Multiwavelength mysteries in Sagittarius B2

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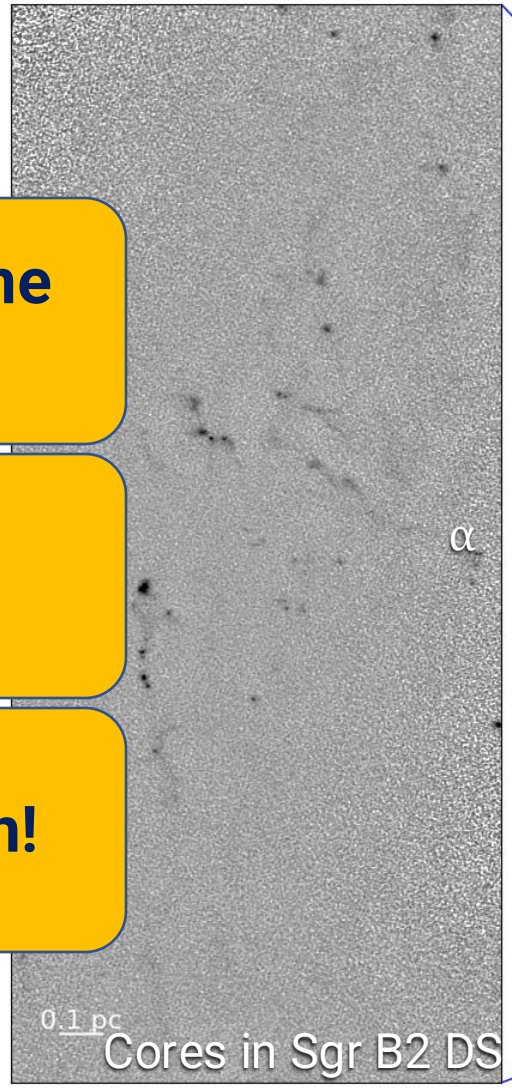
Sagittarius B2

<1% of the CMZ volume
$(5 \times 10^4$ pc$^3)$

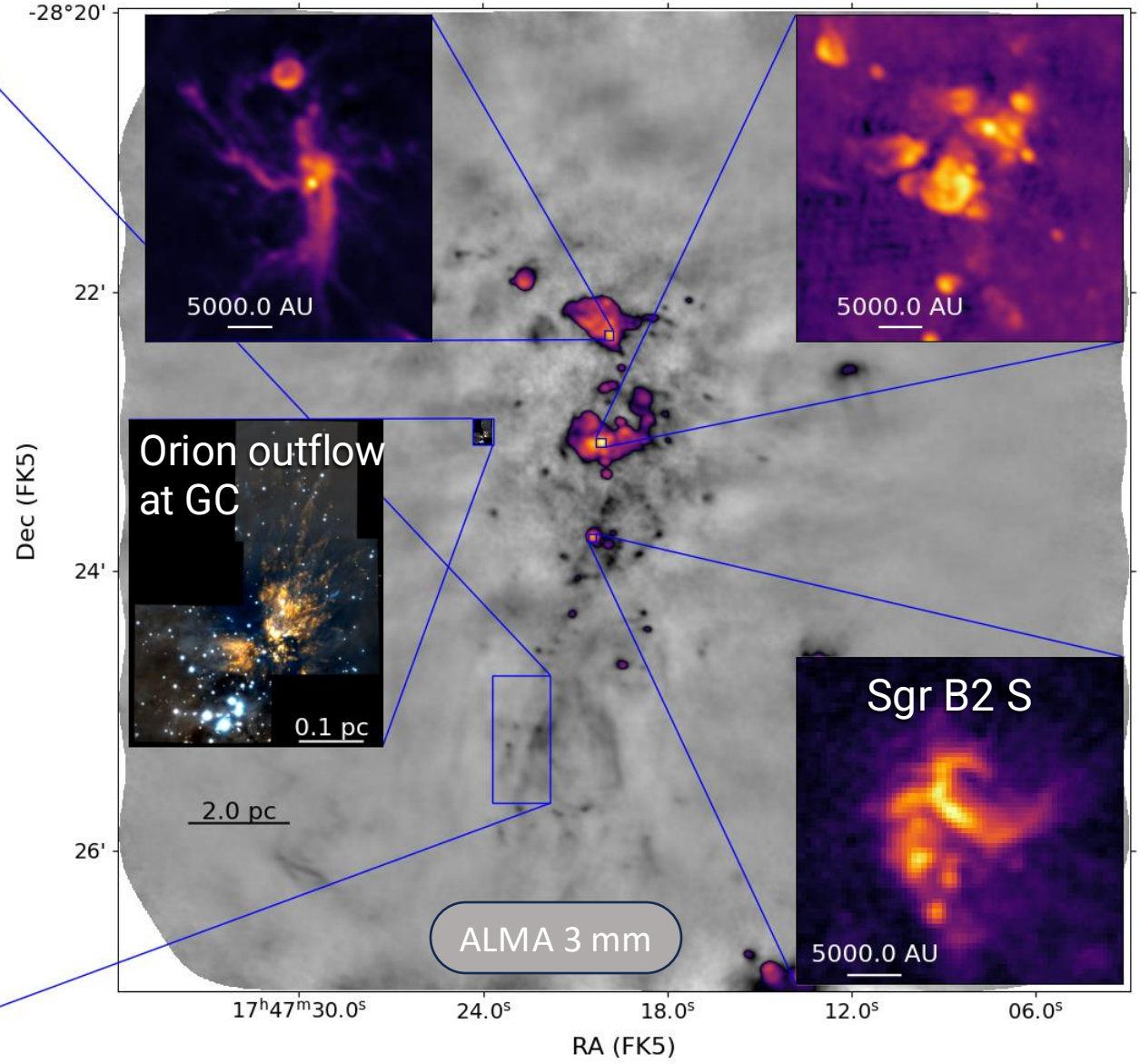
$\sim$10% of the mass
$(8 \times 10^6 M_\odot)$

50% of star formation!

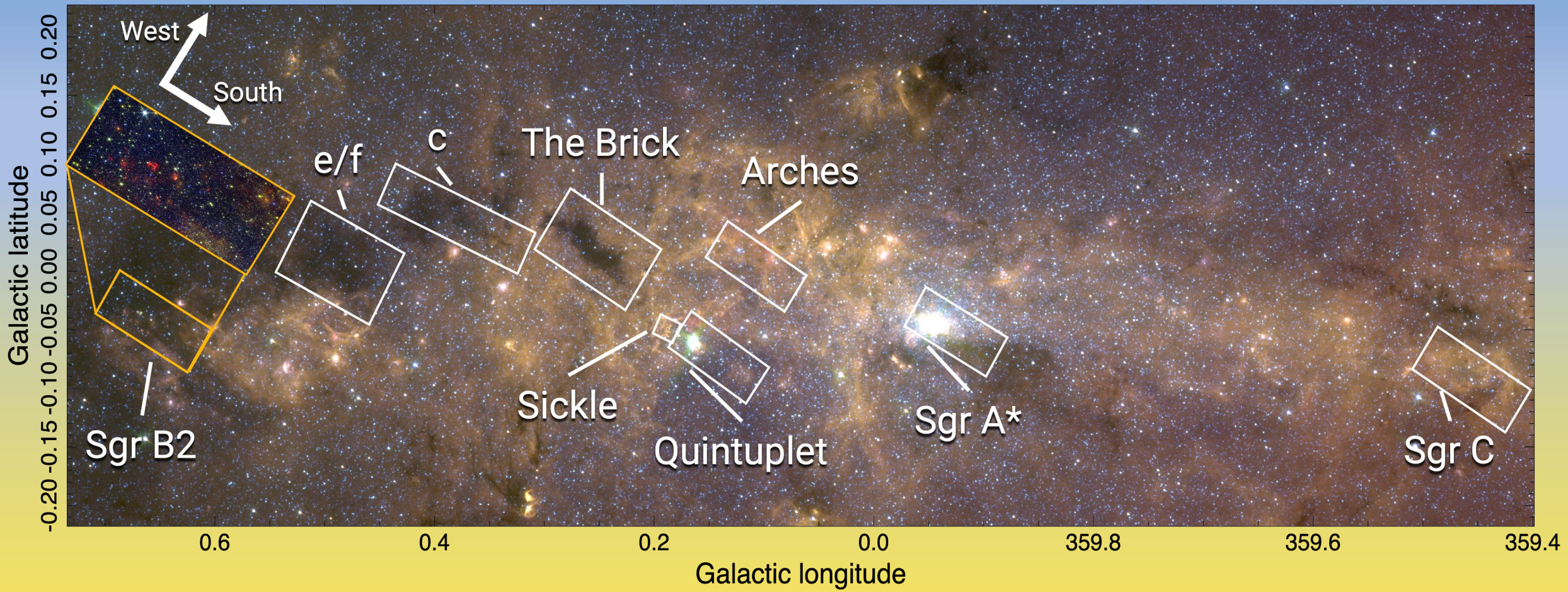


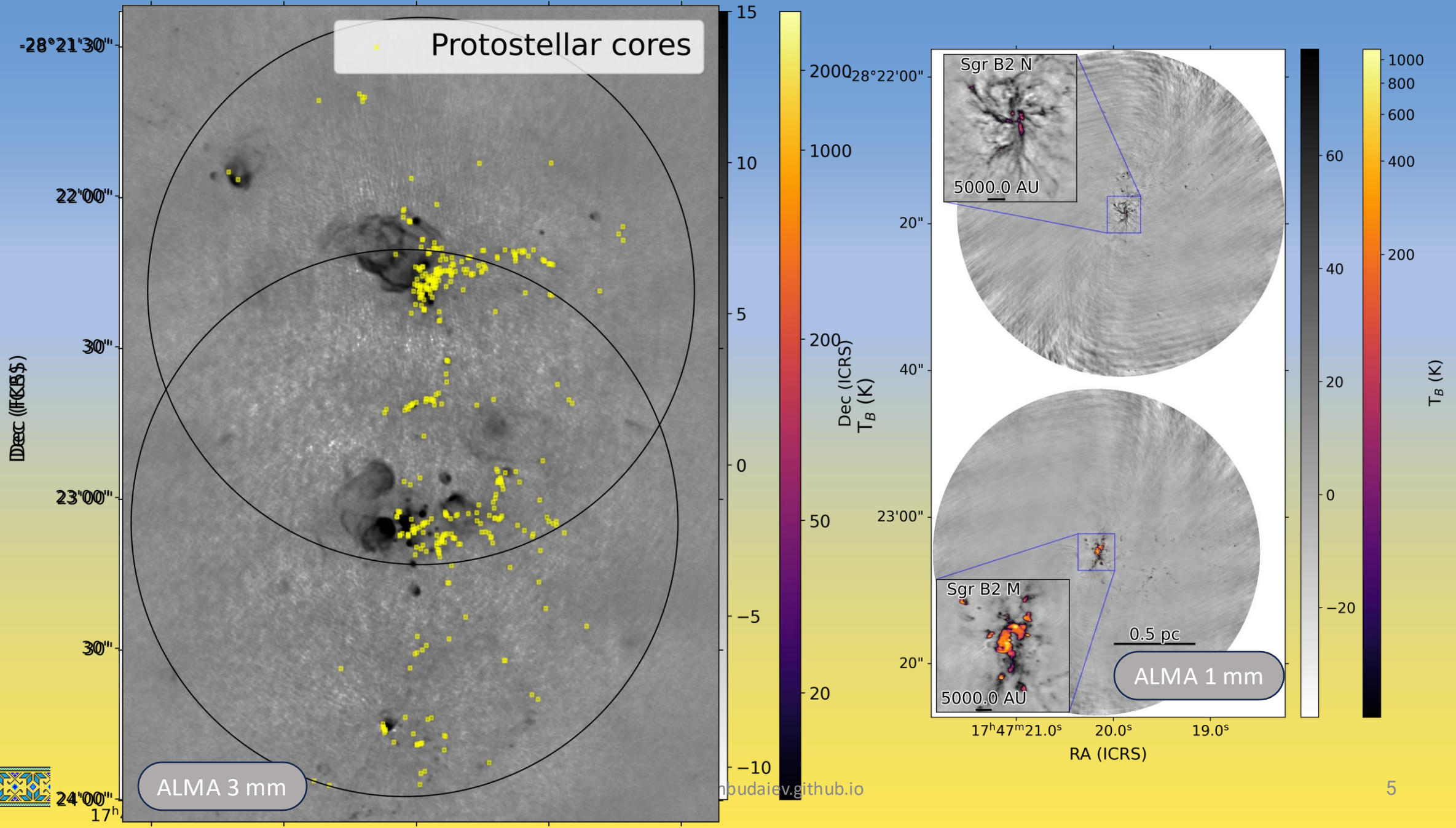
Sgr B2 N protocluster

Sgr B2 M protocluster



CMZ overview

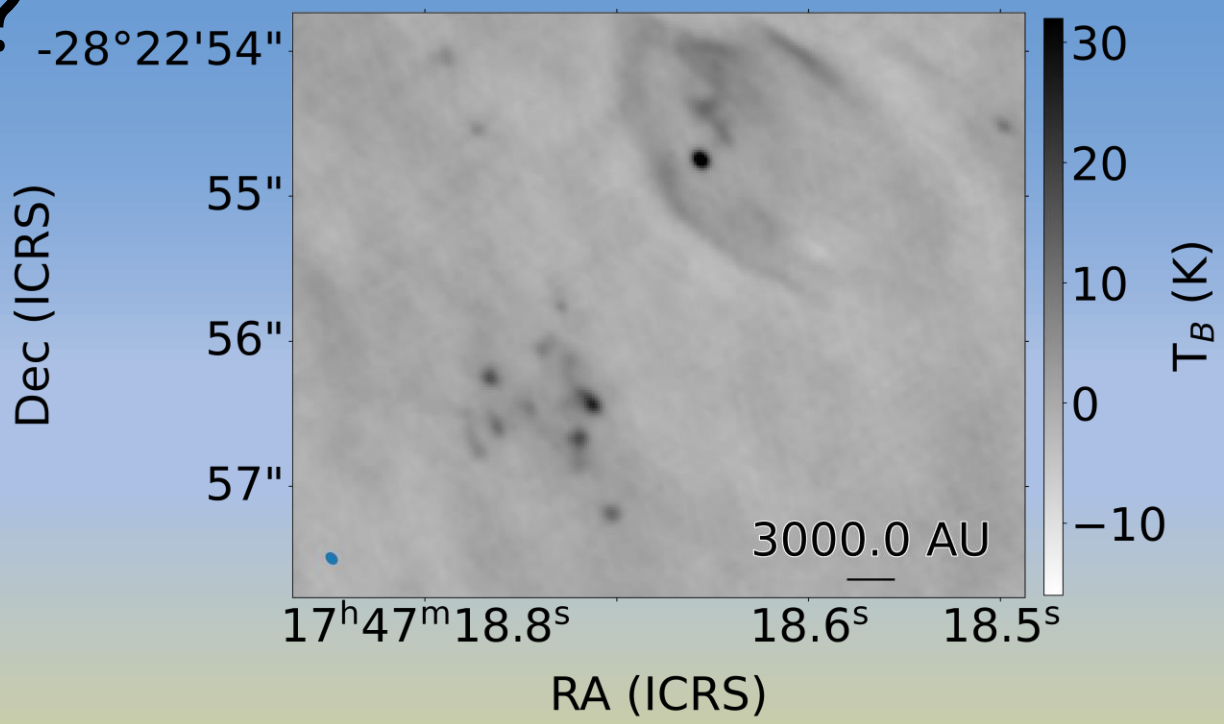



Protostellar cores
ALMA 3 mm
Sgr B2 N
5000.0 AU
Sgr B2 M
5000.0 AU
0.5 pc
ALMA 1 mm
RA (ICRS)
Dec (ICRS)
T_B (K)

What are our sources?

