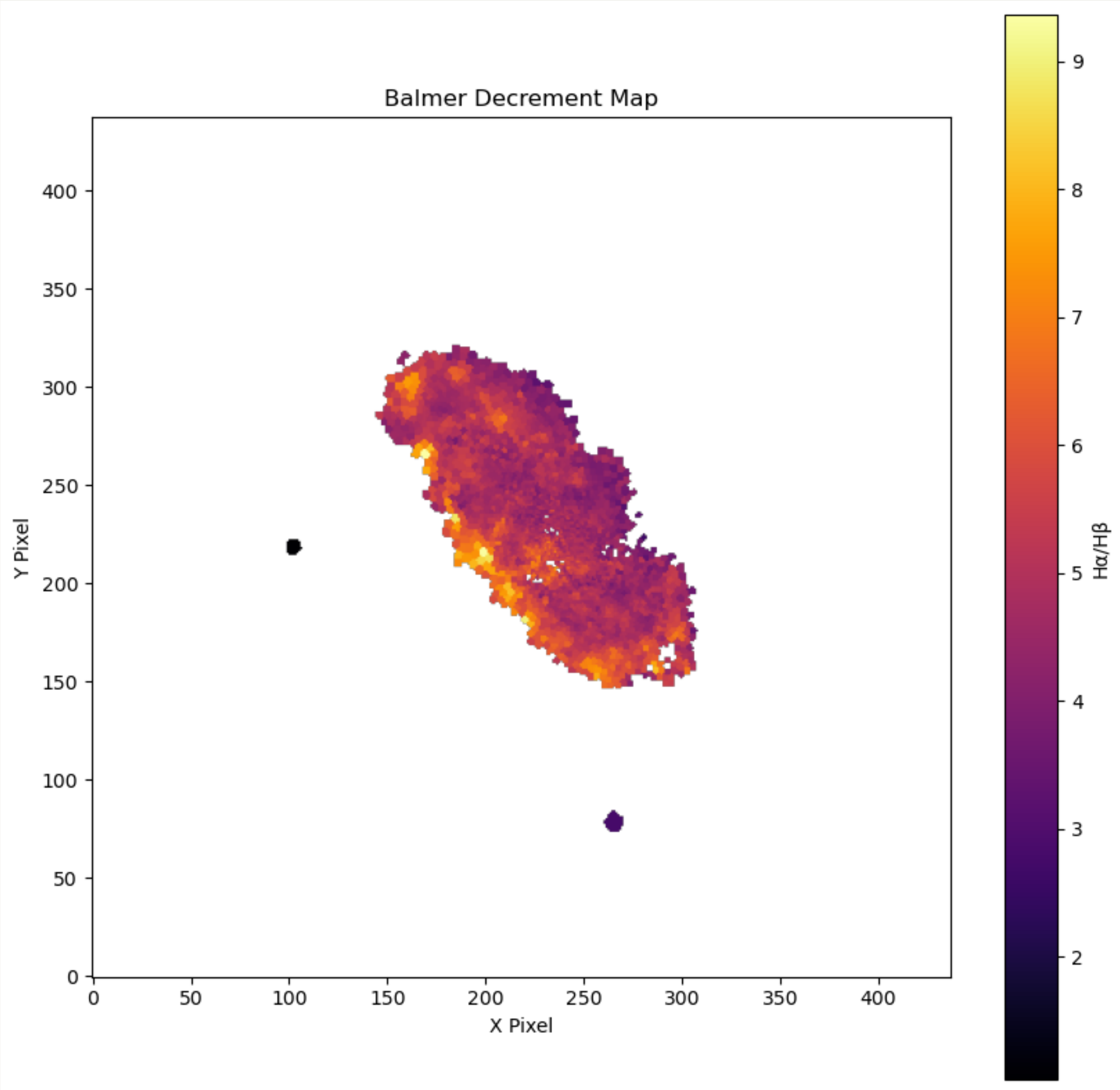
20250605 BD BPT SFR.md

Be careful with `1e-20` and 10^{20}, not `10e-20`!!!

