Dancing Clusters:

Quantitatively Tracing Spatial Evolution and the Morphological Features of YMCs

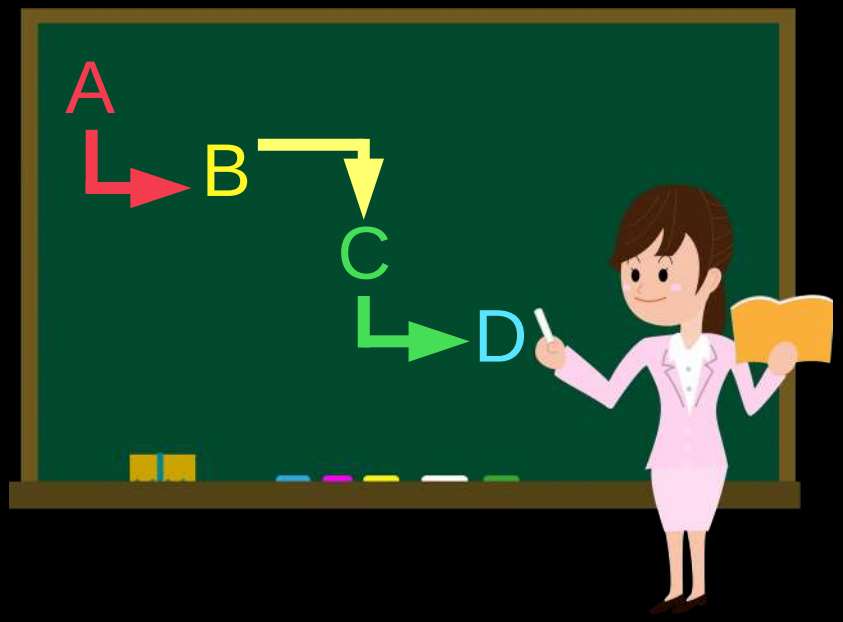
Anne Buckner (University of Leeds)
& the SFM Collaboration

SFM STARFORMMAPPER

UNIVERSITY OF LEEDS

Talk Outline

- Stellar Association
- INDICATE
- NGC 3372
- Westerlund 1



Stellar “Association”

- Point processes
  - intensity
  - correlation
  - spatial distribution

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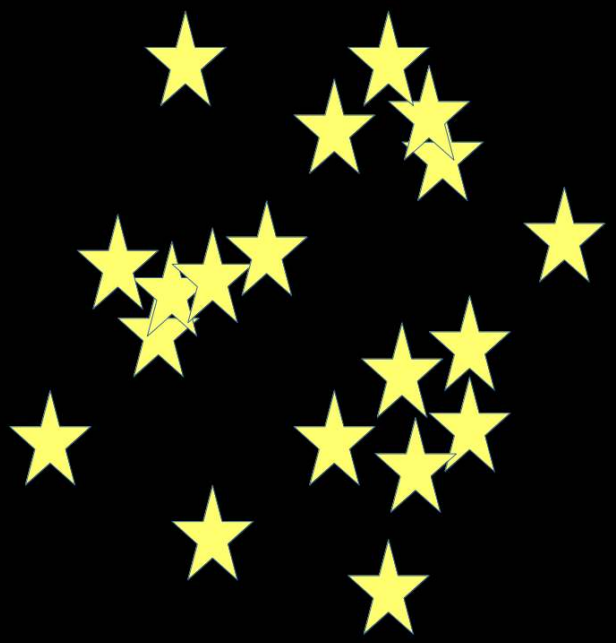
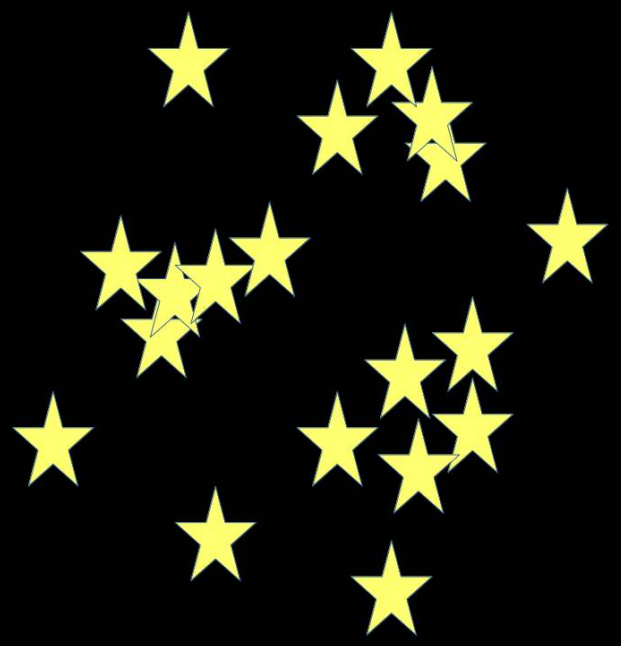
Q. How “clustered” are stars?

Stellar “Association”



Stellar “Association”

- Global measures



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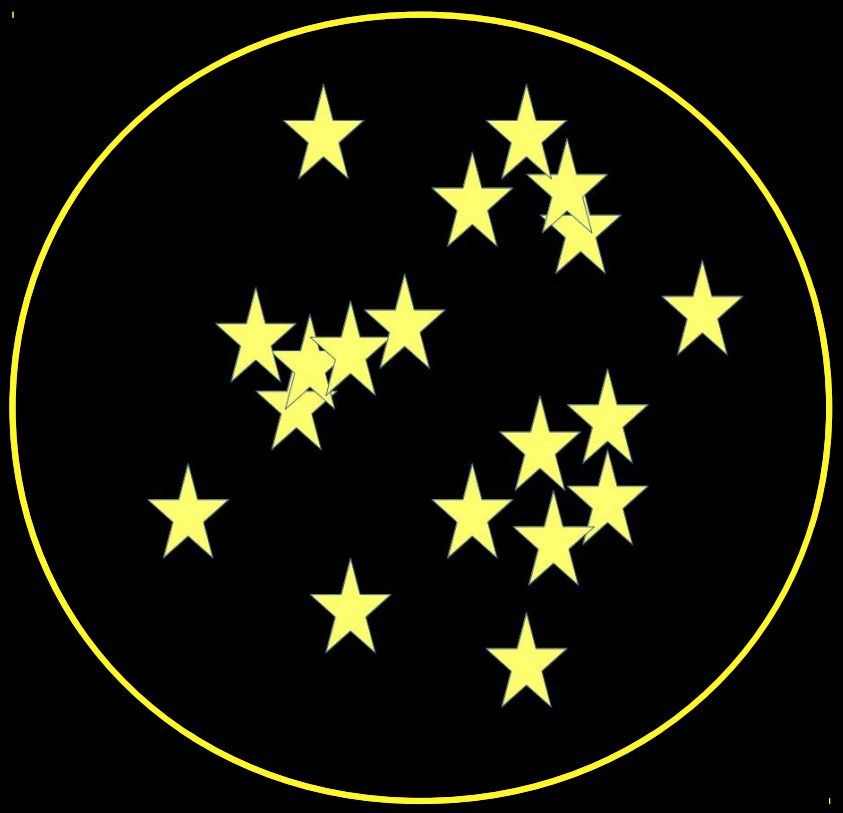
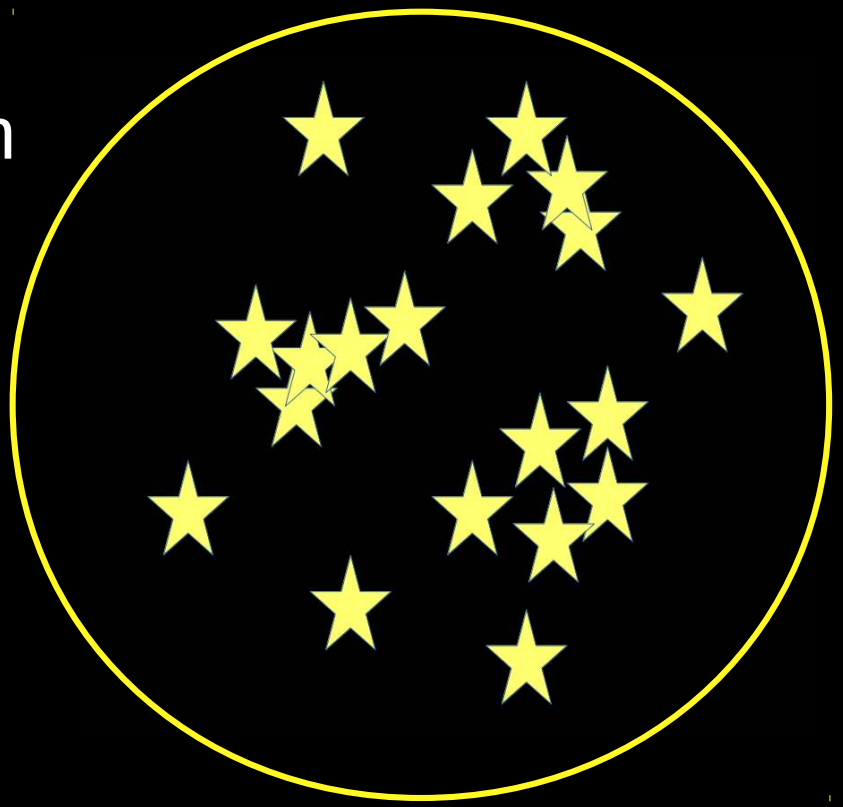


= X

Stellar “Association”

- Global measures
  - 2-point correlation function
  - Hopkins Statistic



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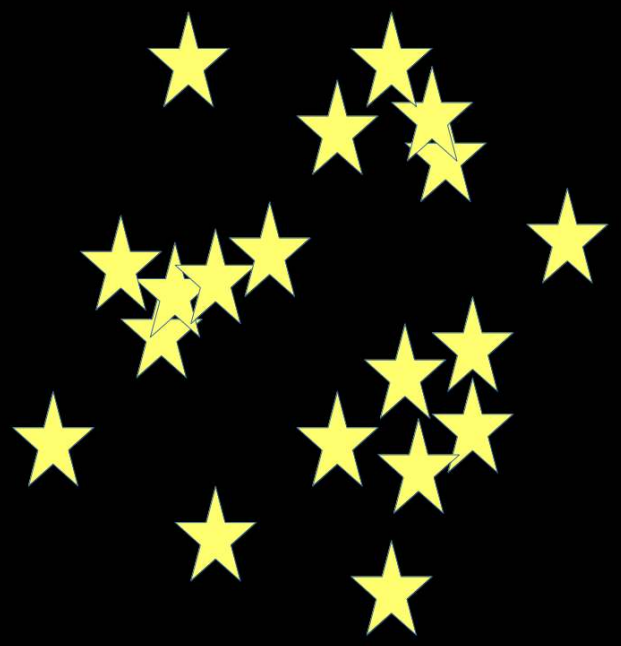

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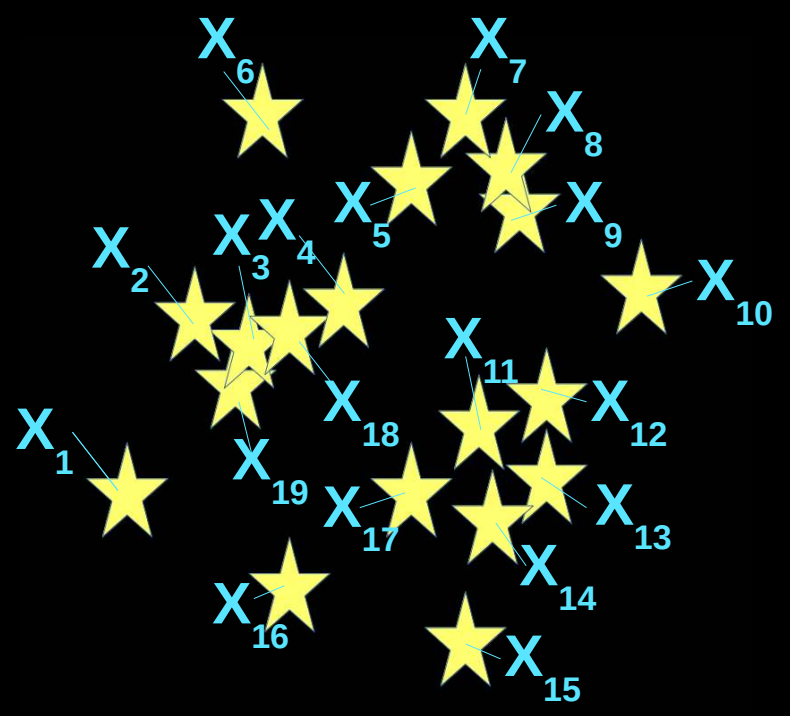