400+ stage 0/I YSOs:

- Compact dusty sources
- Rotationally supported
- 200-1000 AU
- 50 K



Prestellar cores?

$$t_{ff} = \sqrt{\frac{3\pi}{32G\rho}}$$

~1000 years at 1 Msun, 600 AU

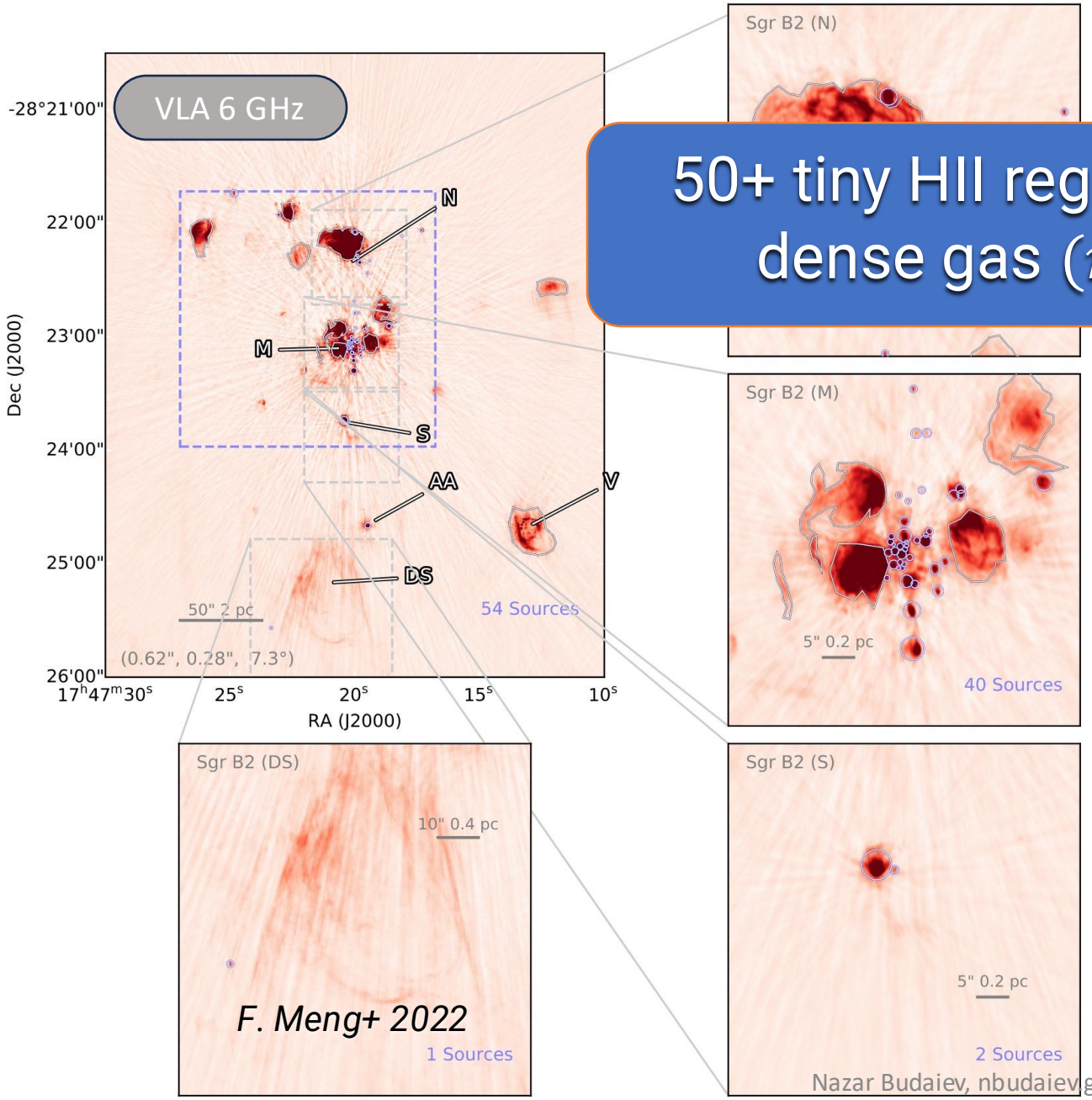
Stage II YSOs?

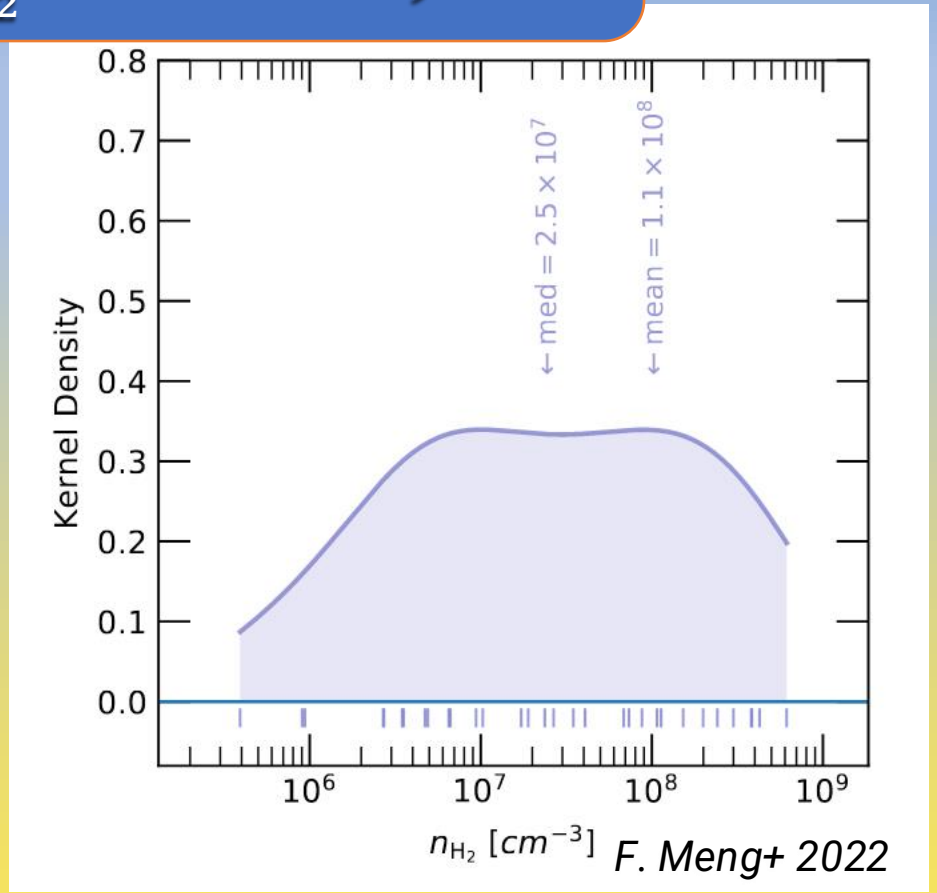
Faintest source -> 30 Msun central star

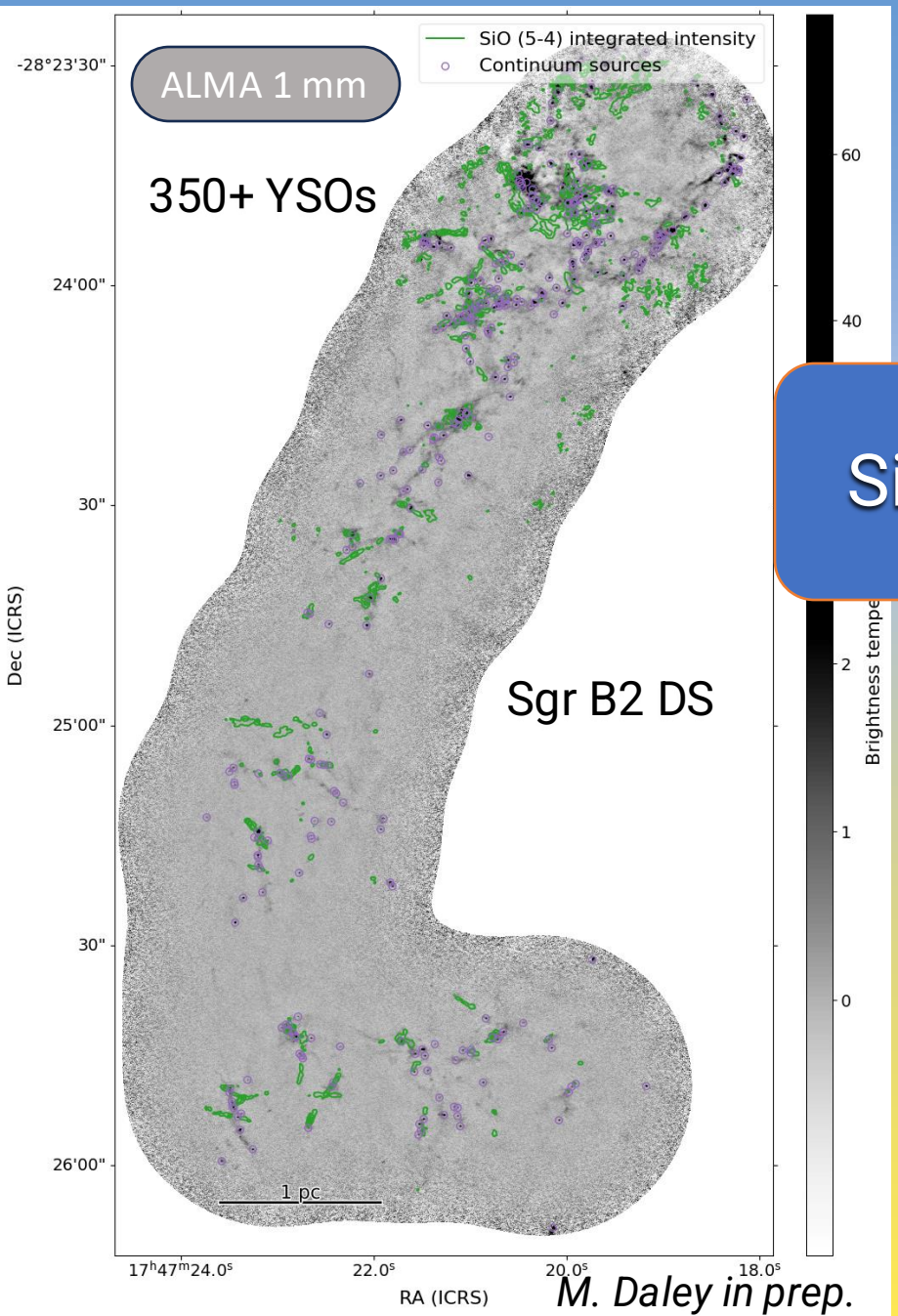
HII regions?

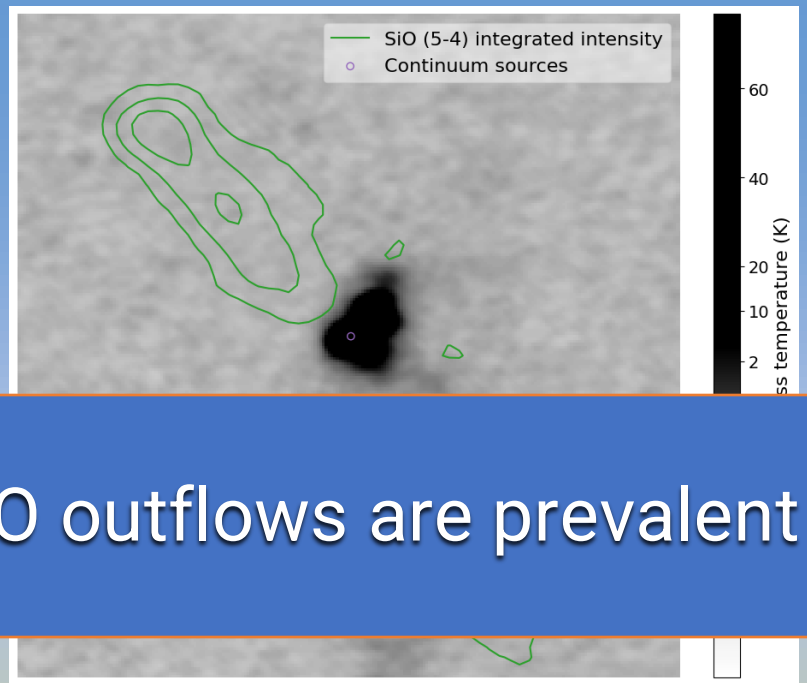
Only optically thick, 30-80 AU in diameter

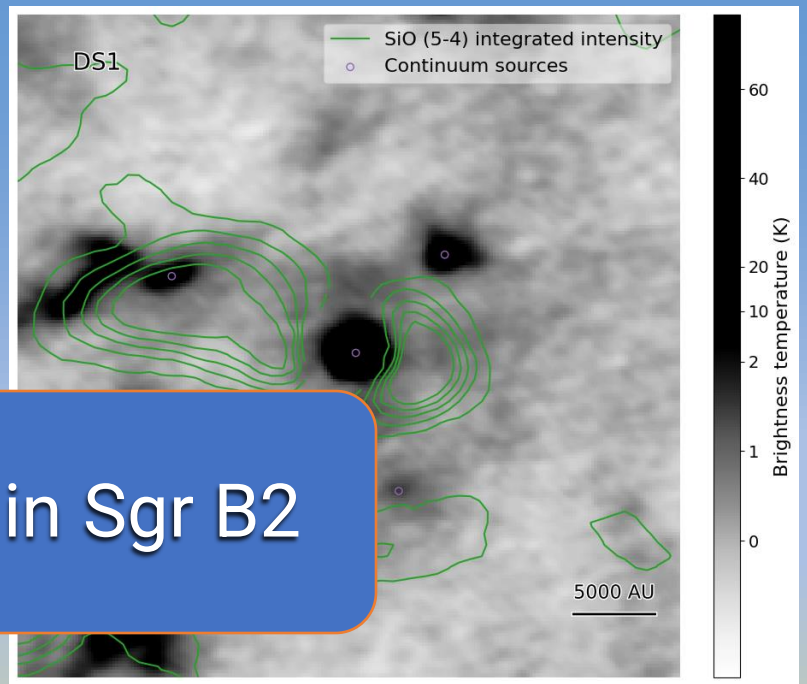
50+ tiny HII regions surrounded by dense gas ($n_{\mathrm{H_2}} > 10^7 \mathrm{cm}^{-3}$)

