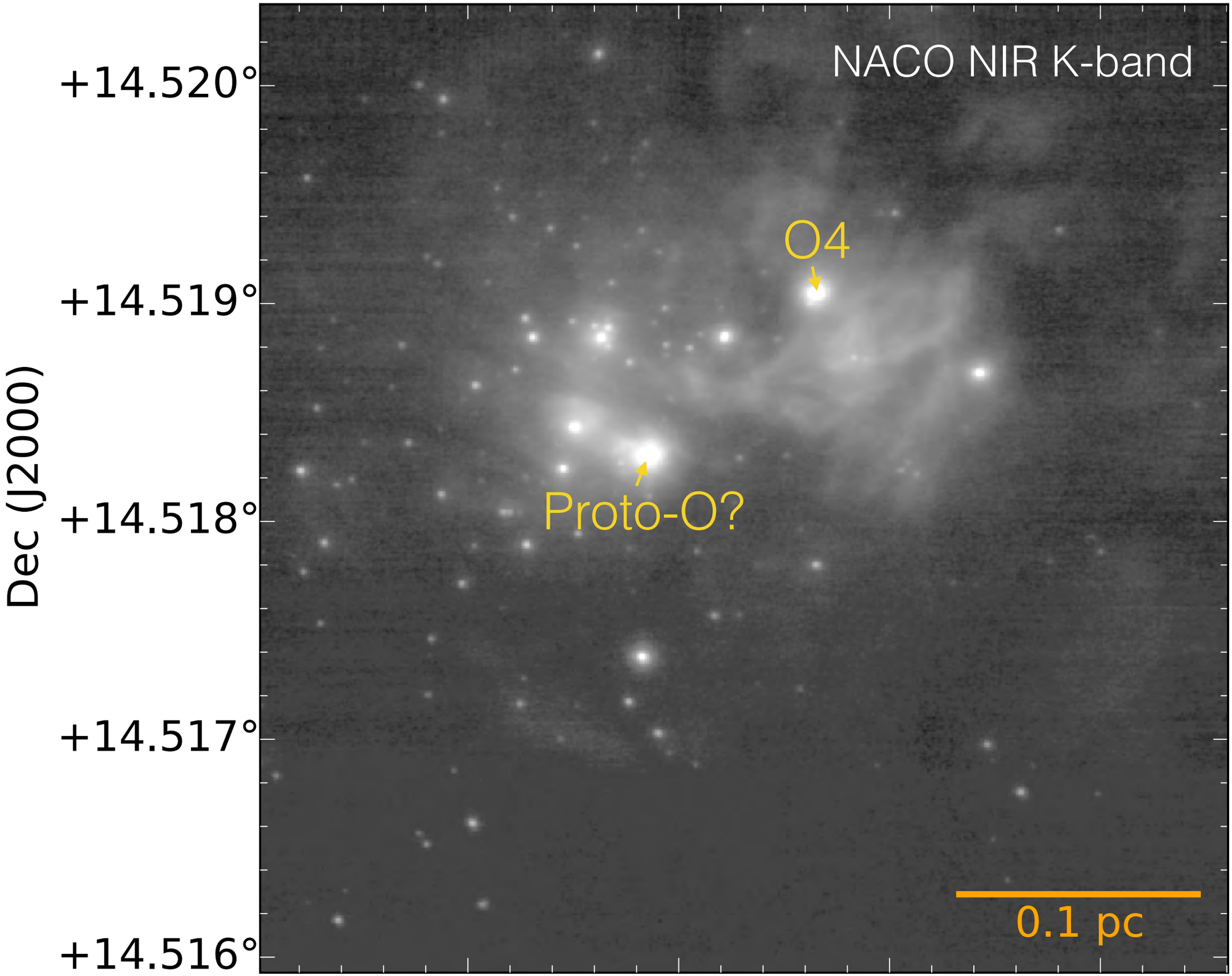

Figueredo 2008
Barbosa 2008

+14.520°
+14.519°
+14.518°