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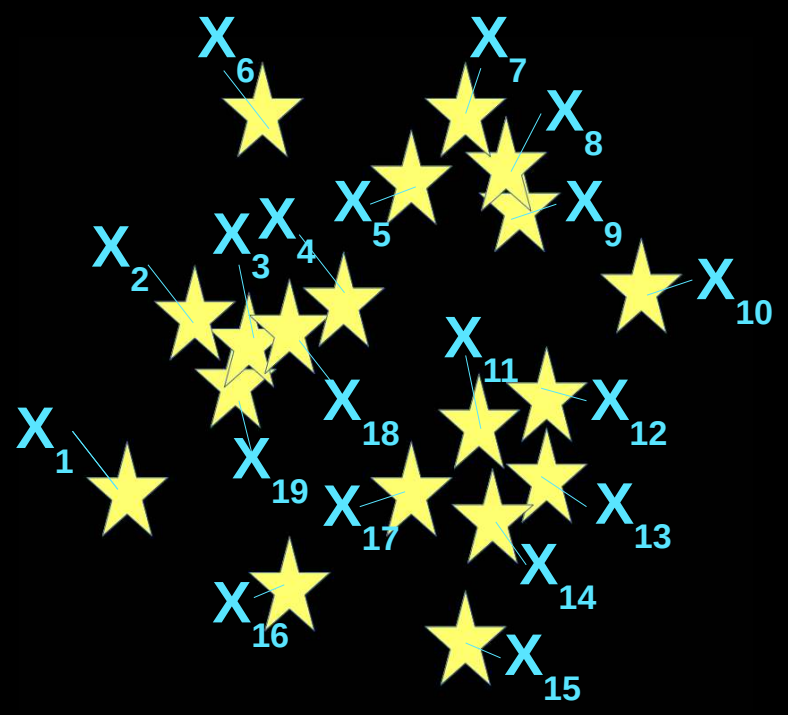

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- Any parameter space
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- Local measure of degree of stellar association
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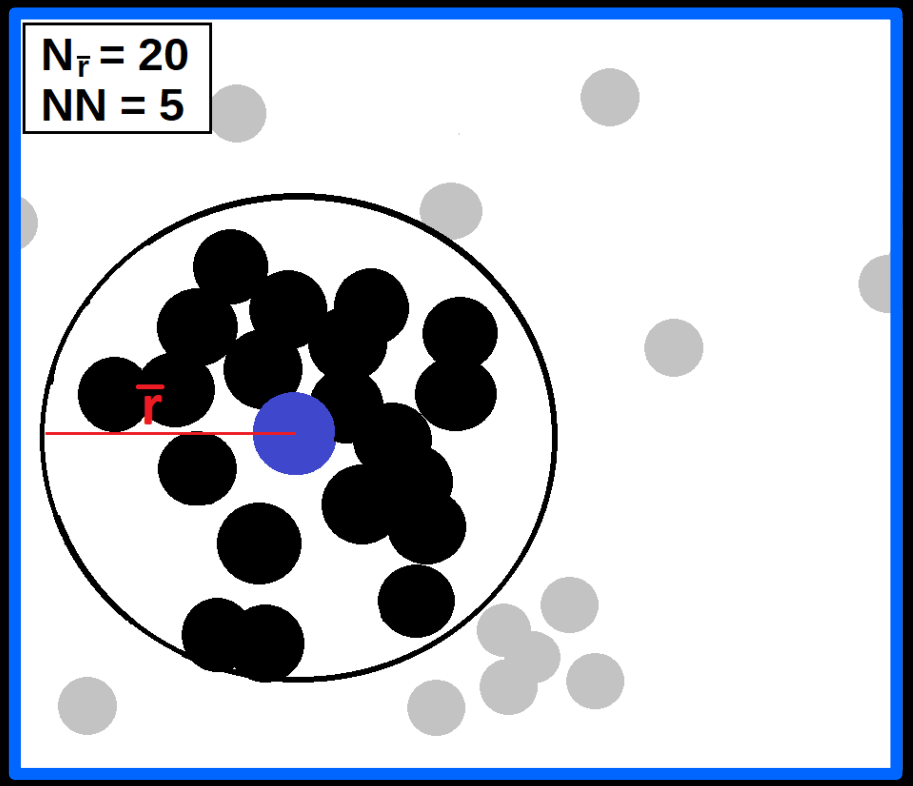
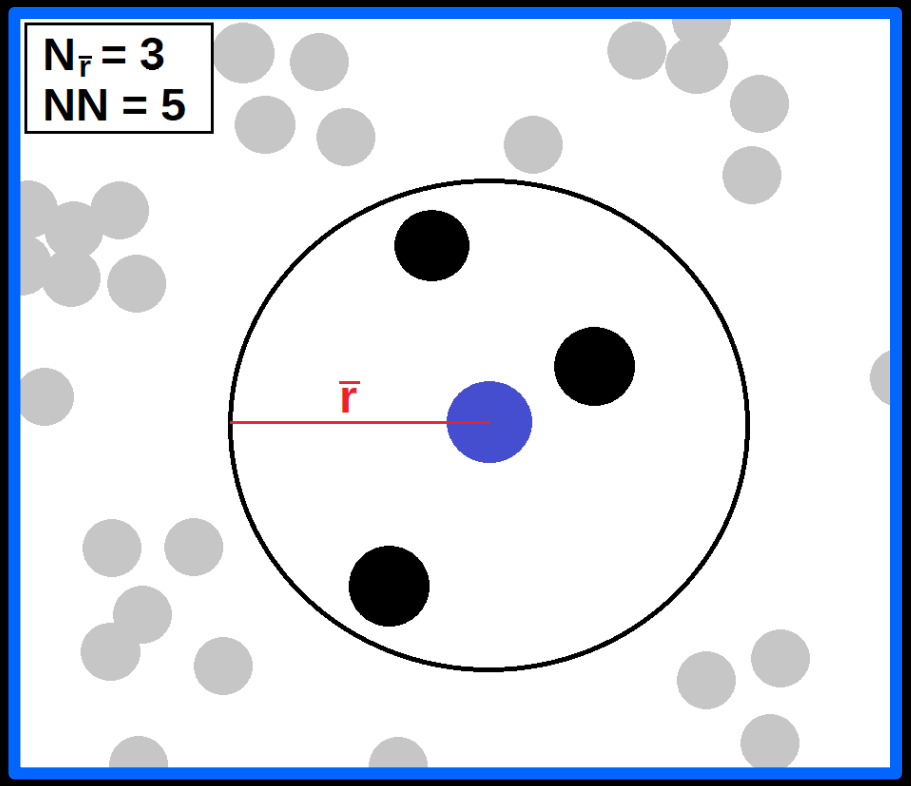
- Assigns a clustering index to each star
- Comparison of number of nearest neighbours with an evenly spaced control field
- Meaningful index values → calibrated against random distributions

INDICATE



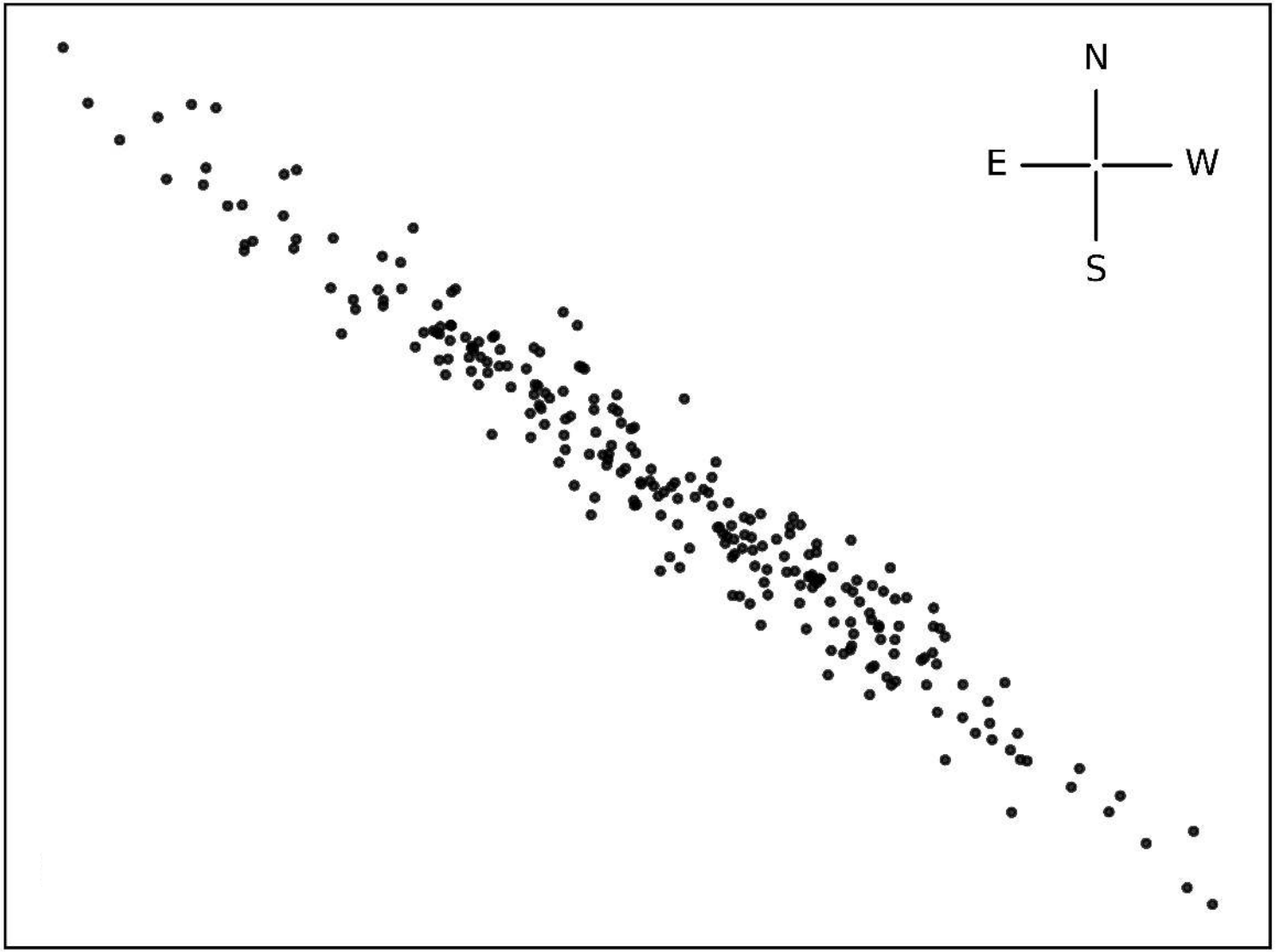
I = 20/5 = 4



I = 3/5 = 0.6

INDICATE

Example



Buckner et al. 2018 (in review)

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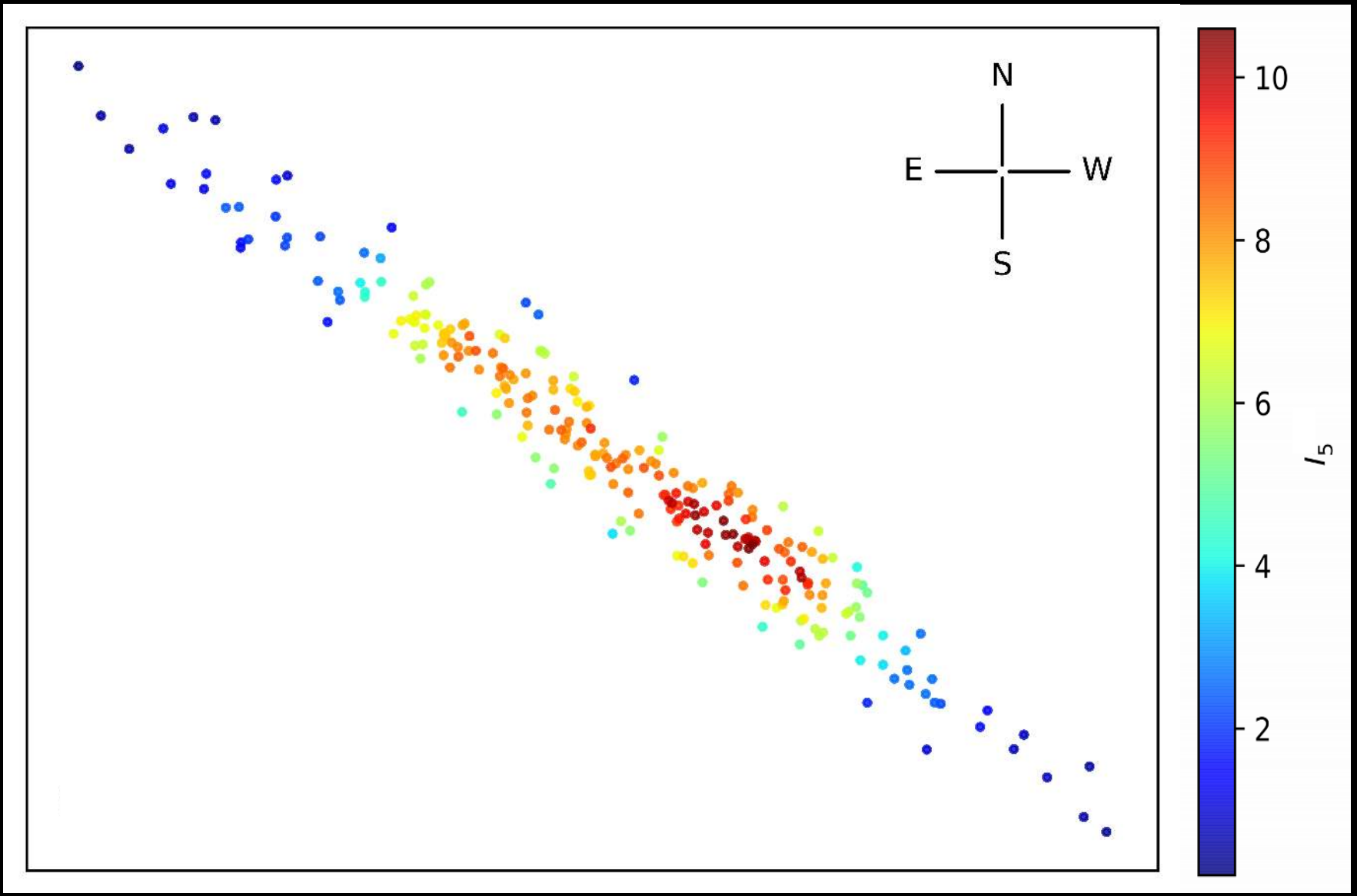
Example