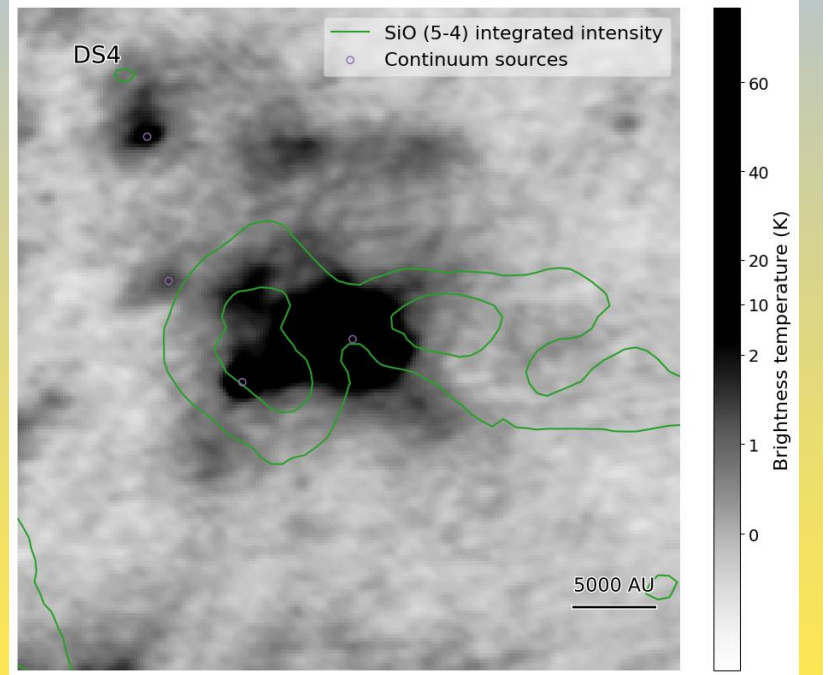


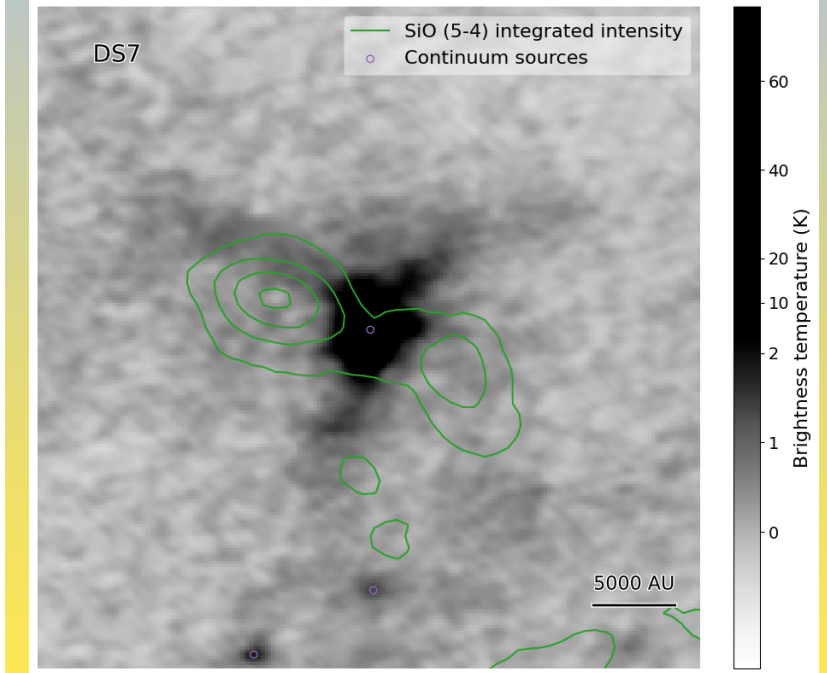








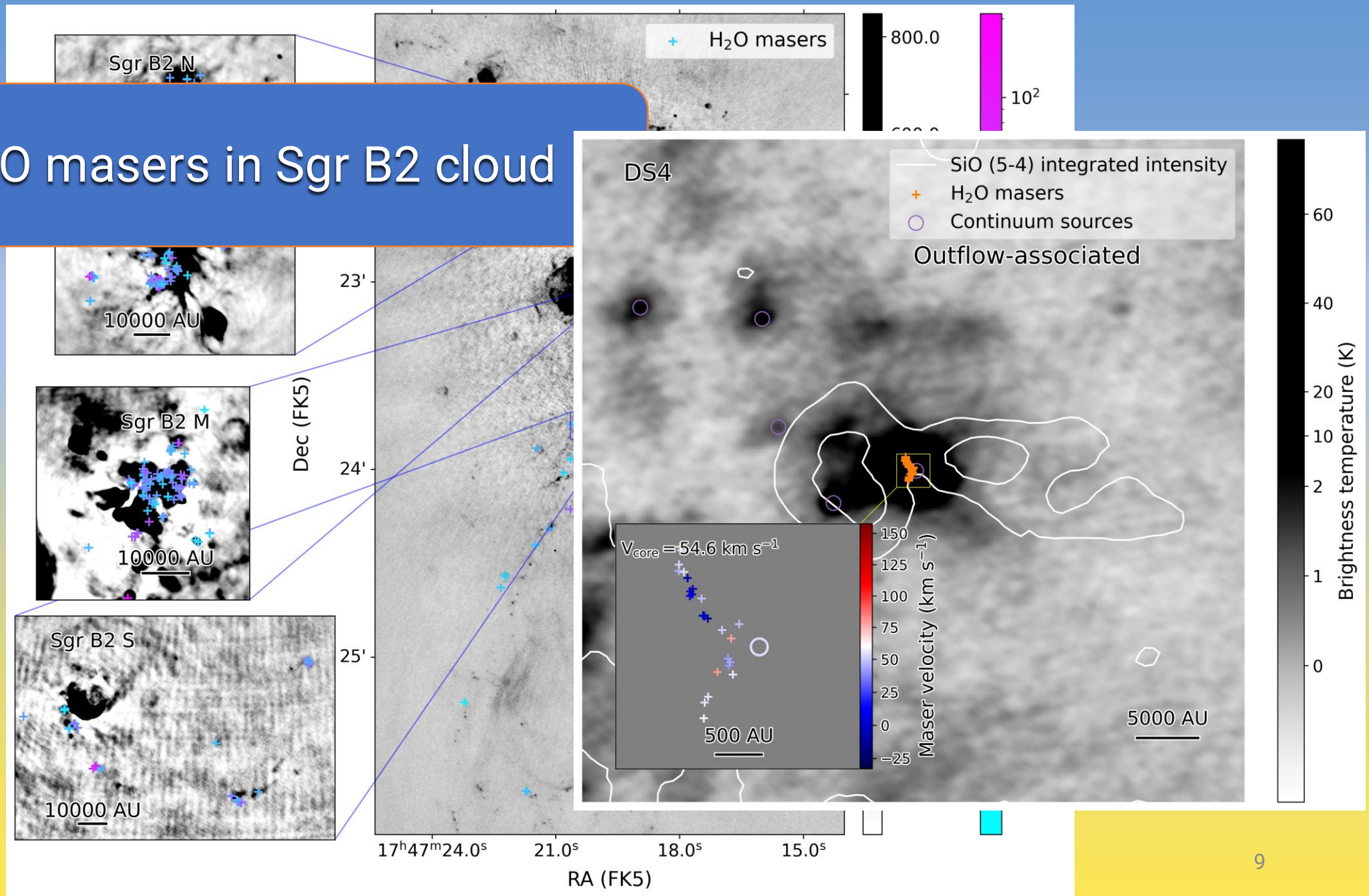


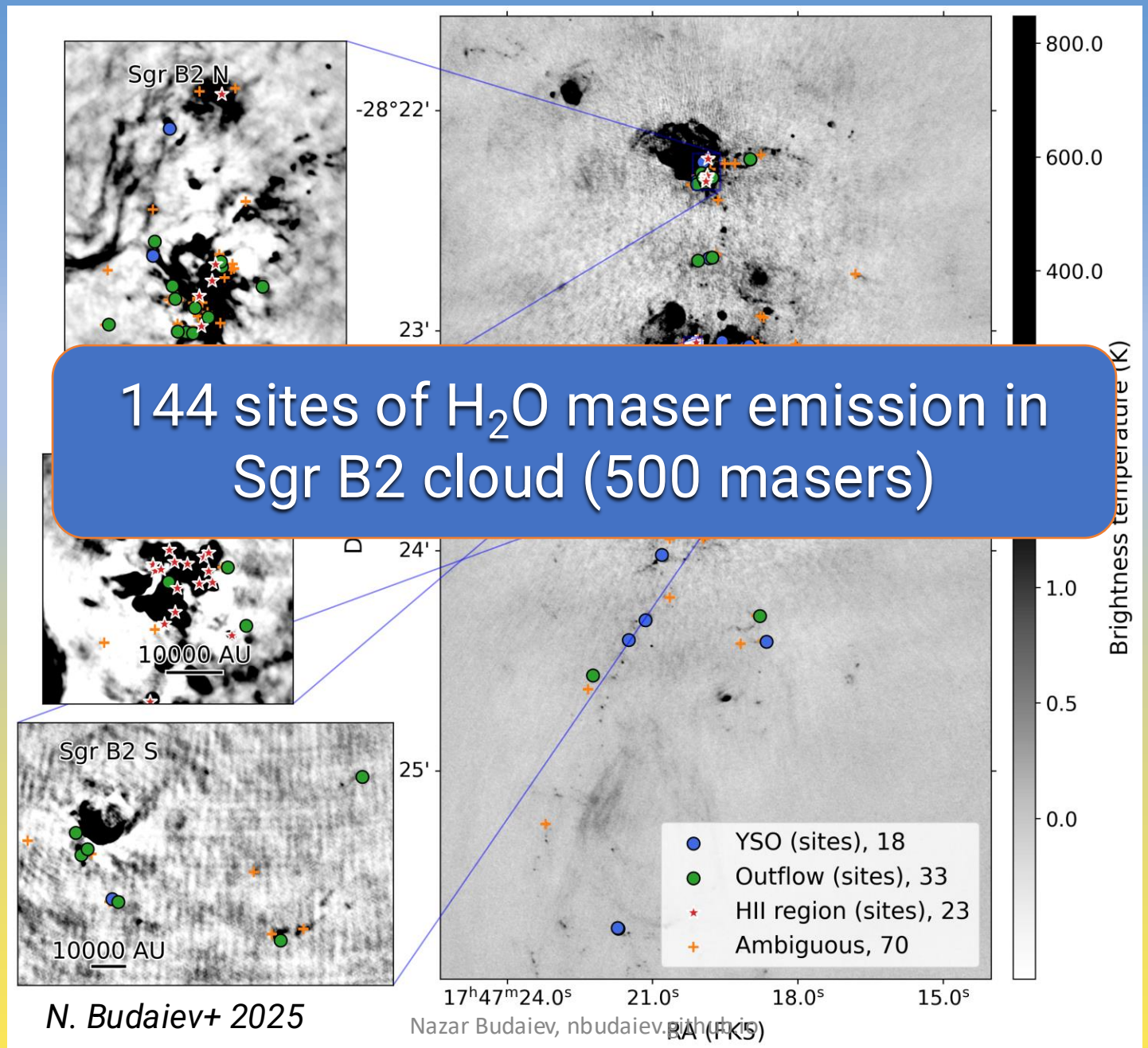


SiO outflows are prevalent in Sgr B2

M. Daley in prep.

500 H_2O masers in Sgr B2 cloud

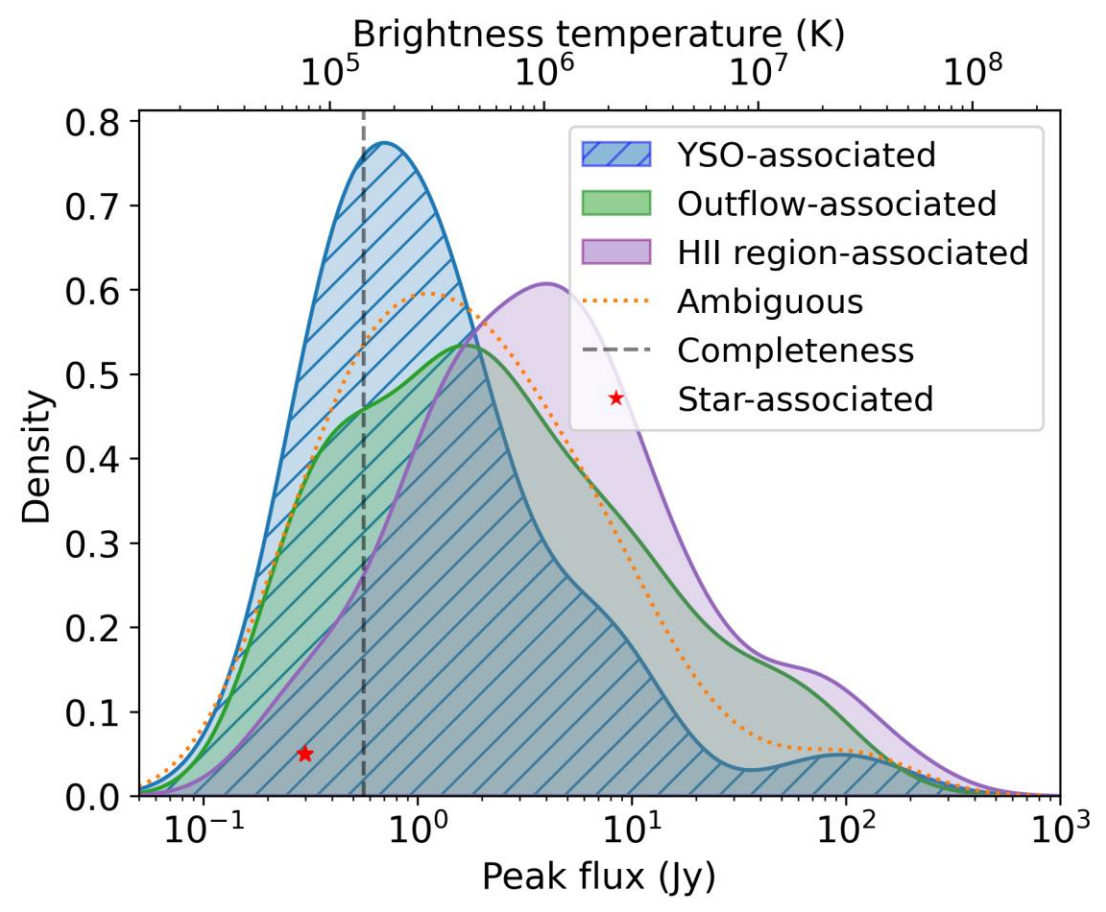


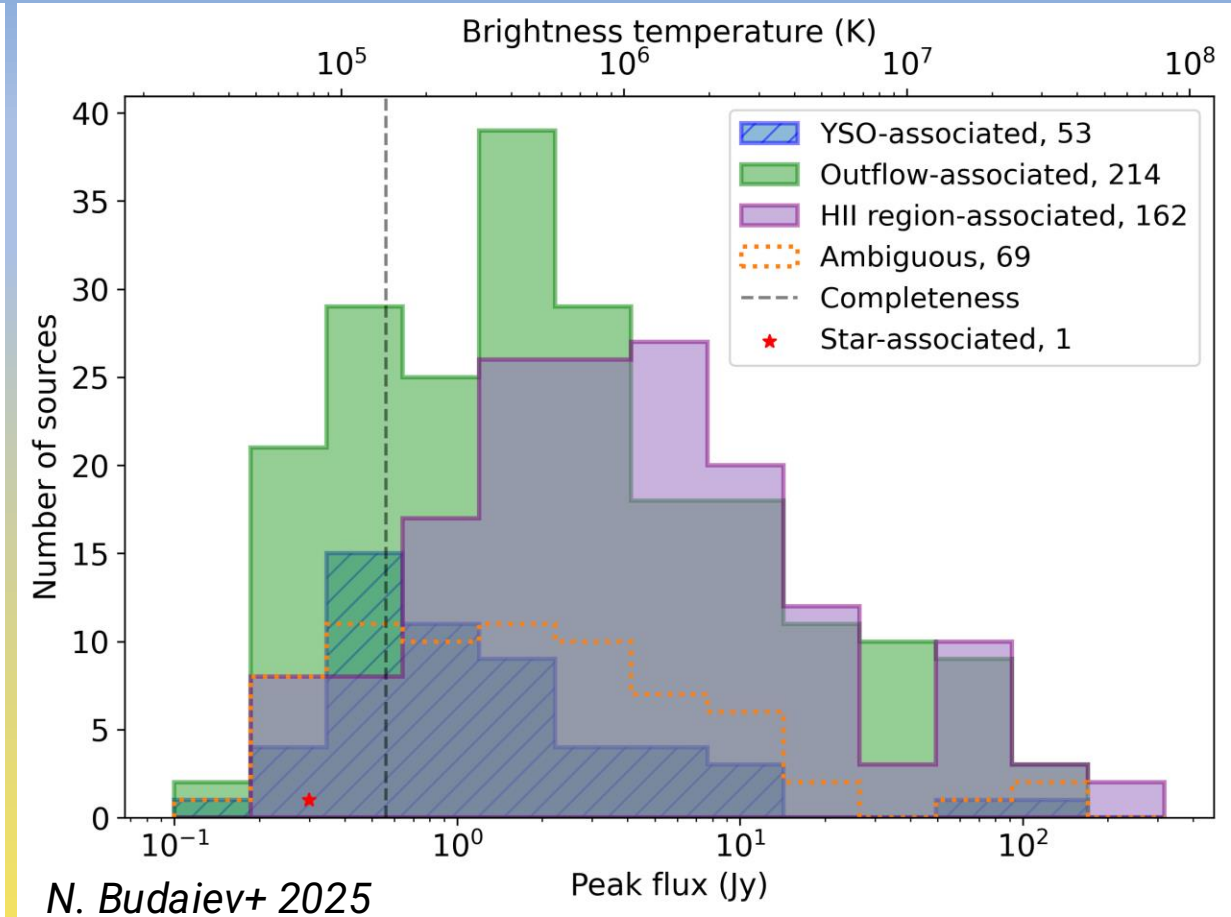


144 sites of H_2O maser emission in Sgr B2 cloud (500 masers)

