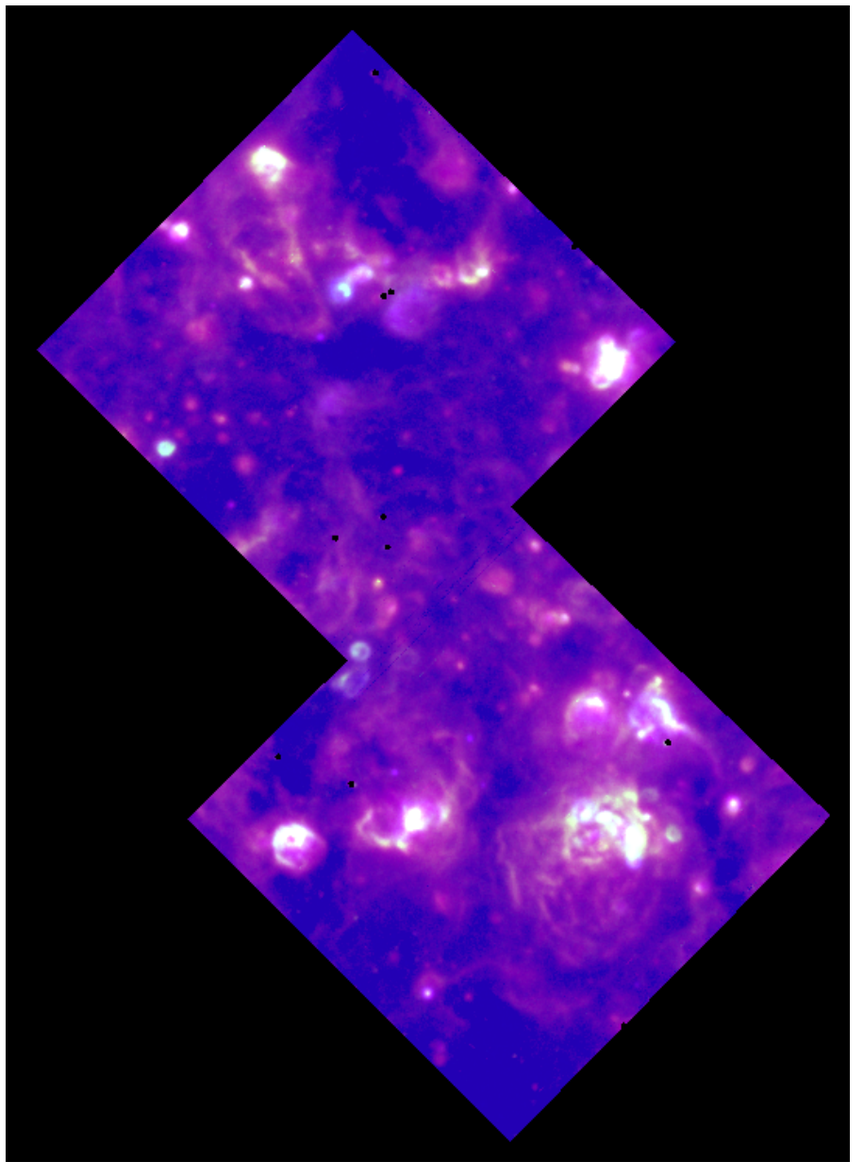
# The emerging phase of YSCs: constraints for LyC photon leakage from HII regions in NGC7793

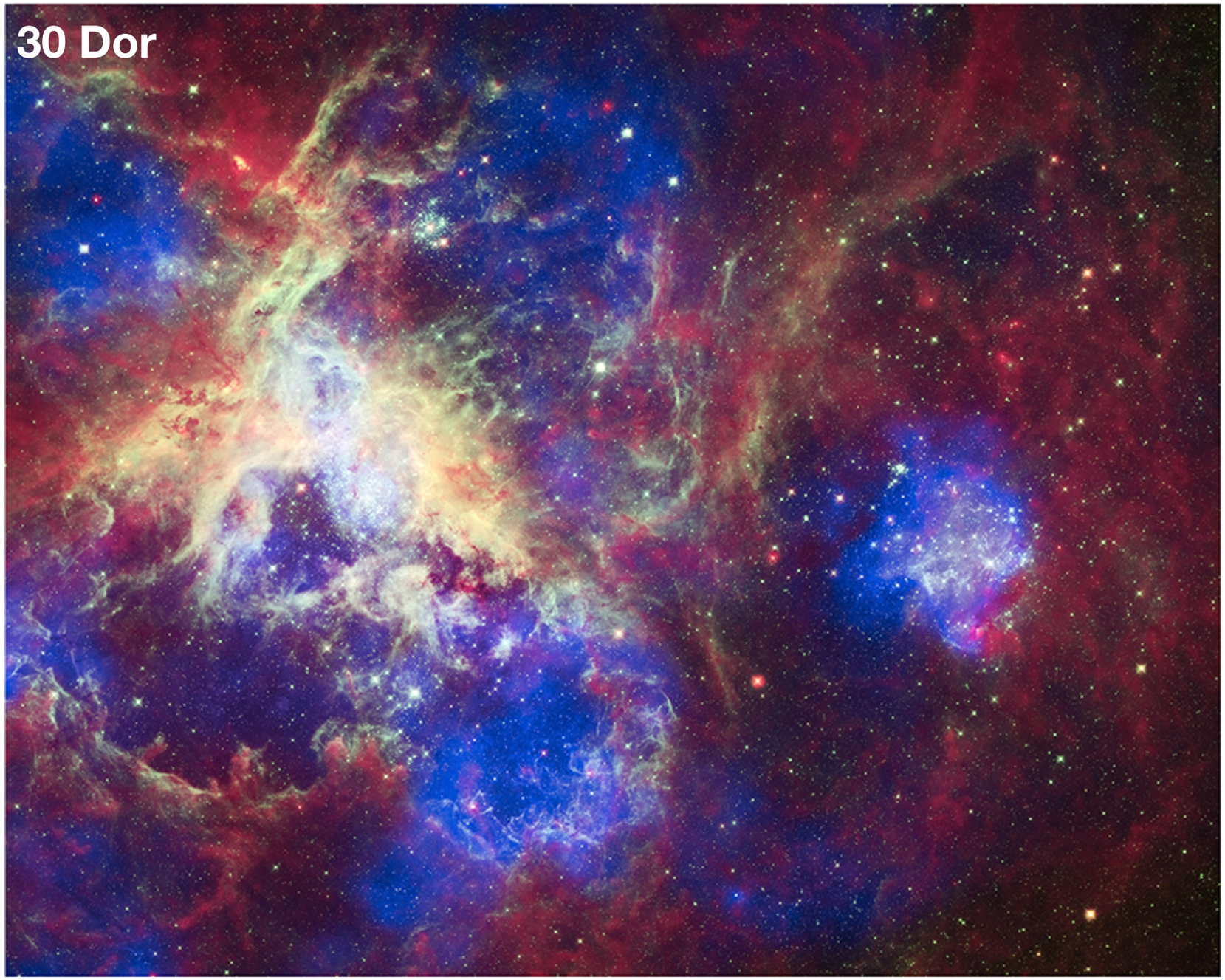
Lorenza Della Bruna

A. Adamo, G. Östlin, A. Bik, A. Fox, M. Fumagalli

Stockholm University



# The role of YSCs as source of stellar feedback

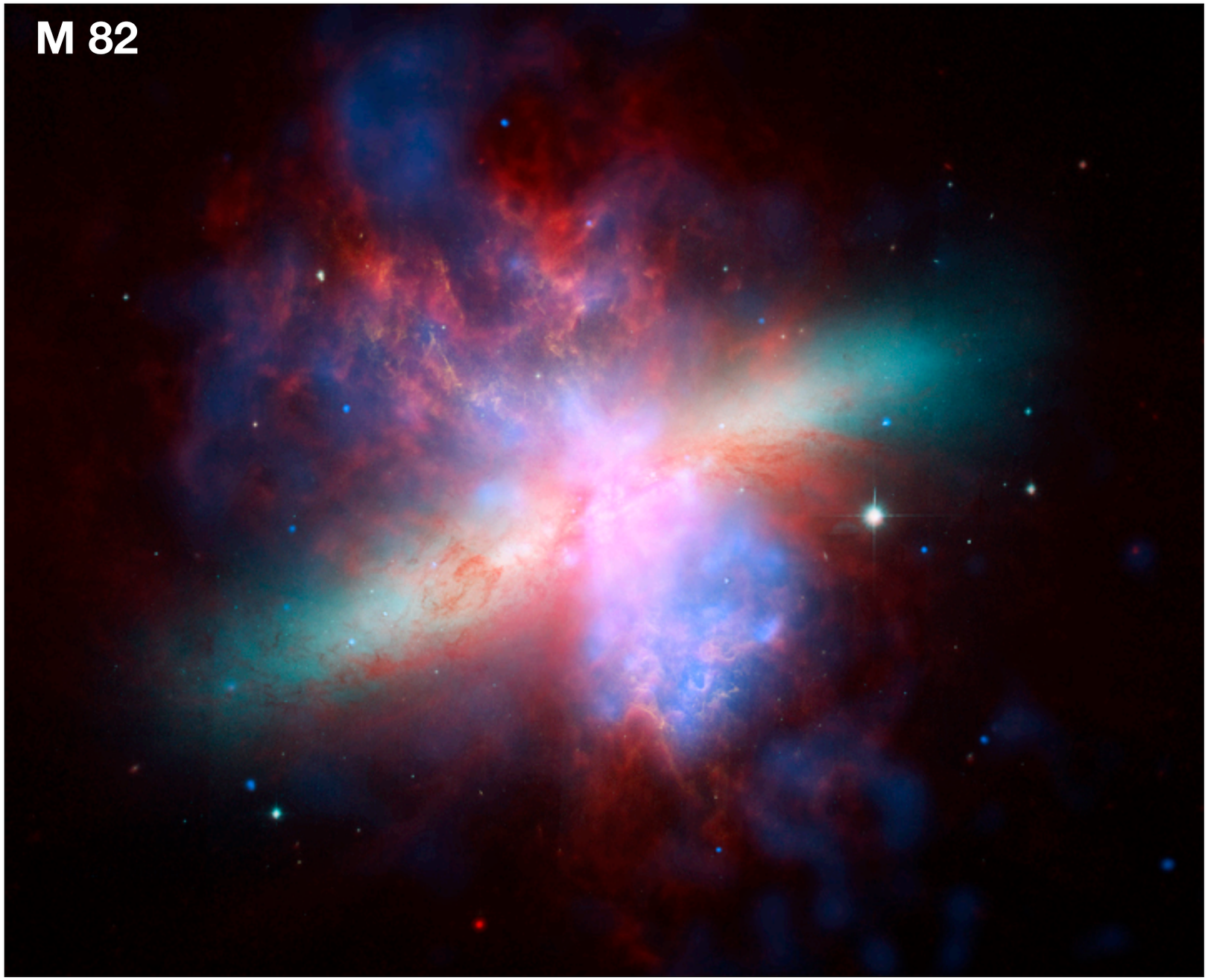



**Chandra**
**HST**
**Spitzer**



*http://chandra.harvard.edu*

# The role of YSCs as source of stellar feedback



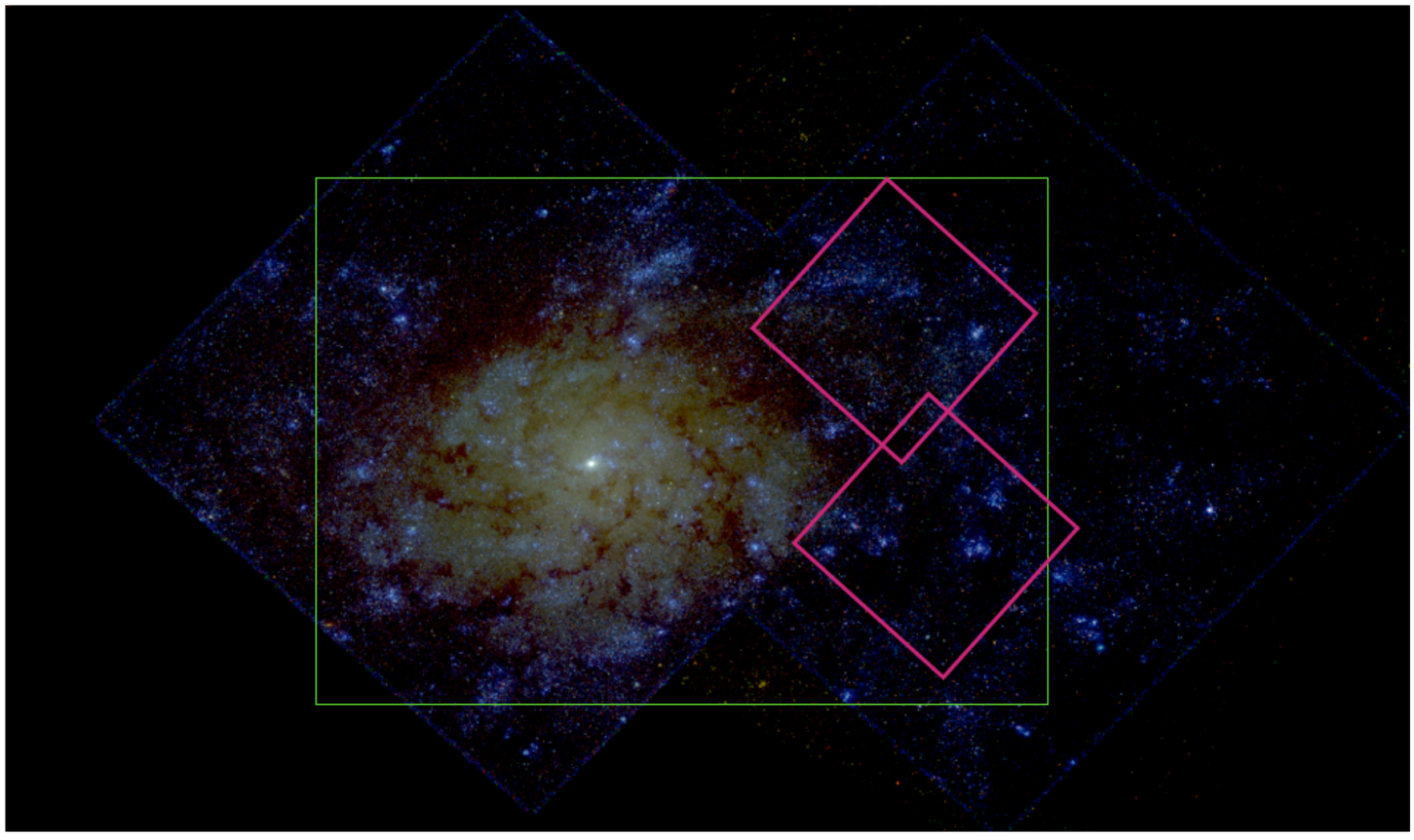

**Chandra**
**HST**
**Spitzer**



*http://chandra.harvard.edu*

# NGC 7793

- d = 3.4 Mpc
- MUSE: λ = 4600 - 9350 Å, seeing ~ 0.7” (10 pc)



**HST**

**ALMA**

**MUSE AO science verification (PI A. Adamo)**

# Data reduction

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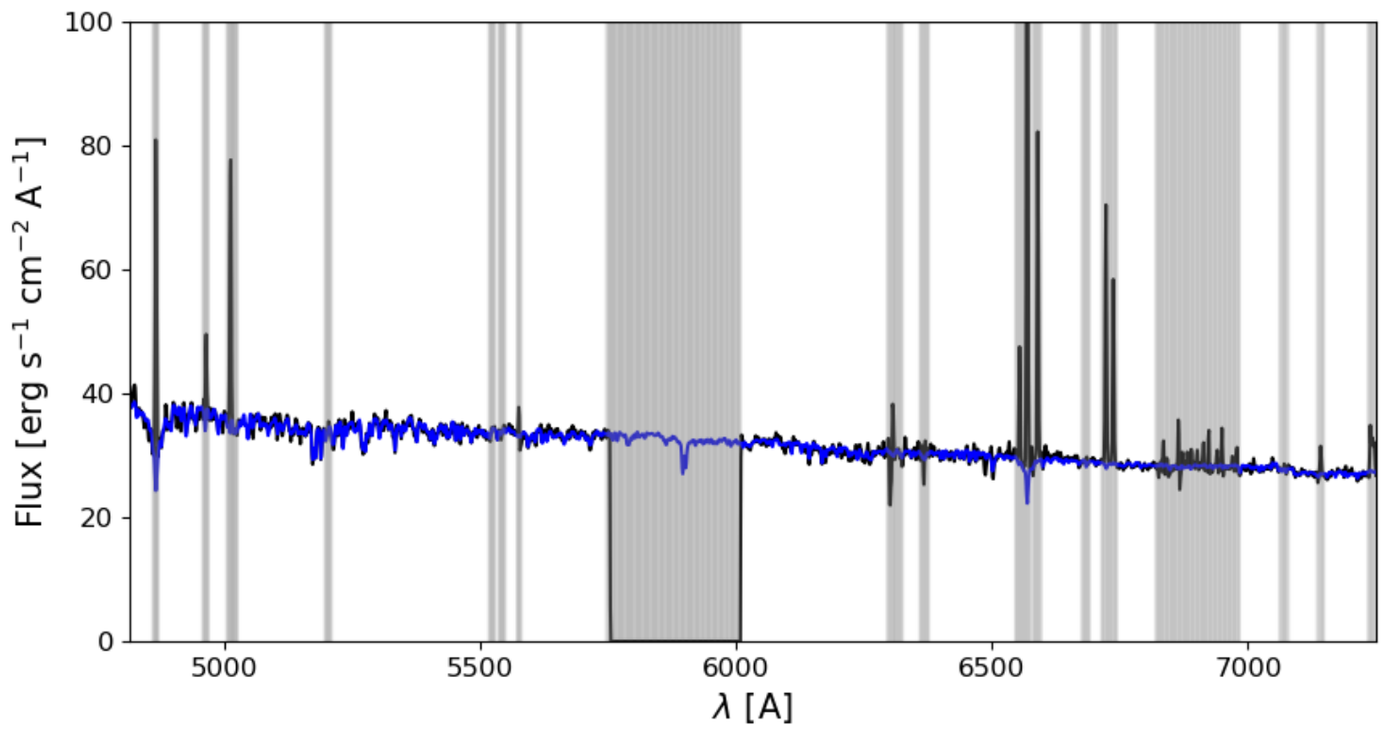
- Stellar continuum subtraction with pPXF [Cappellari and Emsellem 2004]:
  - eMILES  SSPs (Z = -2.32 — 0.22, age = 60 Myr — 18 Gyr).