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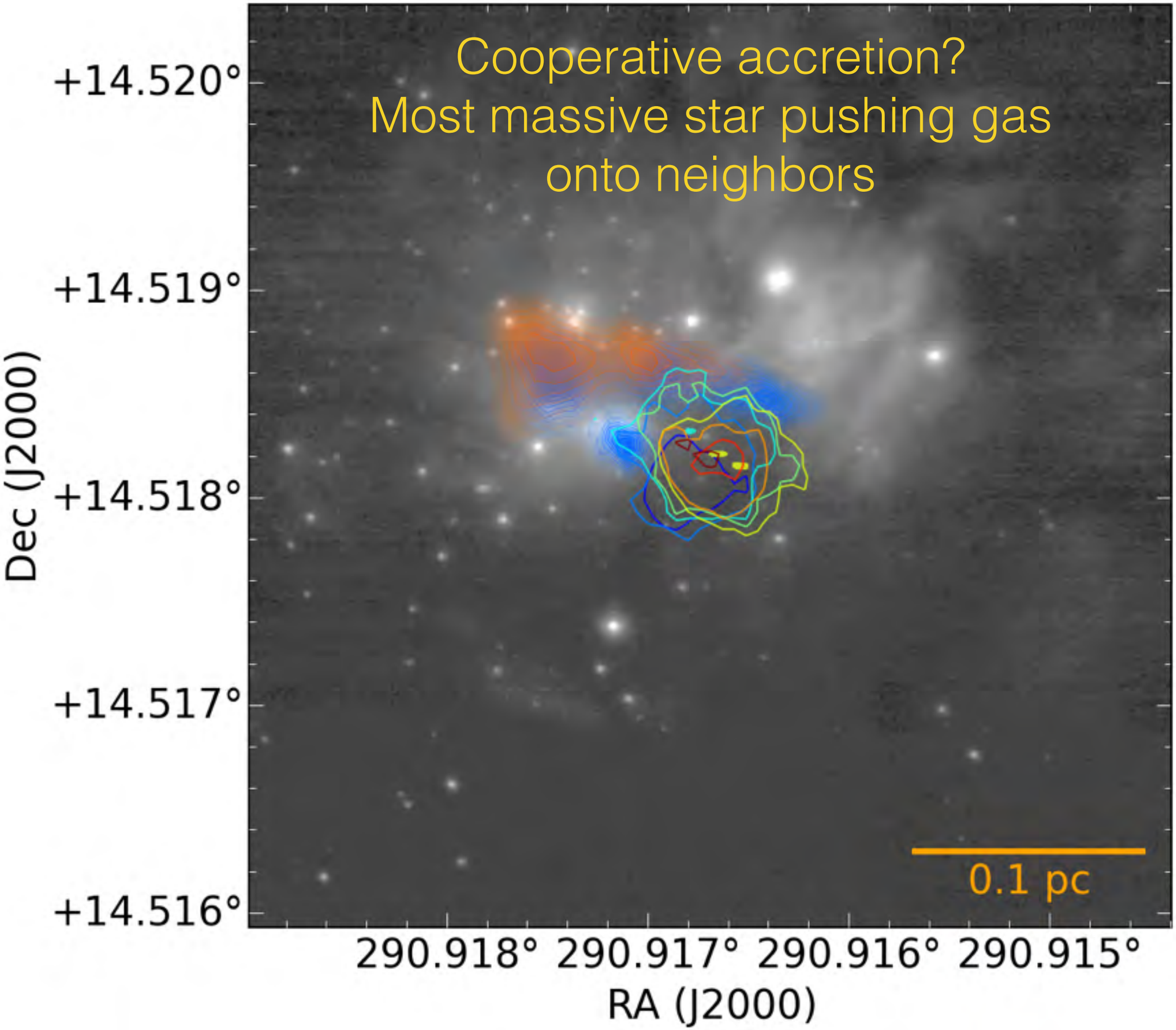
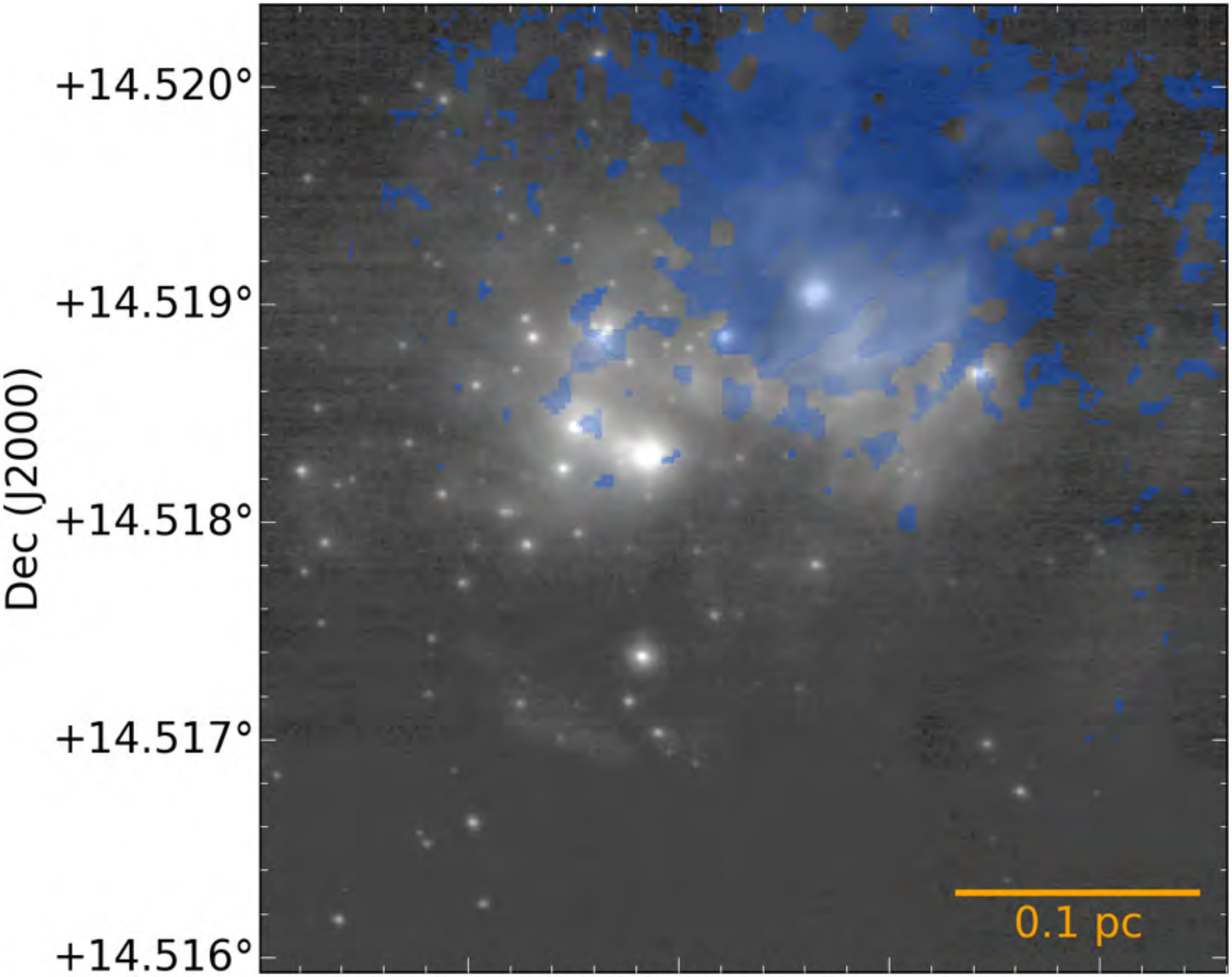
Dec (J2000)
290.918° 290.917° 290.916° 290.915°
RA (J2000)
0.1 pc


Cooperative accretion?