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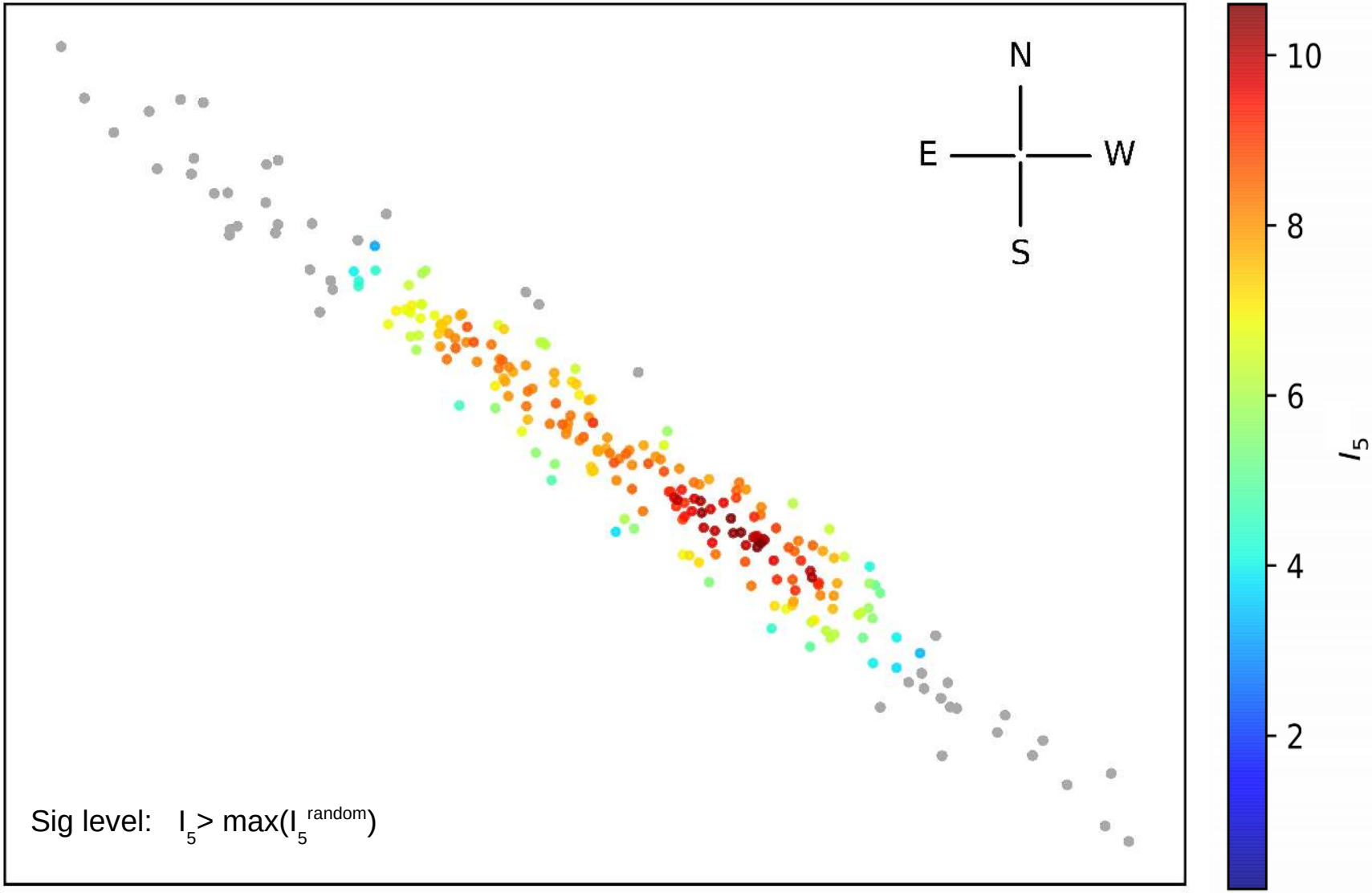

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Lets apply to some star forming regions

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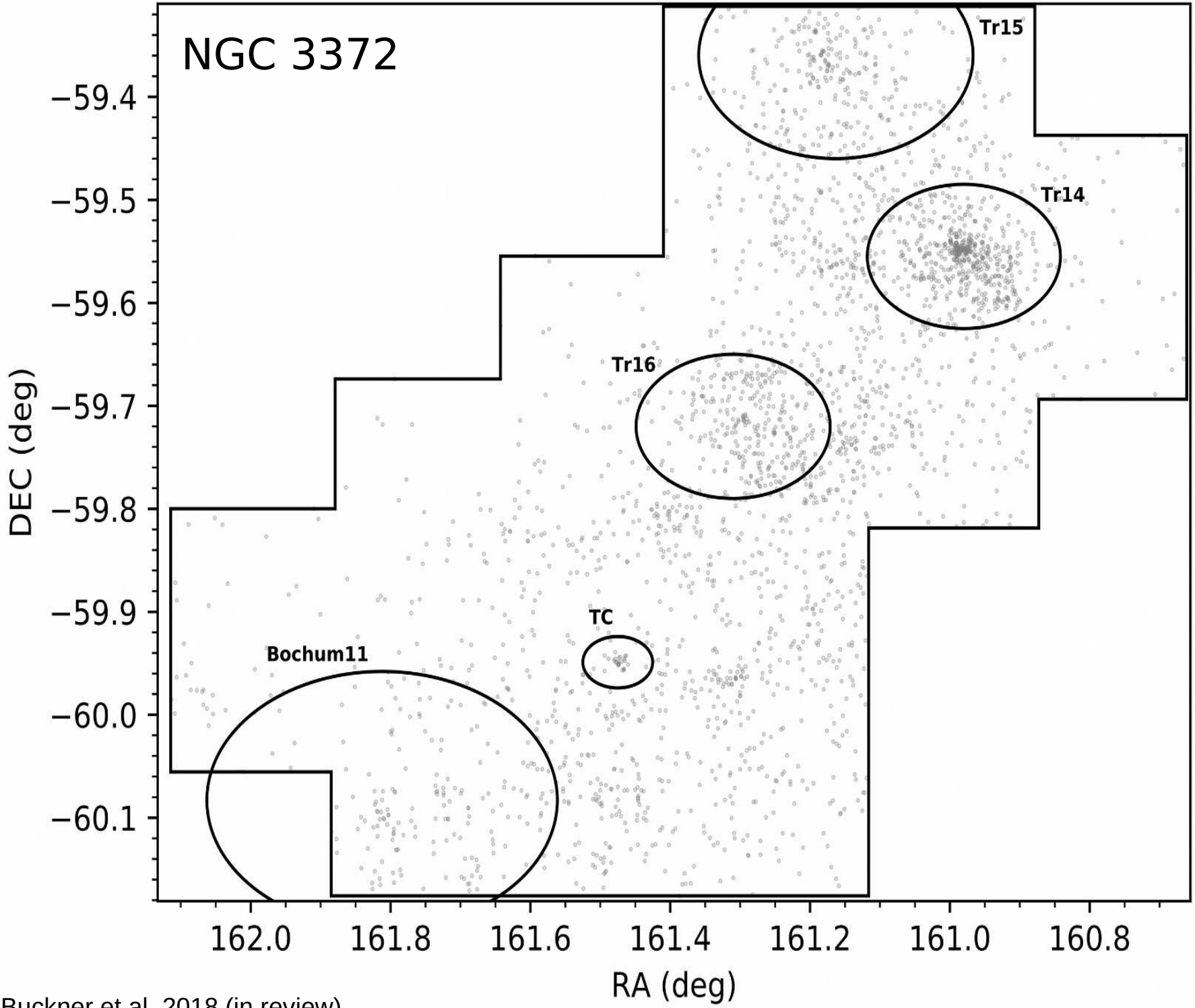

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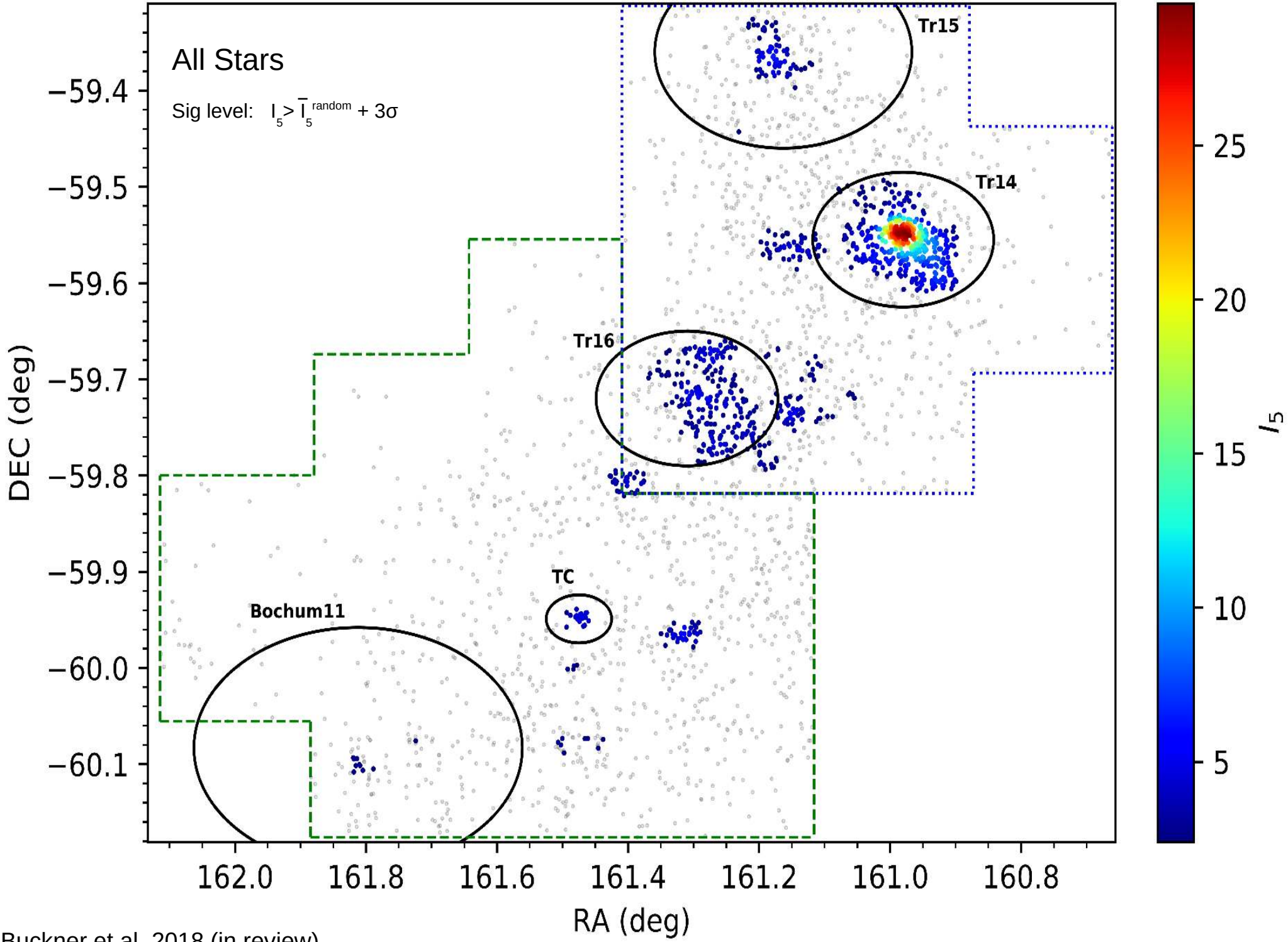