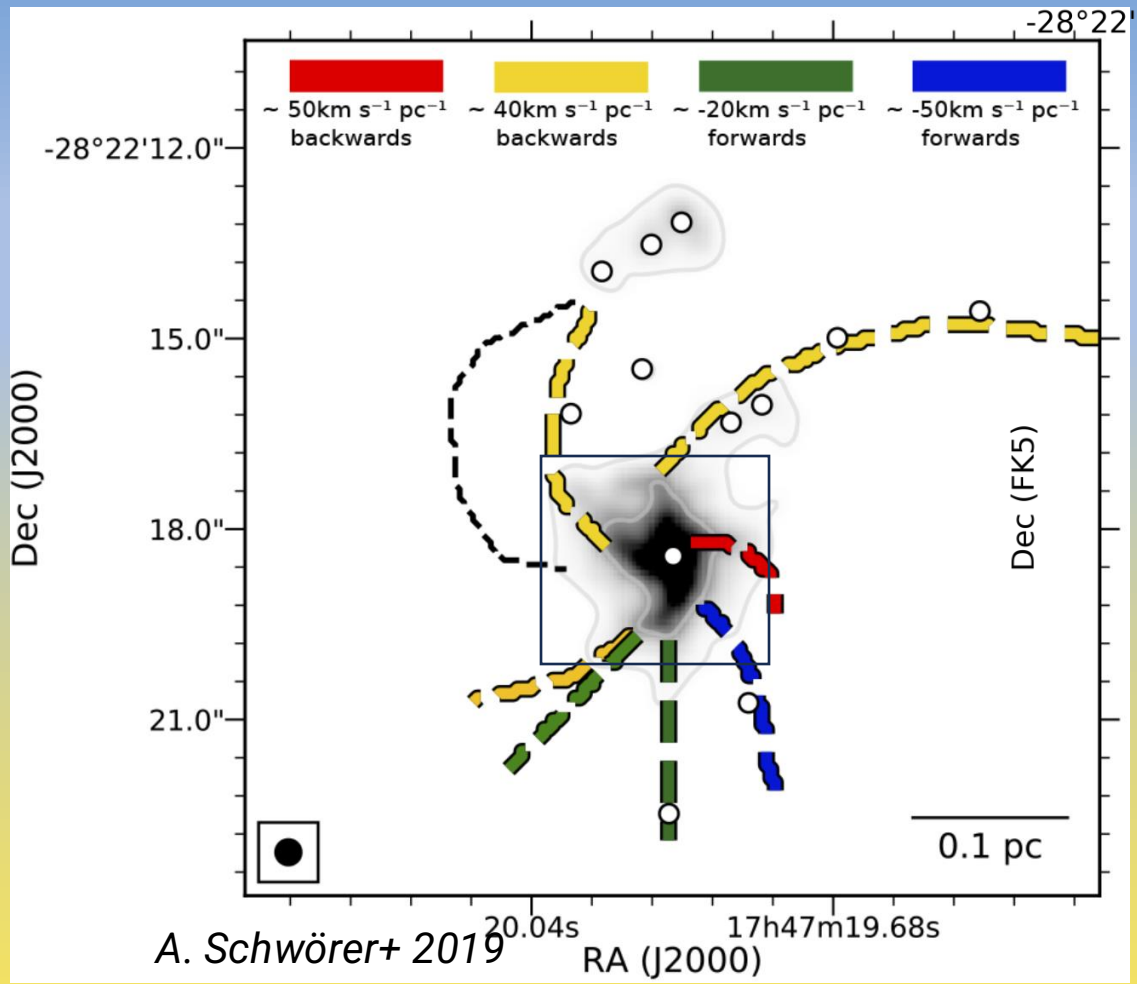
N. Budaiev+ 2025

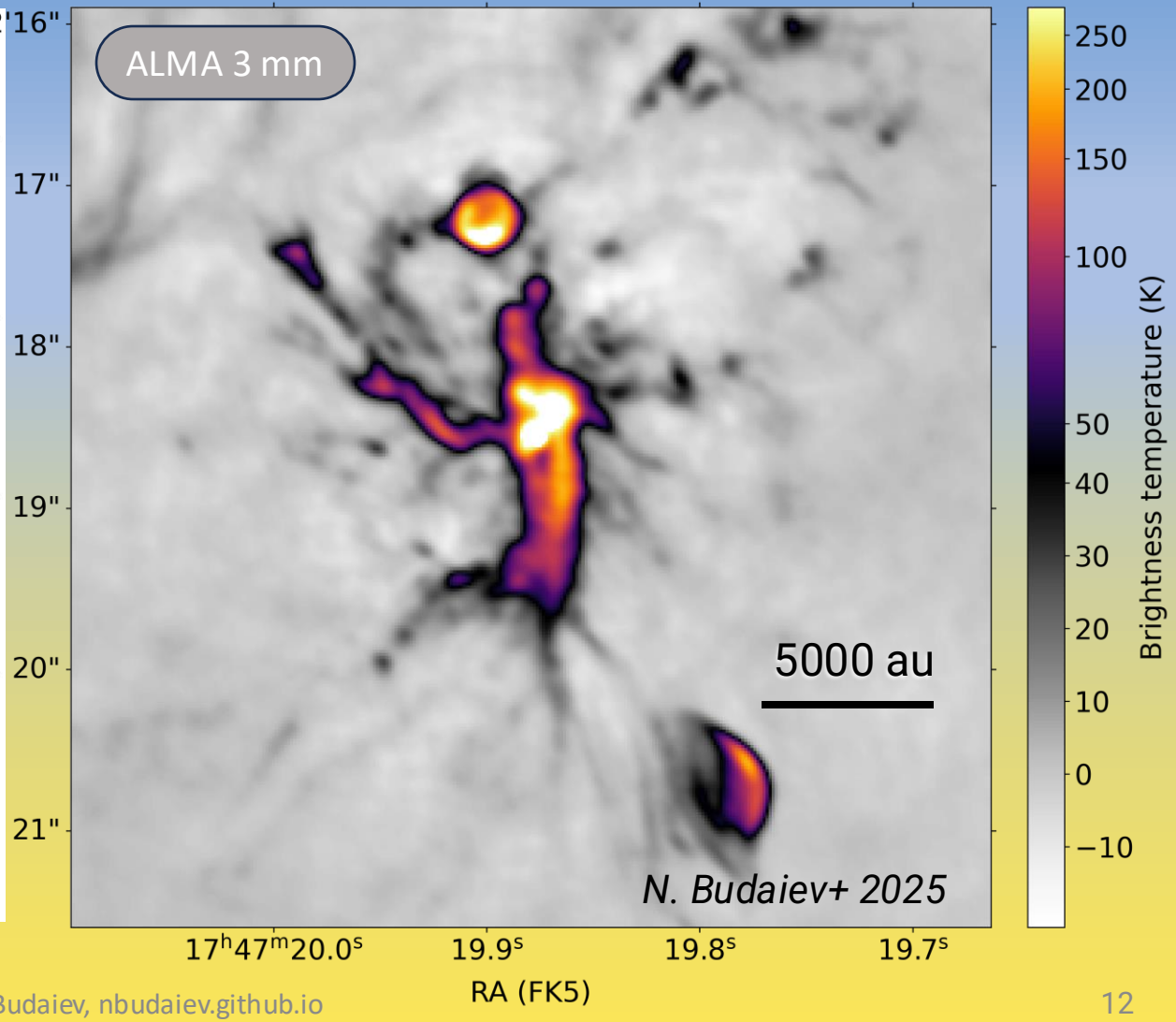
Interpretation for surveys



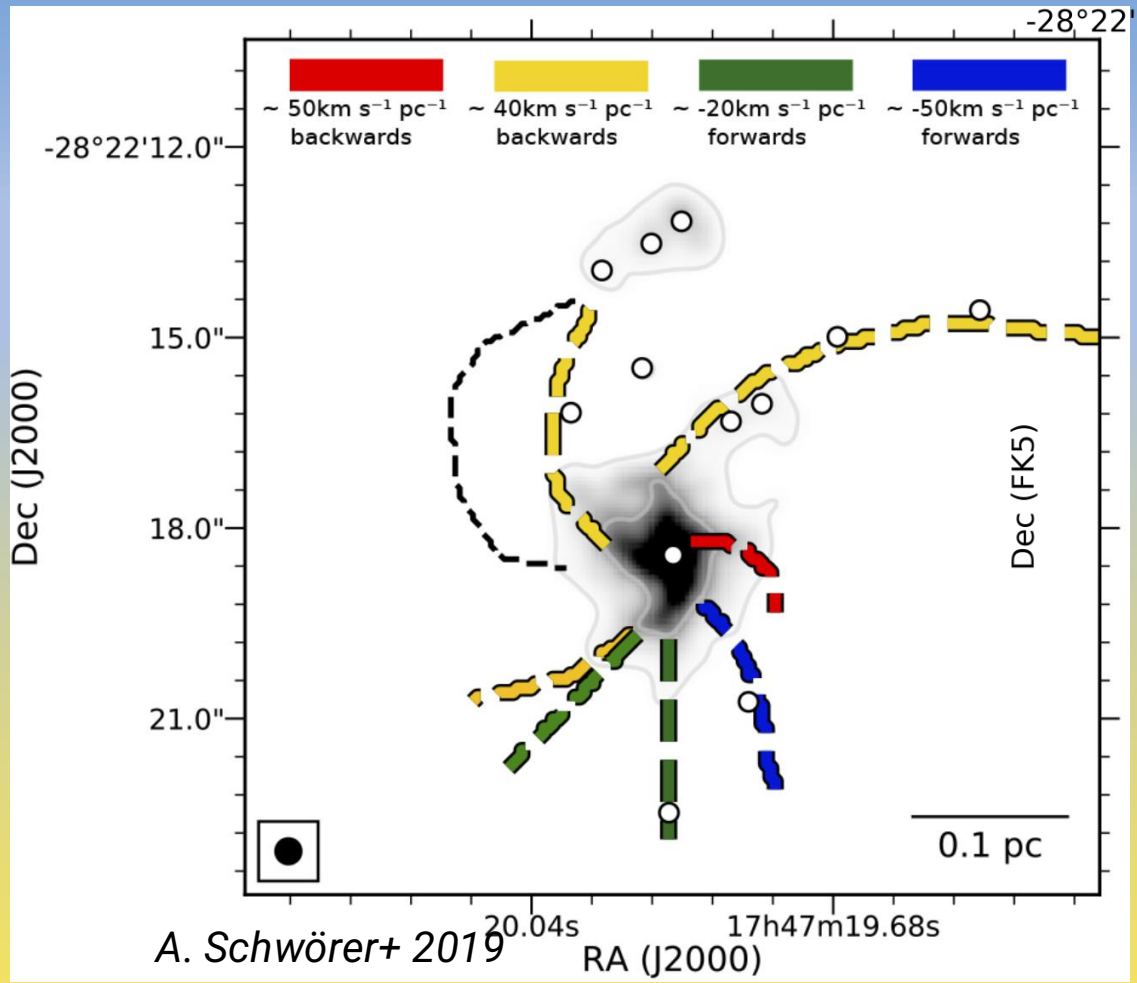


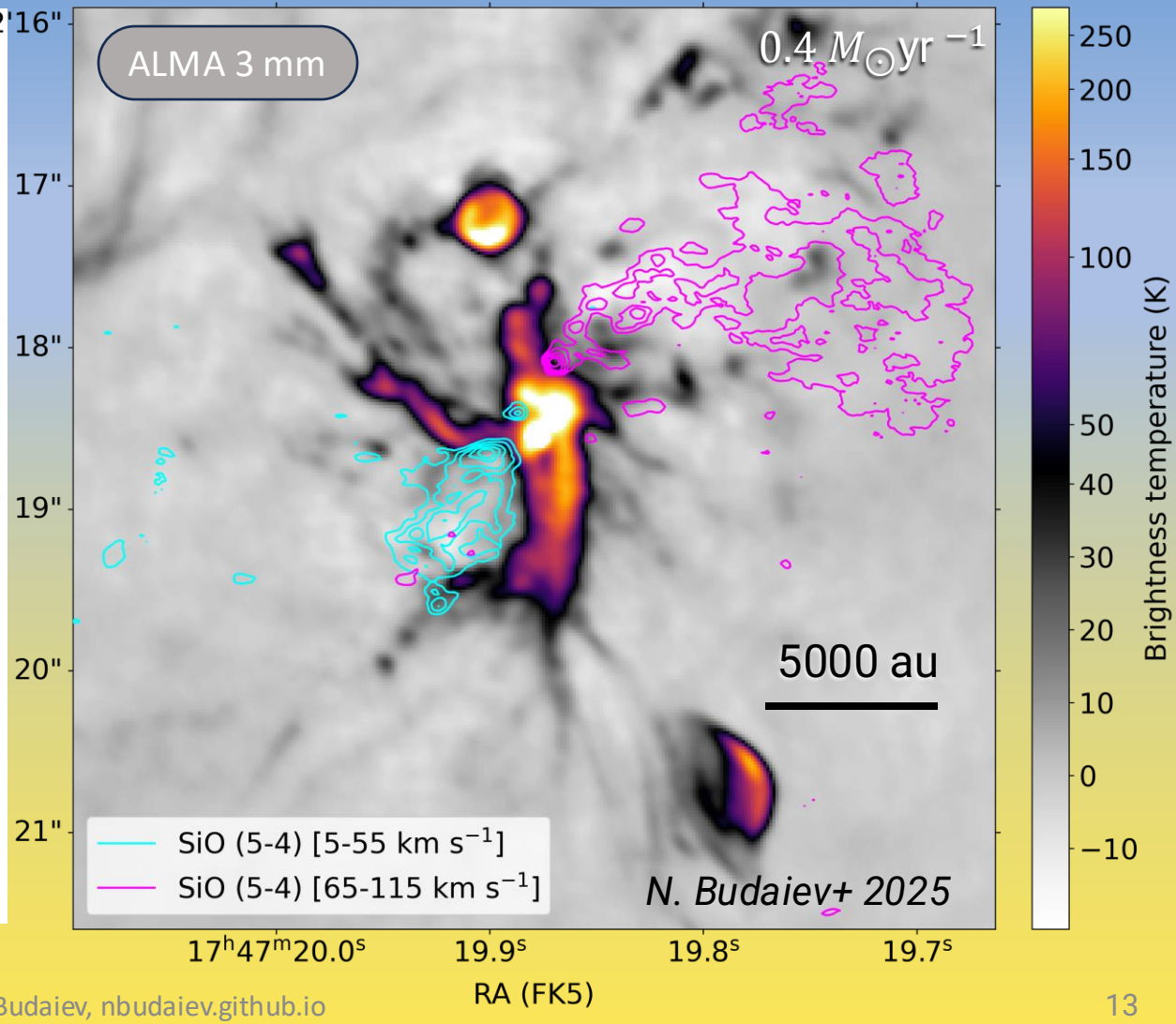
Large-scale material flow in Sgr B2 N





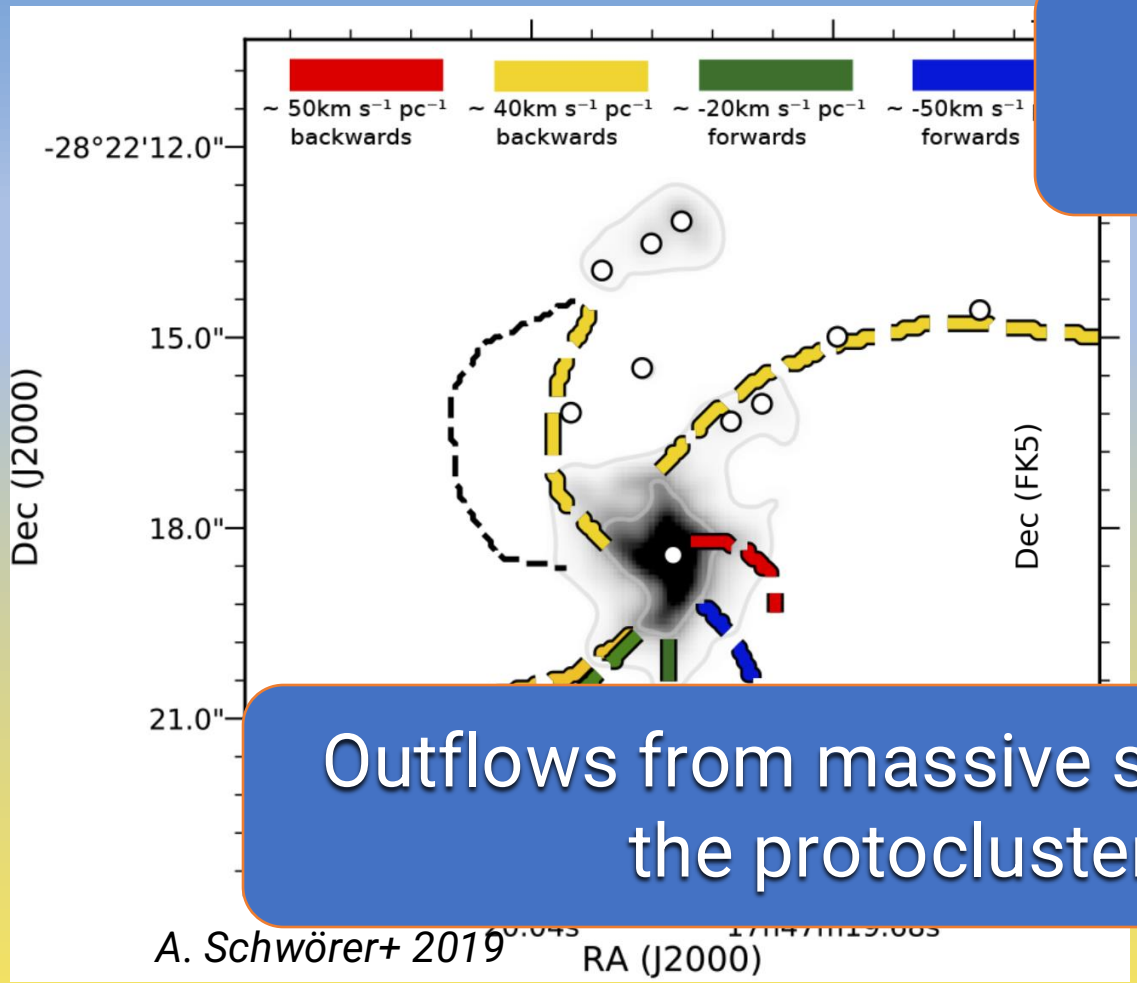
Large-scale material flow in Sgr B2 N





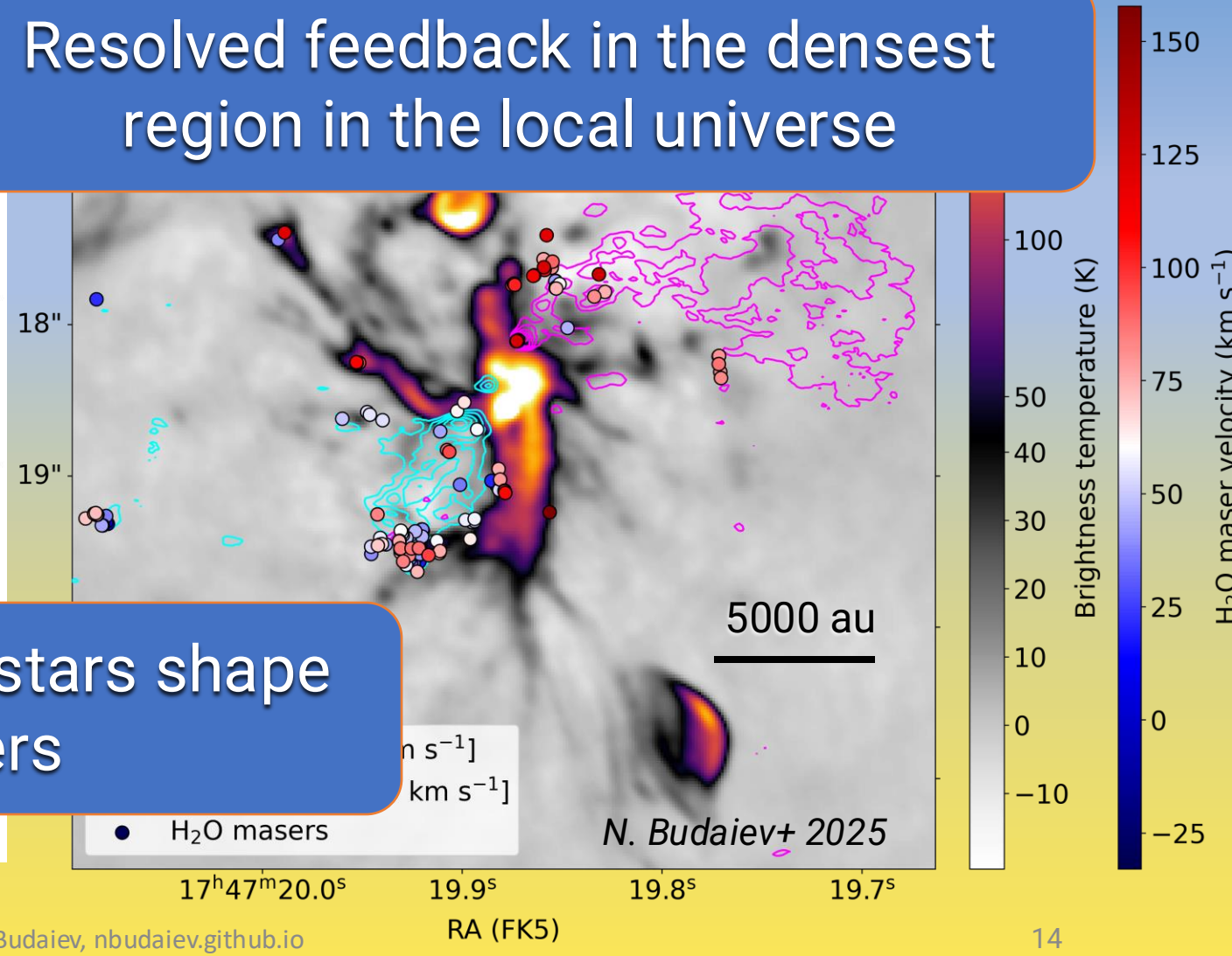
Large-scale material flow in Sgr B2 N

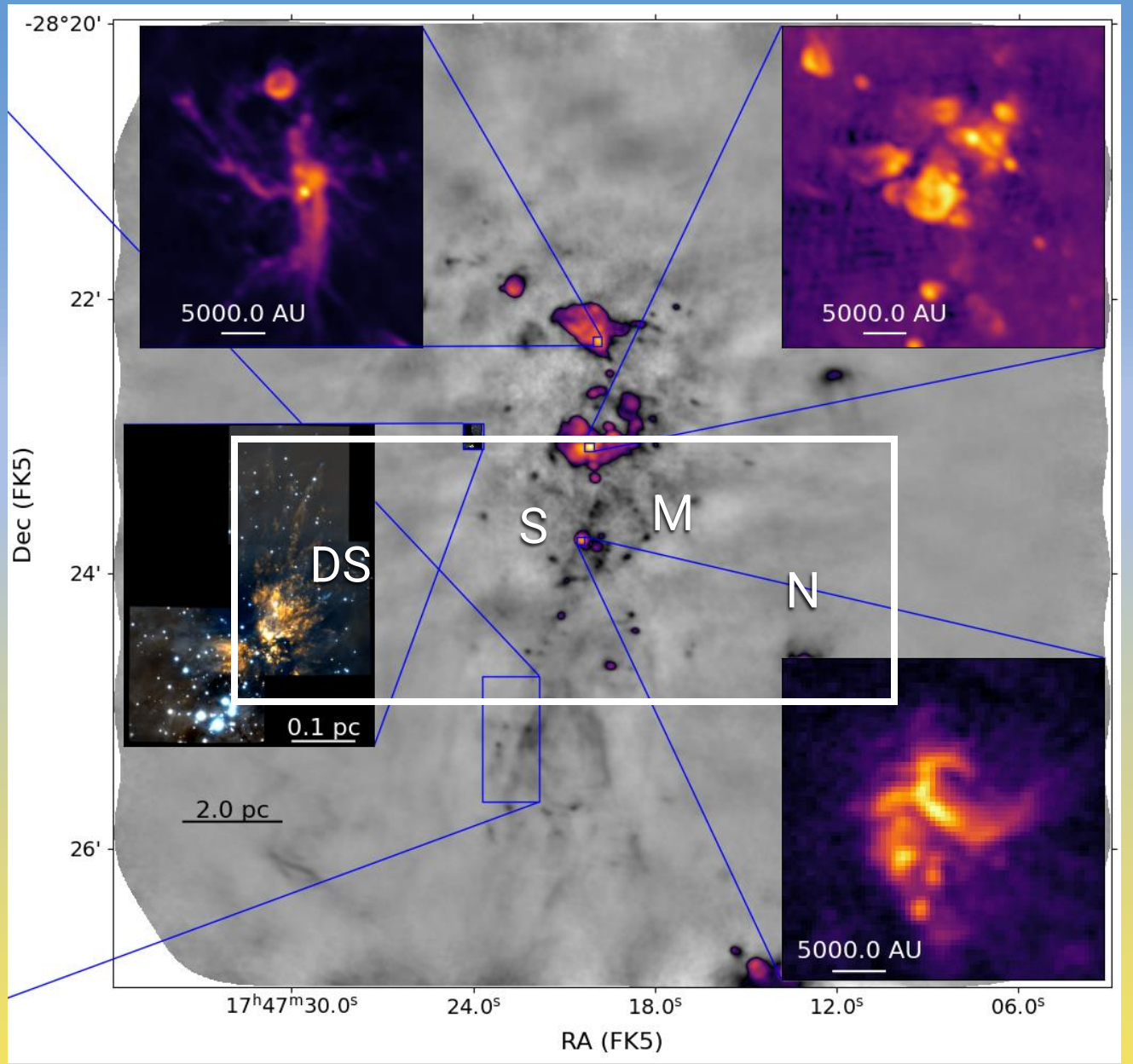