Most massive star pushing gas
onto neighbors
+14.520°
+14.519°
+14.518°
+14.517°
+14.516°
Dec (J2000)
290.918° 290.917° 290.916° 290.915°
RA (J2000)
0.1 pc


+14.520°
+14.519°
+14.518°
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Dec (J2000)
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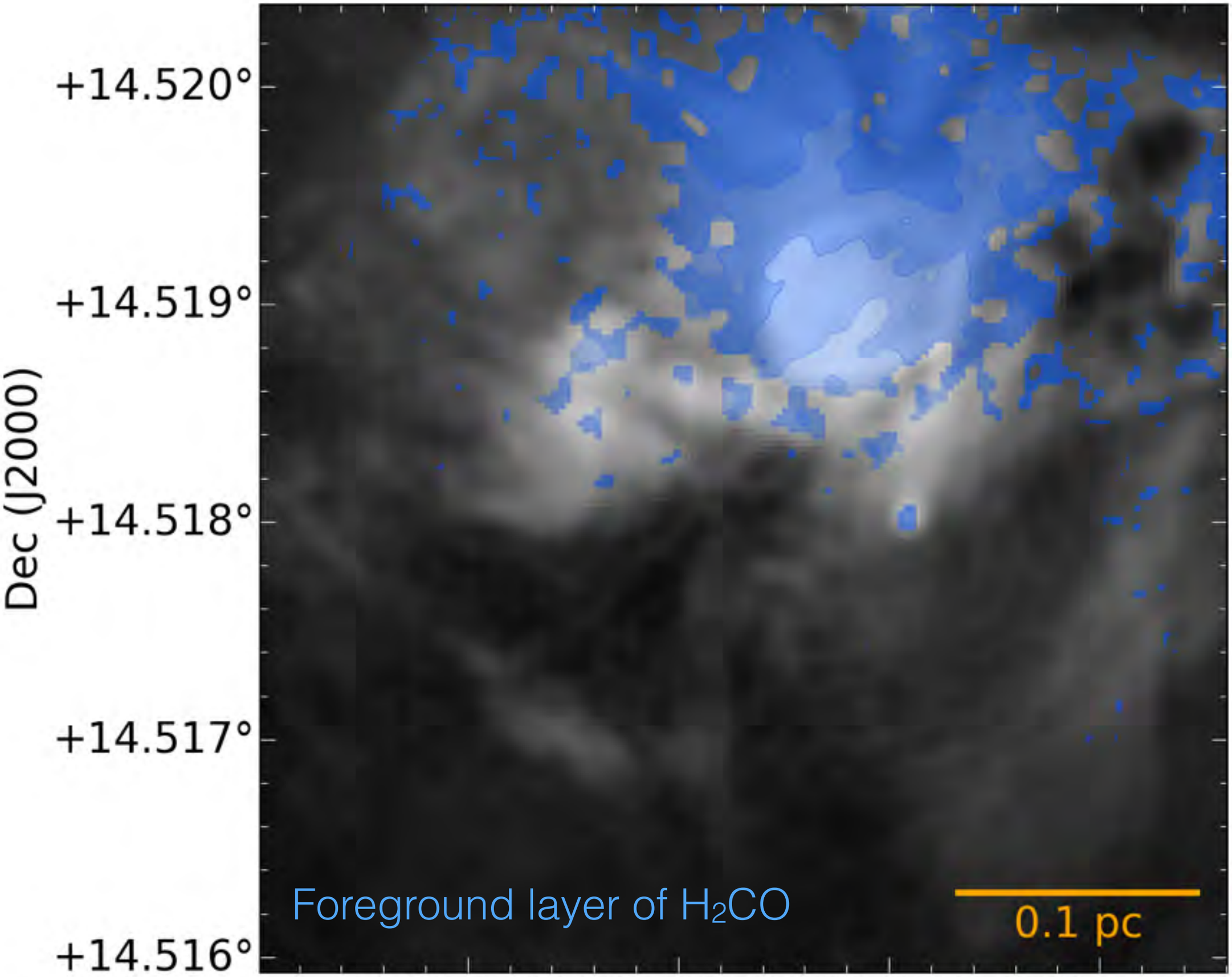
RA (J2000)
0.1 pc


+14.520°
+14.519°
+14.518°
+14.517°
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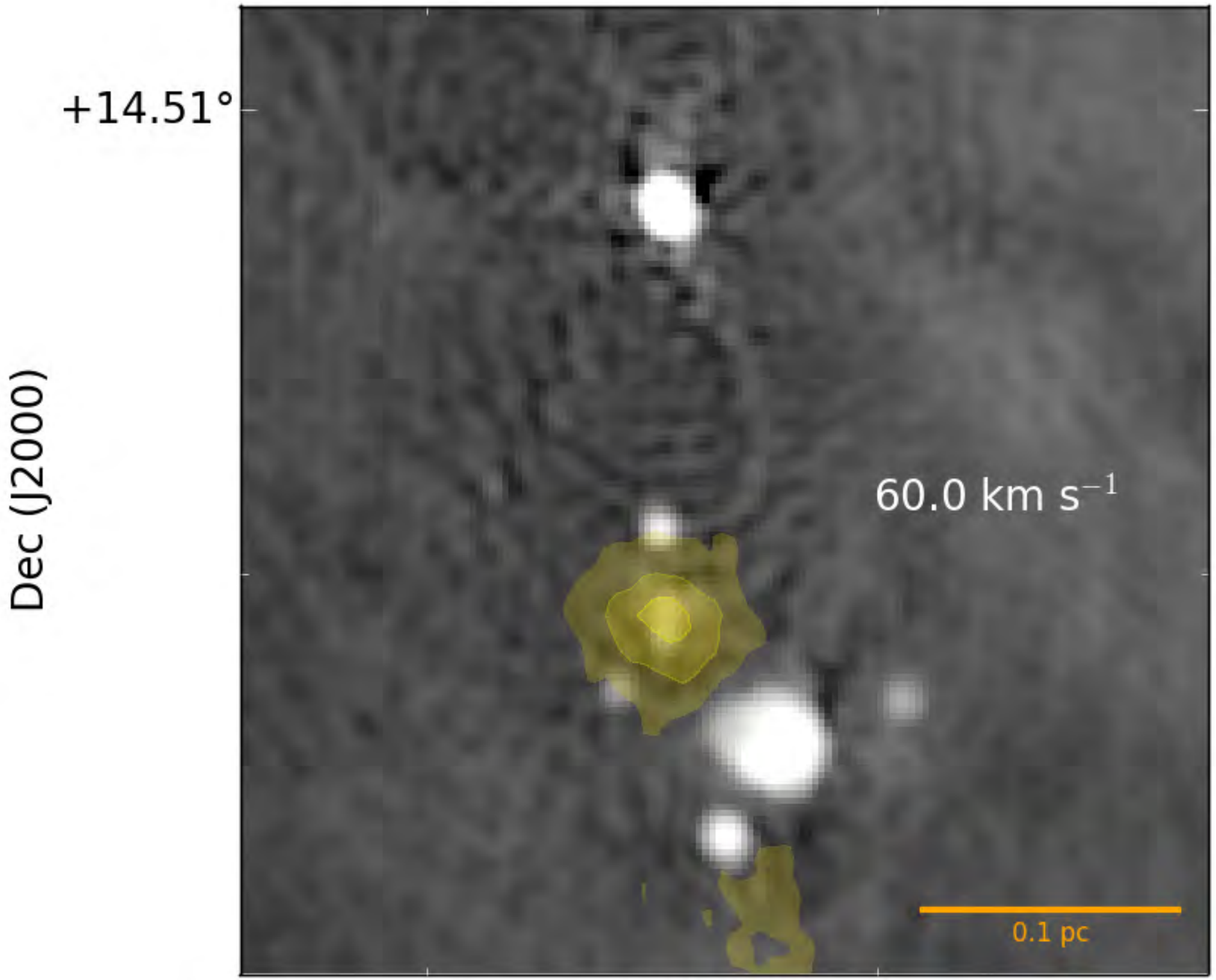