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  - gaussian templates
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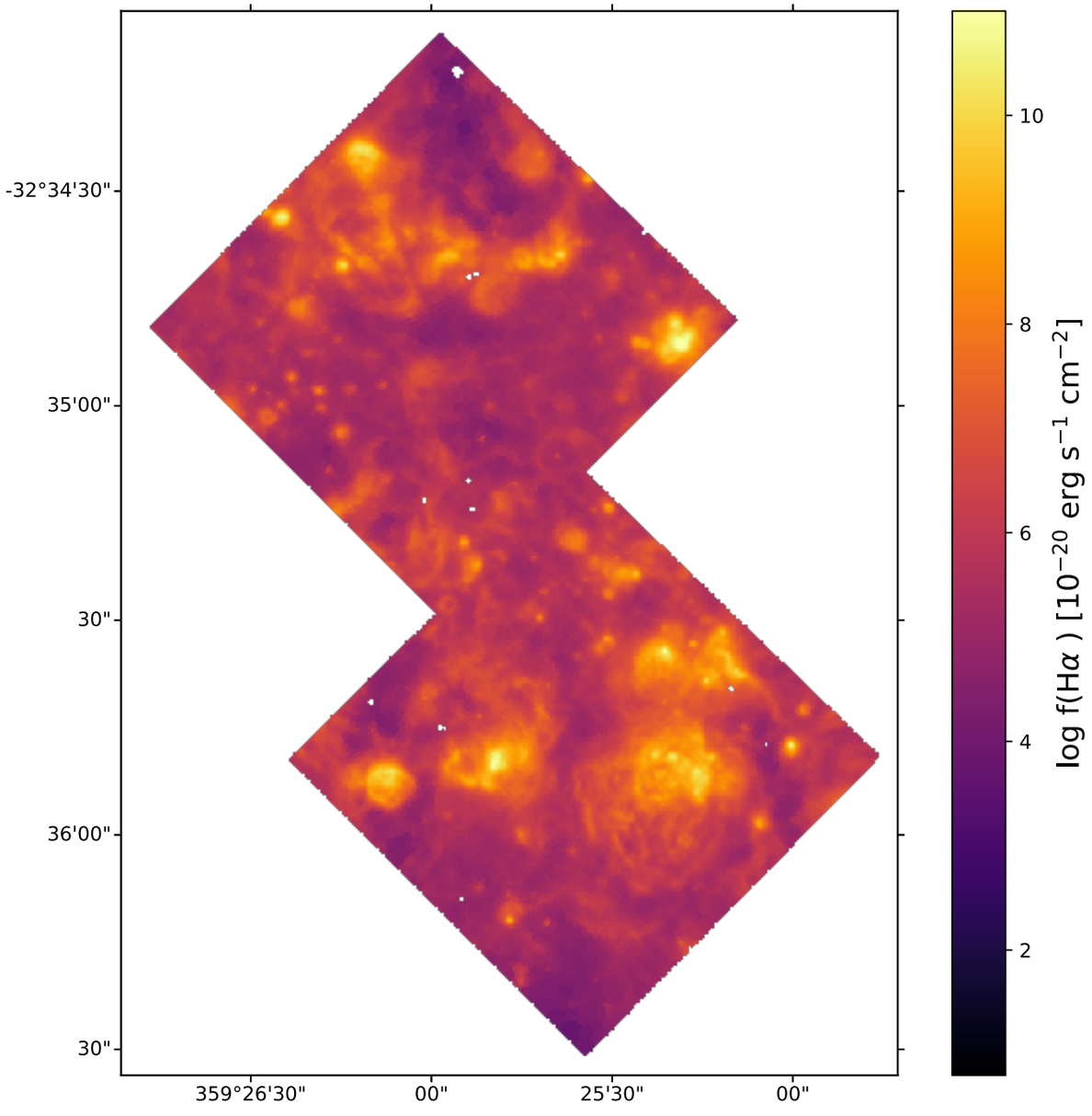
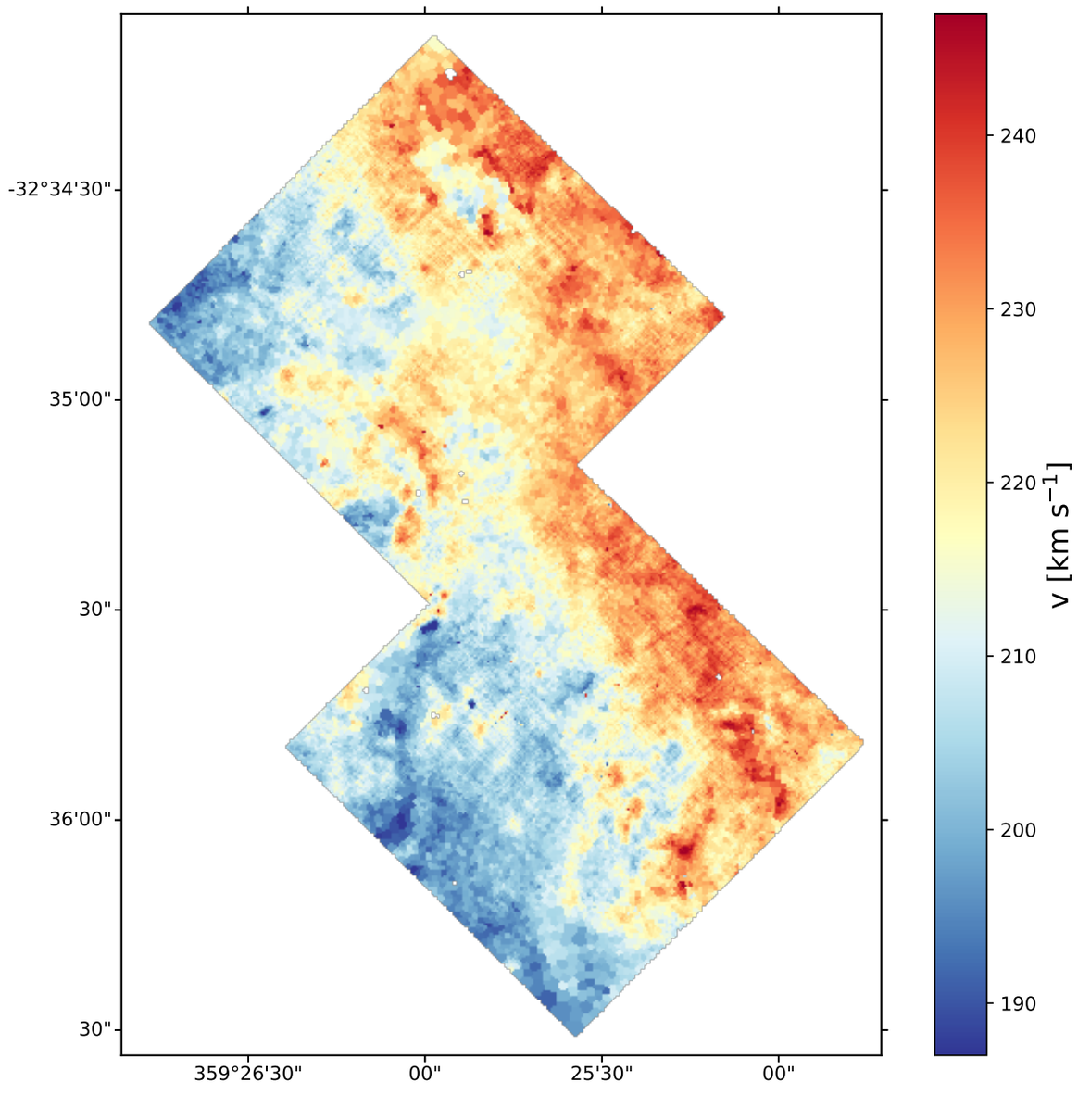
- Reddening correction with Pyneb [Luridiana et al. 2014].