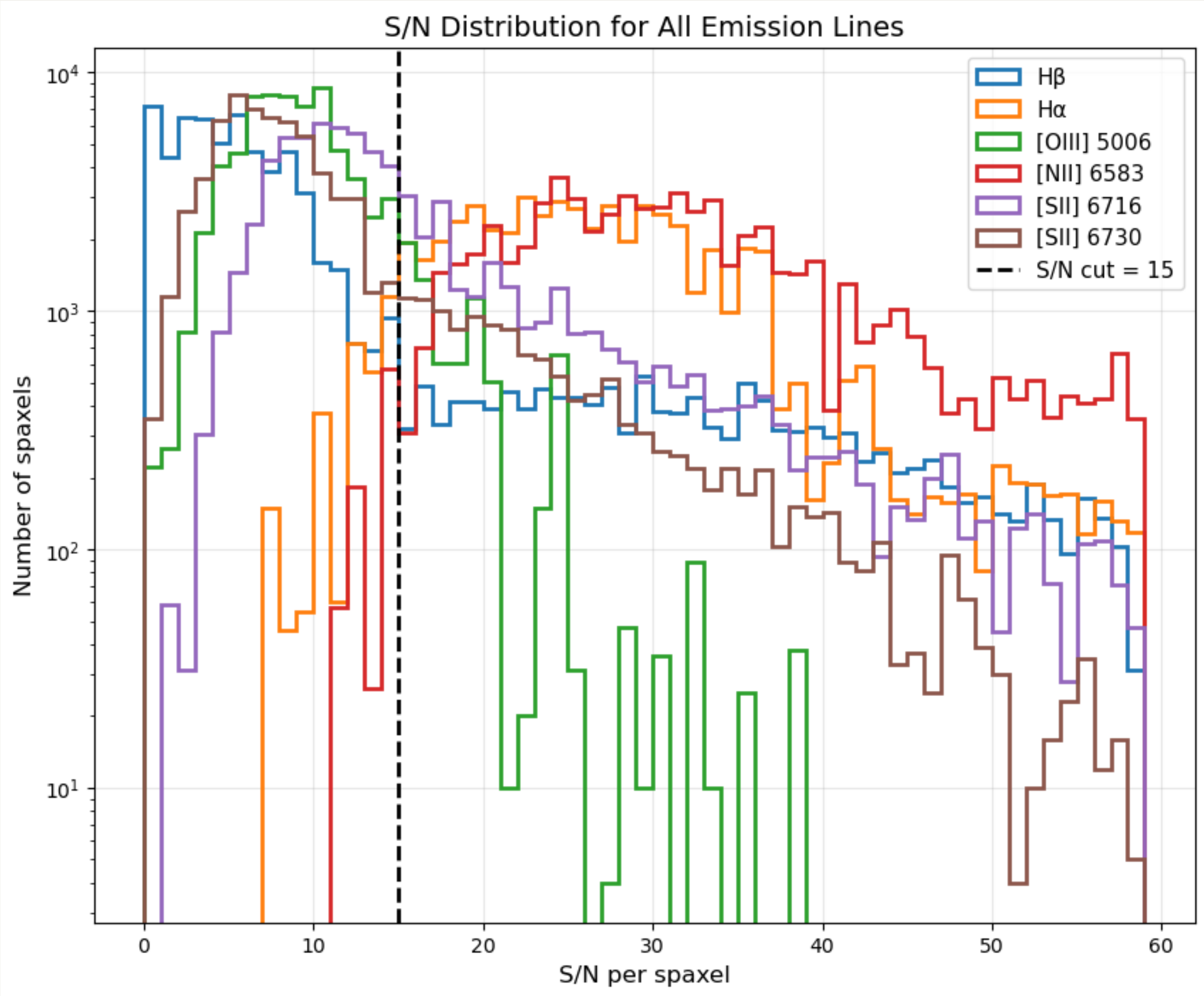
Balmer decrement

At first, I use a threadhold that $\mathrm{flux}/\mathrm{flux}_{\mathrm{err}} > 5$ for both Hα and Hβ lines, but for the outer region, a few bins have $\frac{H_\alpha}{H_\beta} < 2.86$. After tweaking, I decide to use the threadhold at 15 so that only two bins have negative $E(B-V)_{BD} < 0$.