Resolved feedback in the densest region in the local universe



A. Schwörer+ 2019

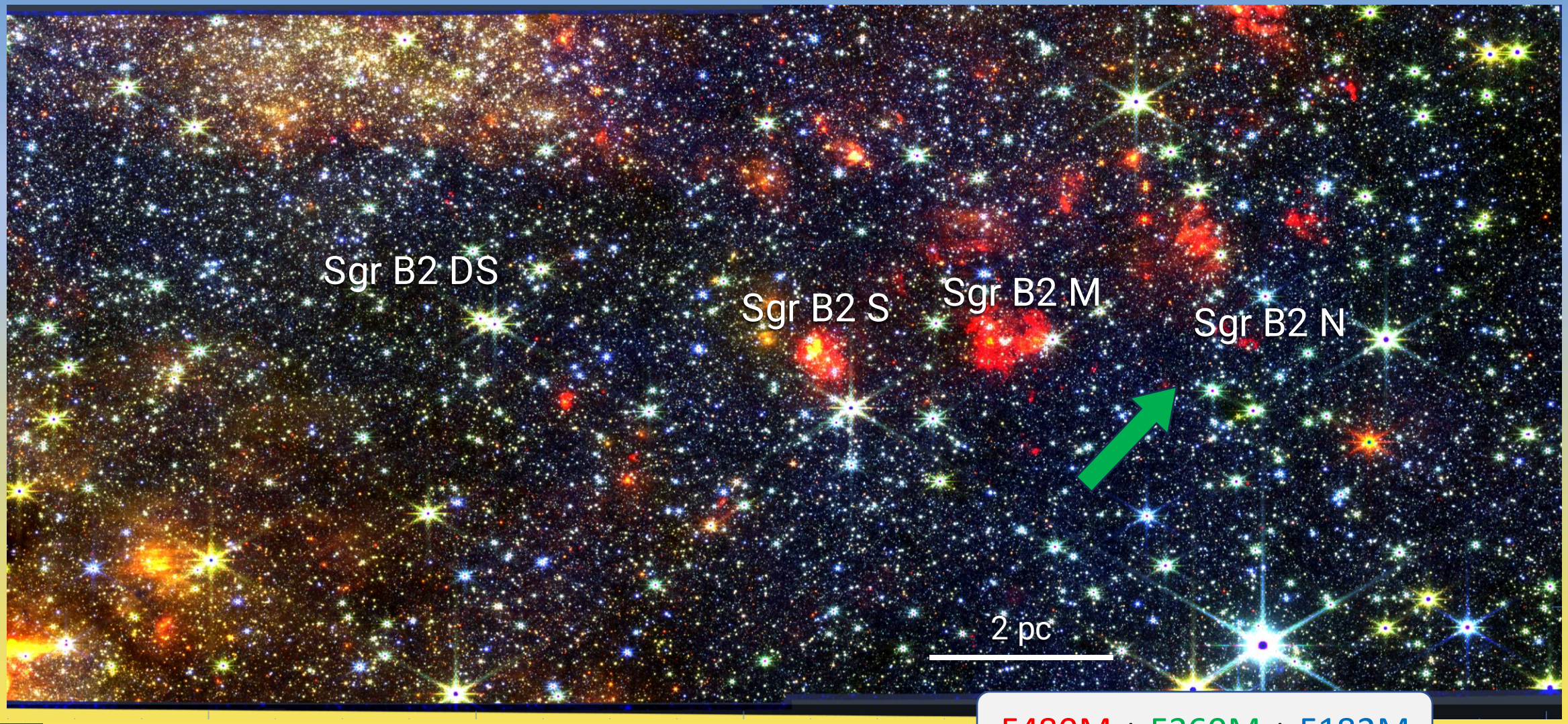
Outflows from massive stars shape the protoclusters



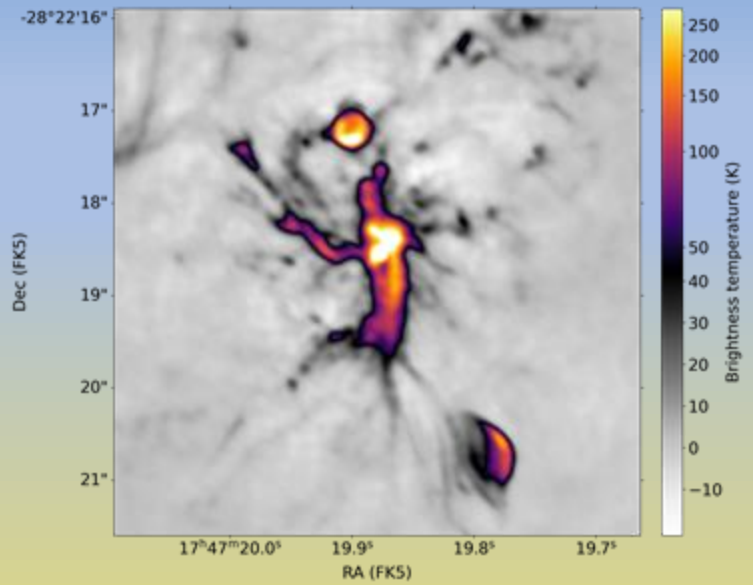

-28°20'
22'
24'
26'
Dec (FK5)
5000.0 AU
5000.0 AU
DS
S
M
N
0.1 pc
2.0 pc
5000.0 AU
17h47m30.0s
24.0s
18.0s
12.0s
06.0s
RA (FK5)

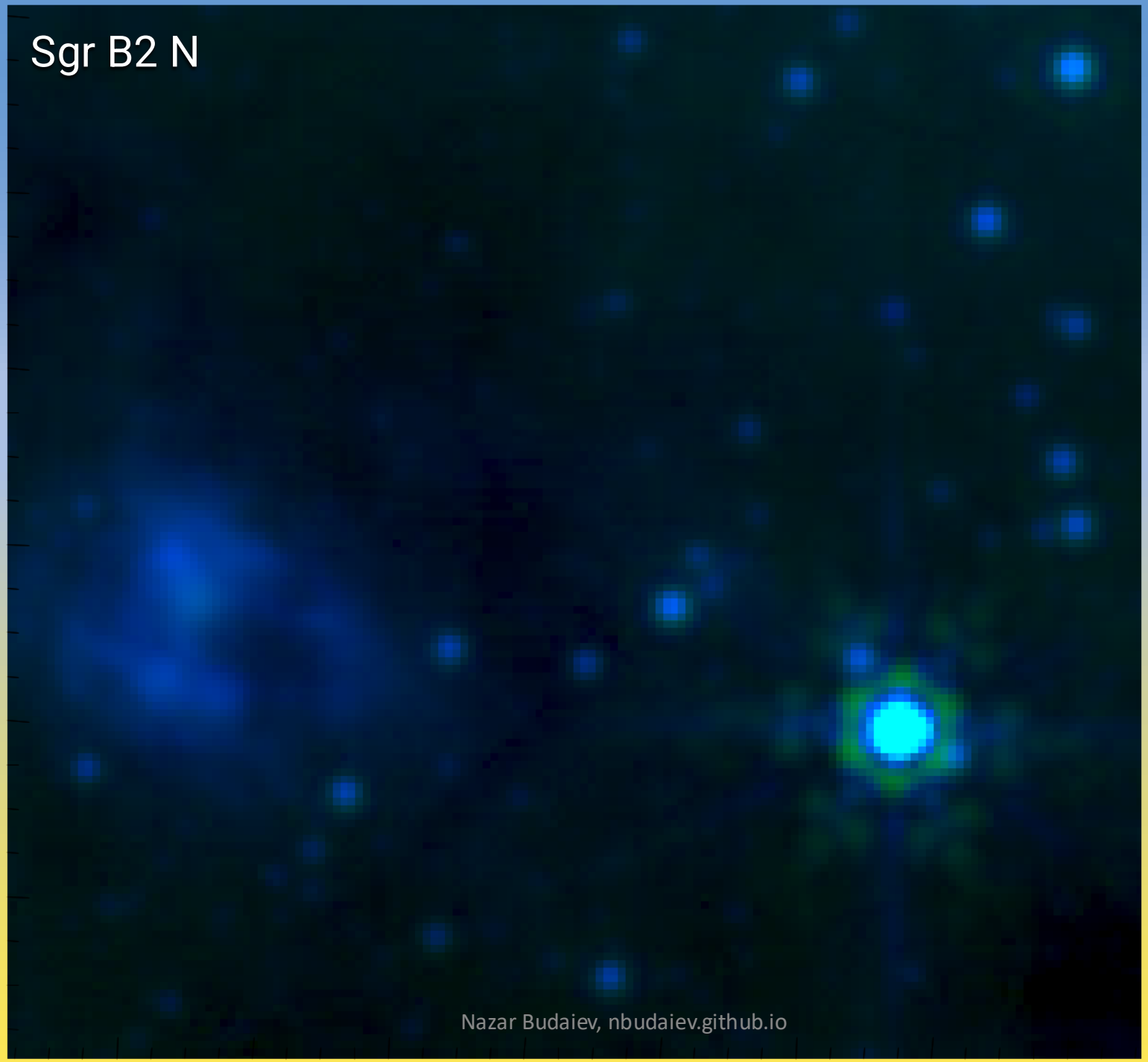
F150W, F182M, F187N, F210M, F212N, F300M, F360M, F405N, F410M, F466N, F480M; F770W, F1280W, F2550W