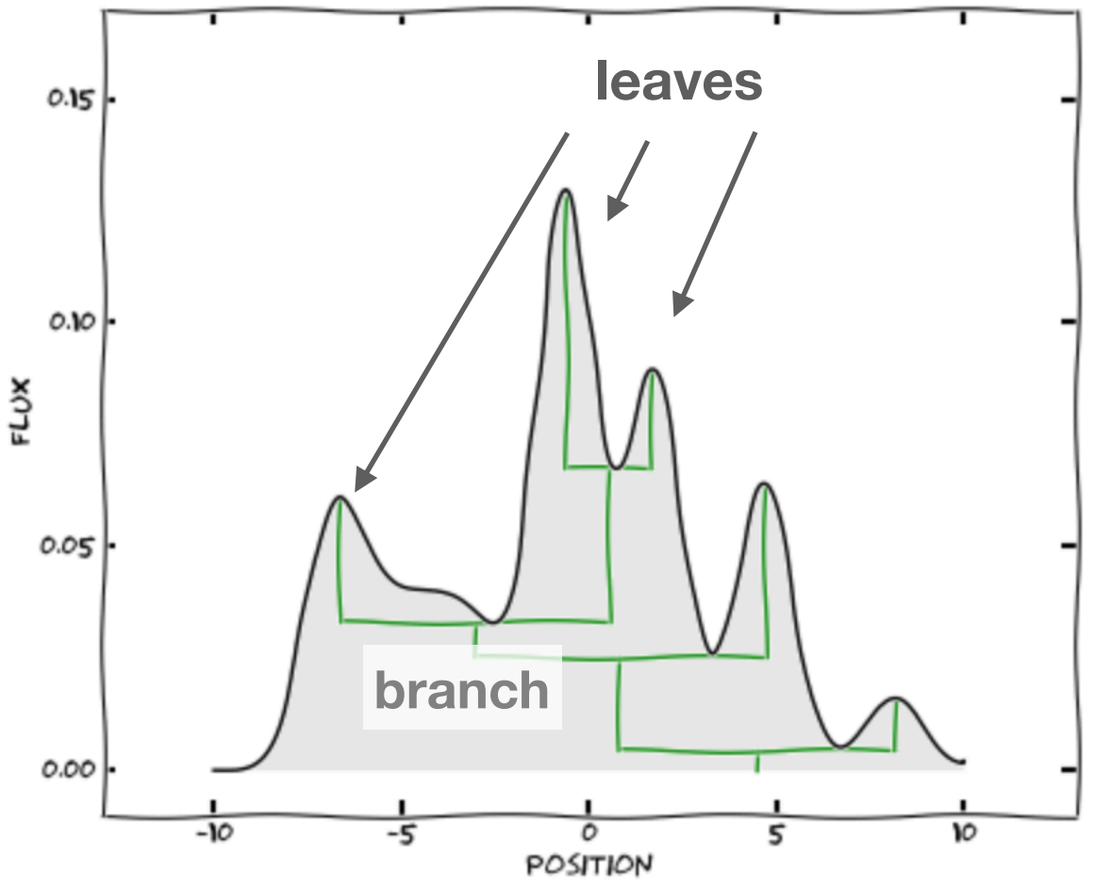
# Halpha line- and velocity map



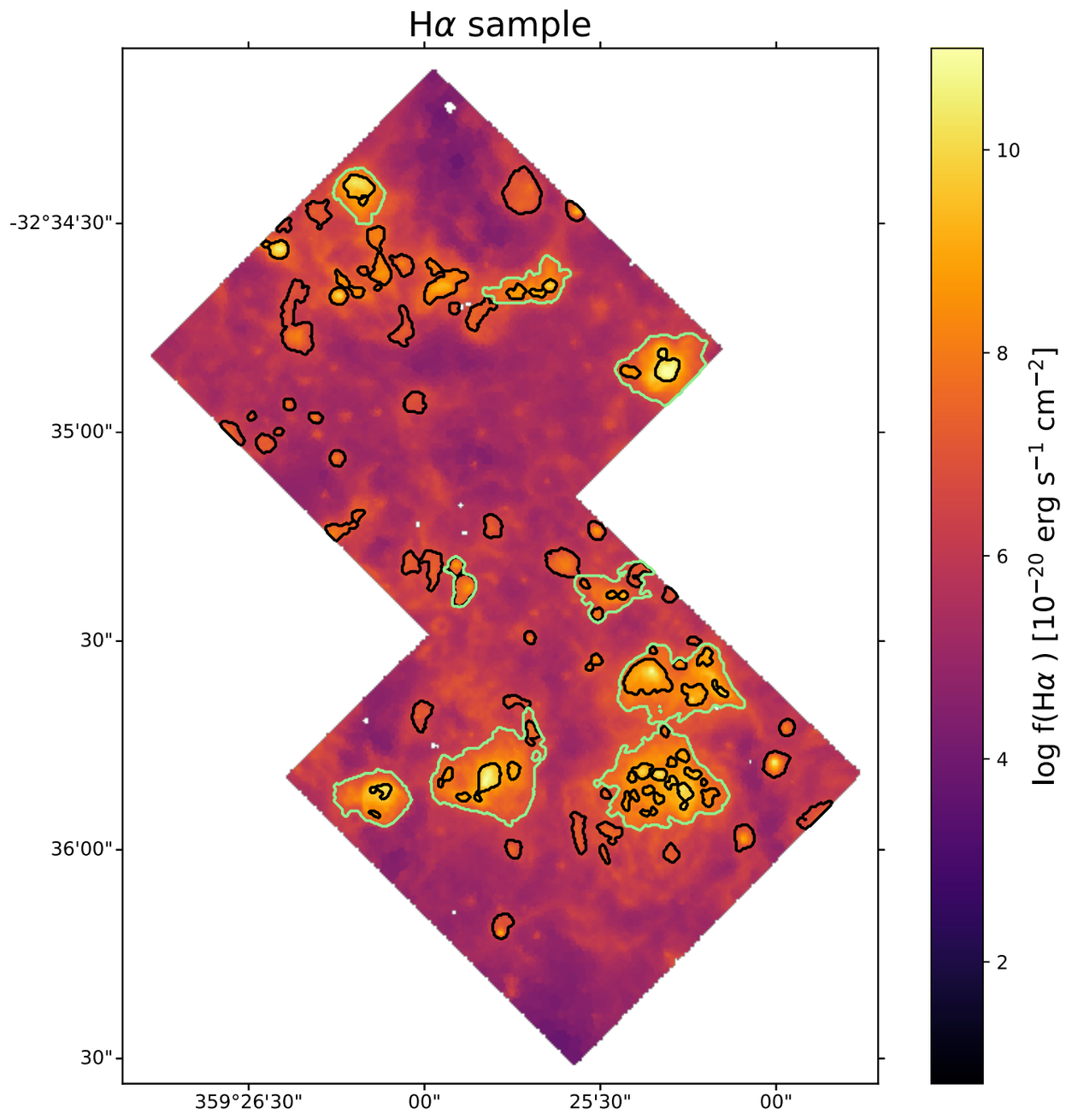



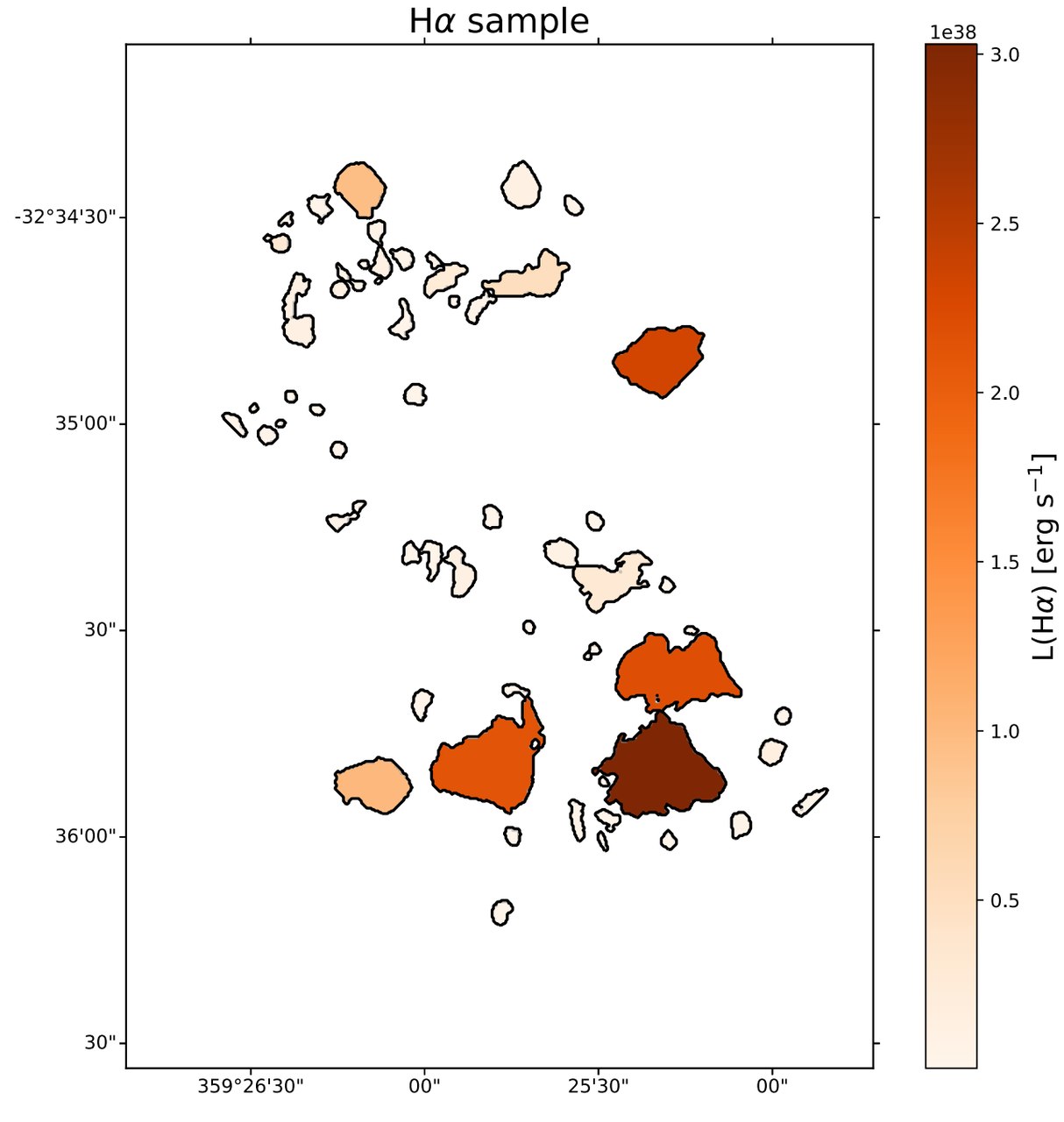
# HII regions selection

- ASTRODENDRO—> tree representing the hierarchy of structures in the data

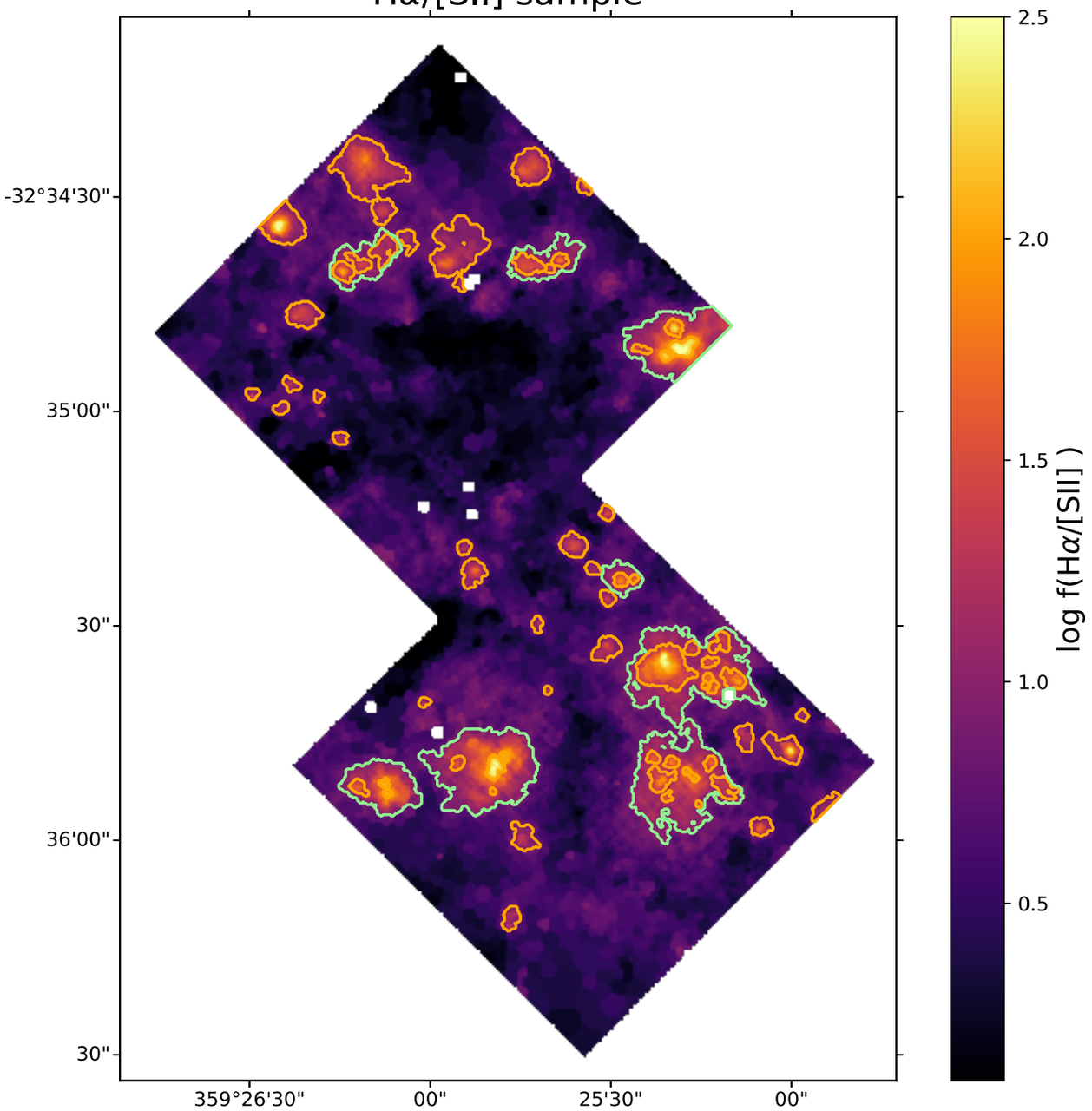



*http:// dendrograms.org*

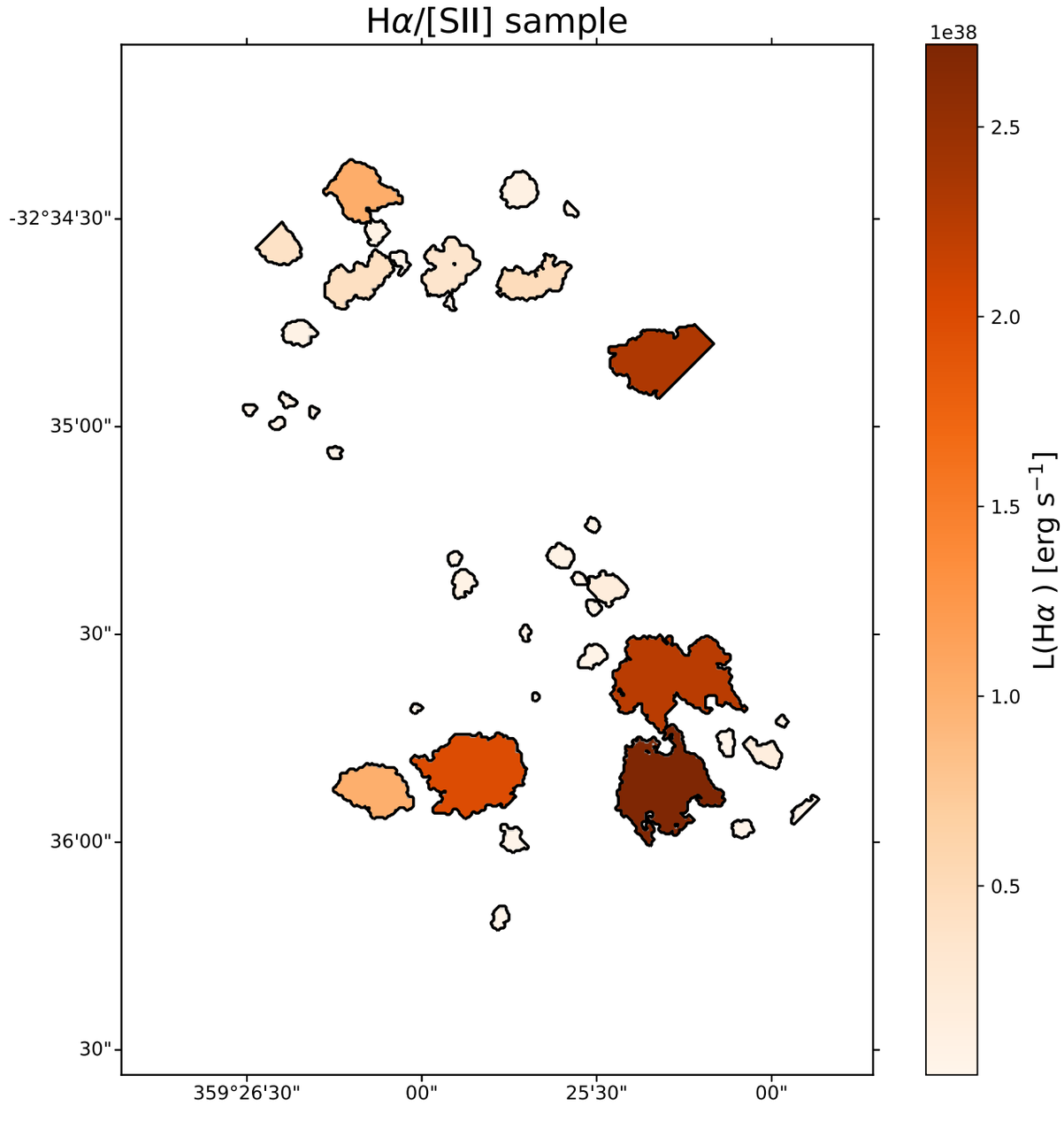

Hα sample
-32°34'30"
35'00"
30"
36'00"
30"
359°26'30"
00"
25'30"
00"
10
8
6
4
2
log f(Hα ) [10−20 erg s−1 cm−2]


Hα sample
-32°34'30"
35'00"
30"
36'00"
30"
359°26'30"
00"
25'30"
00"
1e38
3.0
2.5
2.0
1.5
1.0
0.5
L(Hα) [erg s−1]

104 leaves


Hα/[SII] sample
-32°34'30"
35'00"
30"
36'00"
30"
359°26'30"
00"
25'30"
00"
2.5
2.0
1.5
1.0
0.5
log f(Hα/[SII])

67 leaves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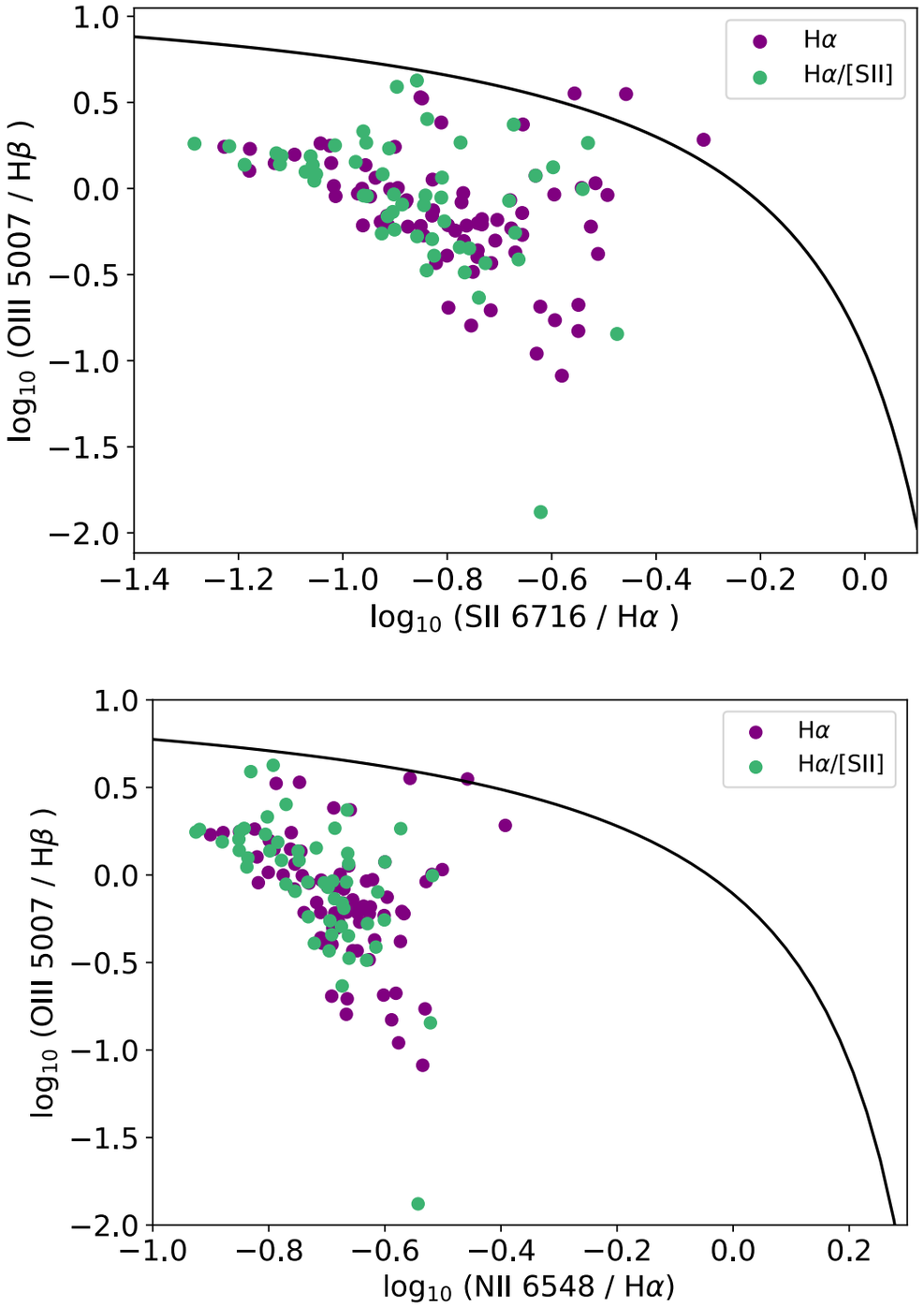
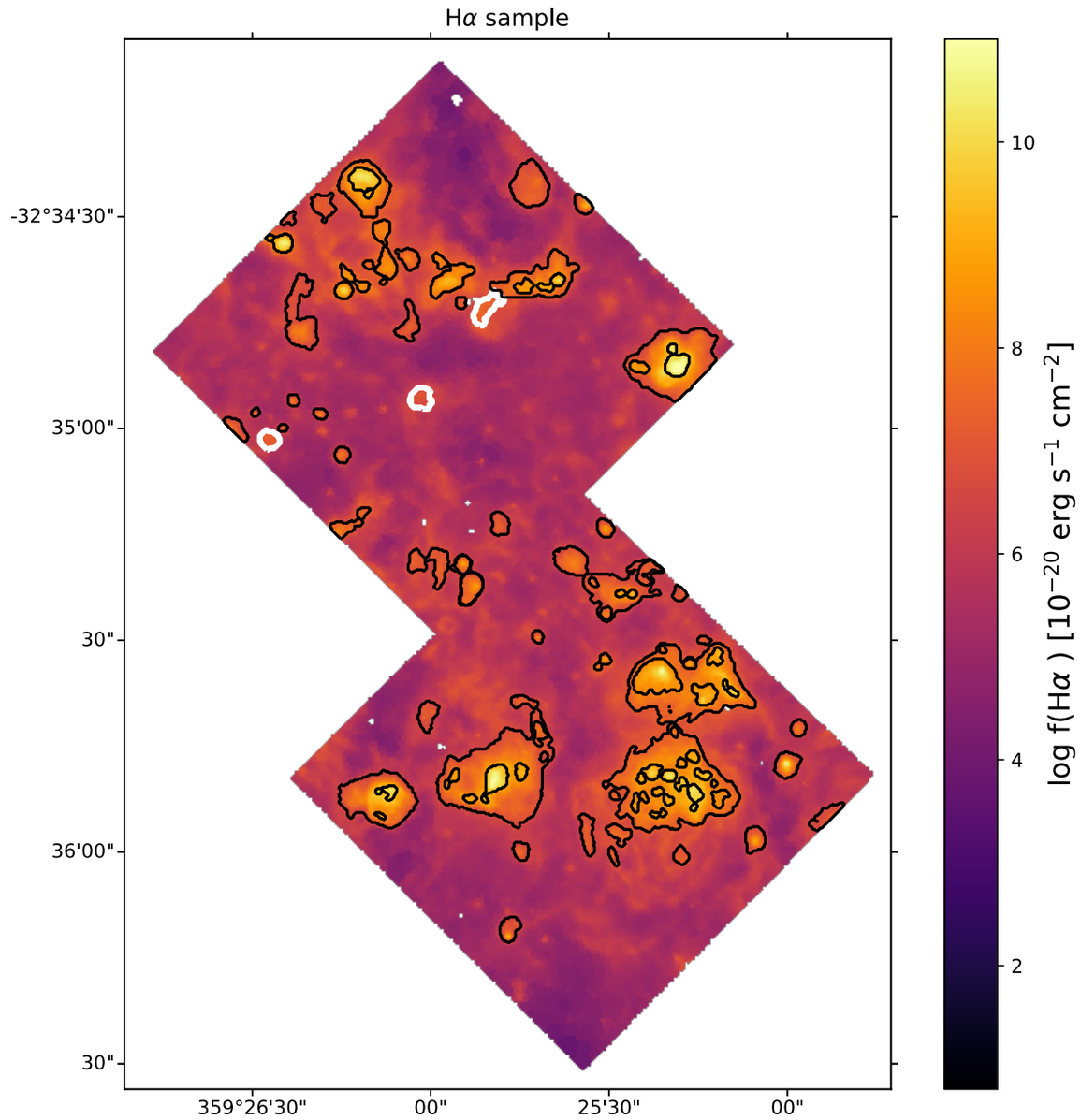
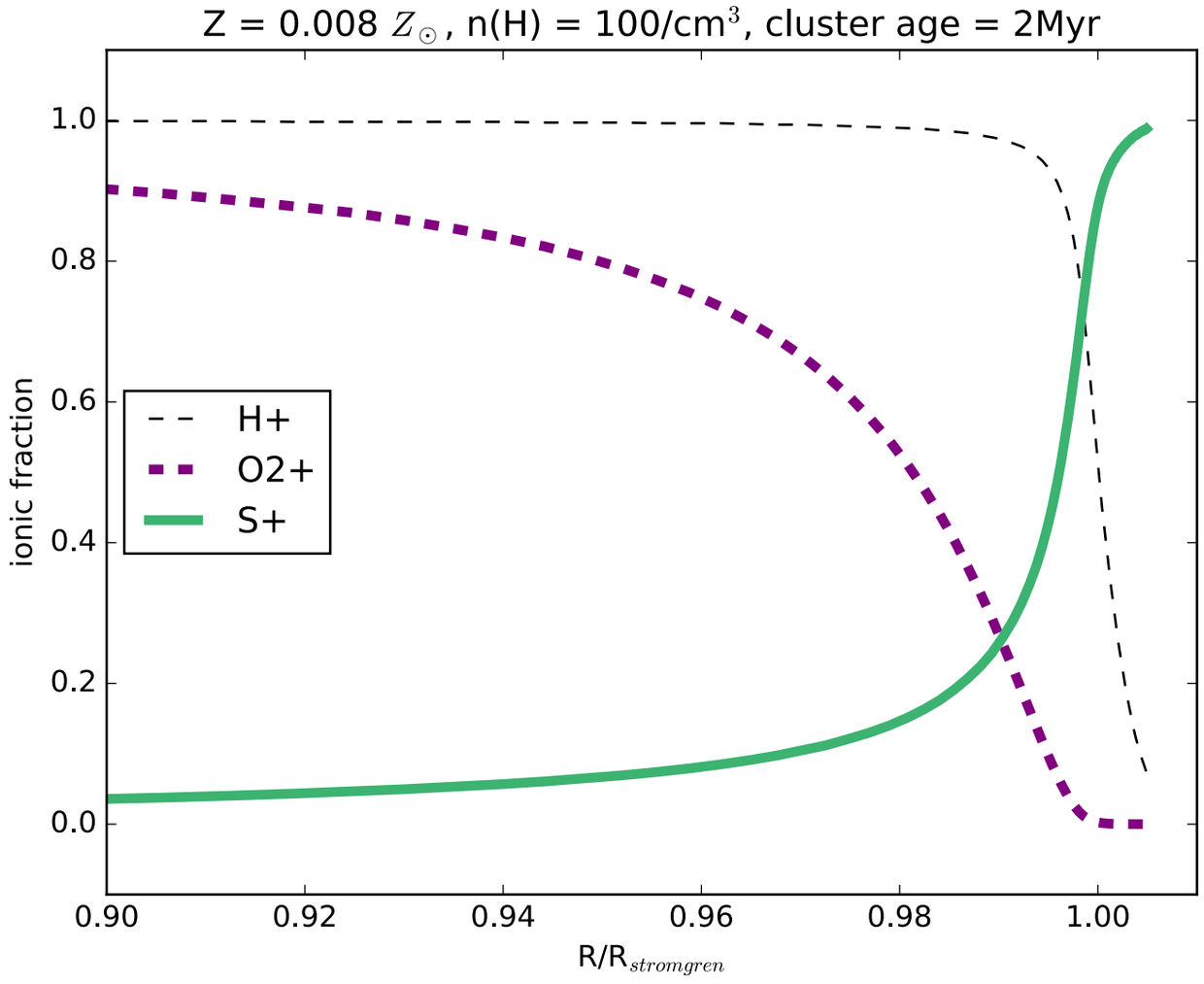