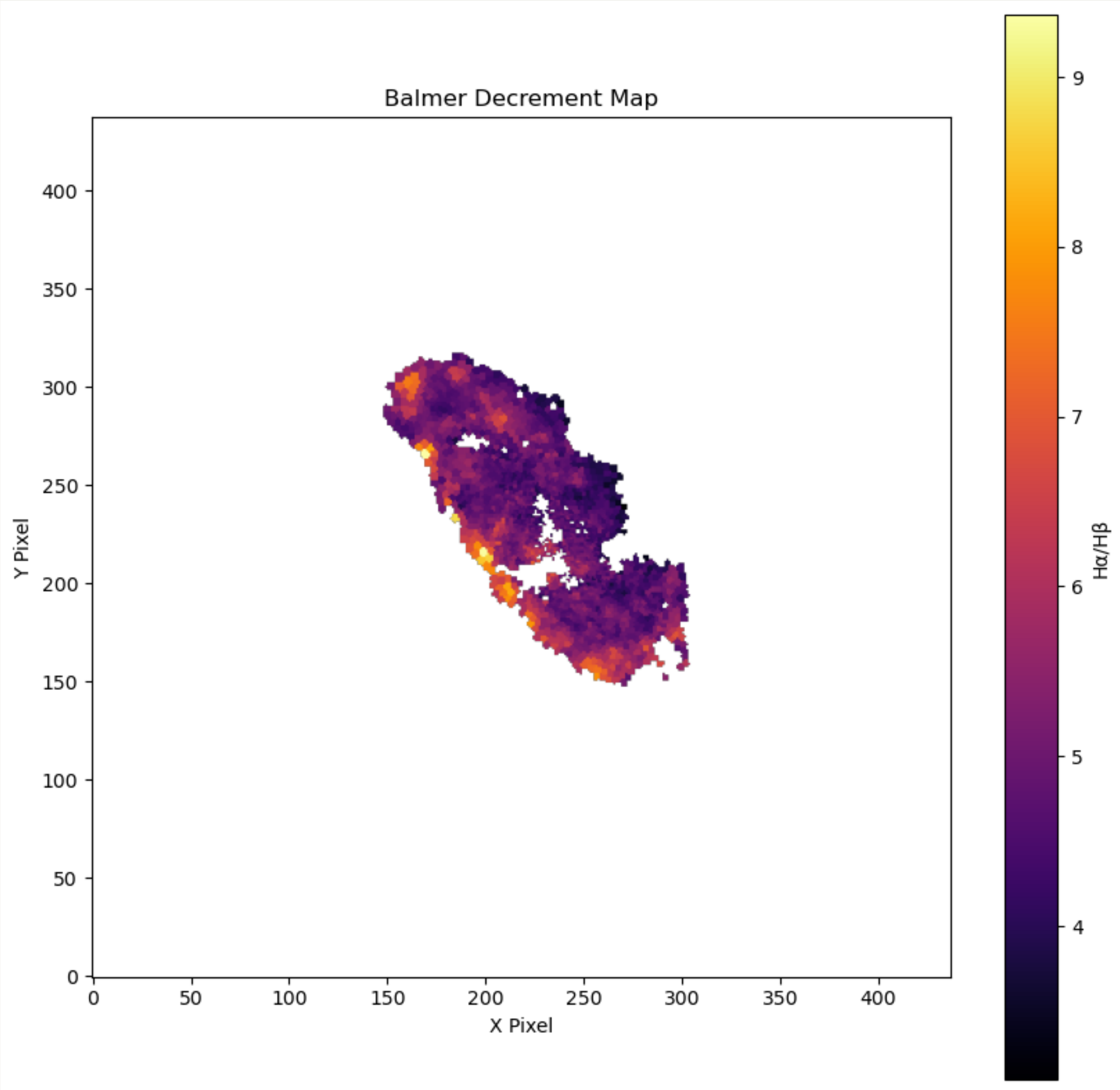



```
Lowest Balmer Decrement: 1.0401808450211778
Highest Balmer Decrement: 9.36650837704988
Lowest 5 unique non-NaN Balmer Decrement values: [1.04018085
2.65574445 2.82774723 3.09627082 3.22428465]
```