Buckner et al. 2018 (in review)

Westerlund 1

Age ~ 5 Myr
A_v ~ 10-12 mag
D ~ 4 kpc
~2 pc across
M ~ 10^5 $M_\odot$

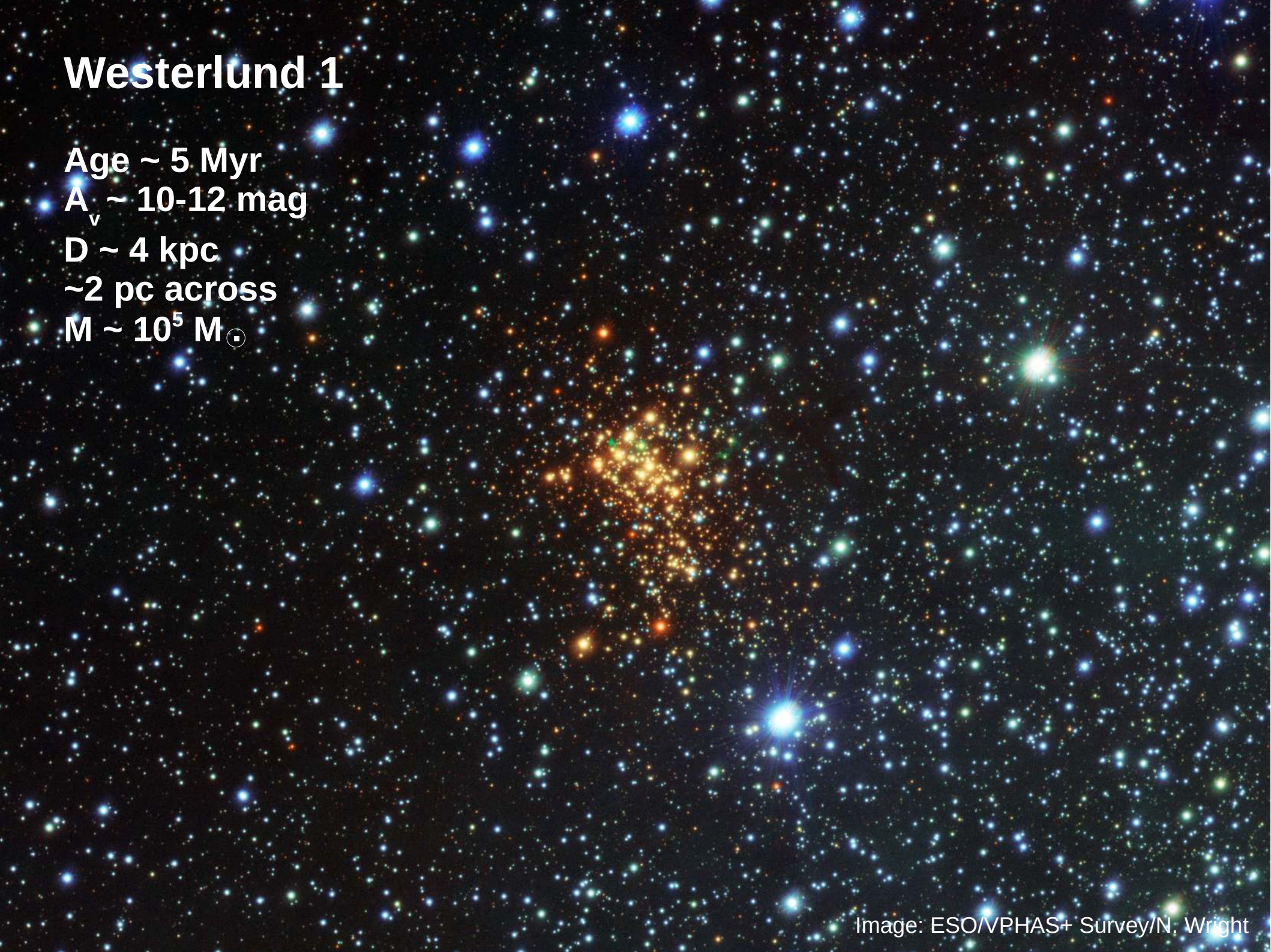
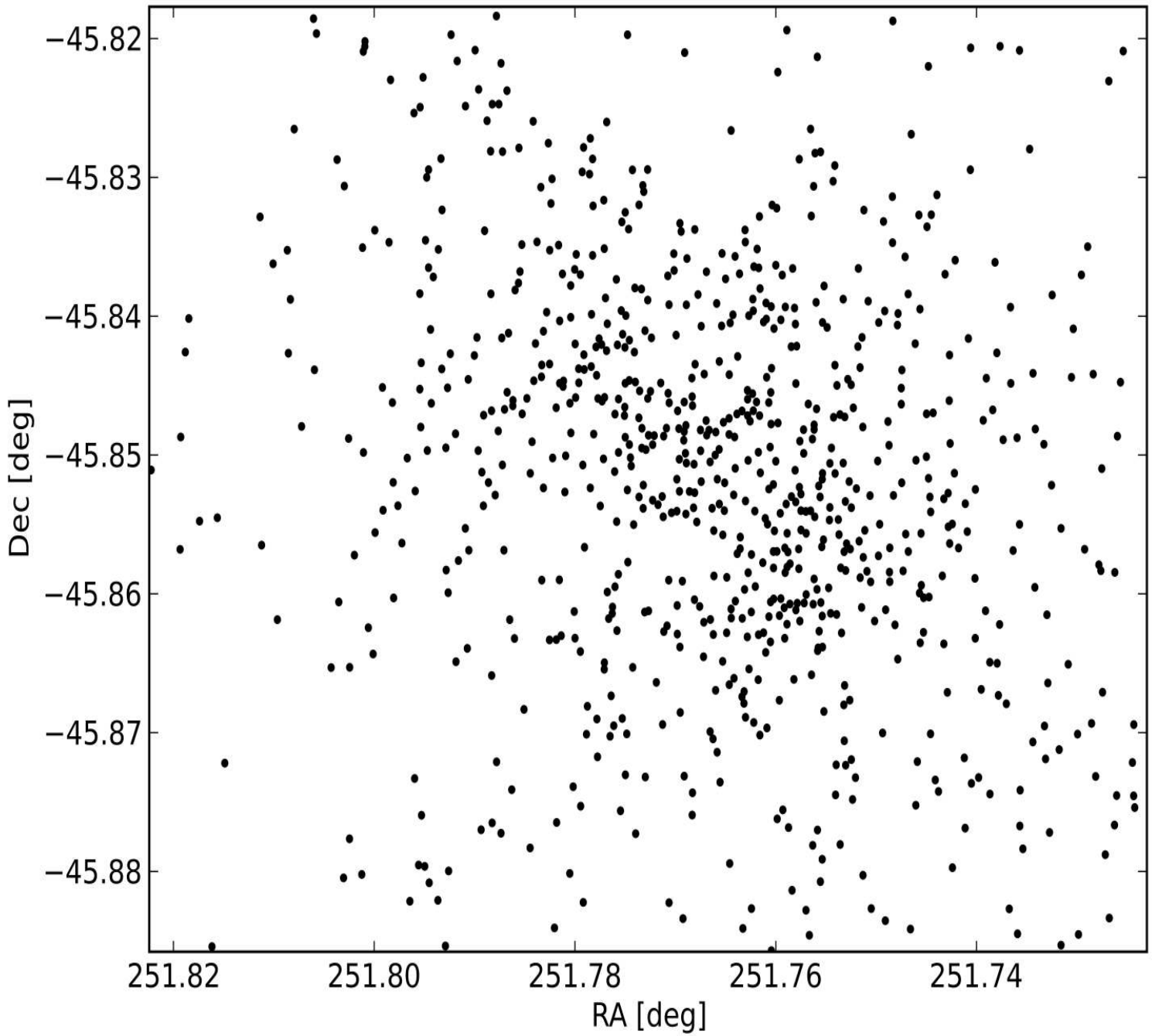


Image: ESO/VPHAS+ Survey/N. Wright

NIR $M_* > 5 M_\odot$

Gennaro et al. (2017)