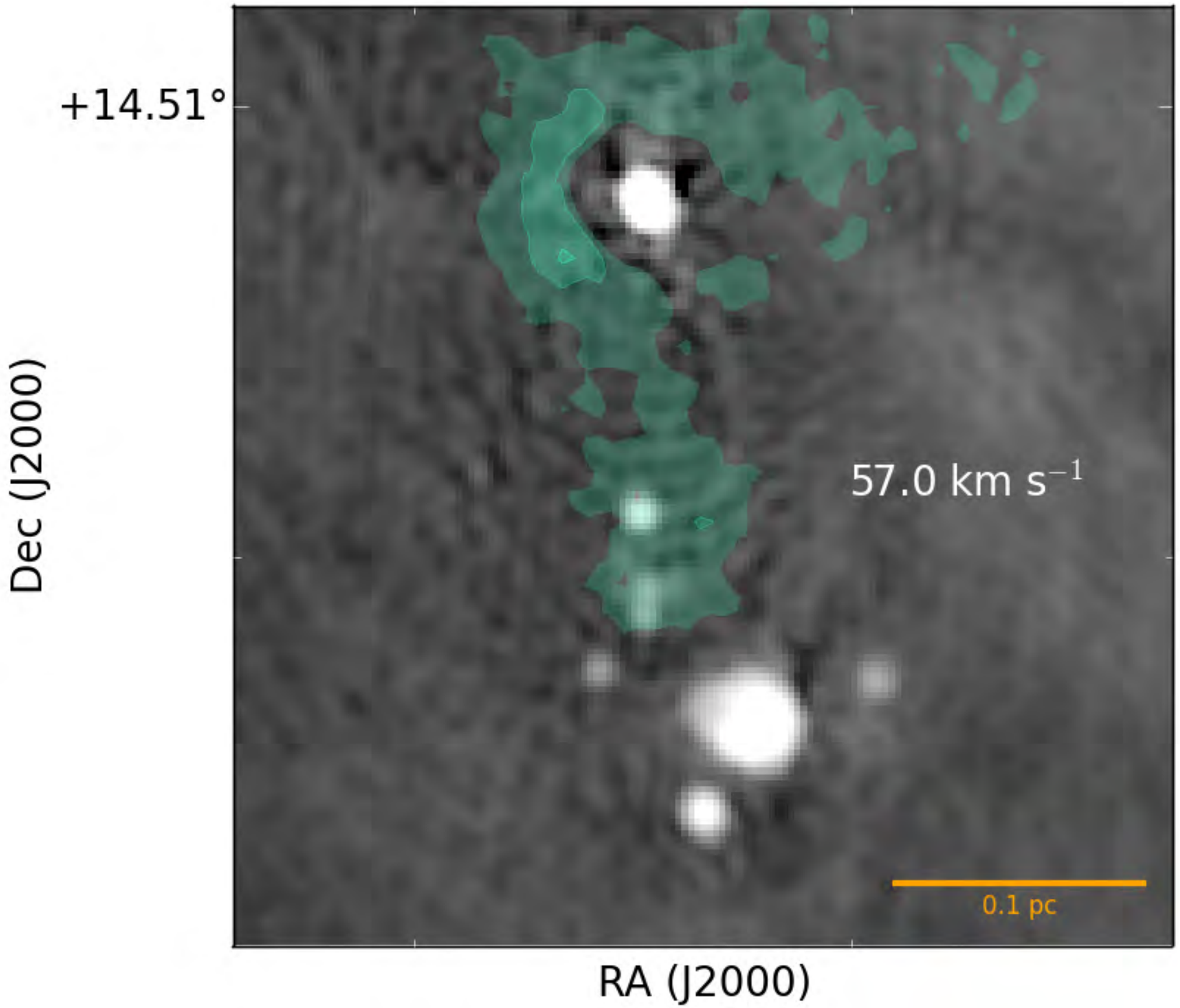
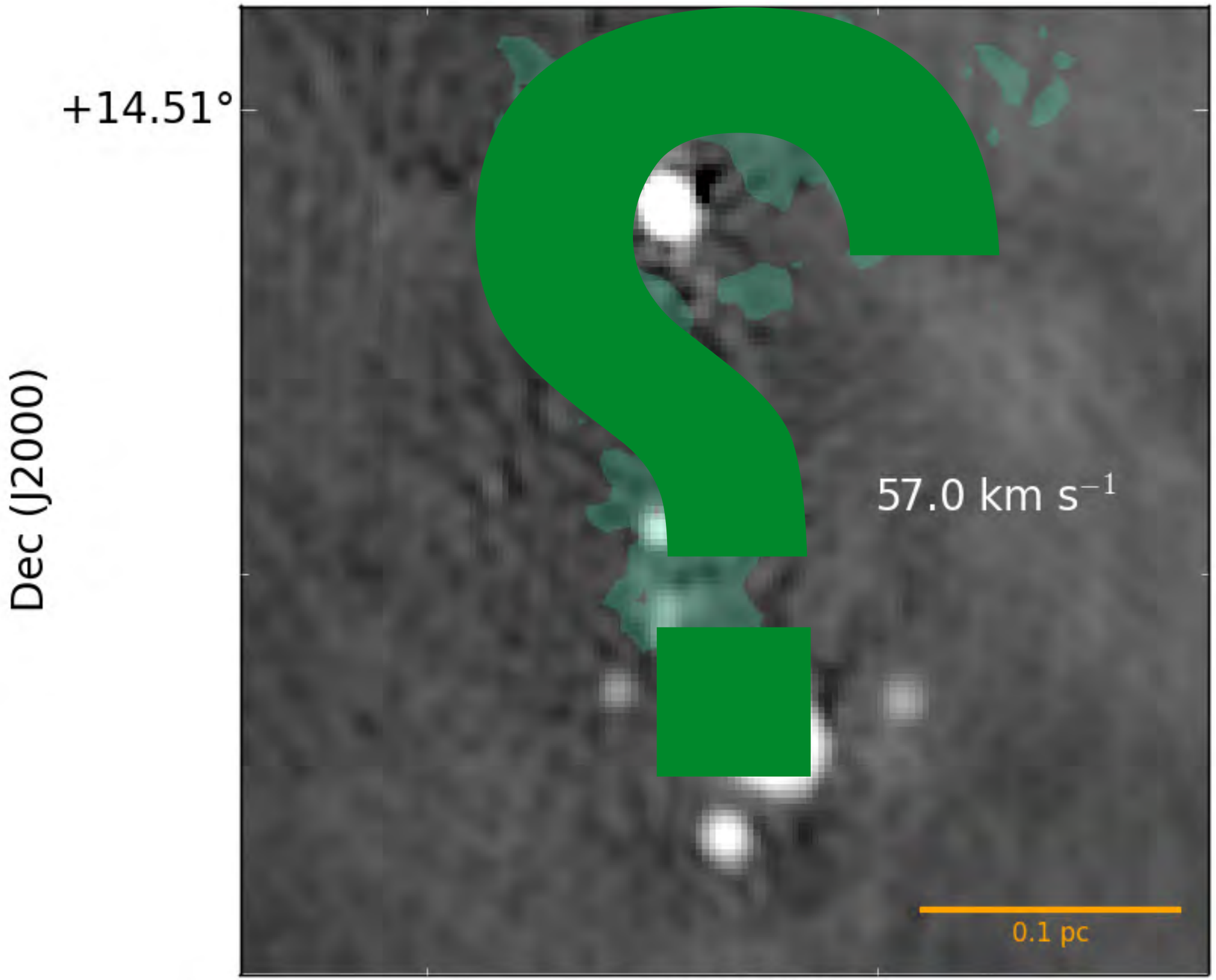
Dec (J2000)
290.918° 290.917° 290.916° 290.915°
RA (J2000)
Foreground layer of H_2CO
0.1 pc


+14.51°
Dec (J2000)
60.0 km s^{-1}
0.1 pc
RA (J2000)


+14.51°
Dec (J2000)
57.0 km s^{-1}
0.1 pc
RA (J2000)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57.0 km s^{-1}
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[see poster too]

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