Below is the histogram of SNR for all emission lines:



In fact, at least 22 can get rid of these two bin:

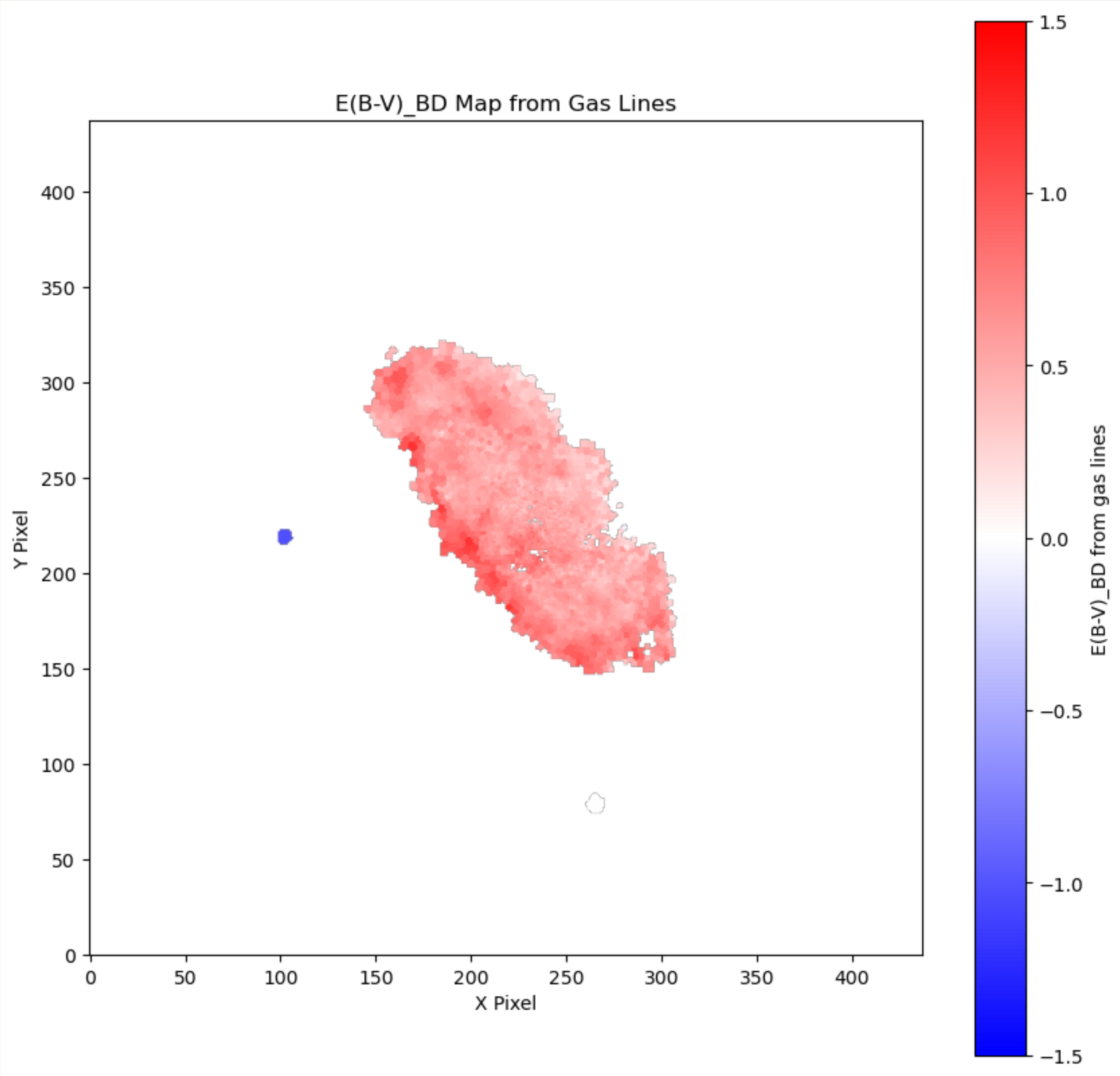


But for now, I choose 15.