# Properties of the HII regions: ionisation parameter mapping



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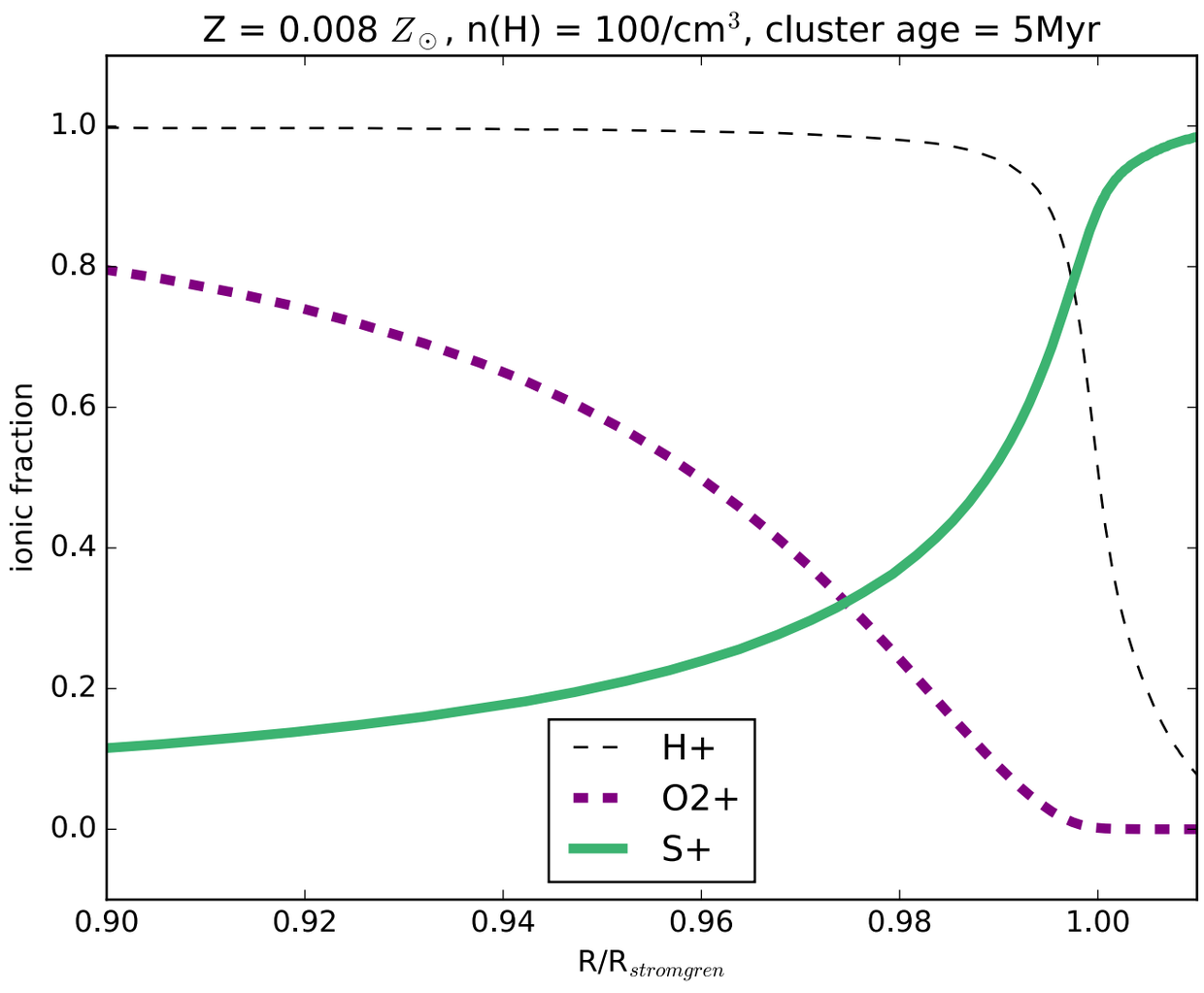

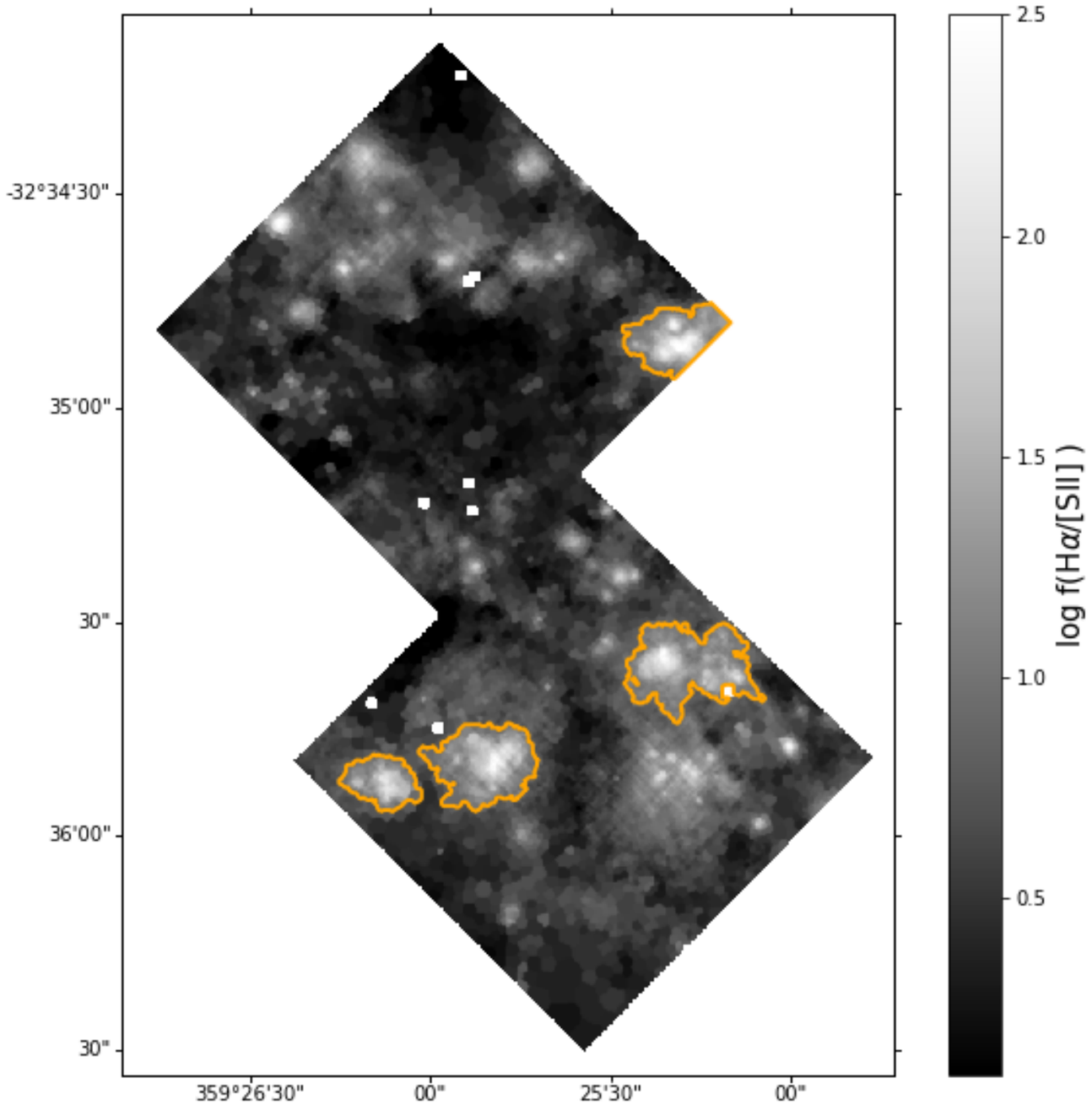
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00"
2.5
2.0
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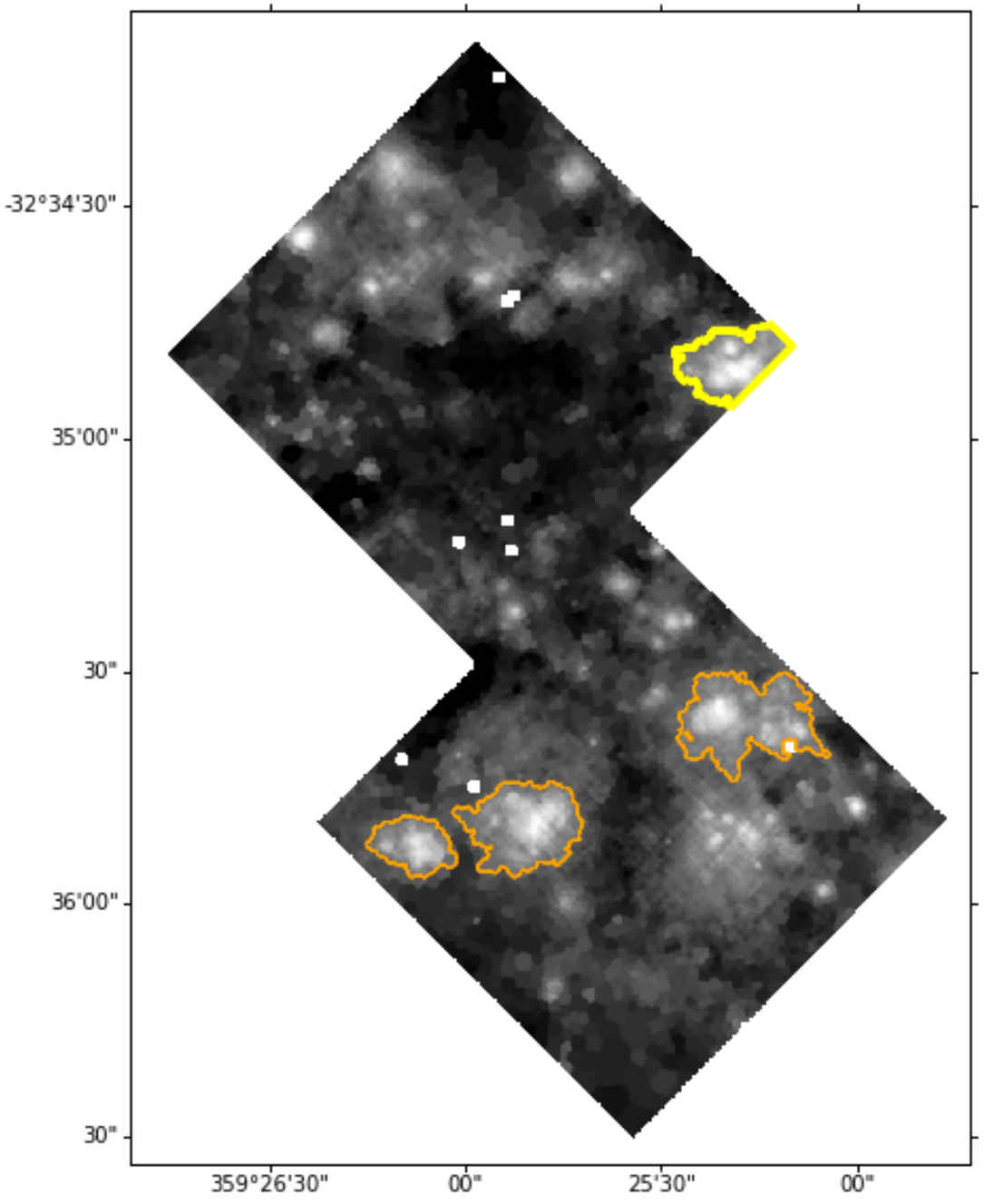
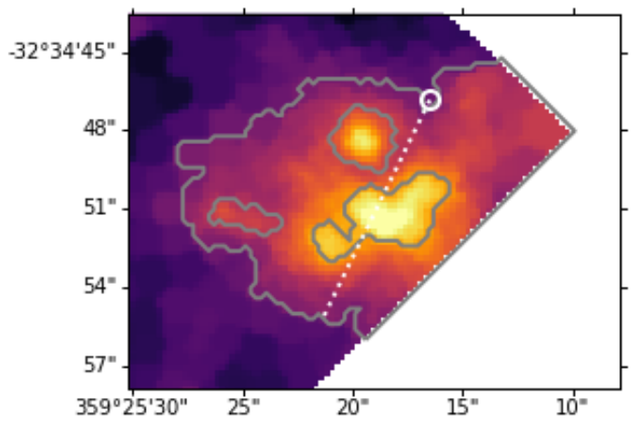
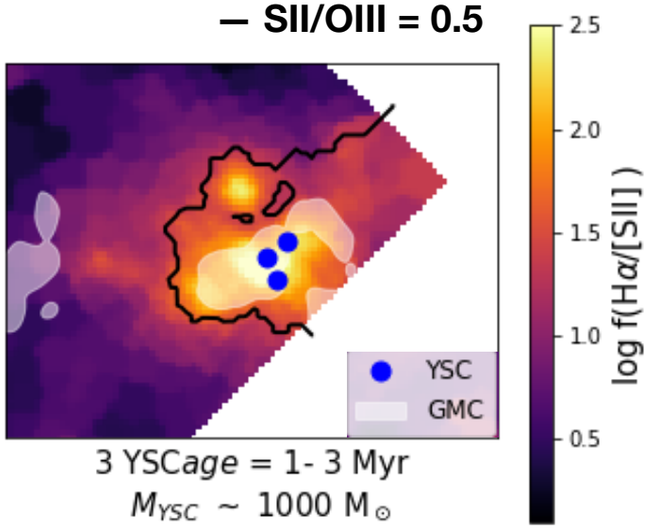



**L(Hα) = 2.3 x $10^{38}$ erg/s**



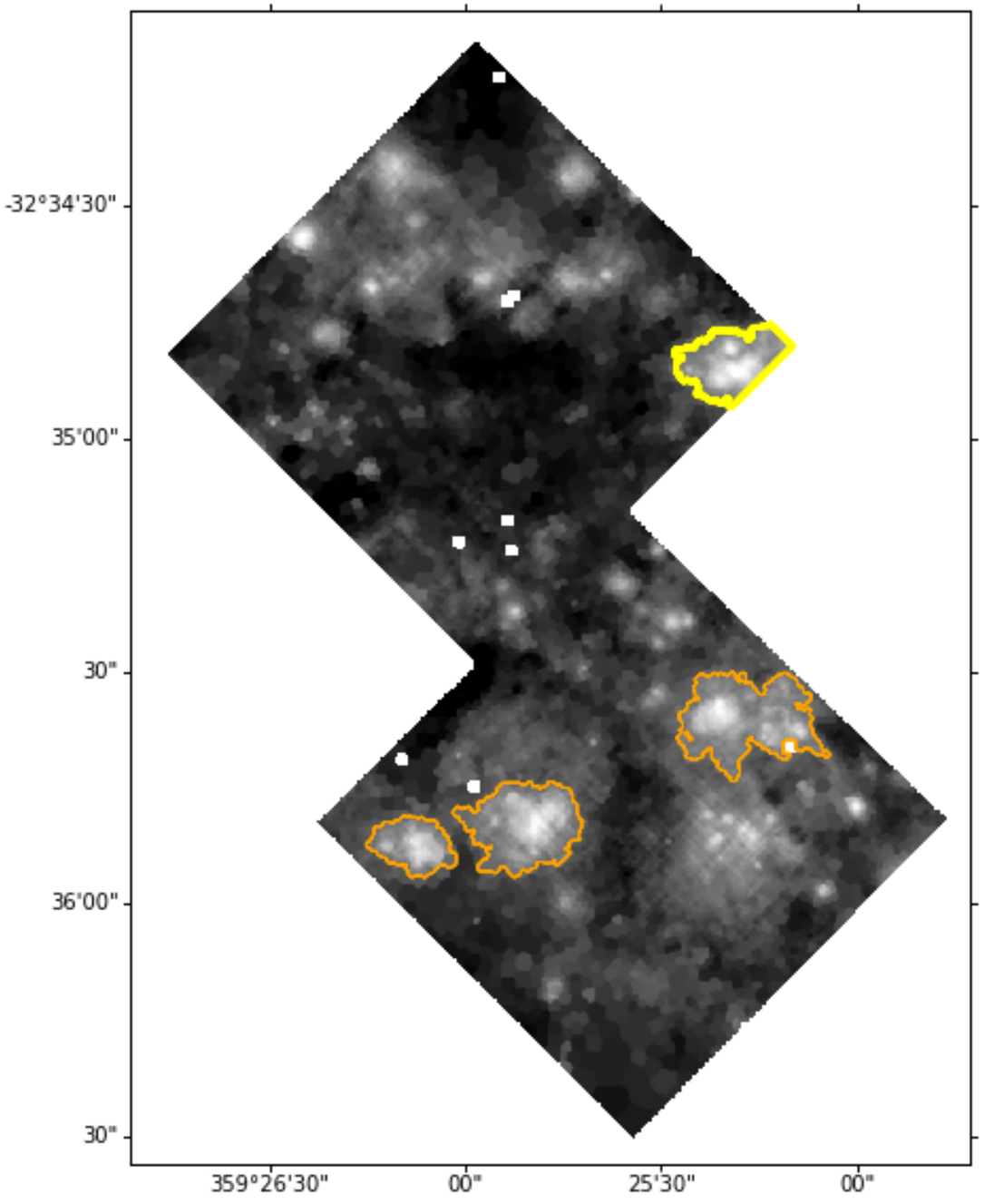

**— SII/OIII = 0.5**




3 YSC*age* = 1- 3 Myr

$M_{YSC}$ ~ 1000 $M_\odot$

$M_{tot,GMC}$ = 2.2E+05 $M_\odot$

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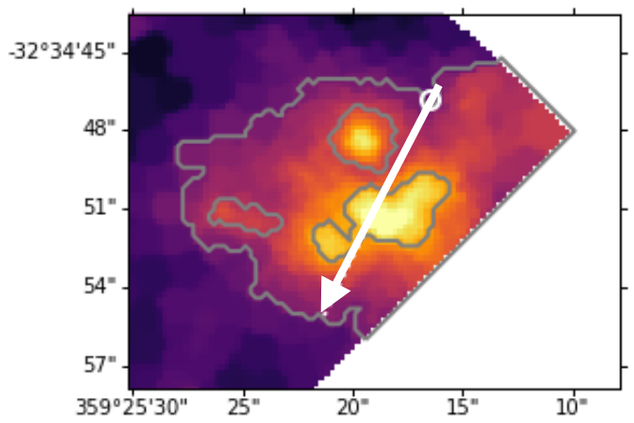


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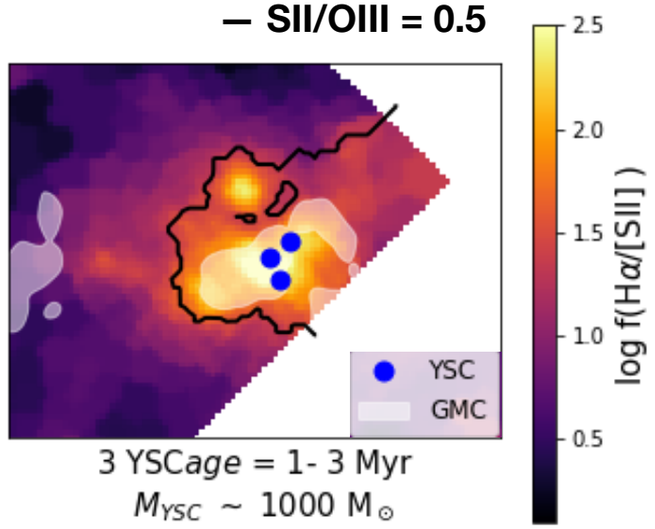