Paα H_2 H_2O ice Brα CO ice PAH Hot dust

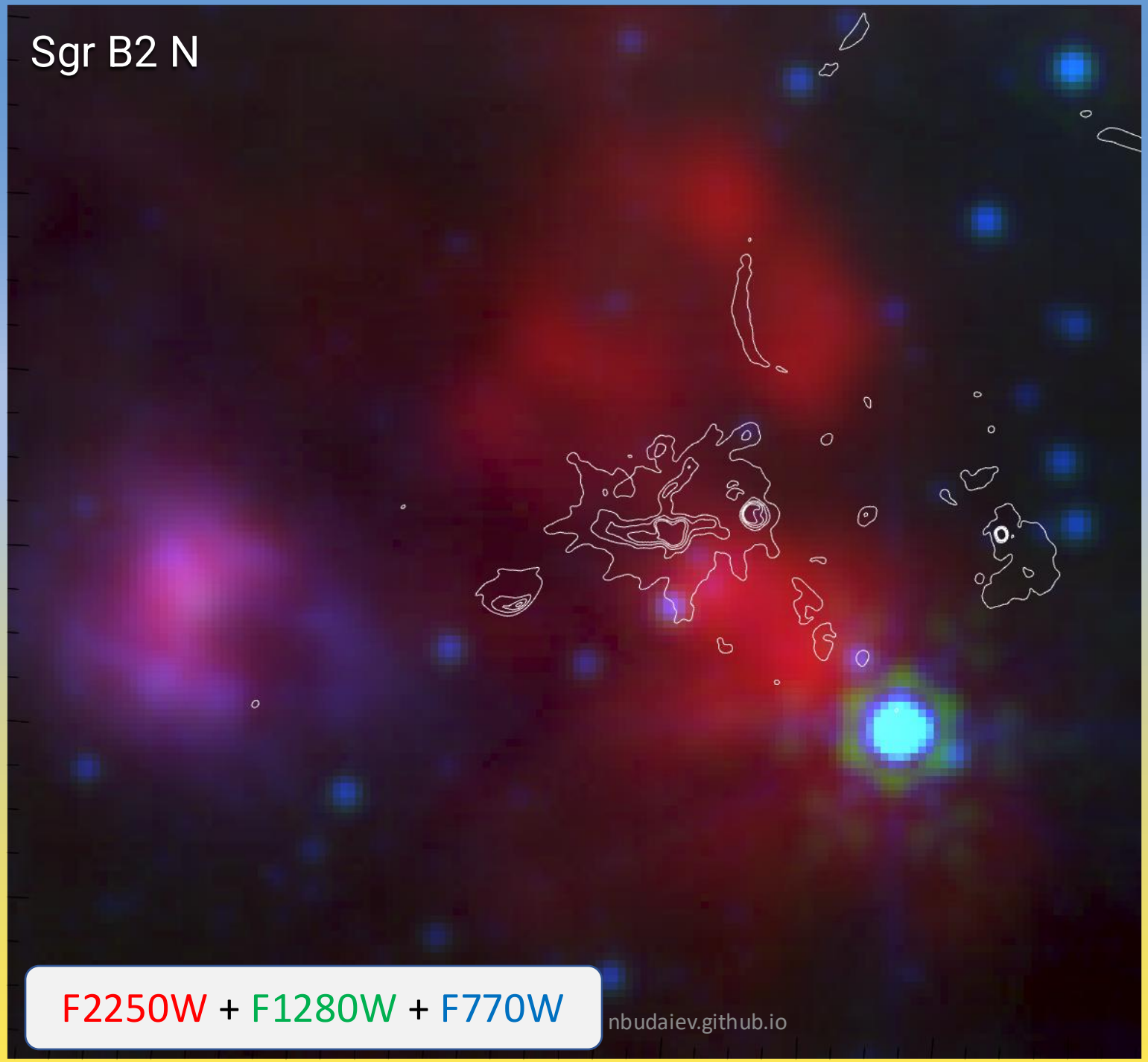


F480M + F360M + F182M


-28°22'16"
17"
18"
19"
20"
21"
Dec (FK5)
17h47m20.0s
19.9s
19.8s
19.7s
RA (FK5)
250
200
150
100
50
40
30
20
10
0
−10
Brightness temperature (K)


Sgr B2 N


Sgr B2 N
F2250W + F1280W + F770W
nbudaiev.github.io


Sgr B2 N
F2250W + F1280W + F770W
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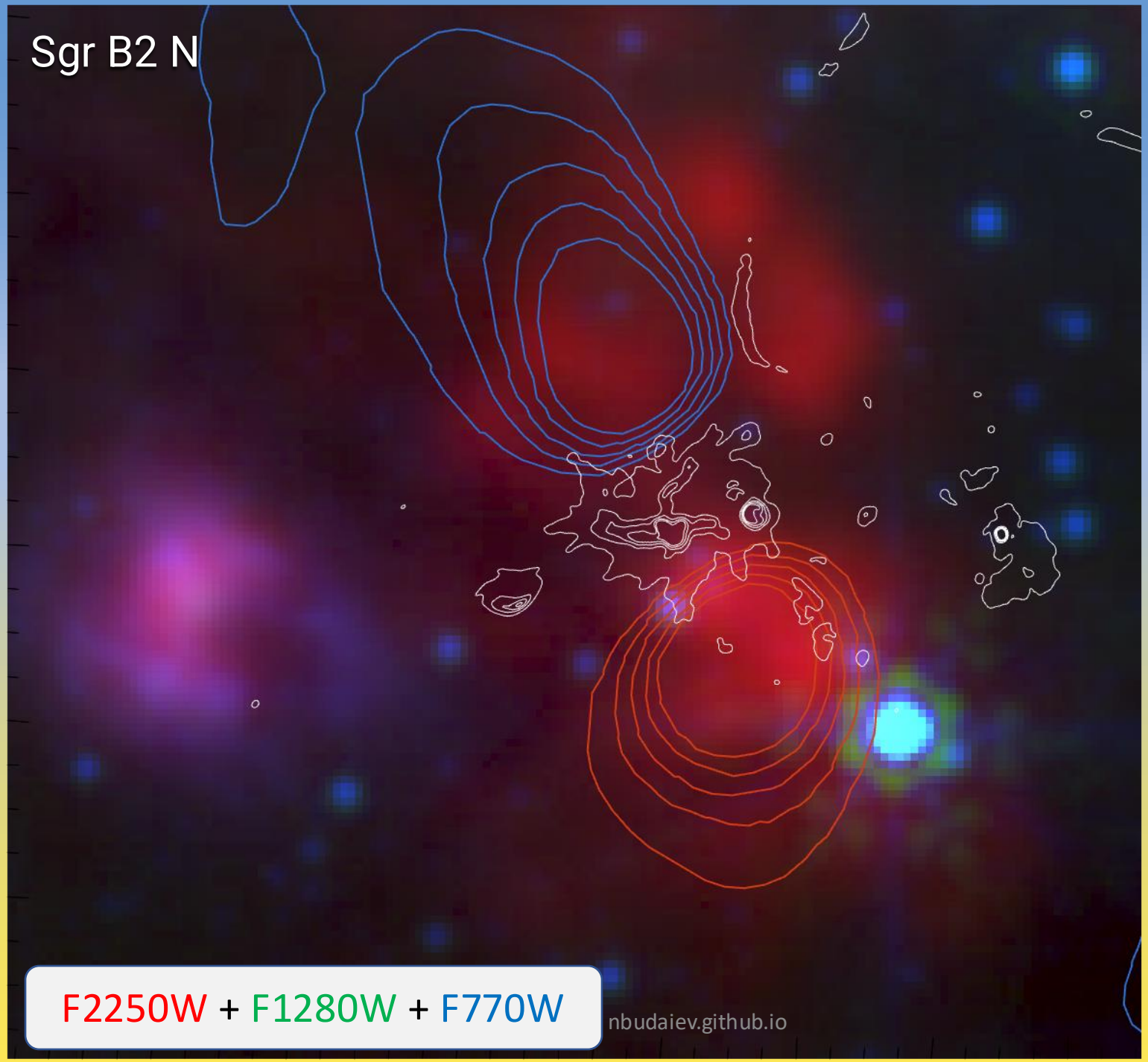
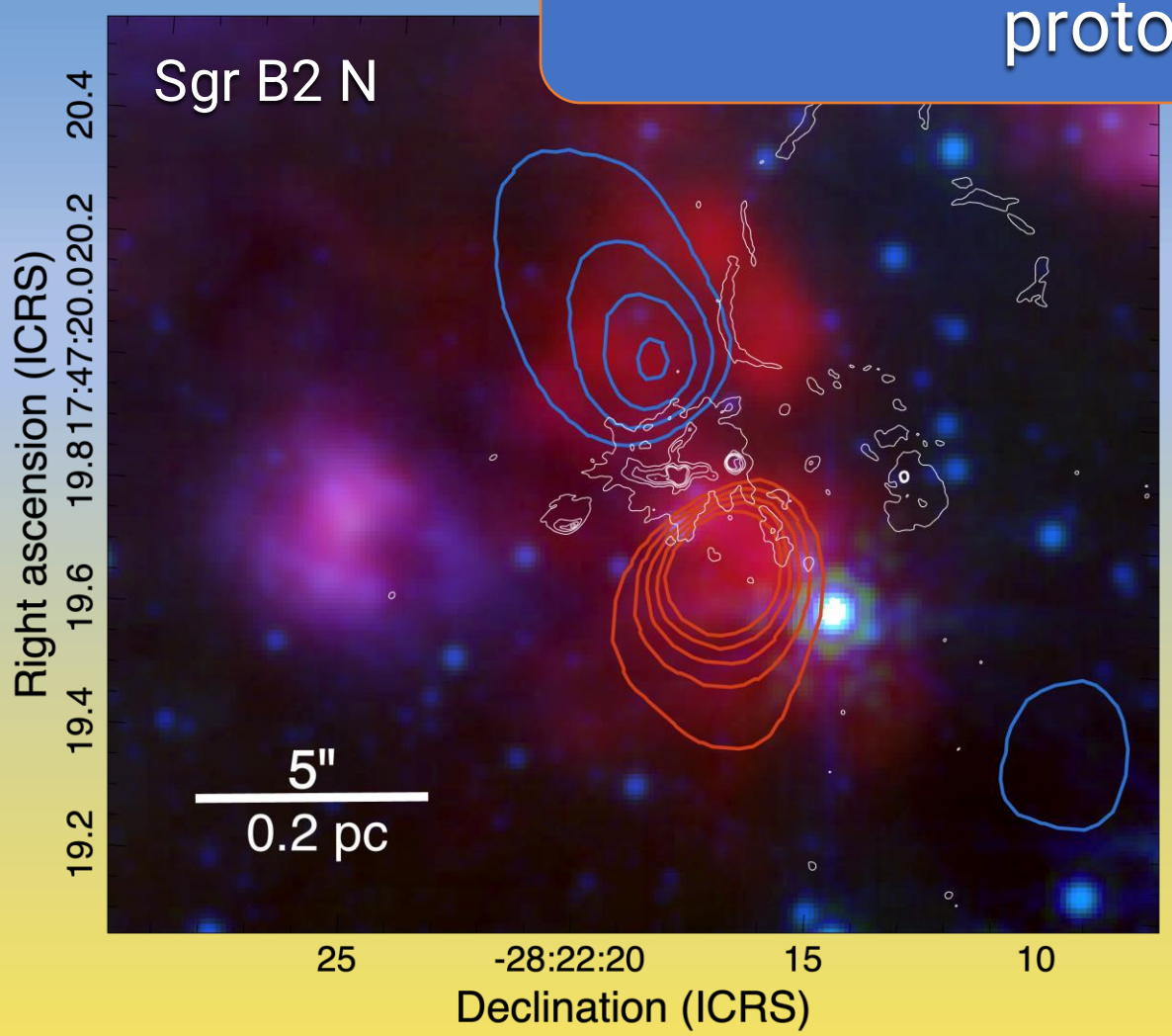
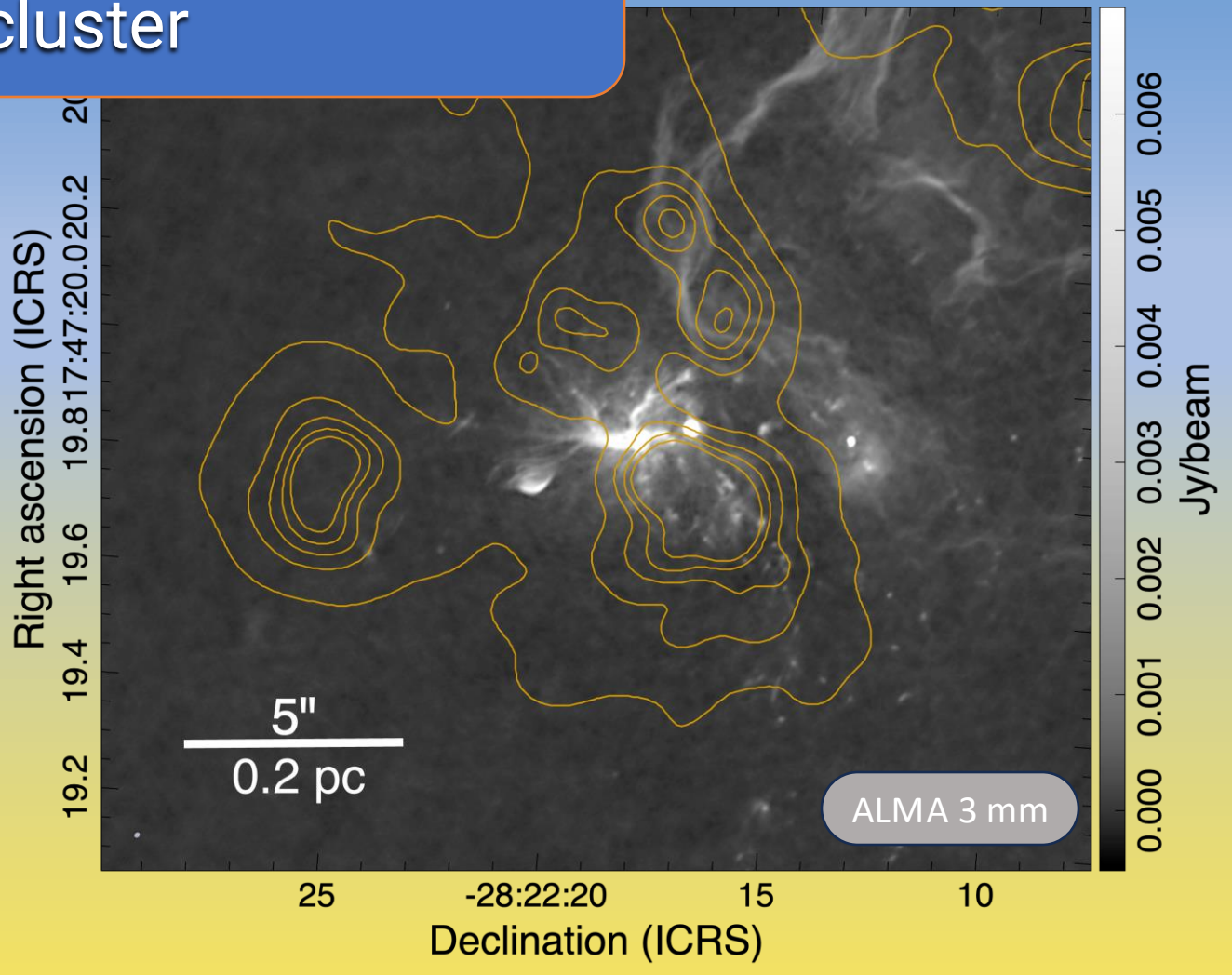

Sgr B2 N
F2250W + F1280W + F770W
nbudaiev.github.io

Radiation escaping dense protocluster





ALMA Thermal Dust Emission
(850μm continuum)