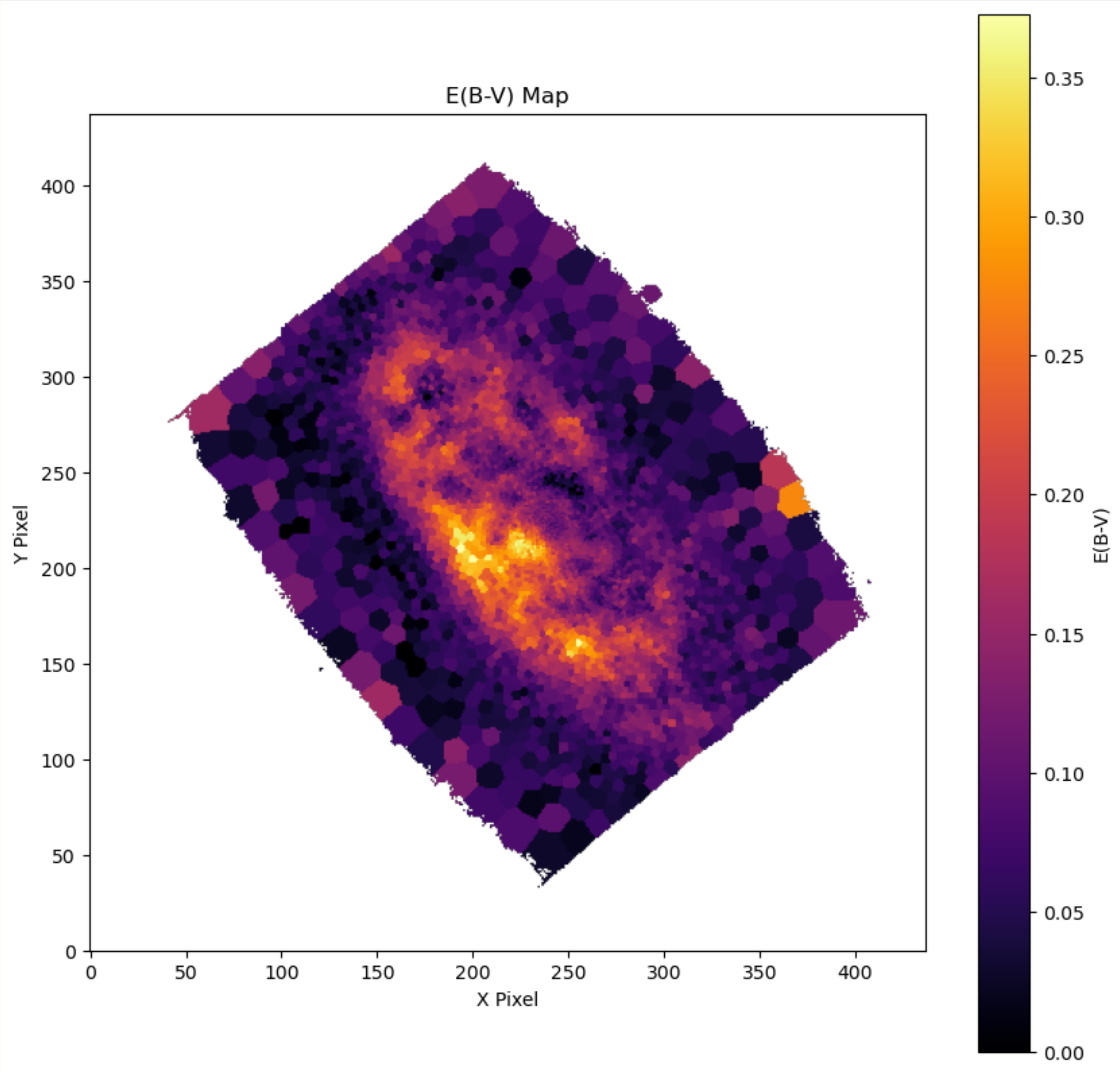
Then I can recreate the gas E(B-V) map using Balmer decrement (same as Belfiore et al. 2023)