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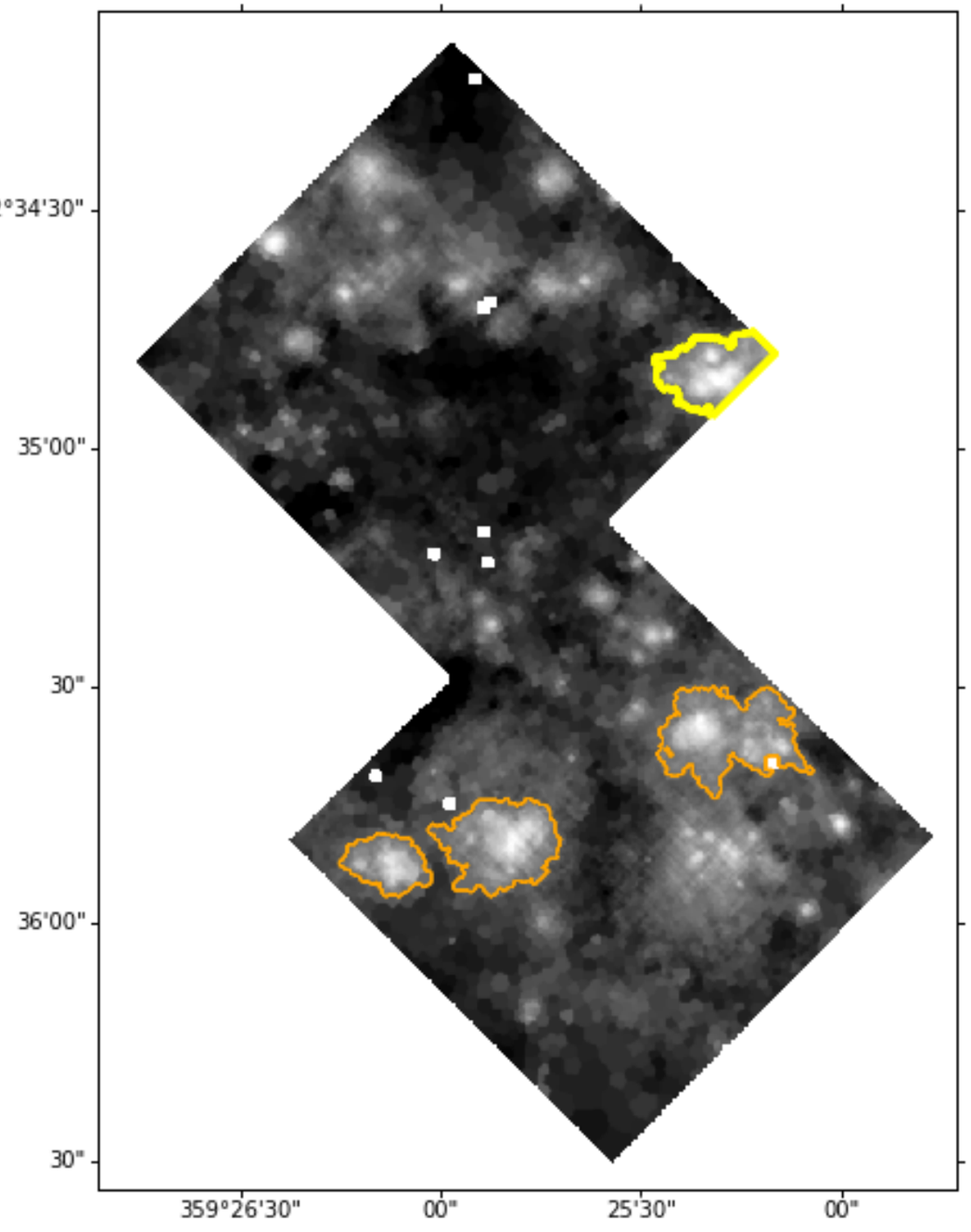


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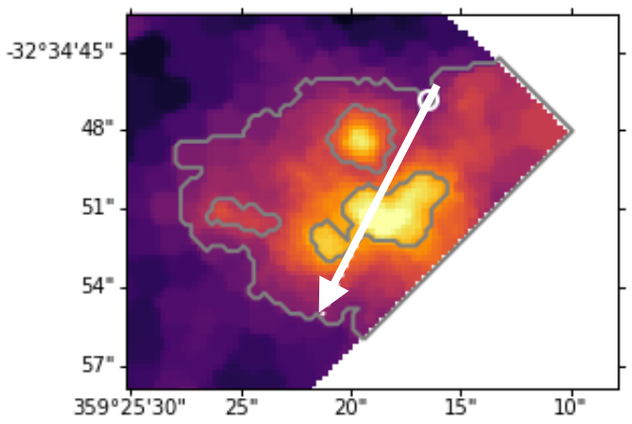


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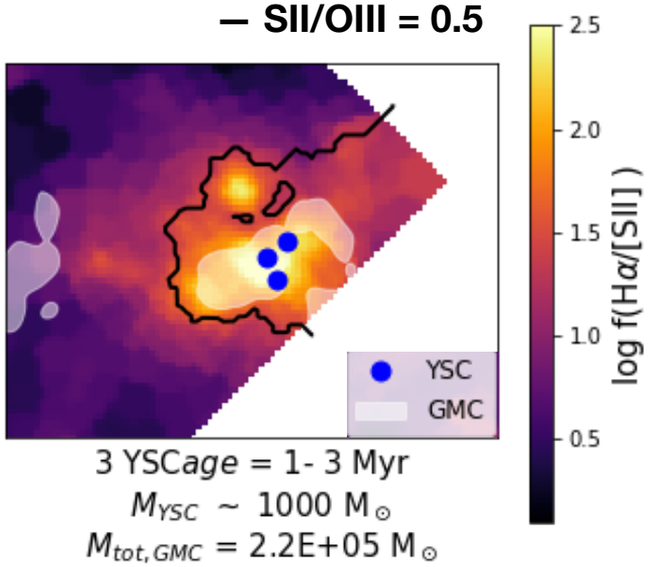


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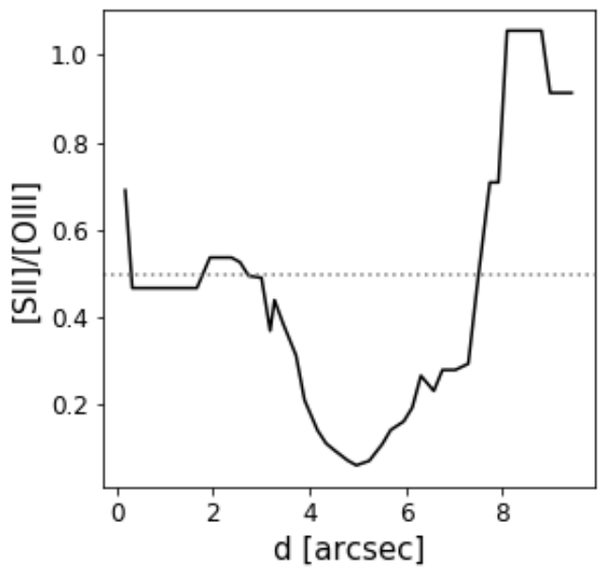
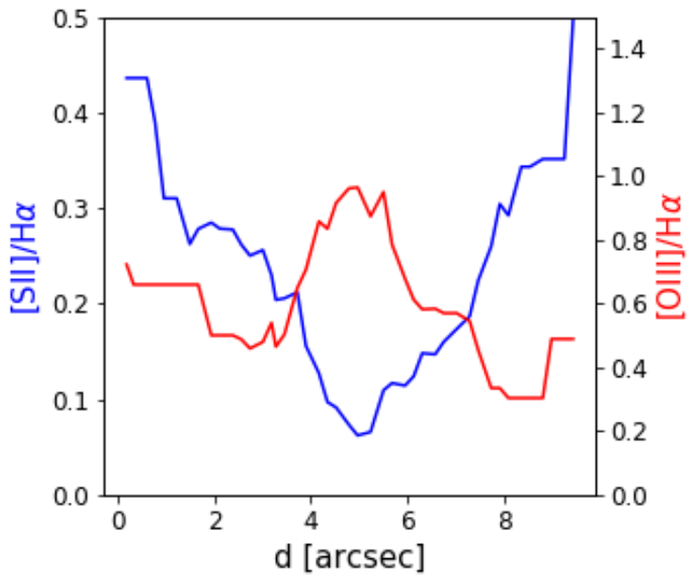
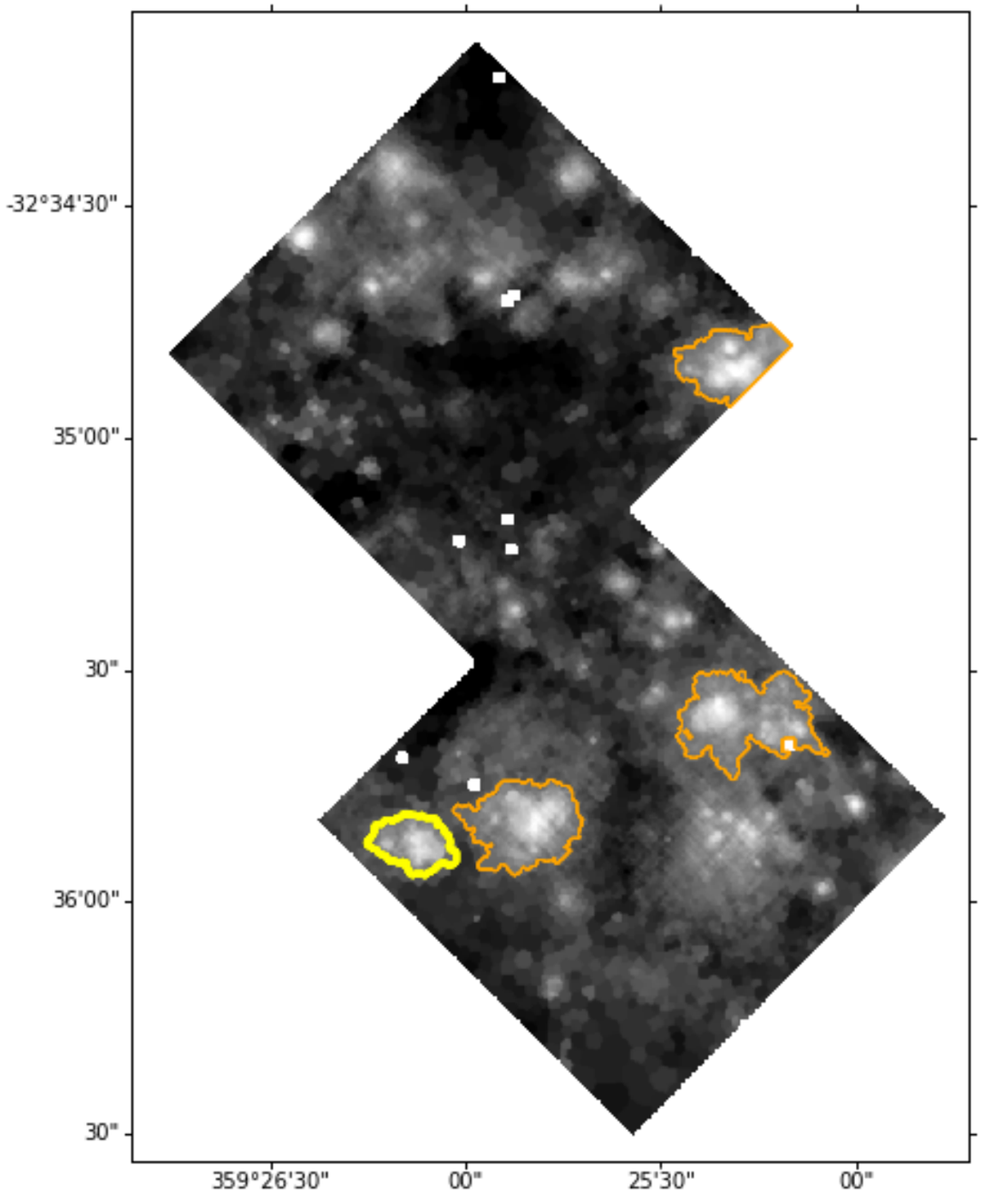
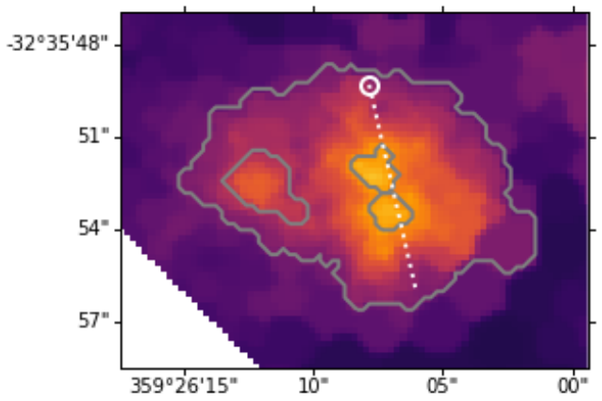





**L(Hα) = 1.0 x $10^{38}$ erg/s**

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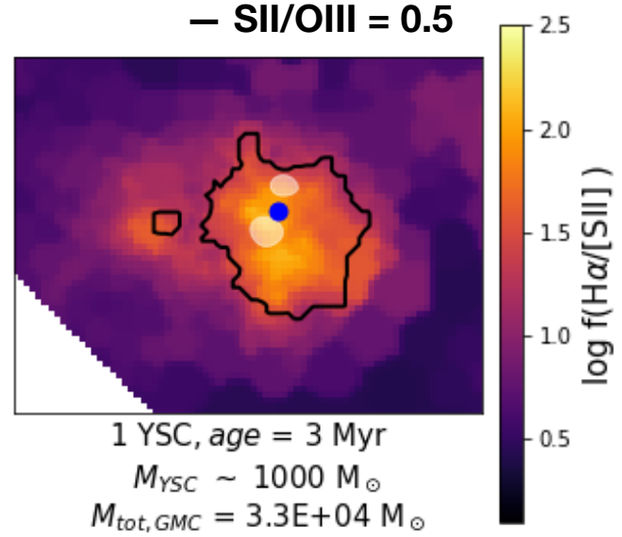
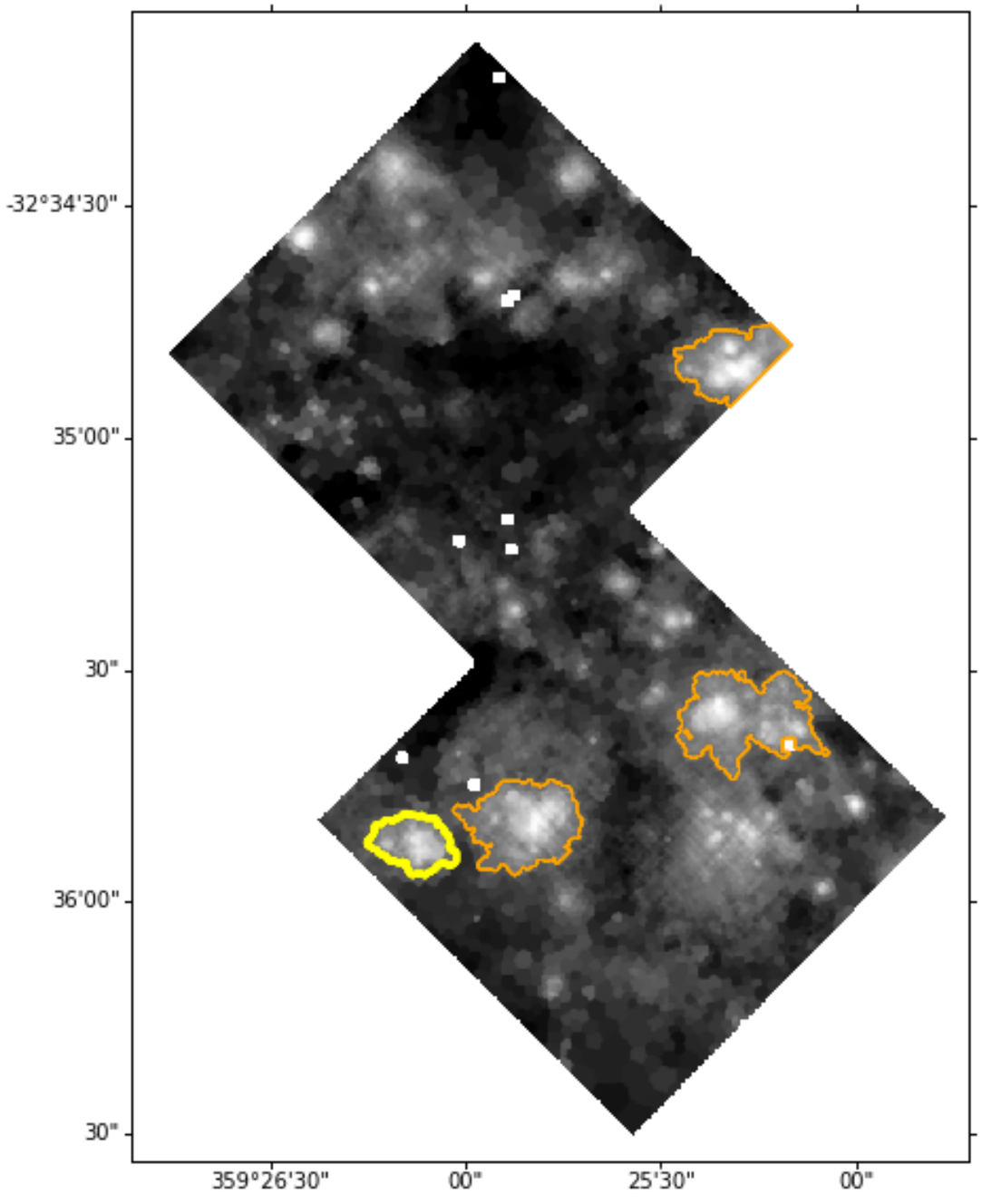



1 YSC, *age* = 3 Myr

$M_{YSC}$ ~ 1000 $M_\odot$

$M_{tot,GMC}$ = 3.3E+04 $M_\odot$

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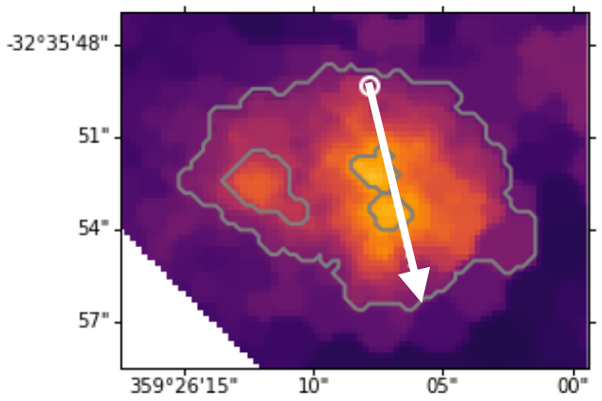


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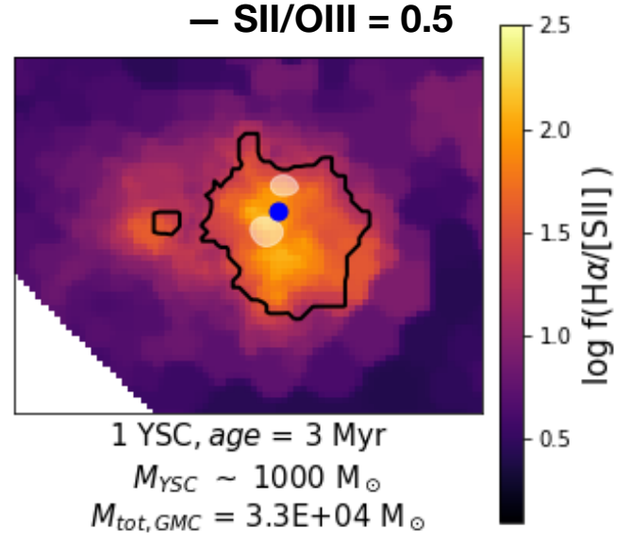