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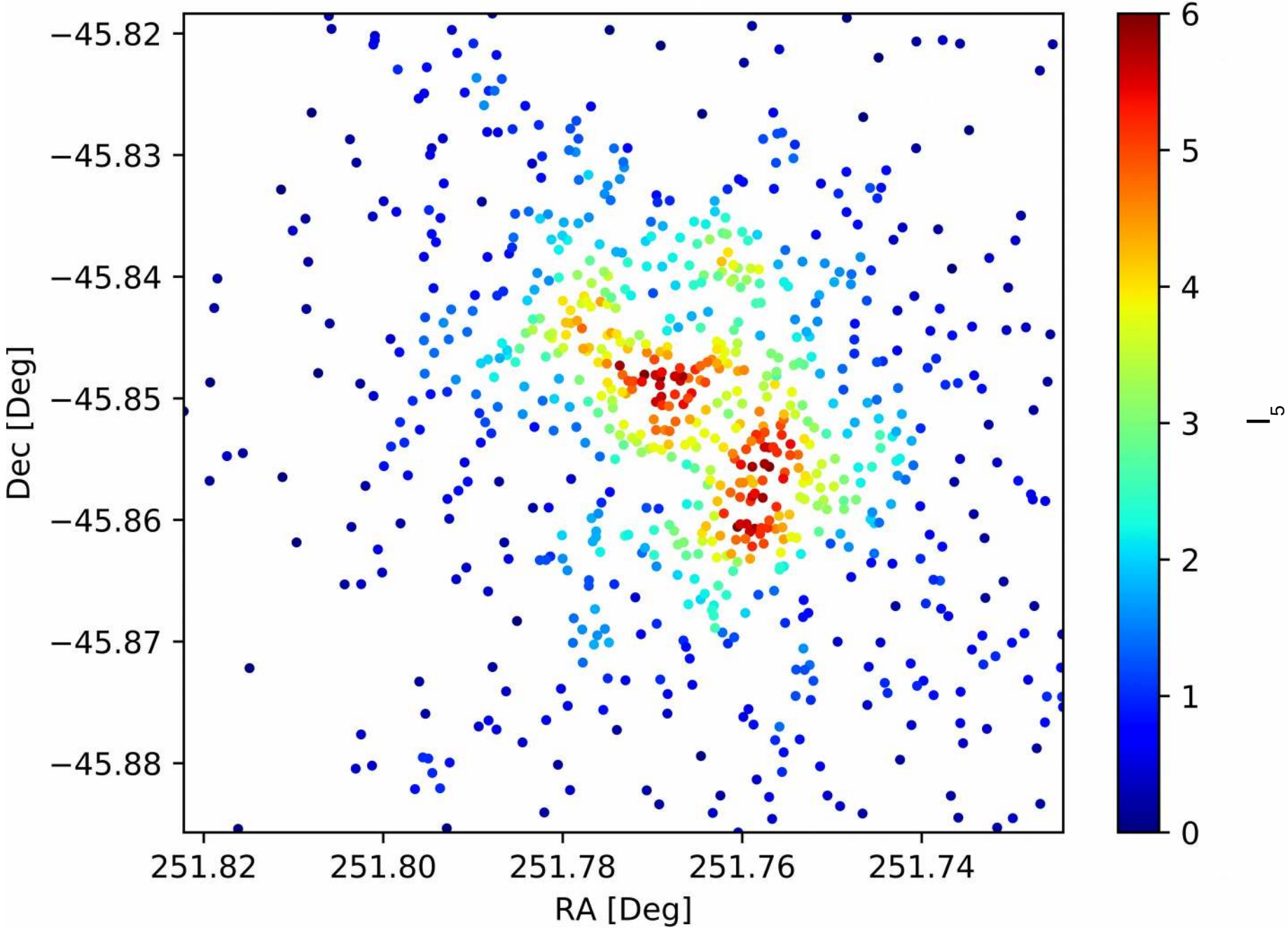
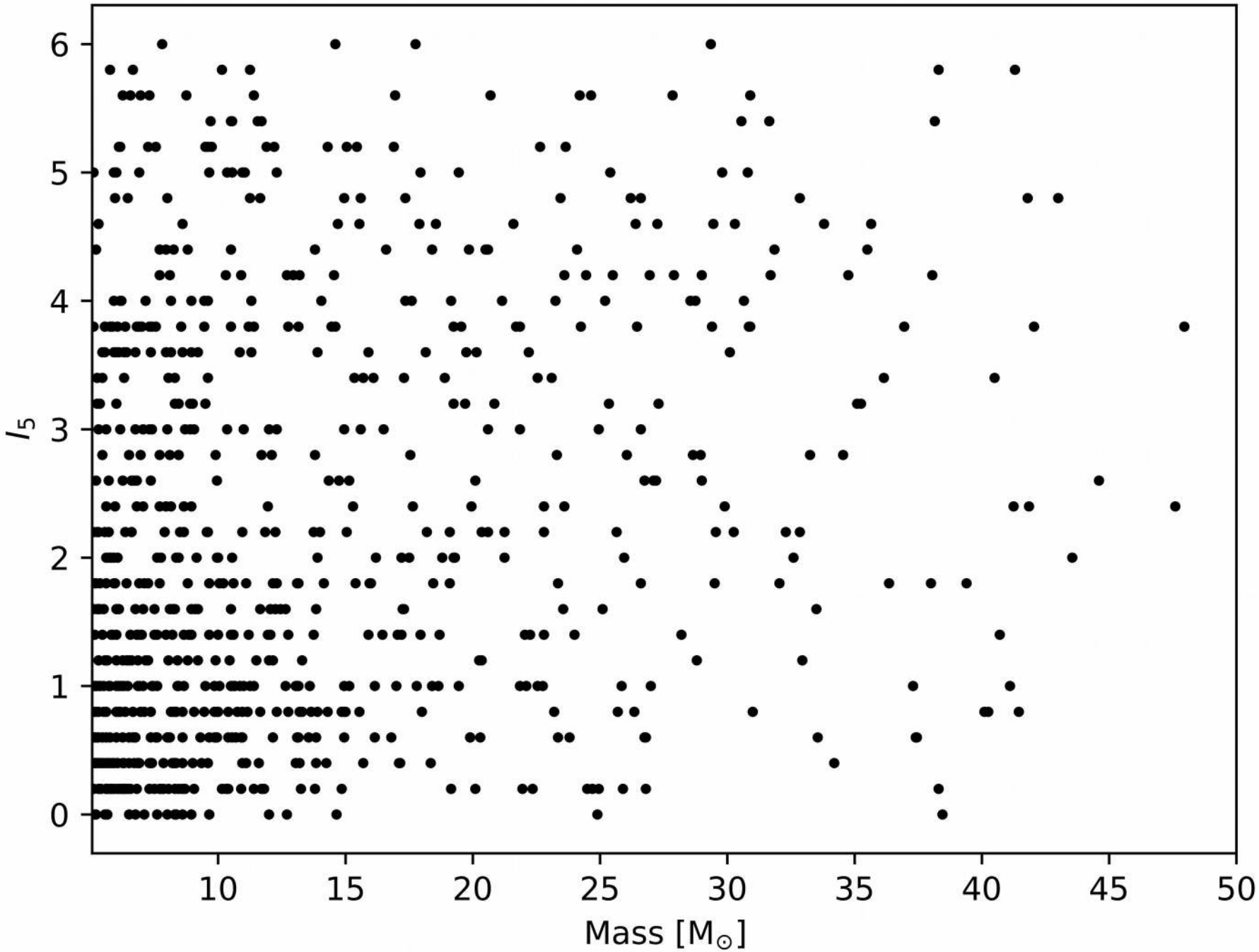
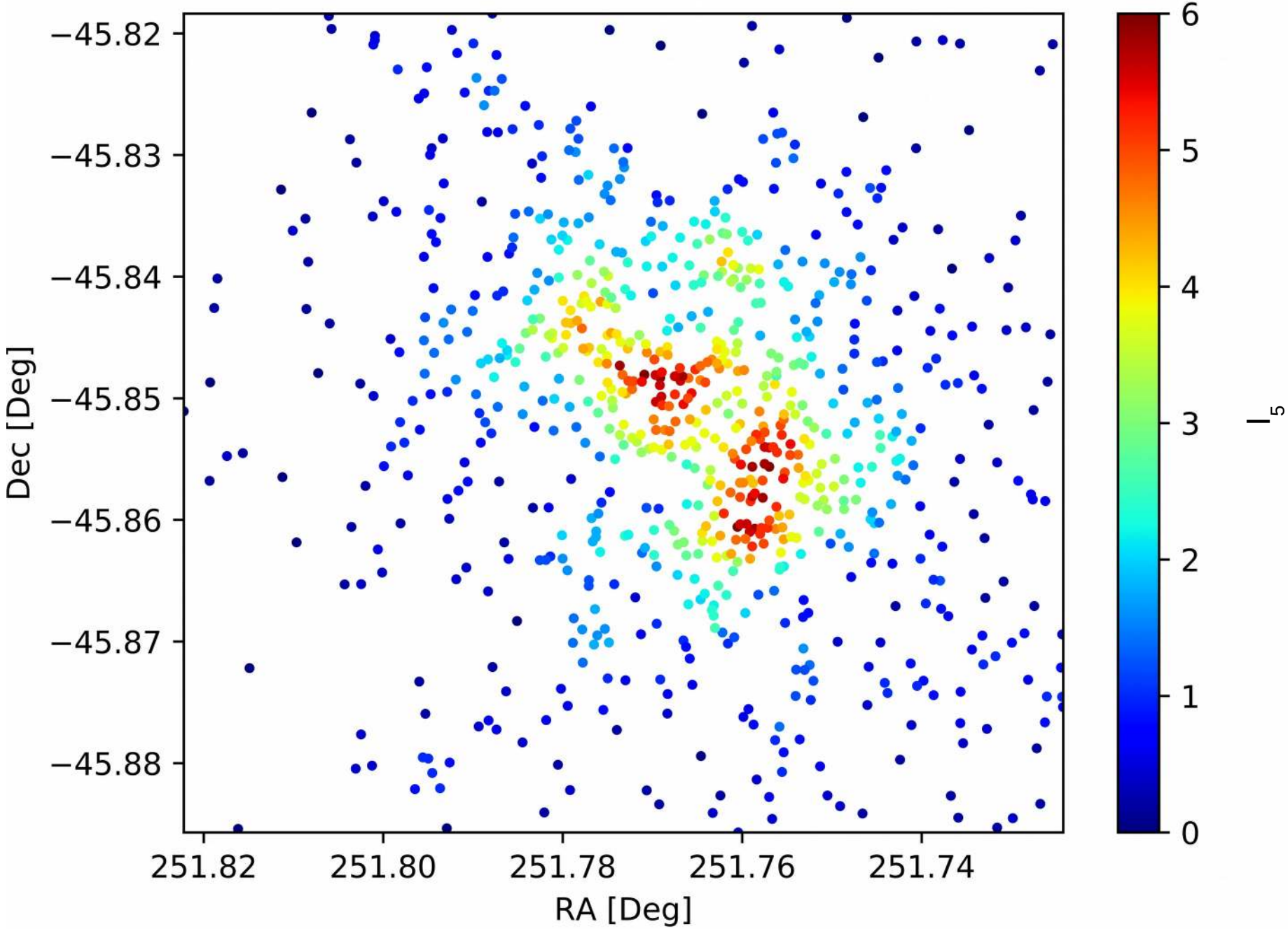
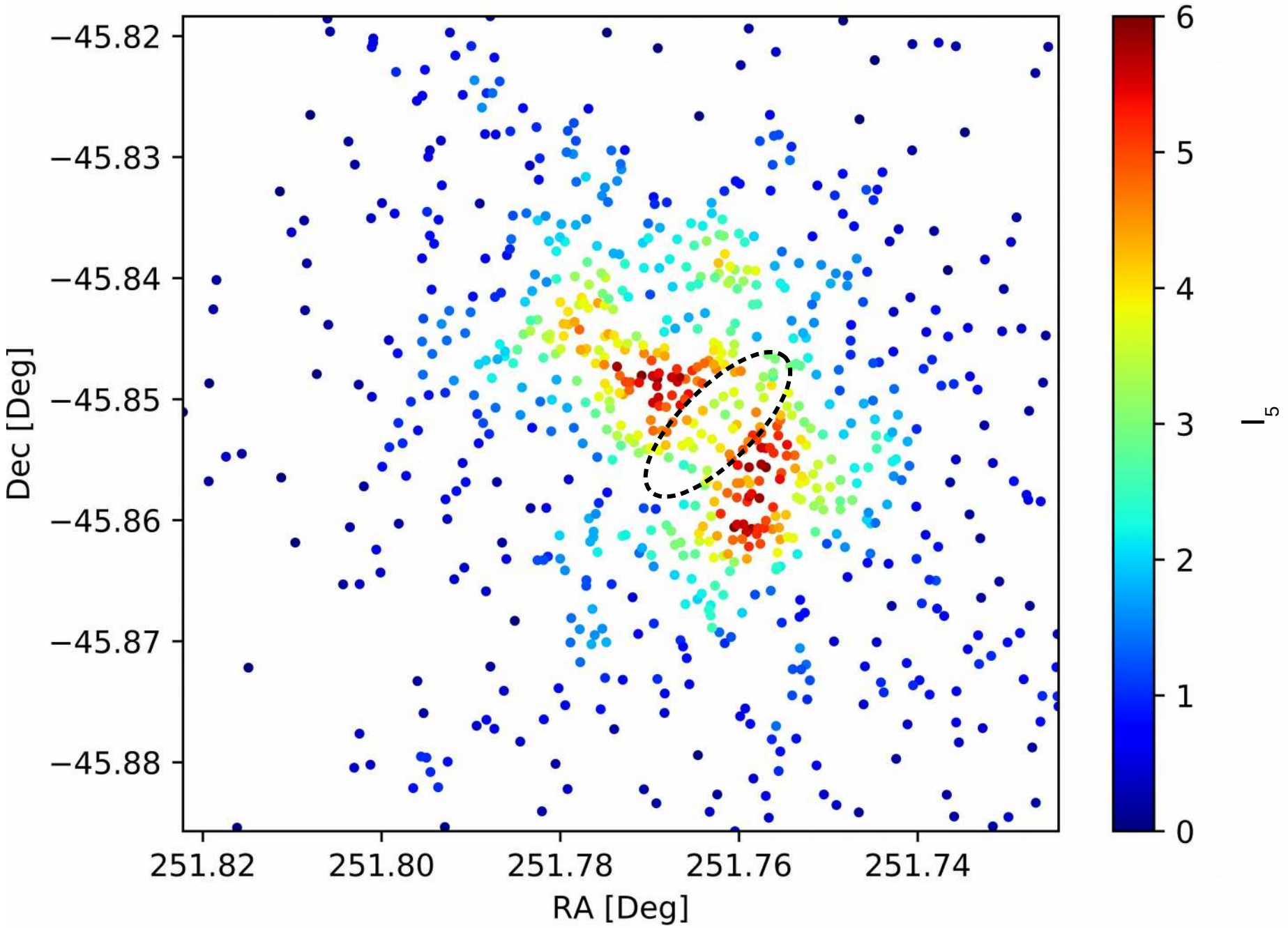



6
5
4
3
2
1
0
l_5
10
15
20
25
30
35
40
45
50
Mass [$M_\odot$]