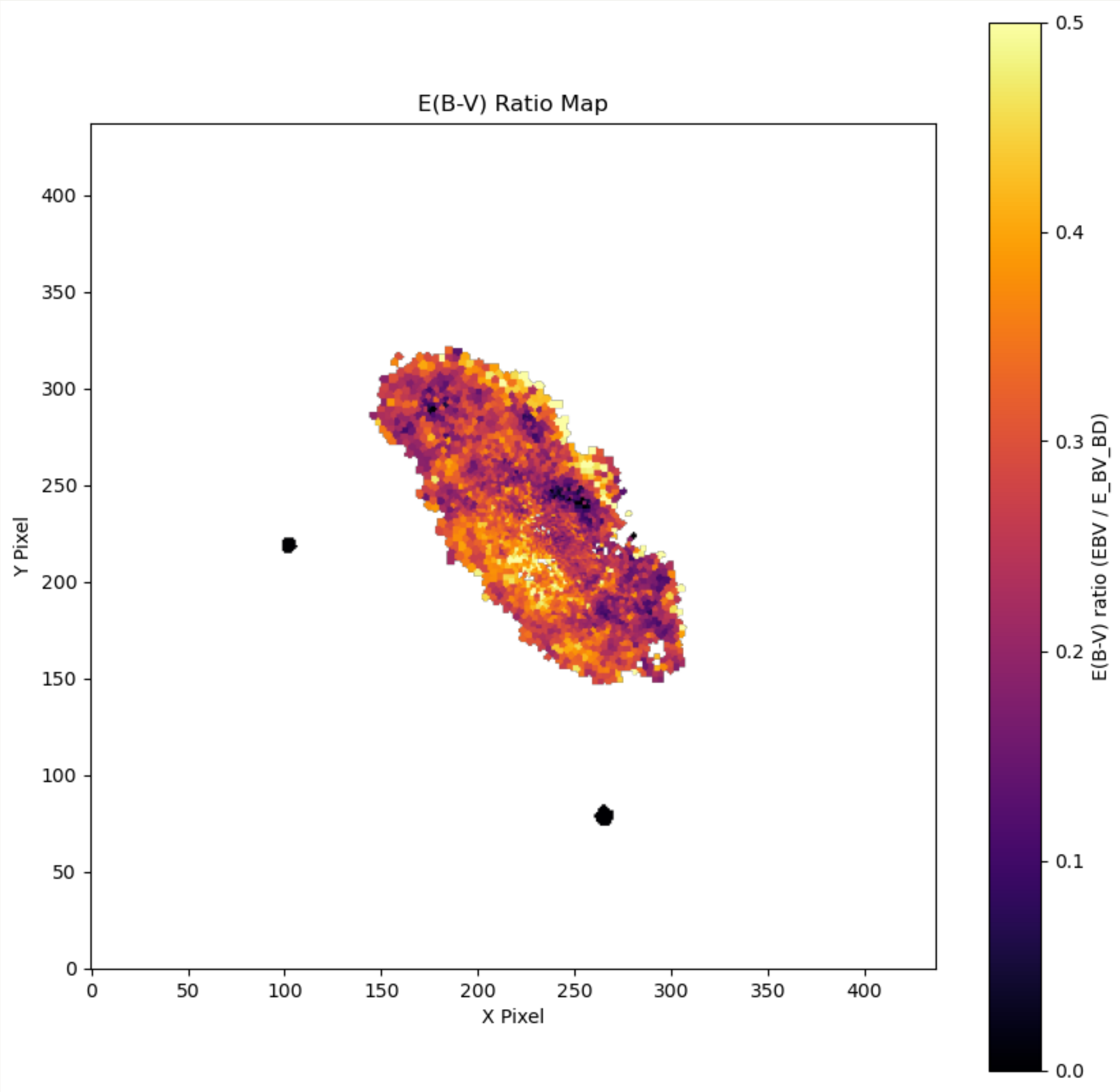
$$E(B-V)_{BD} = \frac{2.5}{k_{H_\beta} - k_{H_\alpha}} \log_{10}[\frac{L_{H\alpha}/L_{H_\beta}}{2.86}] \tag{1}$$