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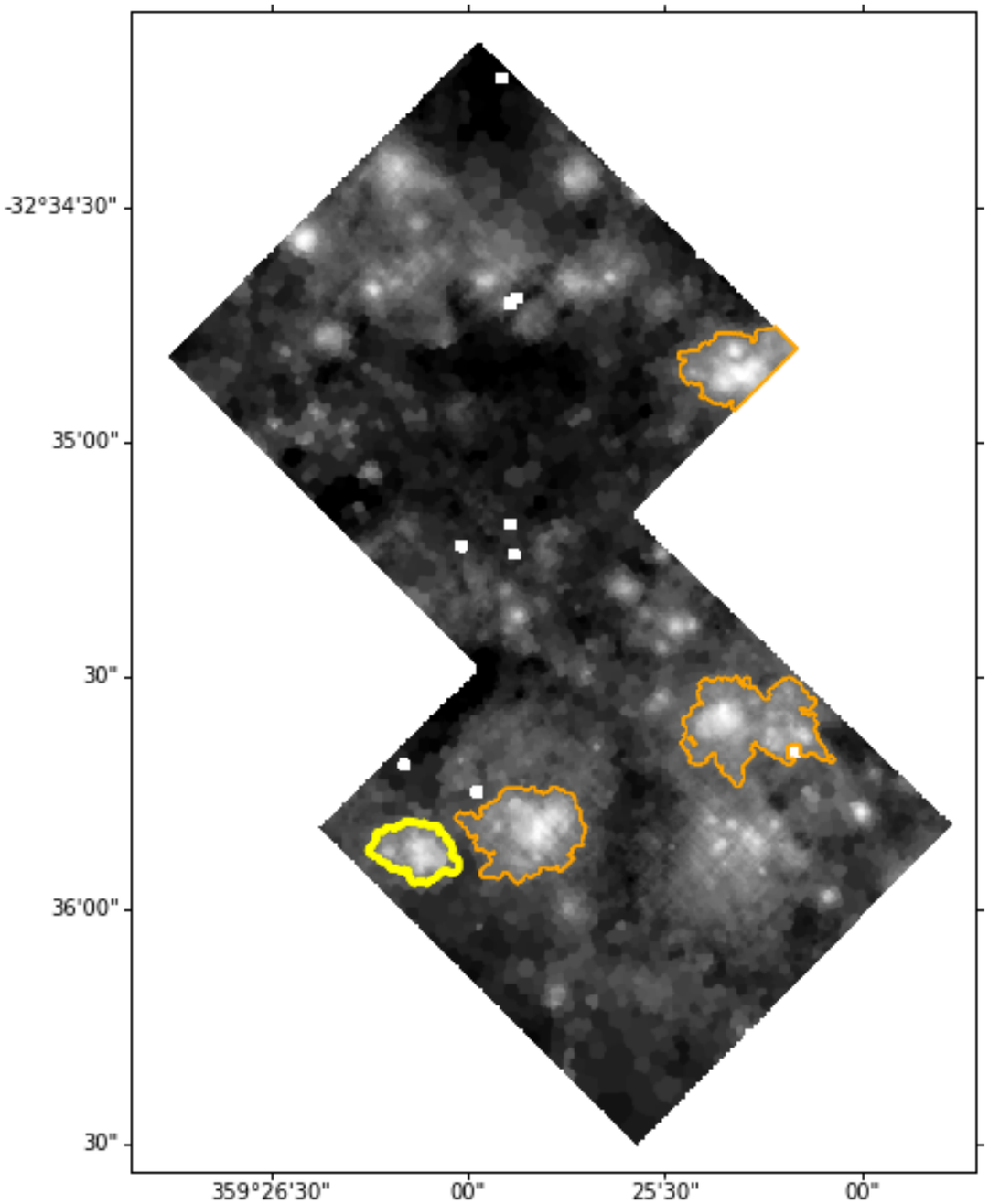


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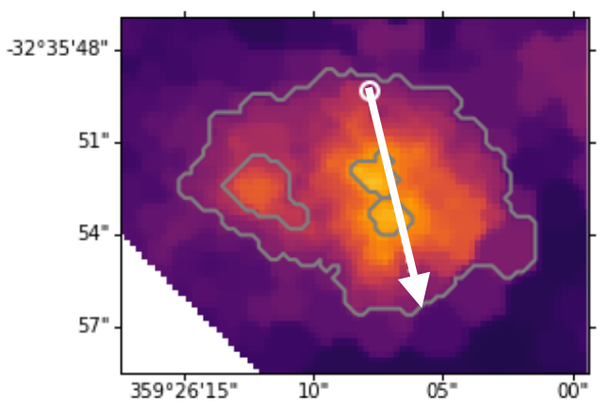


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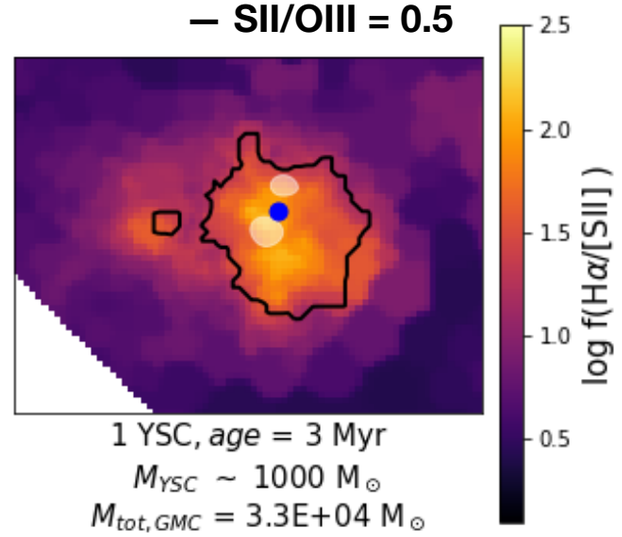


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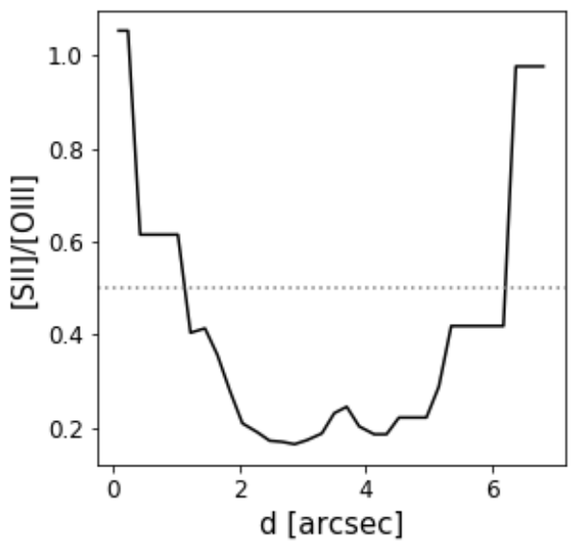
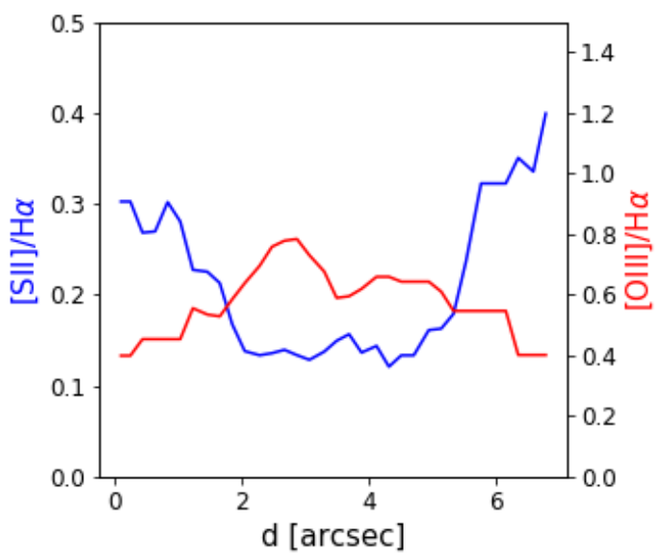
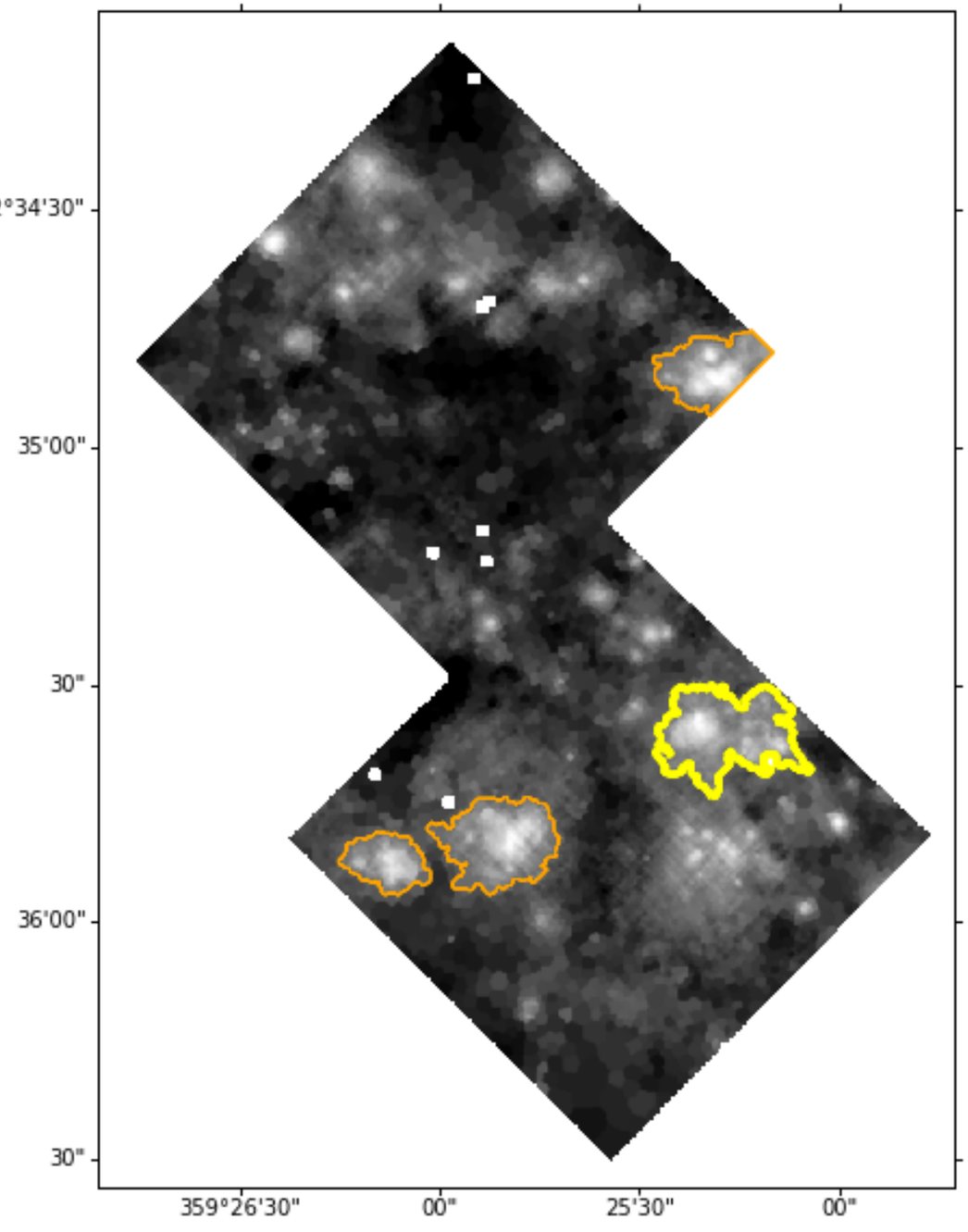
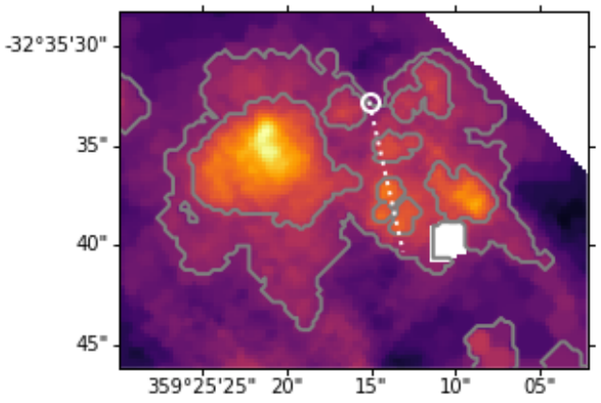





**L(Hα) = 2.2 x $10^{38}$ erg/s**

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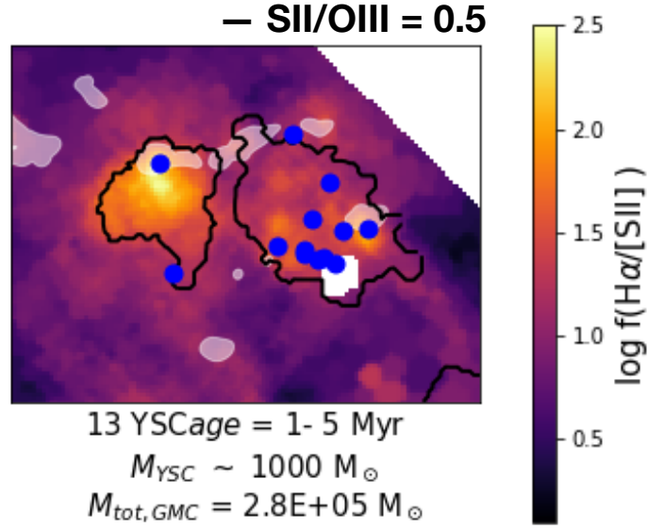


13 YSC*age* = 1- 5 Myr

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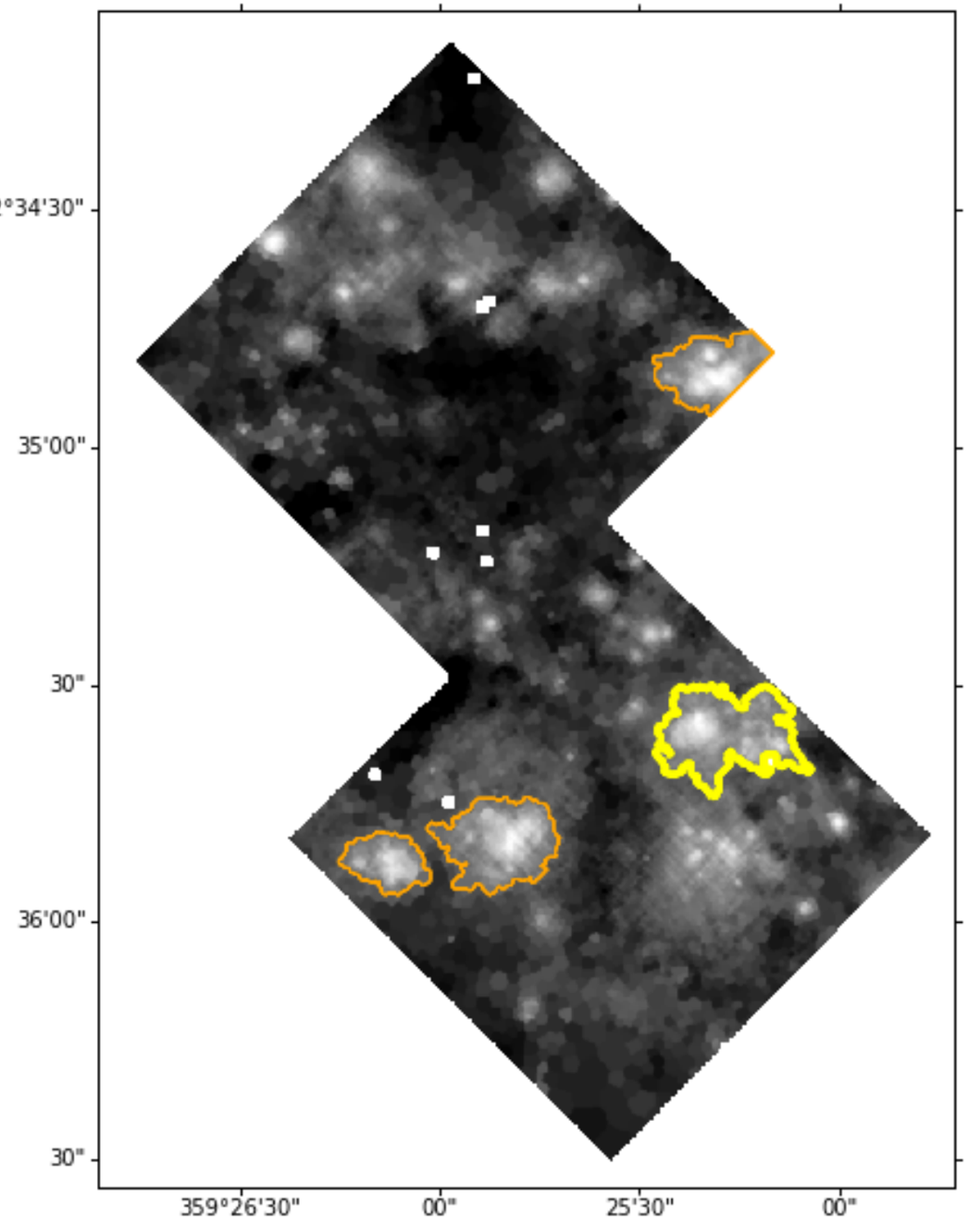


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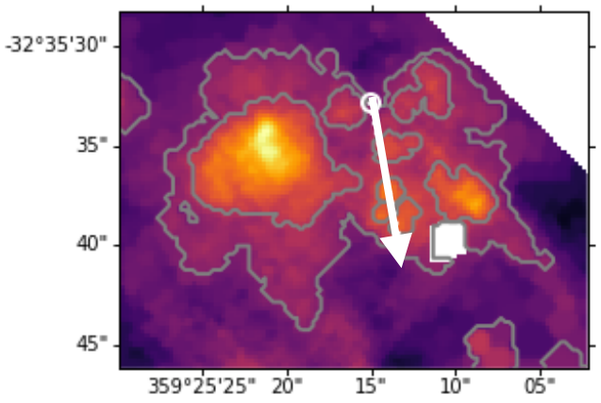


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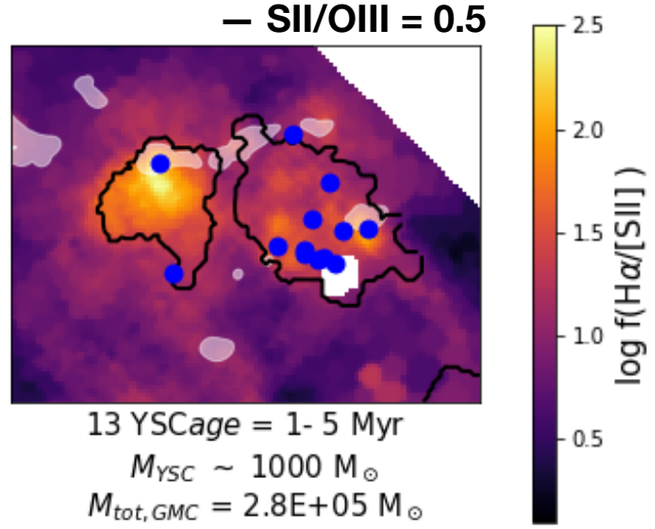