NIR $M_* > 5 M_\odot$

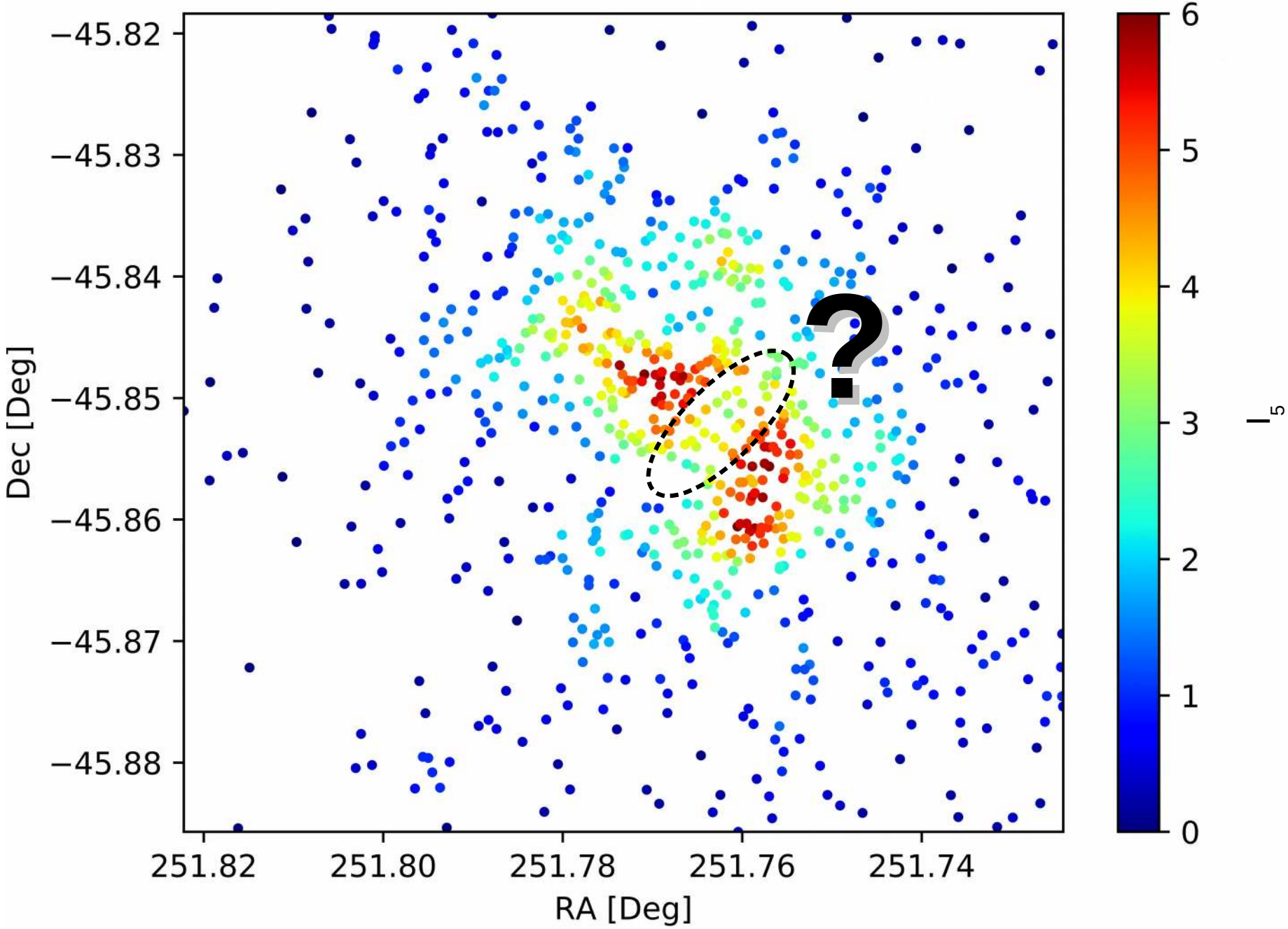
Buckner et al. (2018, in prep)

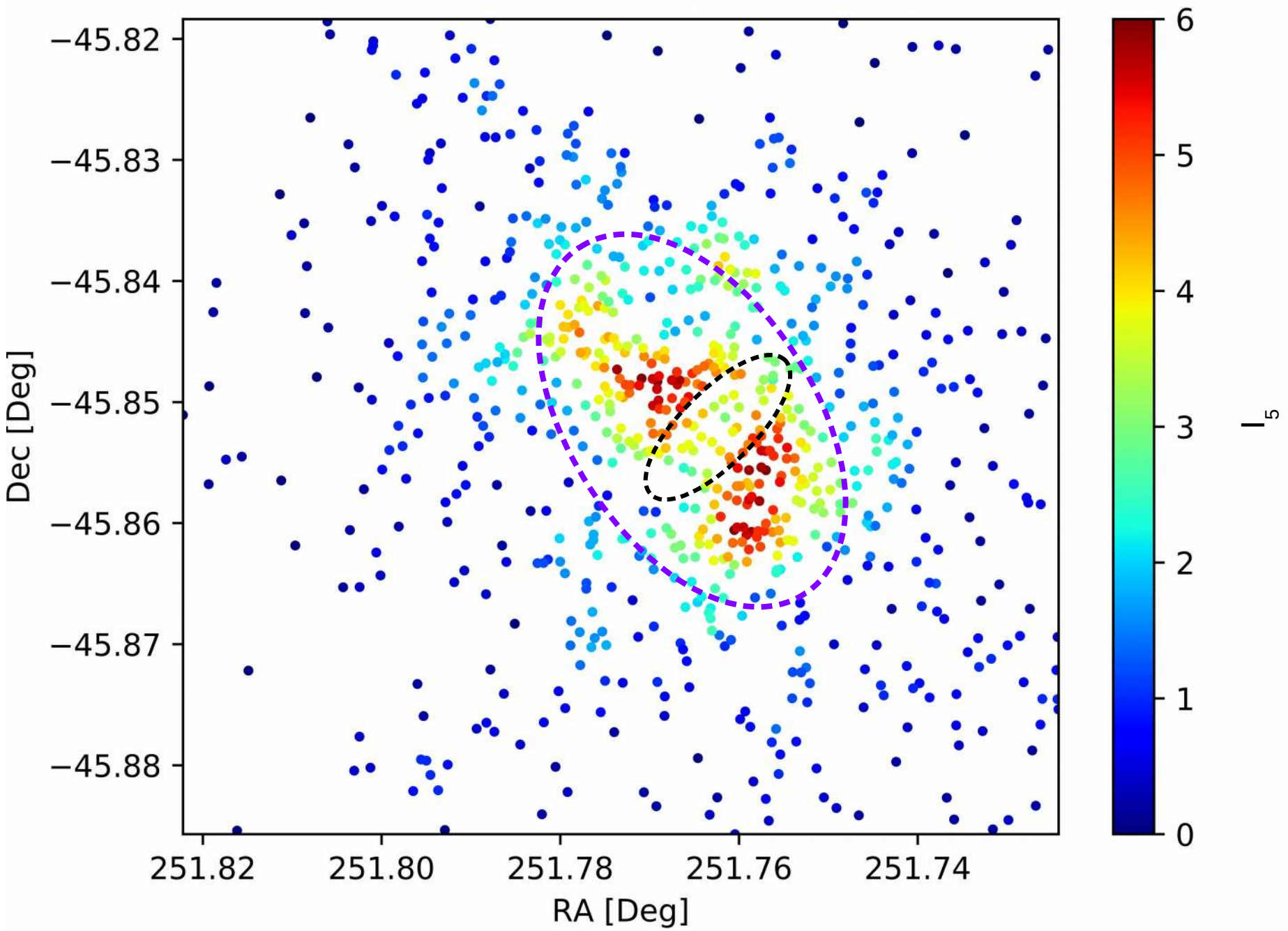



NIR M*>5M⊙
Buckner et al. (2018, in prep)
−45.82
−45.83
−45.84
−45.85
−45.86
−45.87
−45.88
Dec [Deg]
251.82
251.80
251.78
251.76
251.74
RA [Deg]
6
5
4
3
2
1
0
I5

NIR $M_* > 5M_\odot$

Buckner et al. (2018, in prep)

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6
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2
1
0
I_5

NIR $M_* > 10 M_\odot$

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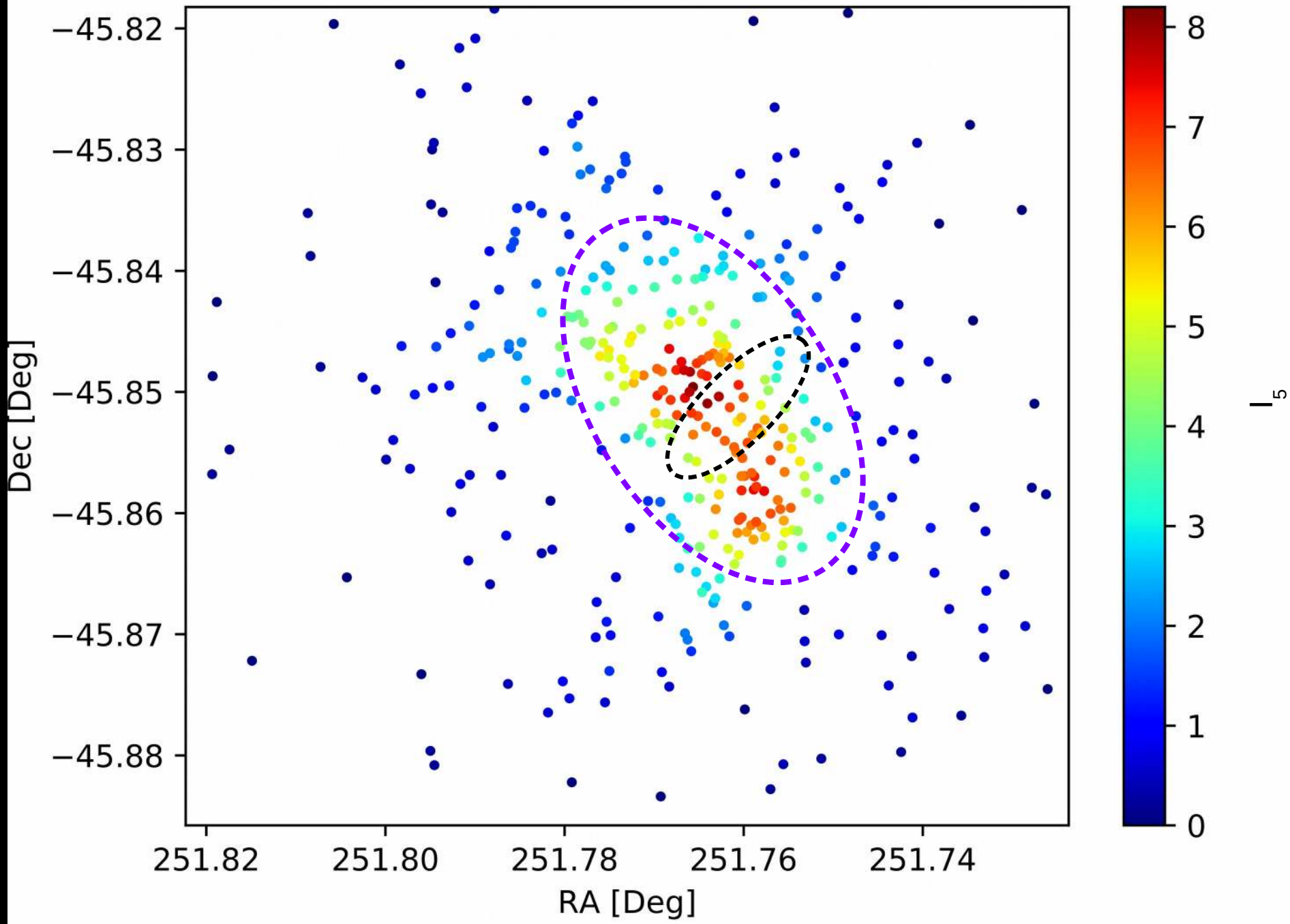
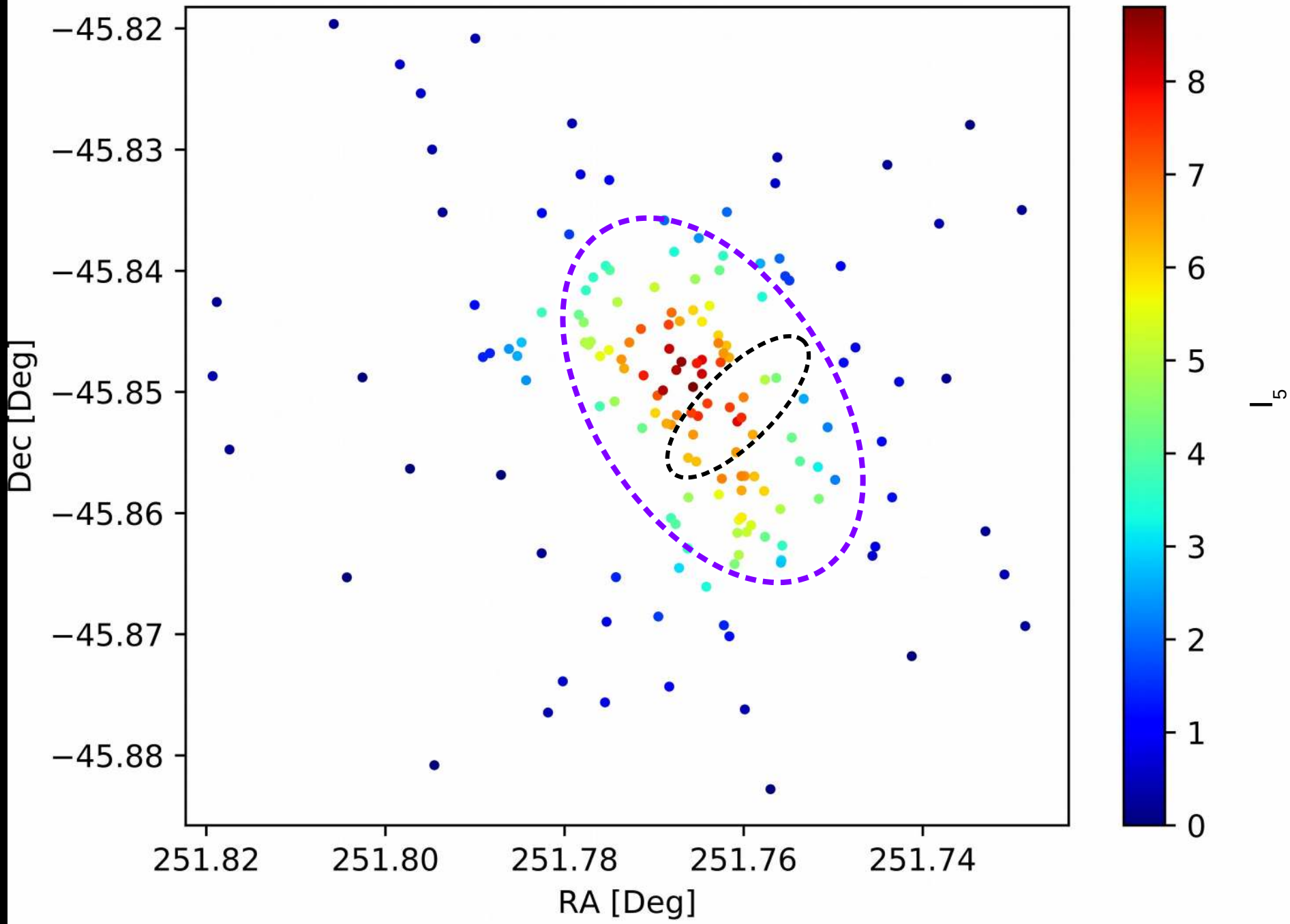