SSC 14

- $M_* = 10^{5.5}\ M_\odot$
- $M_{gas} = 10^{5.7}\ M_\odot$
- r = 0.5 pc

NGC 253

0.028" (0.48 pc) beam

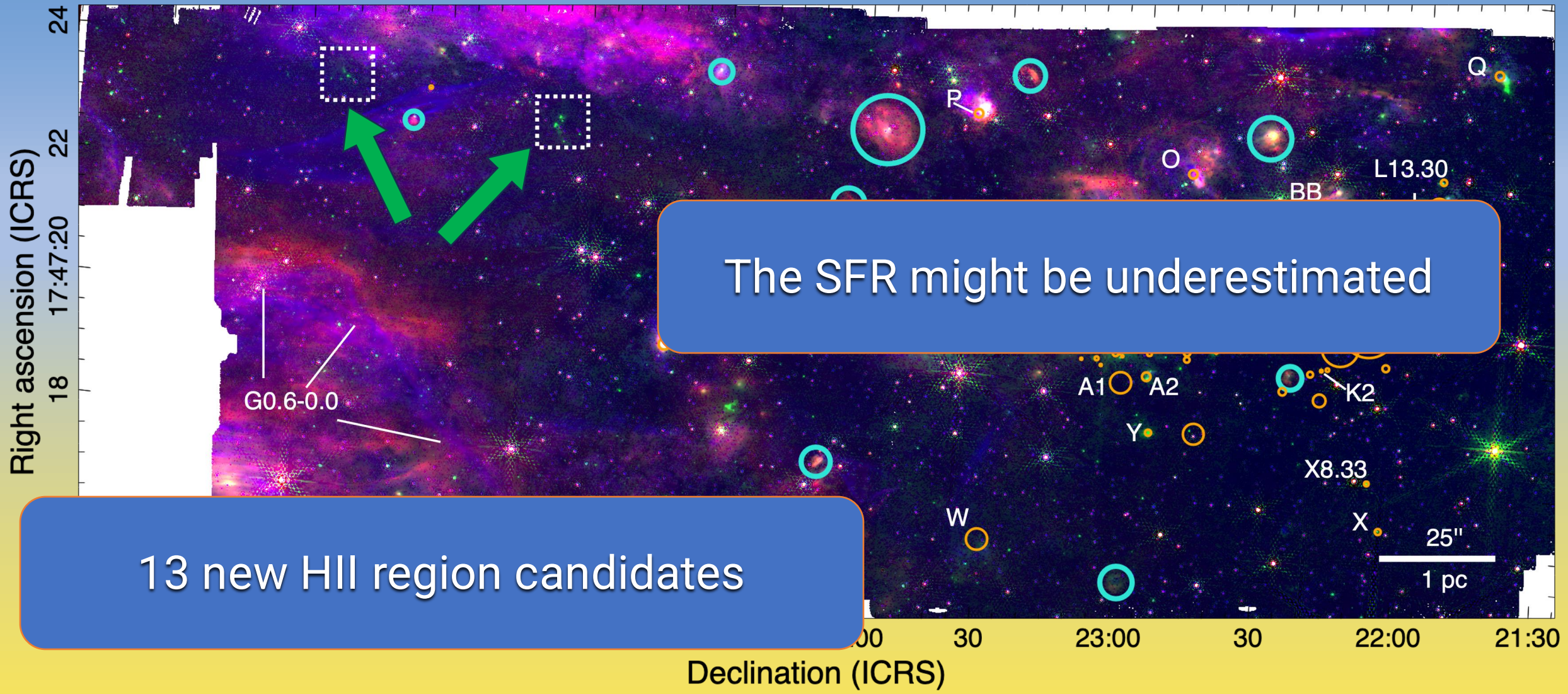
1" ≈ 17 pc

♠ACES: The ALMA CMZ Exploration Survey

Levy et al. (2021, 2022)
Building on Turner & Ho (1985), Ulvestad & Antonucci (1997), Paglione et al. (2004), Sakomoto et al. (2006, 2011), Bendo et al. (2015), Ando et al. (2017), Leroy et al. (2018), Rico-Villas et al. (2020), Krieger et al. (2020), Mills et al. (2021)