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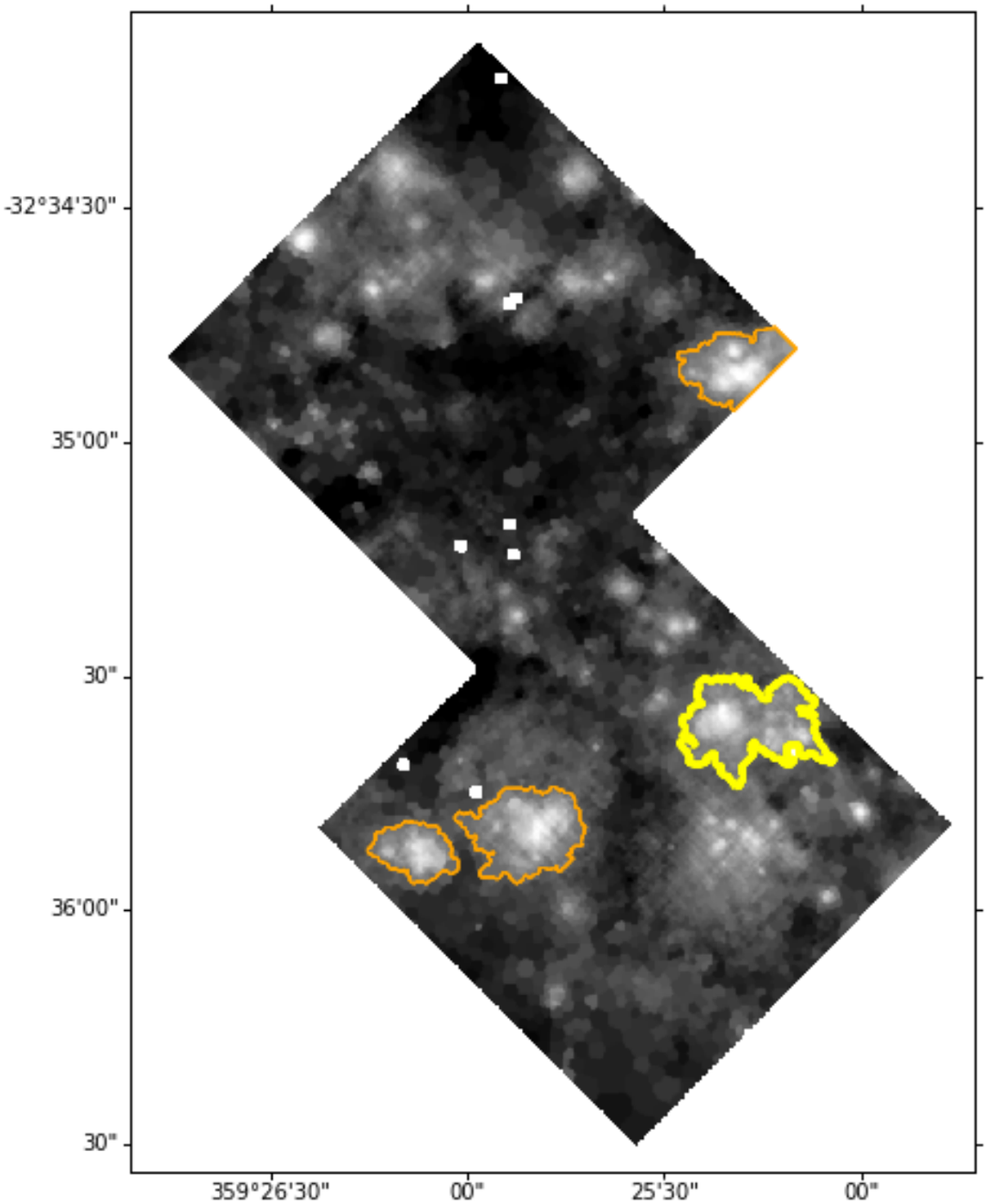


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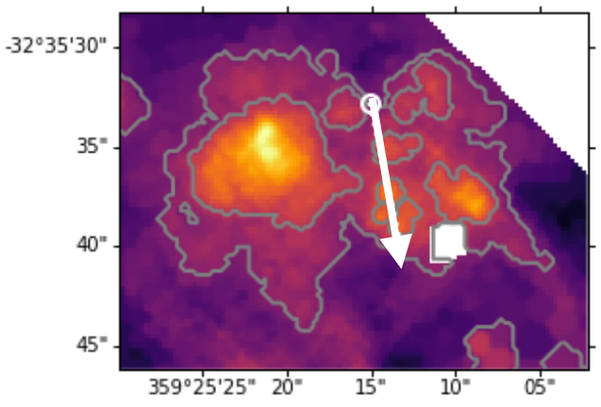


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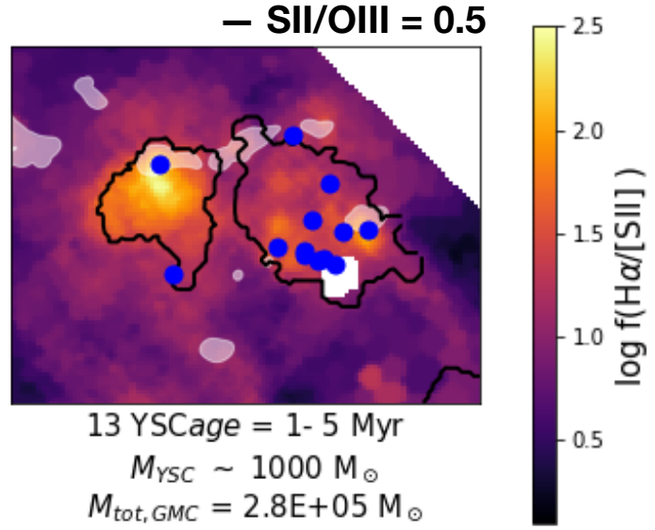
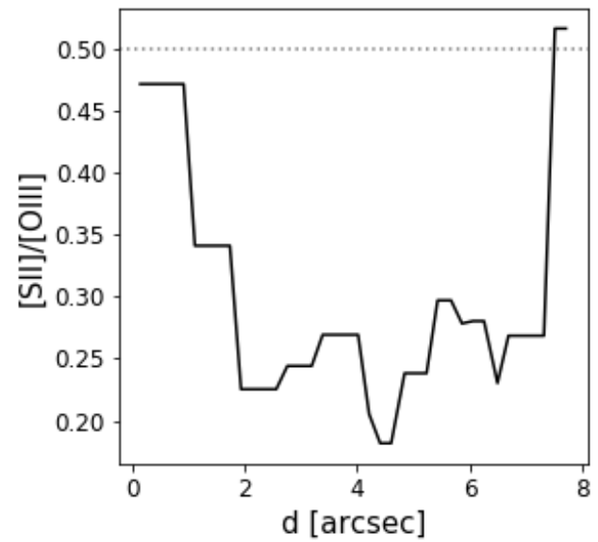
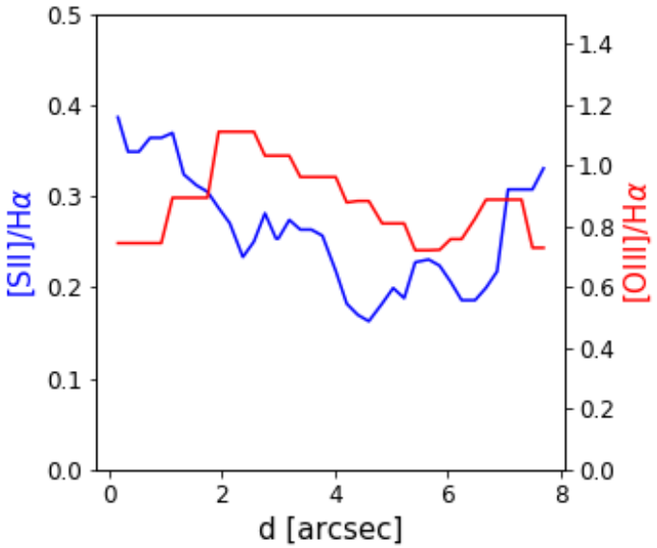
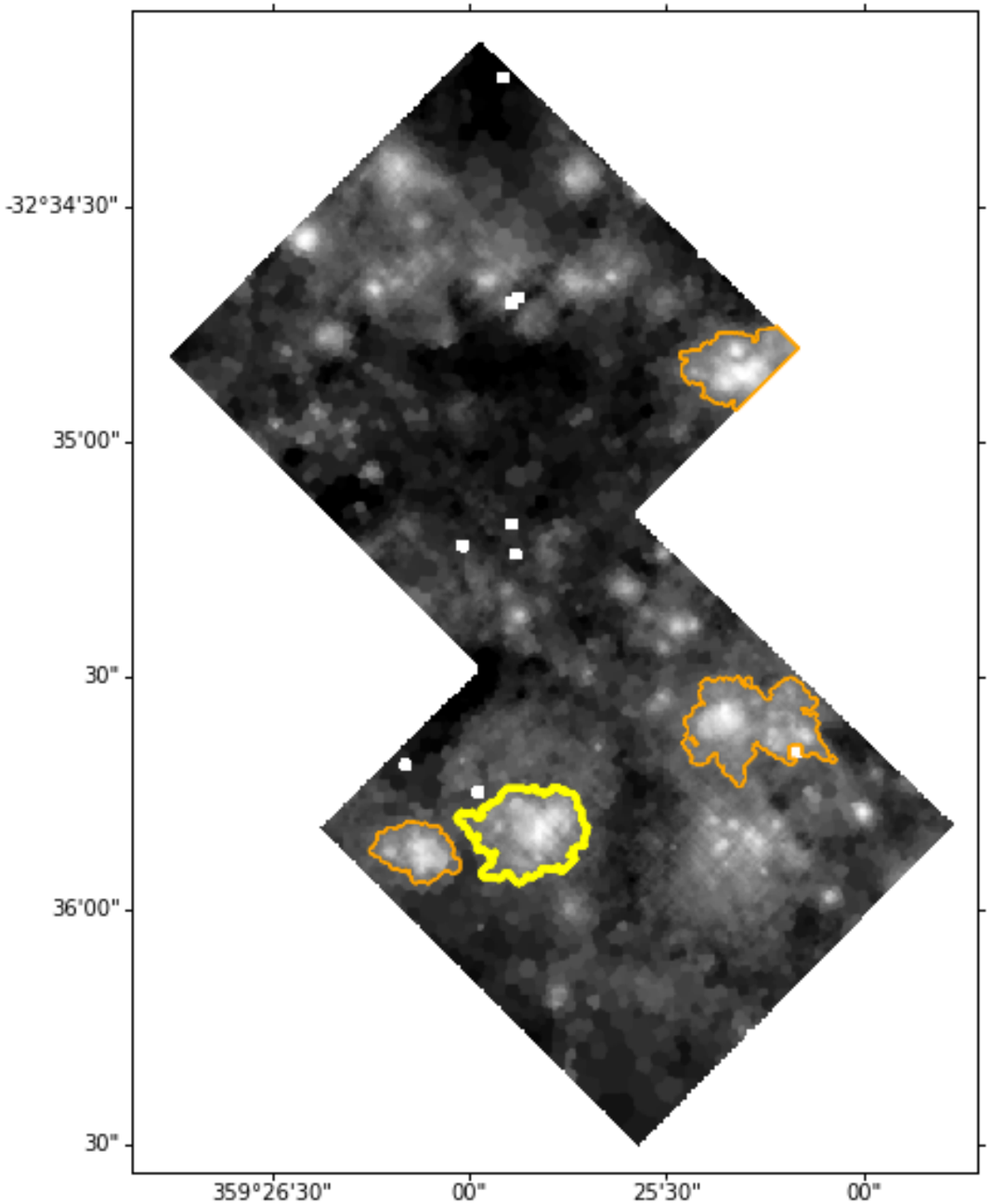
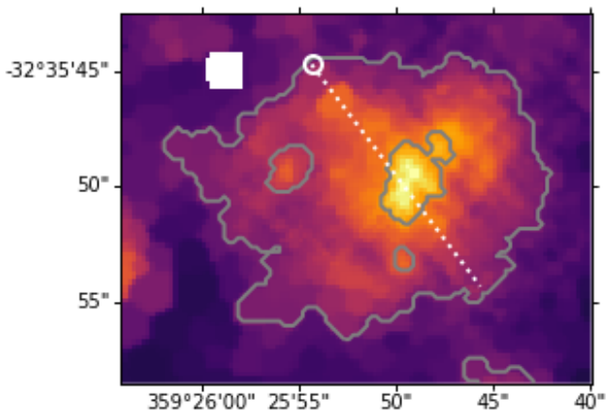


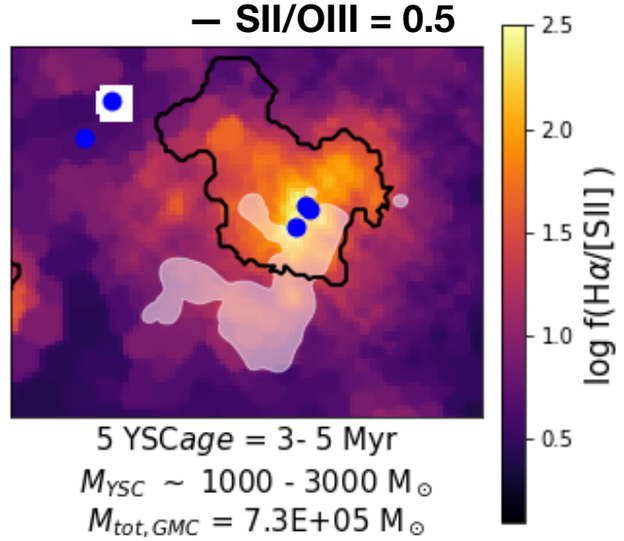






**L(Hα) = 2.0 x $10^{38}$ erg/s**



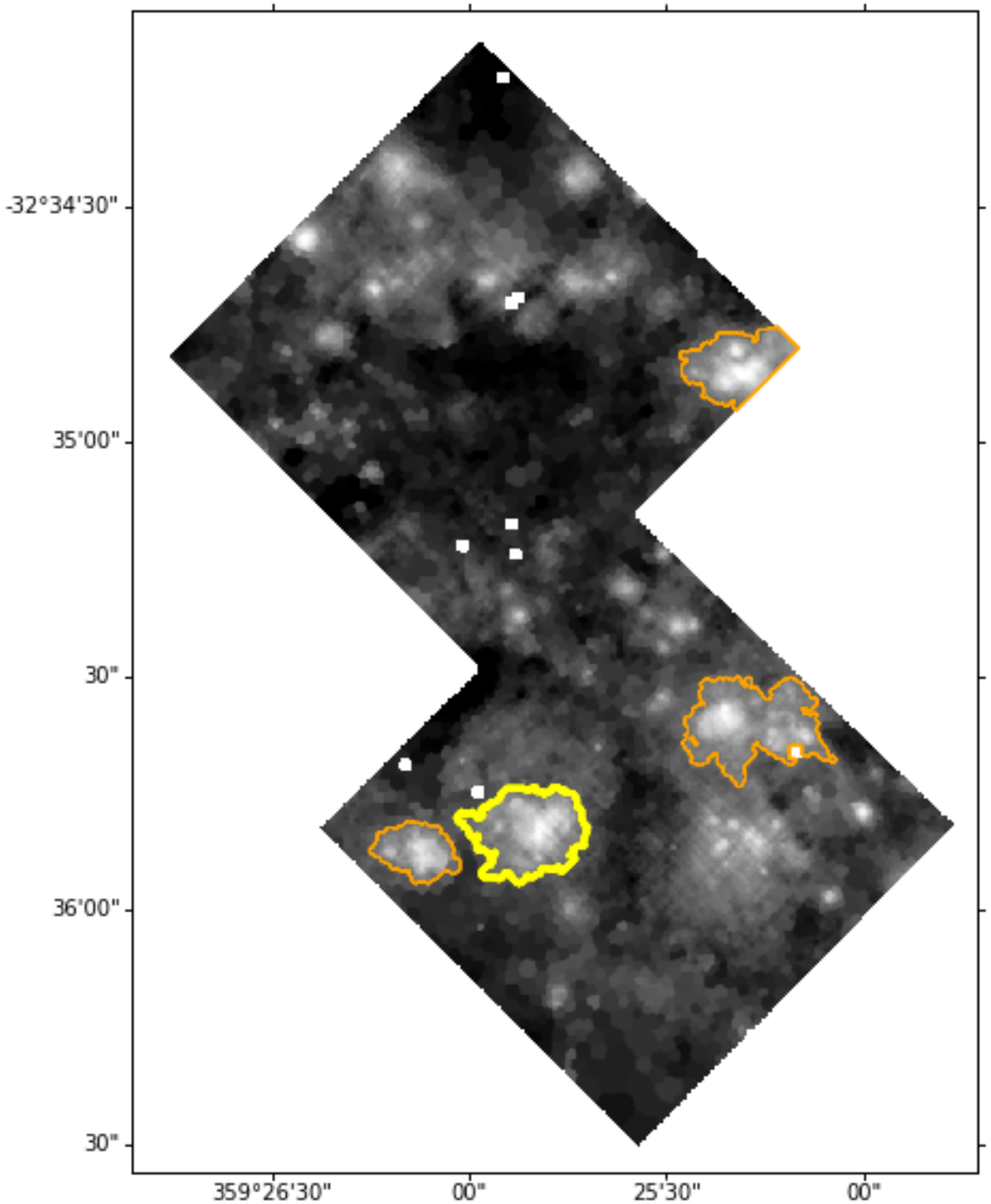

**— SII/OIII = 0.5**




5 YSC*age* = 3- 5 Myr

$M_{YSC}$ ~ 1000 - 3000 $M_\odot$

$M_{tot,GMC}$ = 7.3E+05 $M_\odot$

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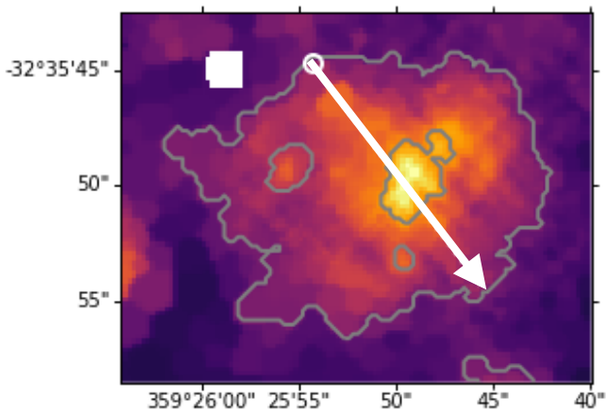


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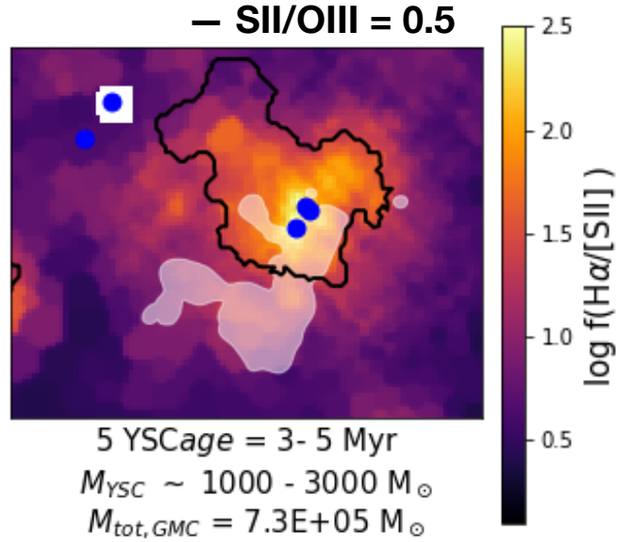