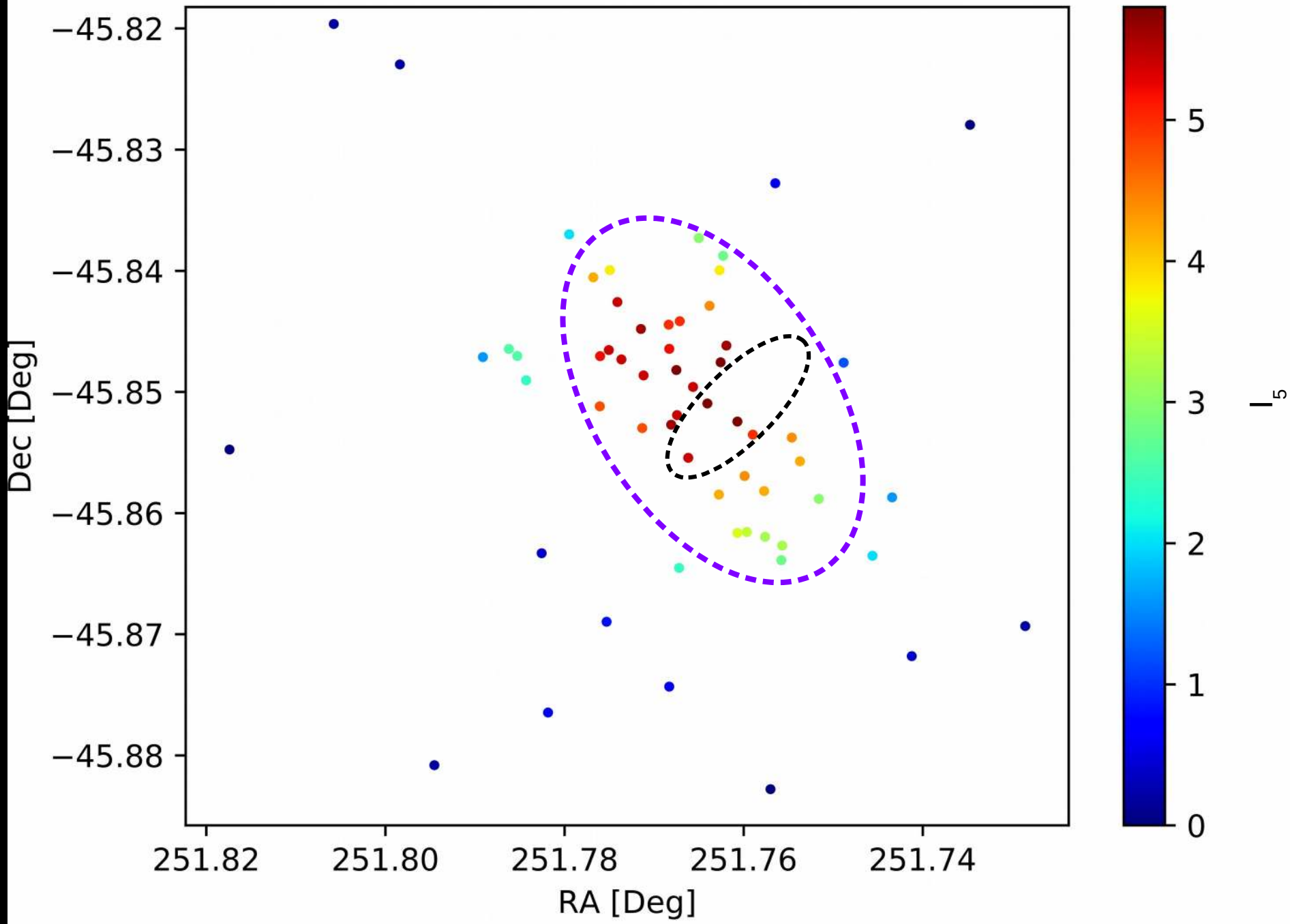
NIR $M_* > 20 M_\odot$

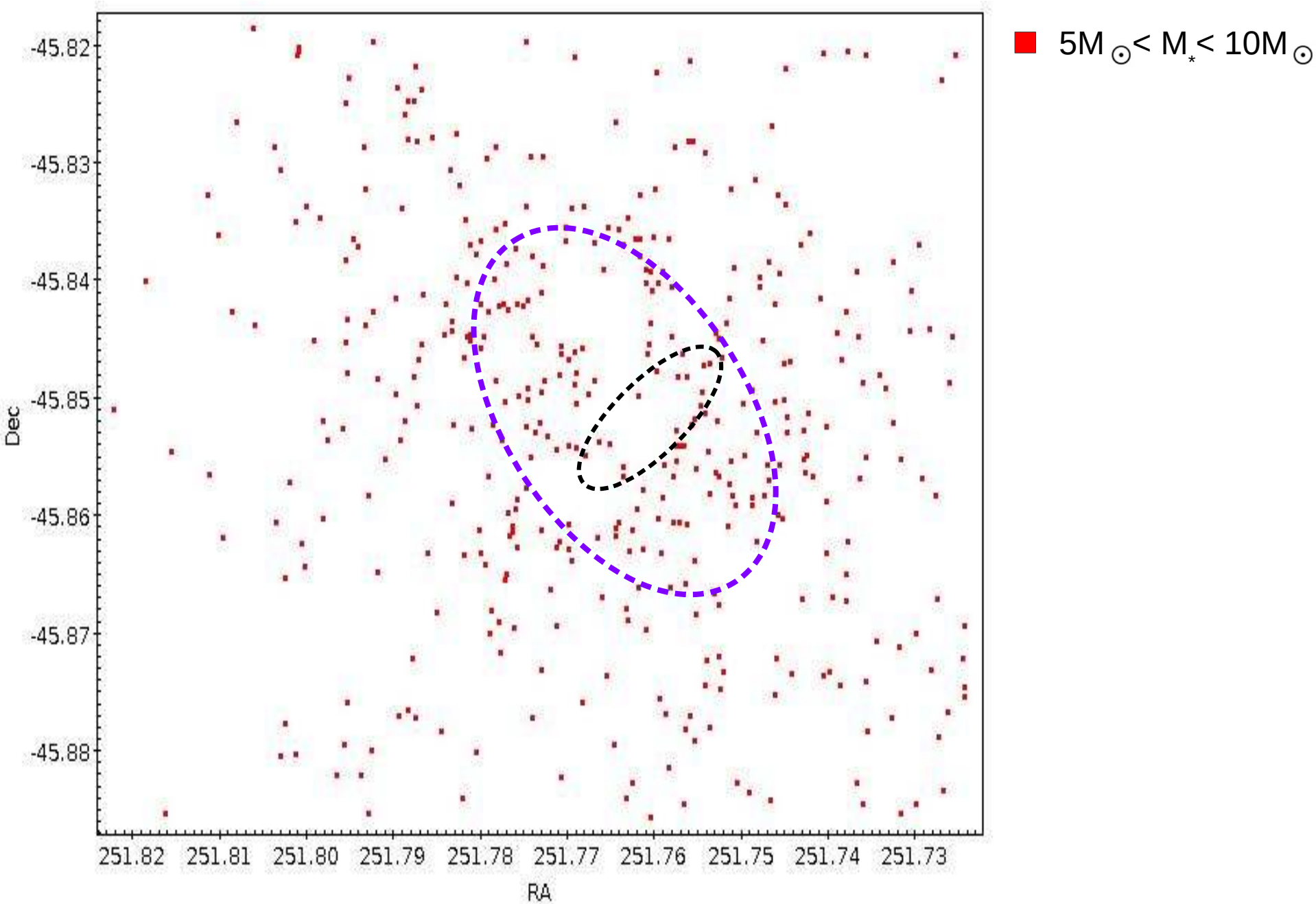
Buckner et al. (2018, in prep)

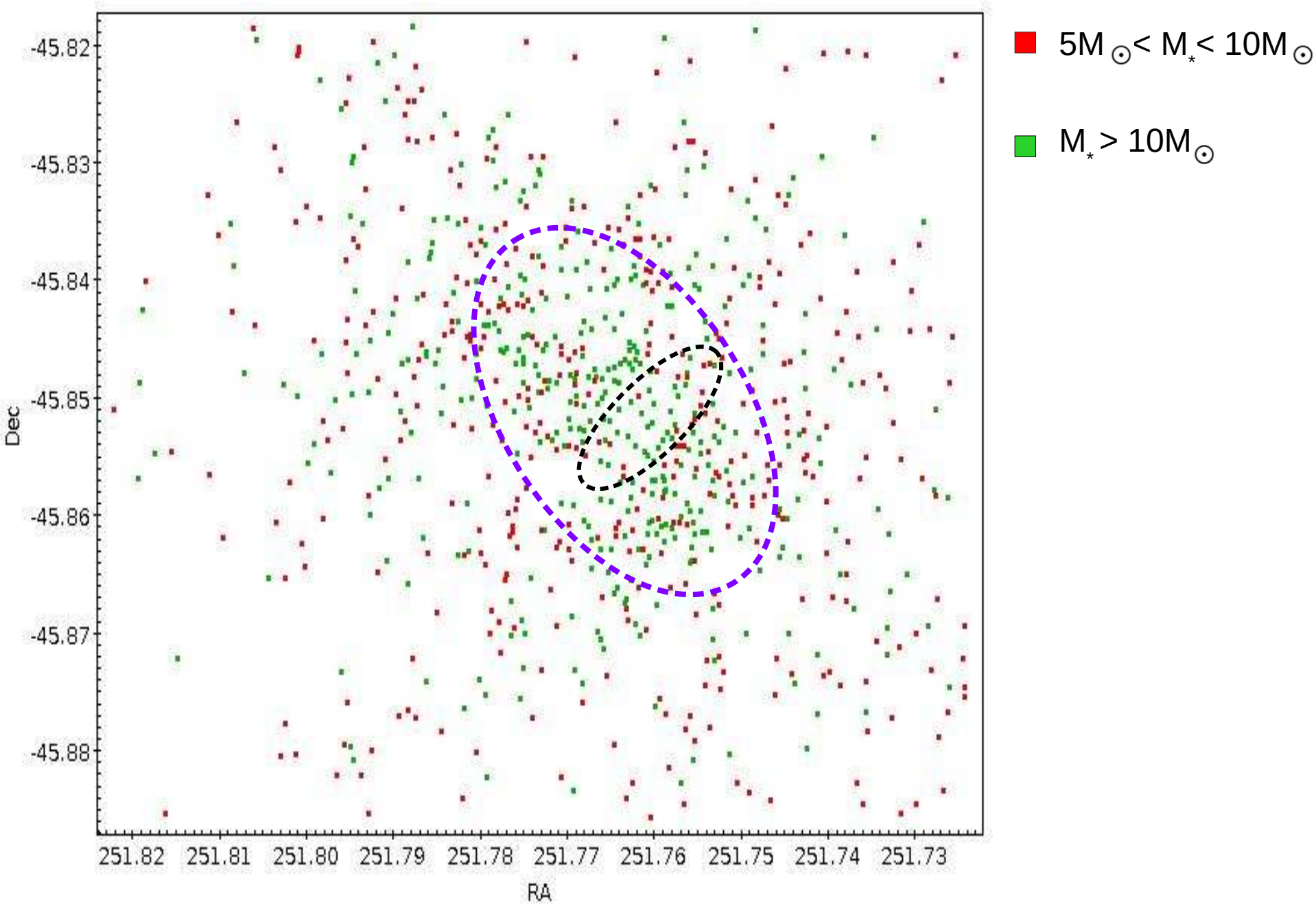


NIR $M_* > 30 M_\odot$

Buckner et al. (2018, in prep)