F770W + F480M-(F410M-F405N) + F410M - F405N

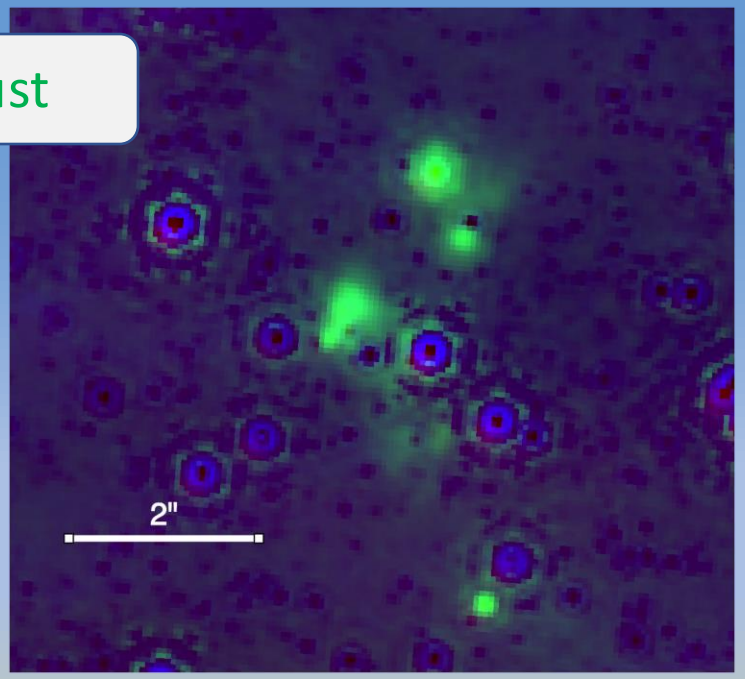
PAH + warm dust + Brα

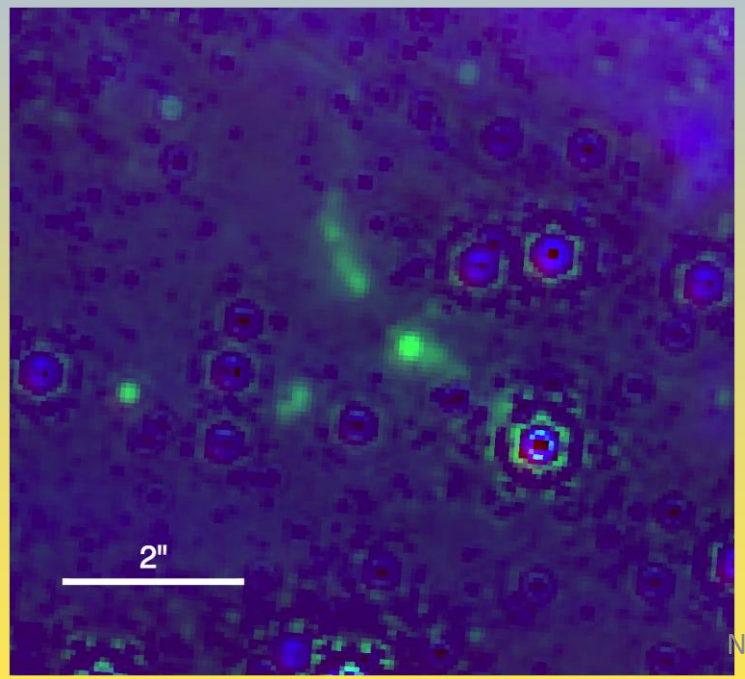


The SFR might be underestimated

13 new HII region candidates

warm dust

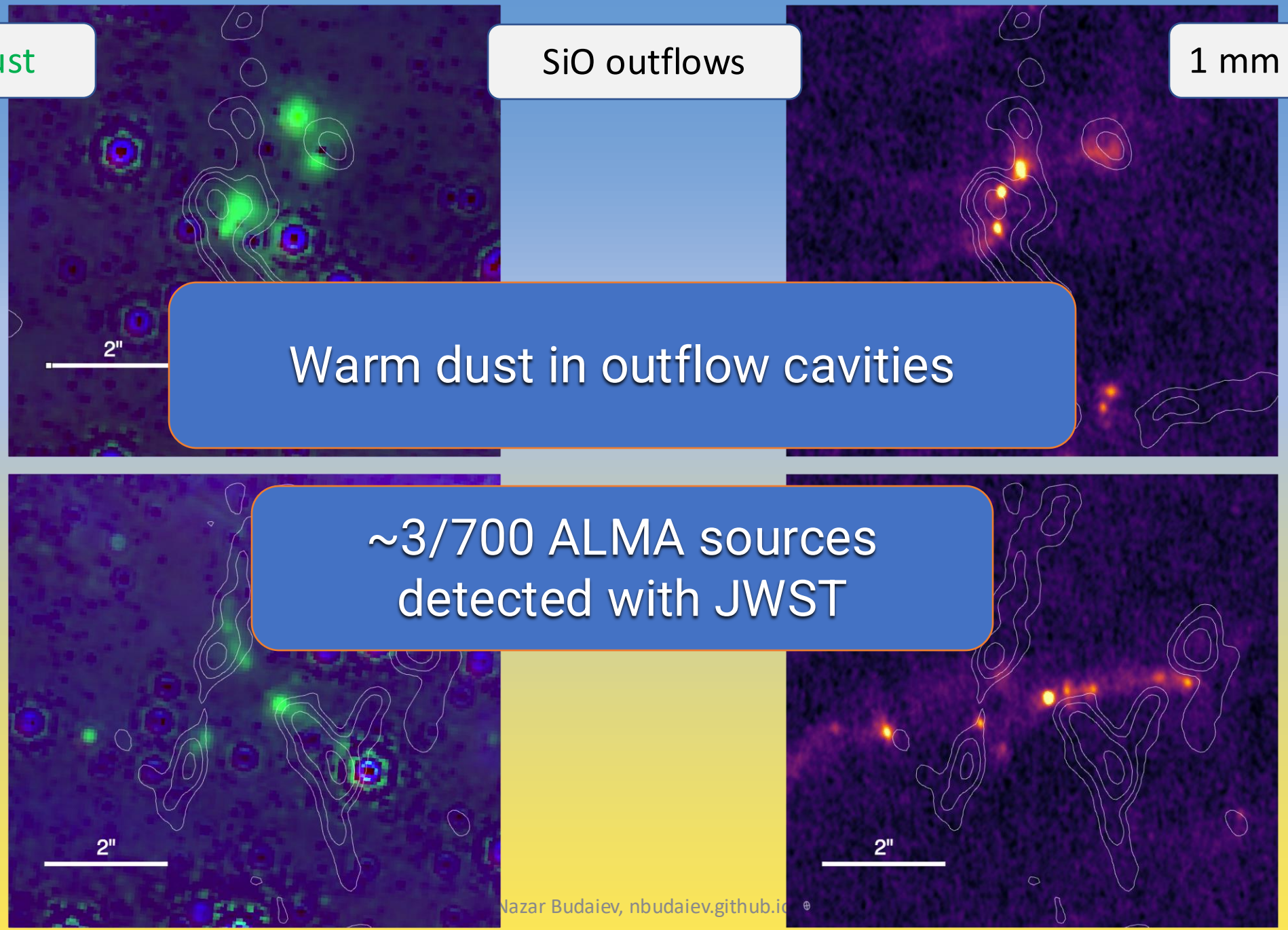




warm dust

SiO outflows

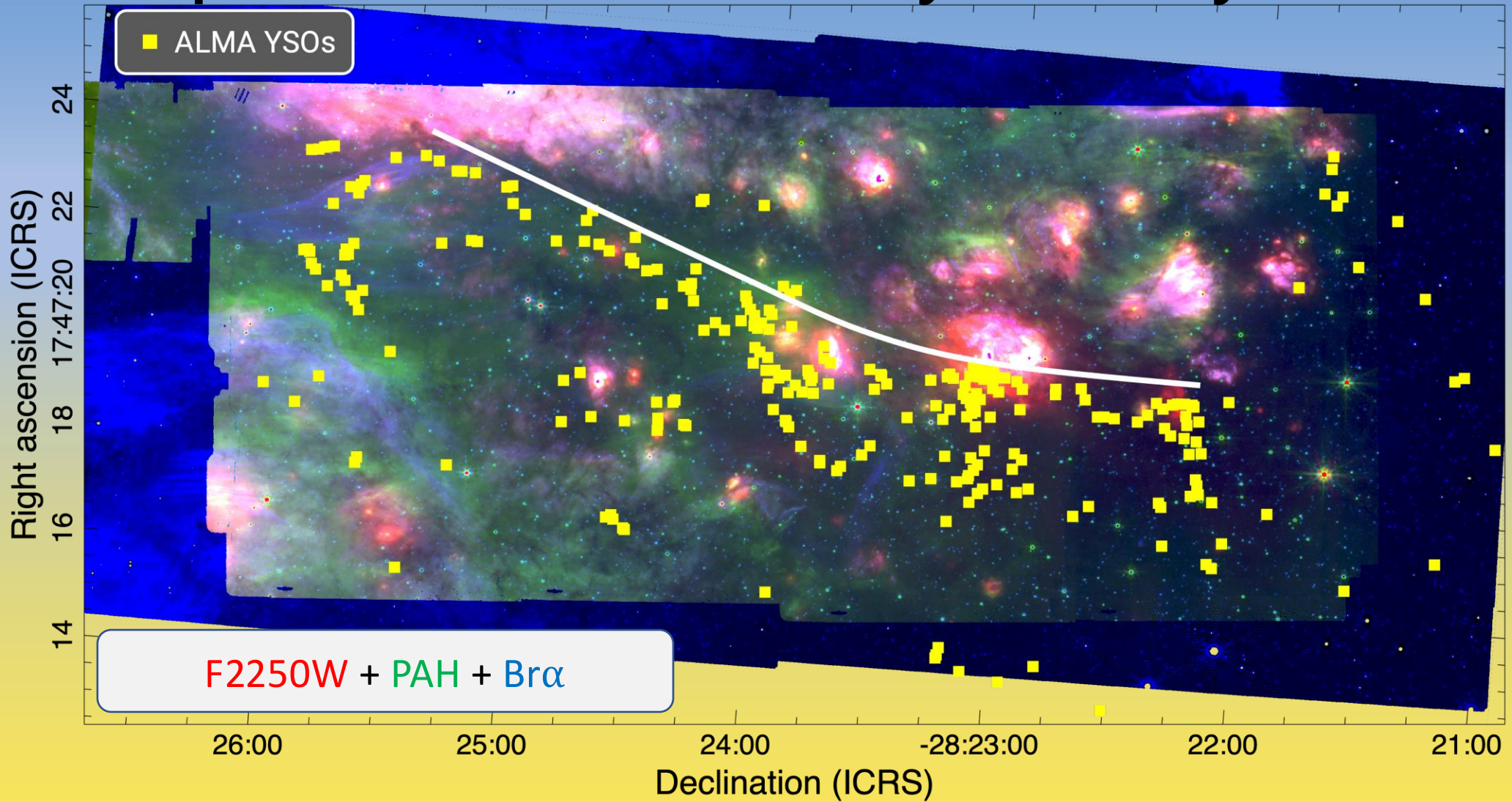
1 mm continuum



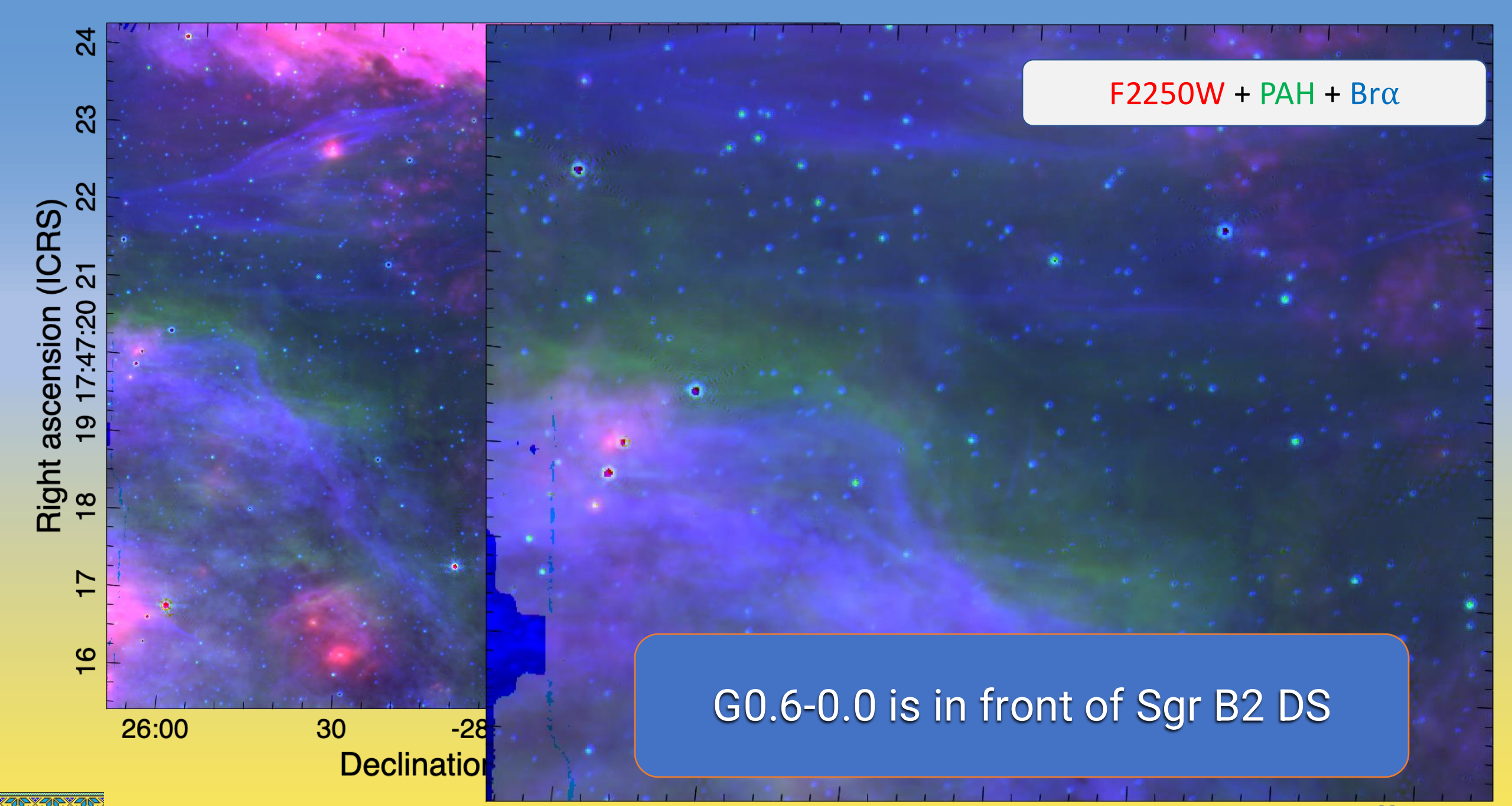
Warm dust in outflow cavities

~3/700 ALMA sources detected with JWST

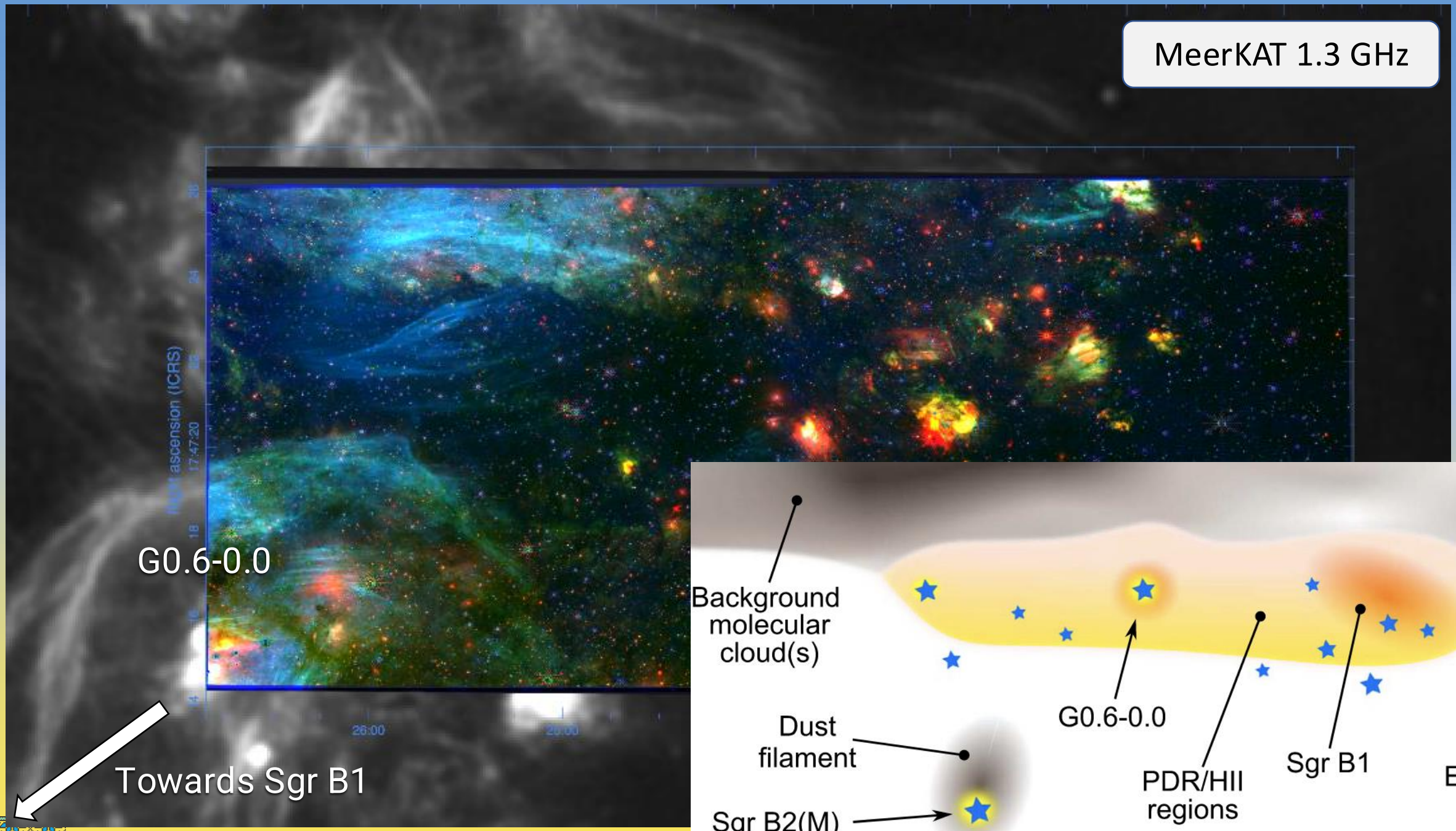
Sharp star formation asymmetry



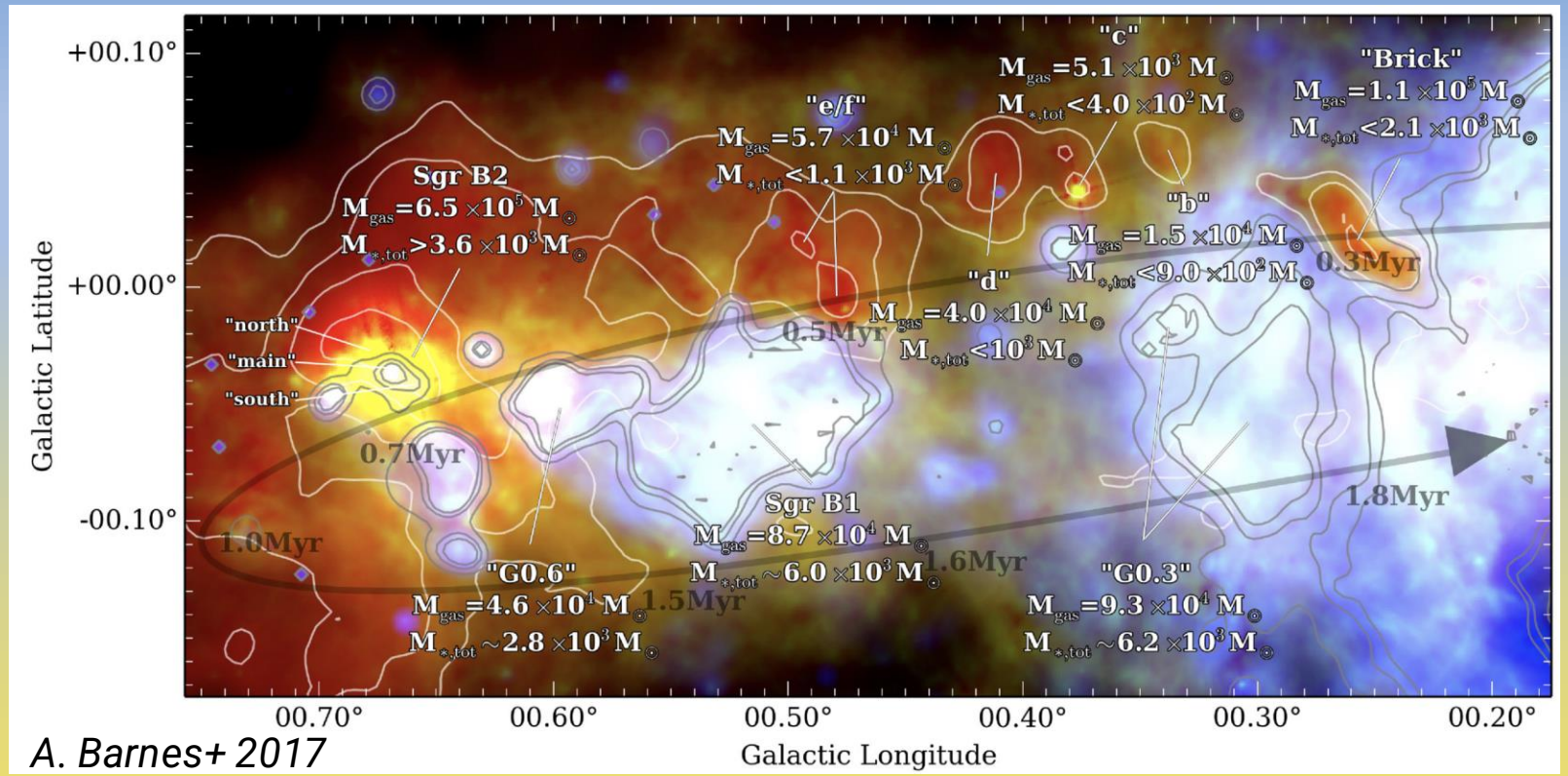
Very sharp cloud edge


F2250W + PAH + Brα
G0.6-0.0 is in front of Sgr B2 DS
Right ascension (ICRS)
24
23
22
21
19 17:47:20
18
17
16
26:00
30
-28
Declinatio

MeerKAT 1.3 GHz

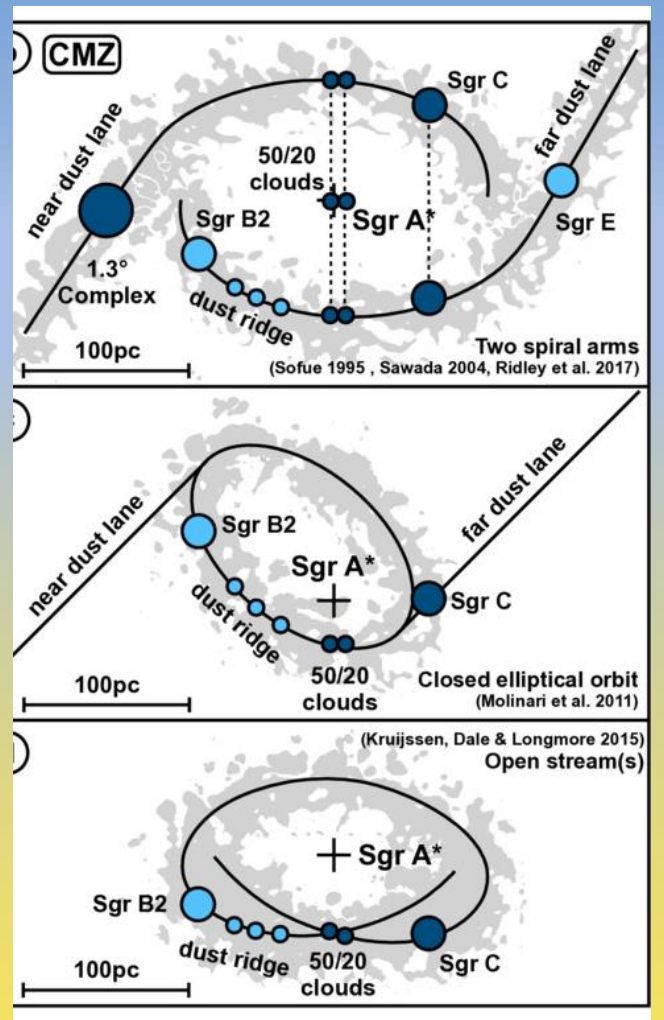


What does it say about the orbit?

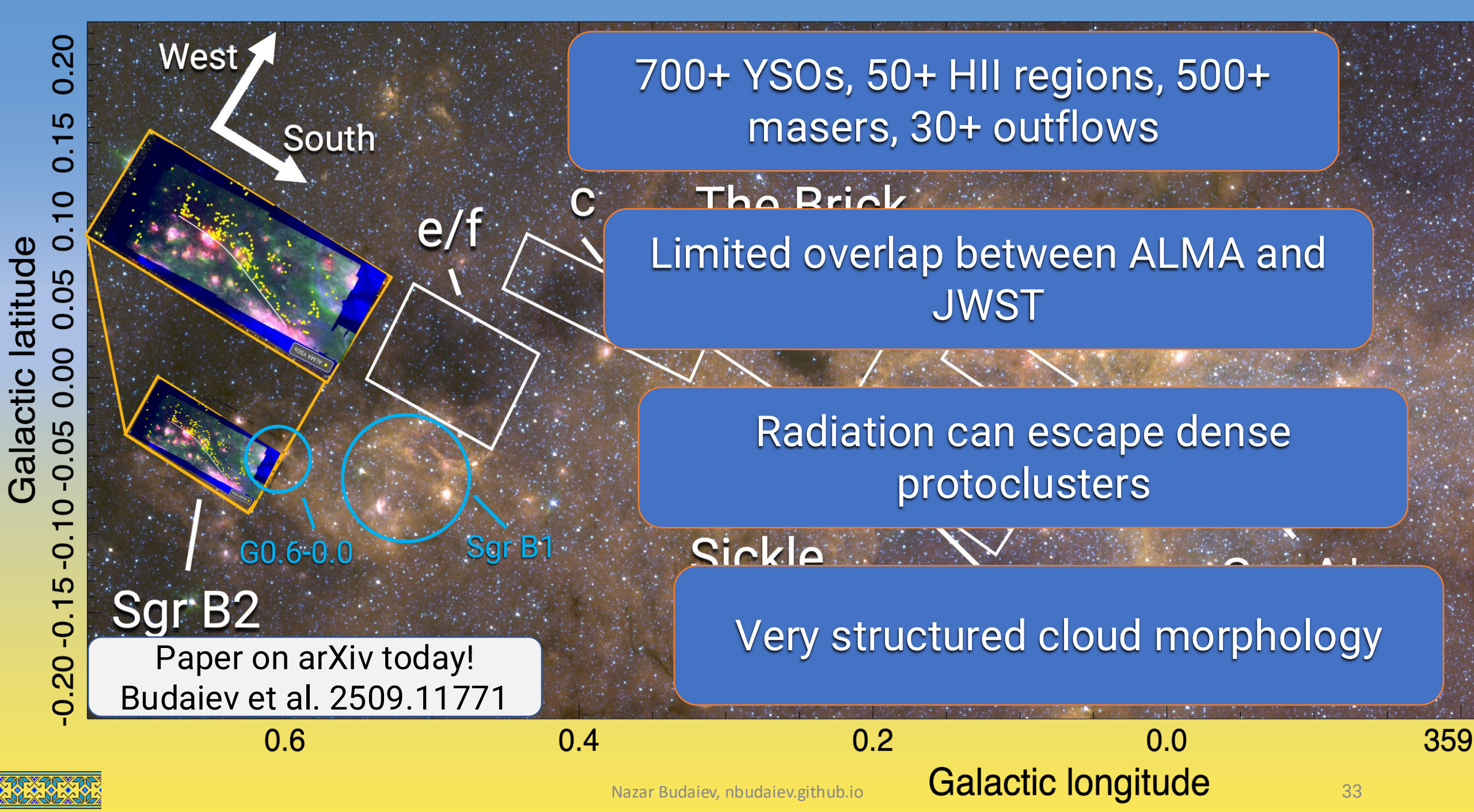


A. Barnes+ 2017

See poster by Dani Lipman



J. Henshaw+ 2023


West
South
e/f
c
The Brick
Sgr B2
G0.6-0.0
Sgr B1
Sickle
700+ YSOs, 50+ HII regions, 500+ masers, 30+ outflows
Limited overlap between ALMA and JWST
Radiation can escape dense protoclusters
Very structured cloud morphology
Paper on arXiv today!
Budaiev et al. 2509.11771
Galactic latitude
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
0.6
0.4
0.2
0.0
359
Galactic longitude