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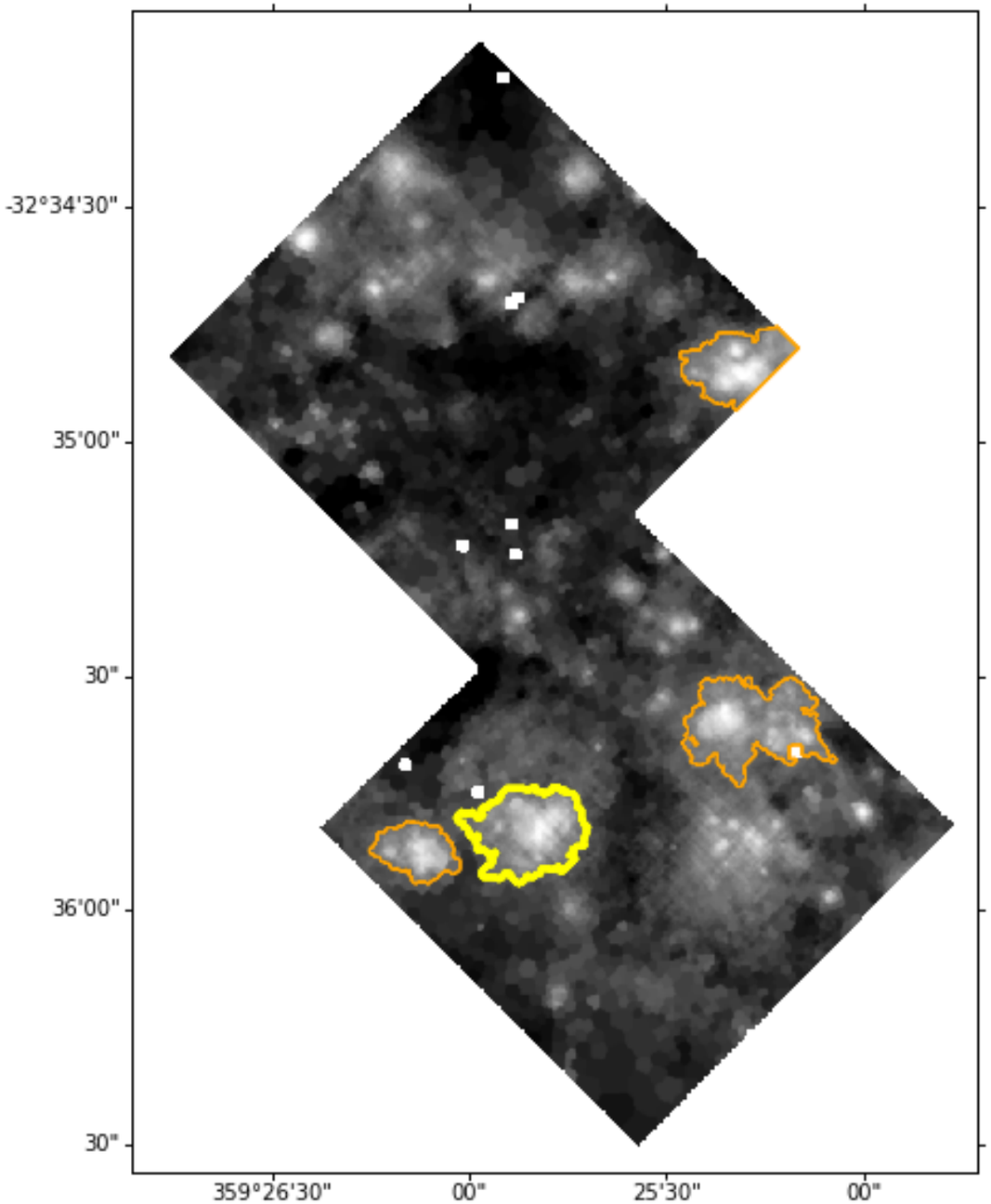


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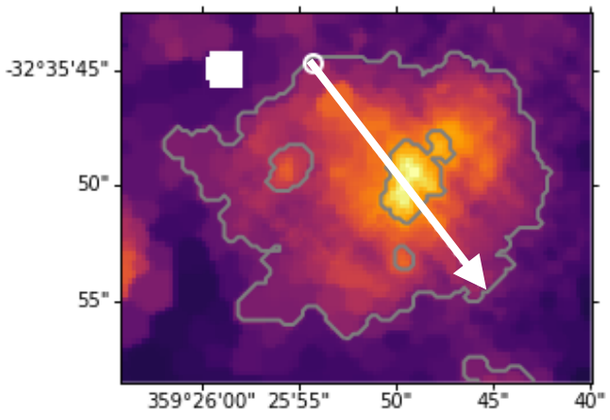


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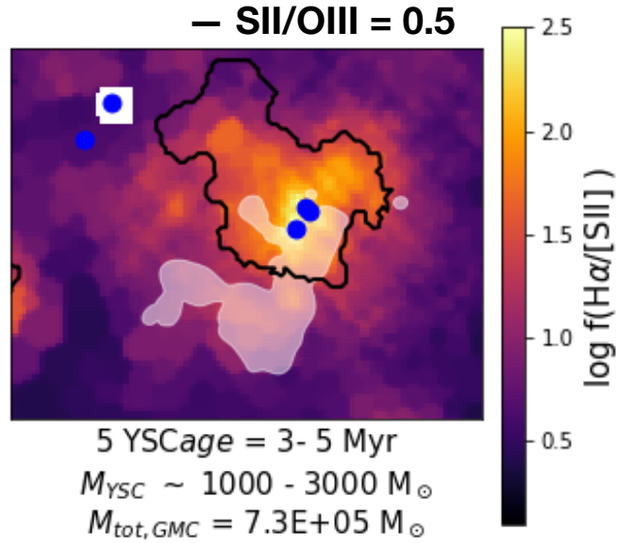


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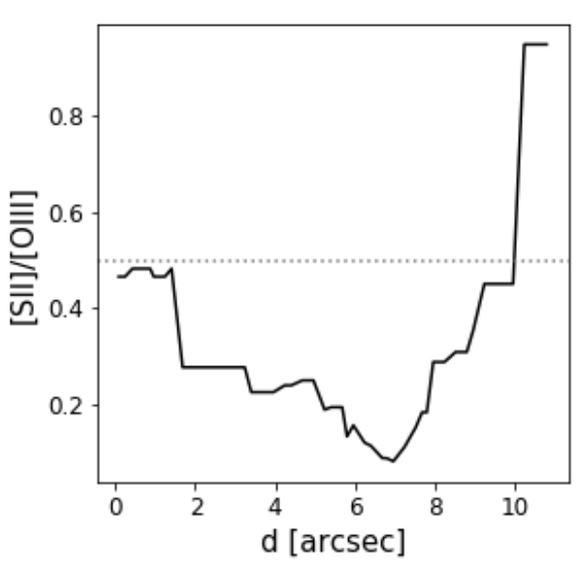
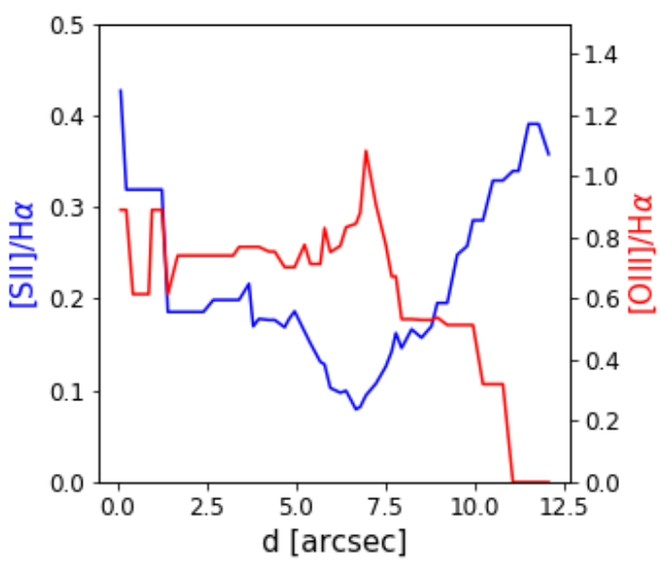


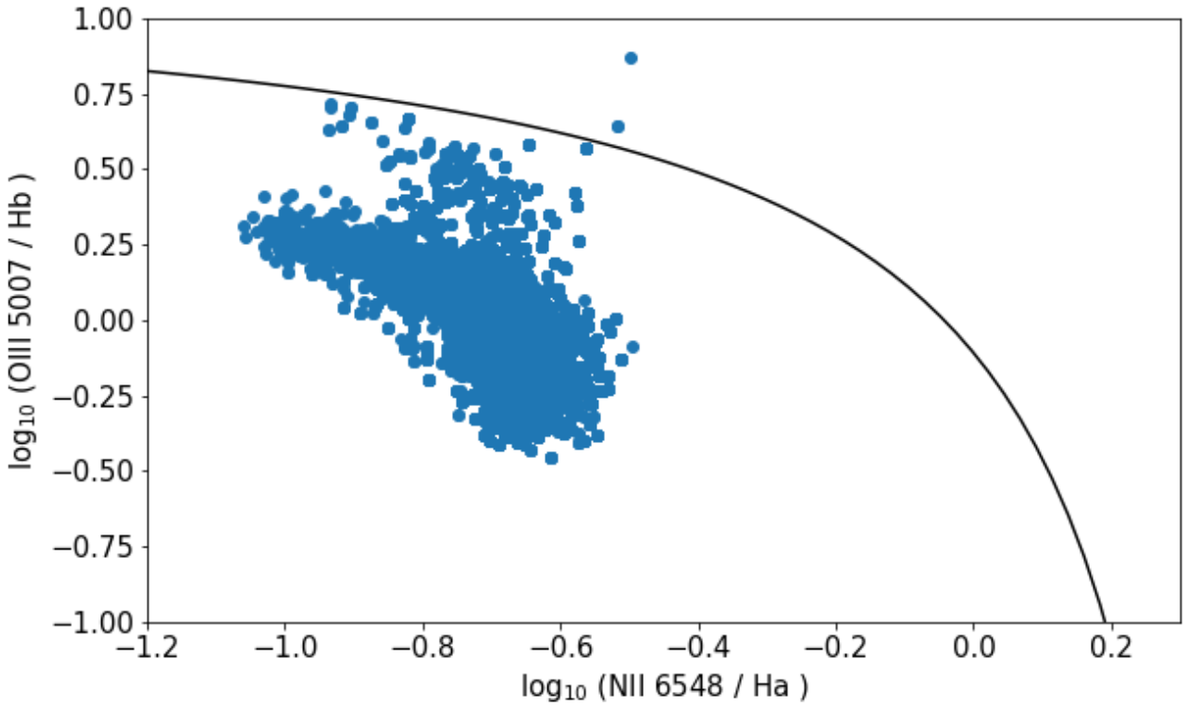



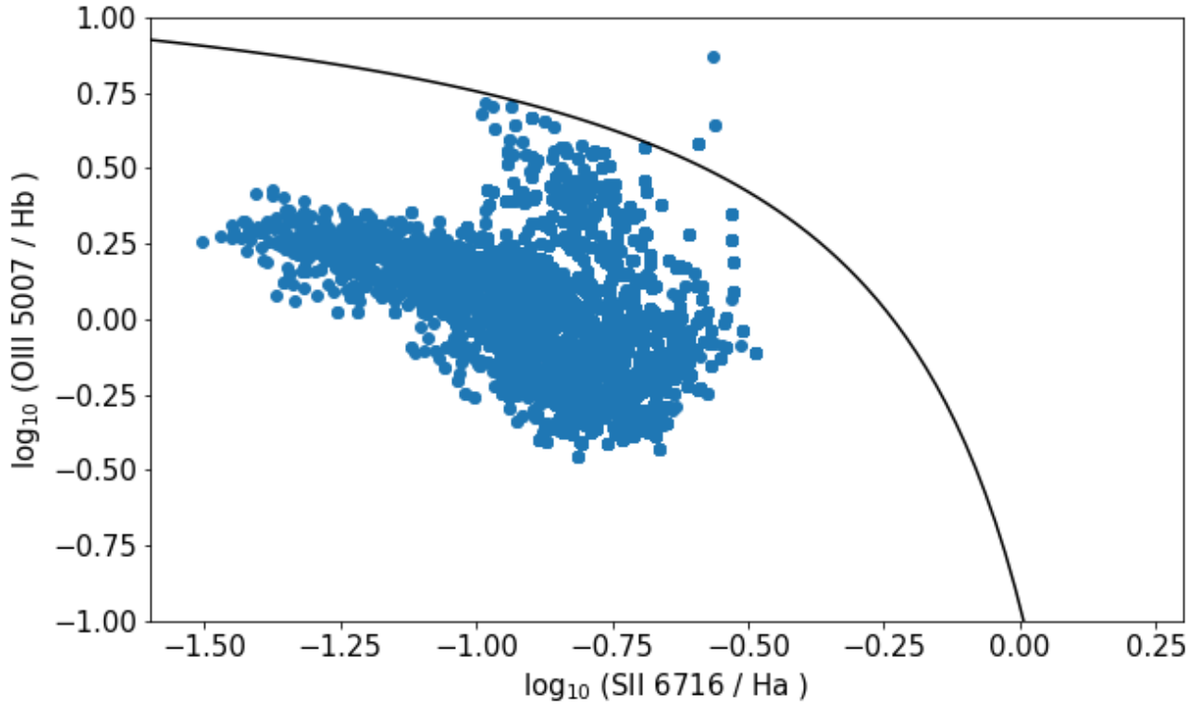
# DIG fraction

- $f_{DIG} = F(H\alpha)_{HII} / F(H\alpha)_{outside}$

- $f_{DIG}$ ~ 0.61 (Hα/SII-selected HII regions)
  $f_{DIG}$ ~ 0.53 (Hα-selected HII regions)

- Distribution of DIG spaxels:



# Conclusion and future work

- We select a sample of HII regions and investigate their ionisation structure using IPM, finding evidence for LyC leaking in at least 2 of the regions

- Next:
  - qualitative estimate of the total $f_{esc}$

*Pellegrini+ 2012*

$$\langle f_{\rm esc} \rangle = \frac{\sum_i L_{{\rm esc},i}}{\sum_i (L_{{\rm esc},i} + L_i)}$$

$$L_{\rm esc} = \sum_i \left( L_i \times \frac{f_{{\rm esc},i}}{1 - f_{{\rm esc},i}} \right)$$

- More quantitatively: YSCs as source of DIG ionization?

$Q(H_0)_{expected}$ ⟷ $Q(H_0)_{observed} \propto L(H\alpha)$

# *Backup slides*

# Estimation of $f_{esc,\,gal}$

$$f_{\mathrm{esc,gal}} = (L_{\mathrm{esc}} - L_{\mathrm{DIG}})/L_{\mathrm{tot}}$$

$$L_{\mathrm{esc}} = \sum_i \left( L_i \times \frac{f_{\mathrm{esc},i}}{1 - f_{\mathrm{esc},i}} \right)$$

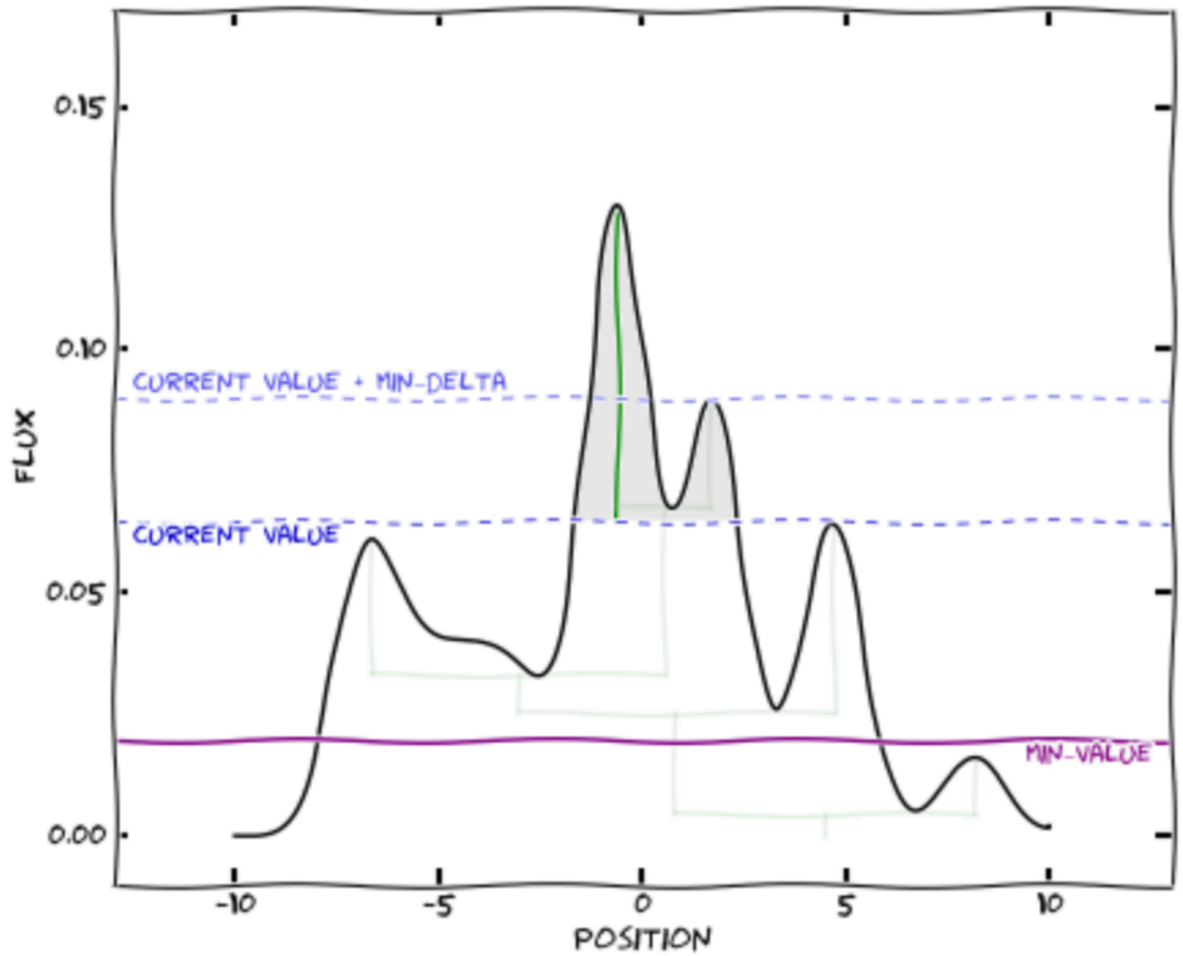
total HII regions
“escape luminosity”

$L_{tot} = L + L_{esc}$

**… + contribution from massive field stars**

# HII regions selection

- Parameters:
  - tree constructed down to 3.7 $\sigma_{bkg}$
  - two structures merged when their peak values are < 0.6 $\sigma_{bkg}$ apart.




*http:// dendrograms.org*