5M ⊙< M*< 10M ⊙
-45.82
-45.83
-45.84
-45.85
-45.86
-45.87
-45.88
Dec
251.82
251.81
251.80
251.79
251.78
251.77
251.76
251.75
251.74
251.73
RA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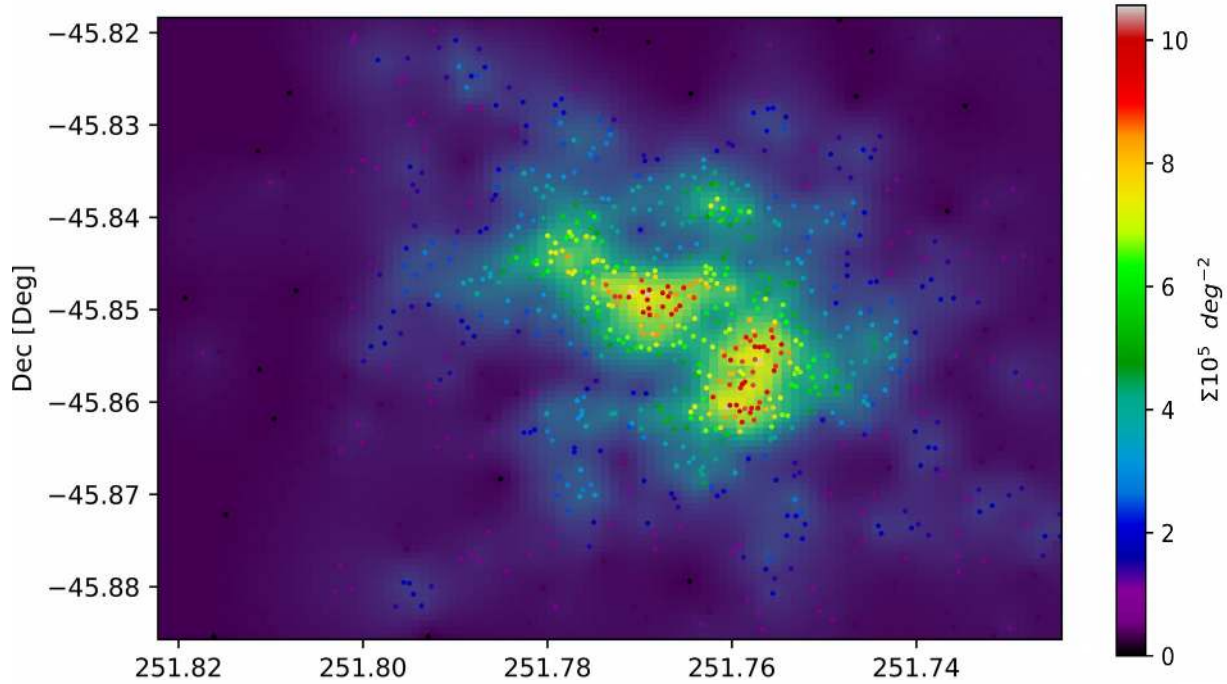
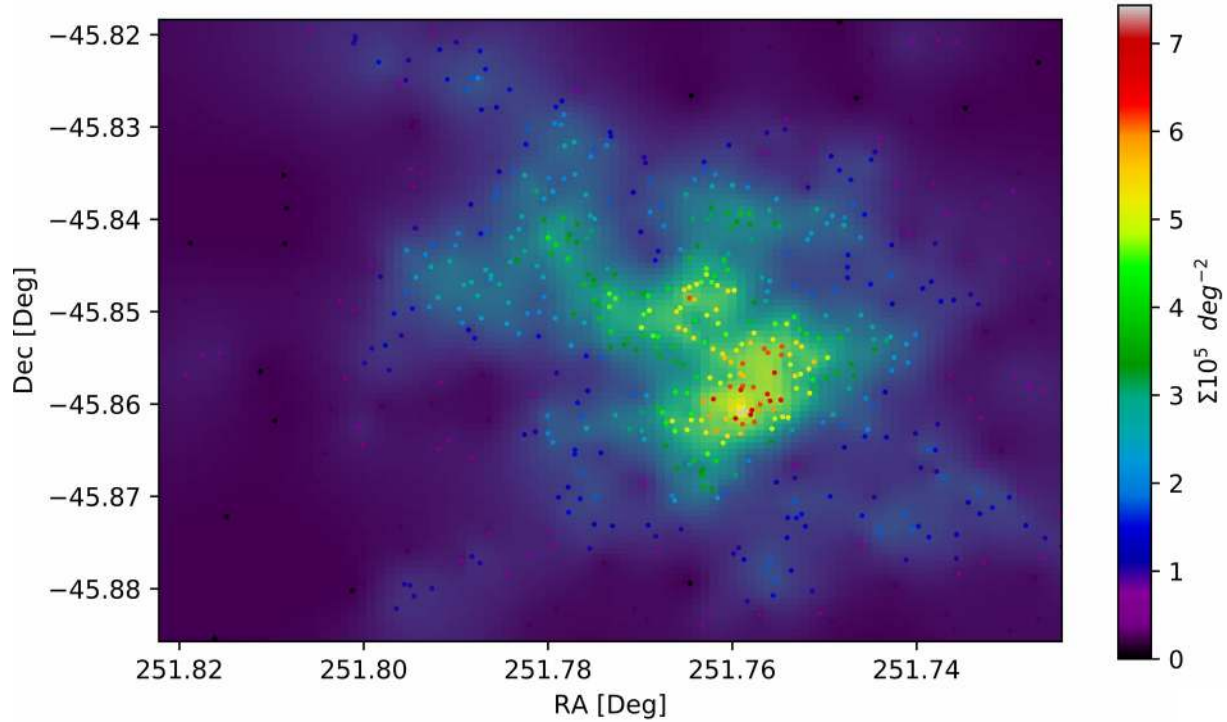
RA
5M ⊙< M* < 10M ⊙
M* > 10M ⊙

NIR $M_* > 5M_\odot$



Gaia $M_* > 5M_\odot$

Cleaned matches
with
pm & parallax



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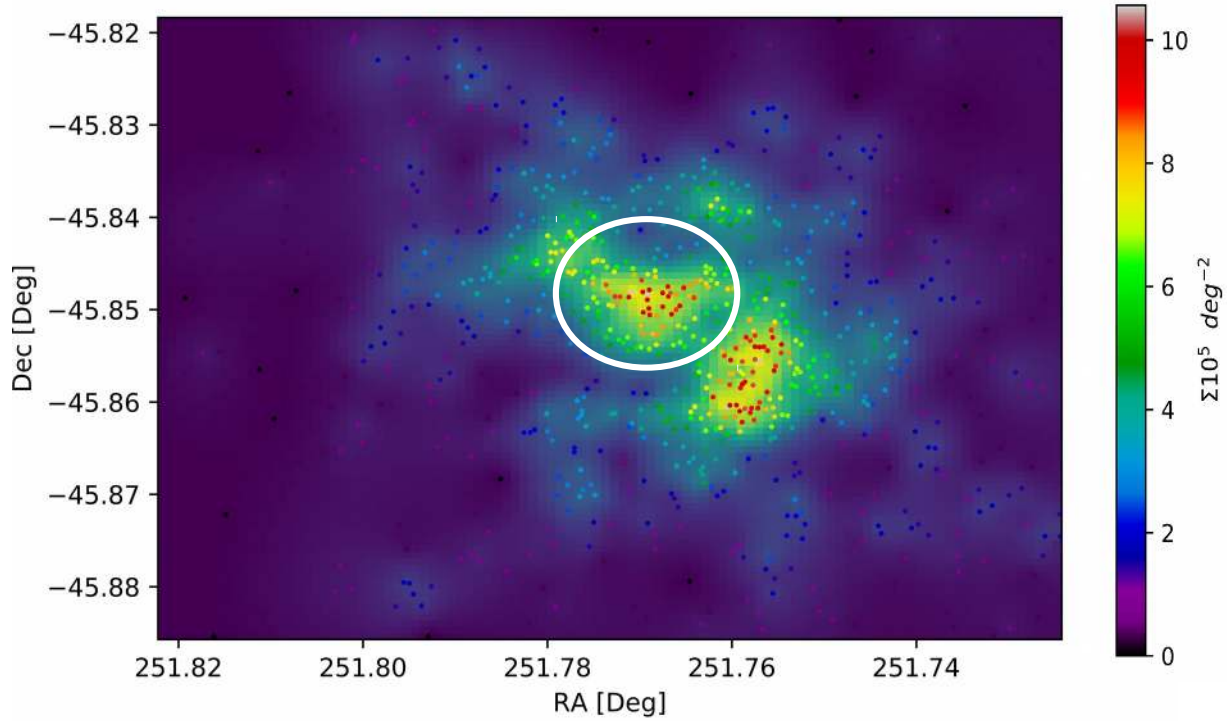

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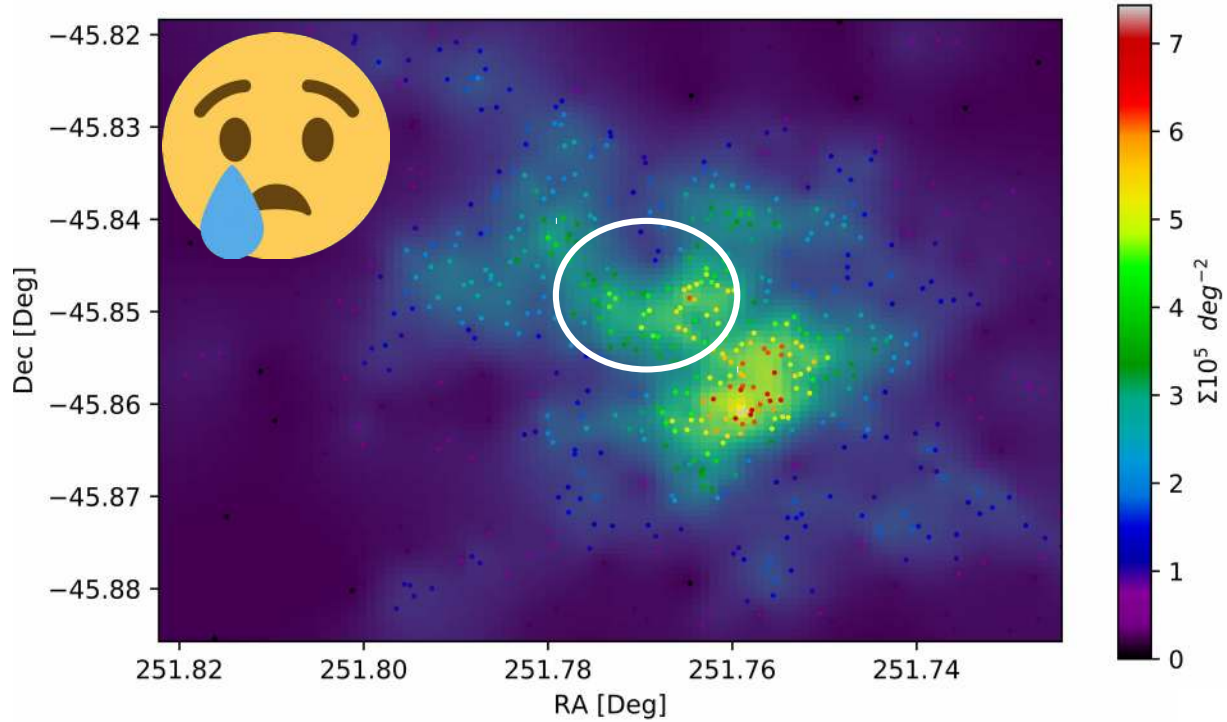
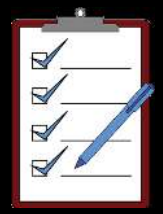


Summary



- INDICATE → powerful local measure of degree of “clustering” of stars
- 2+D, any parameter space
- Trace morphological features in SF regions
- Buckner et al. (2018, A&A, in review)

- Double core found in Westerlund 1
- Observational bias or real?
- Kinematic data required → not available from Gaia DR2