with $k_{H_\beta} = 3.609$ $k_{H_\alpha} = 2.535$ from Cardelli et al. 1989



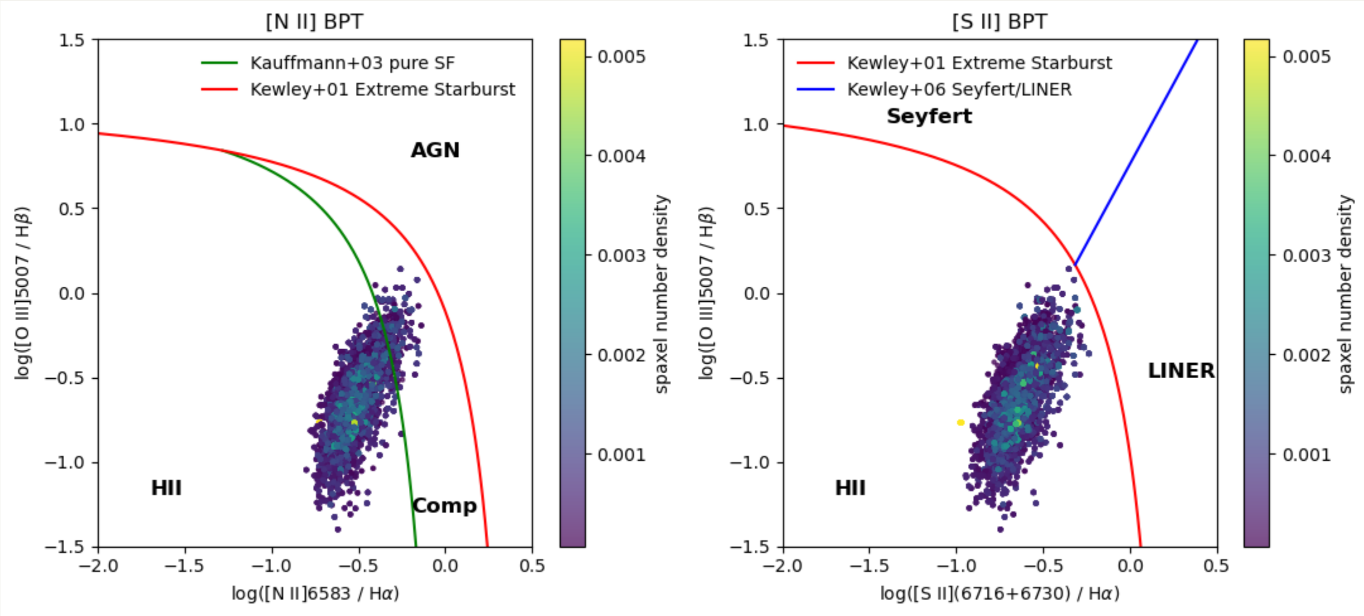
As a comparison, here i show the E(B-V) map from stellar continuum and the ratio between them:


E(B-V) Map
Y Pixel
X Pixel
E(B-V)
0
50
100
150
200
250
300
350
400
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35



BPT diagram

Here I apply the same mask ($\text{flux}/\text{flux}_{\text{err}} > 5$ for Hα and Hβ) for $O[III]\lambda5007$, Hα, $[NII]\lambda6584$, and $[SII]\lambda\lambda6717, 6731$, and adopt the diagnostic from Kewley et al. 2006

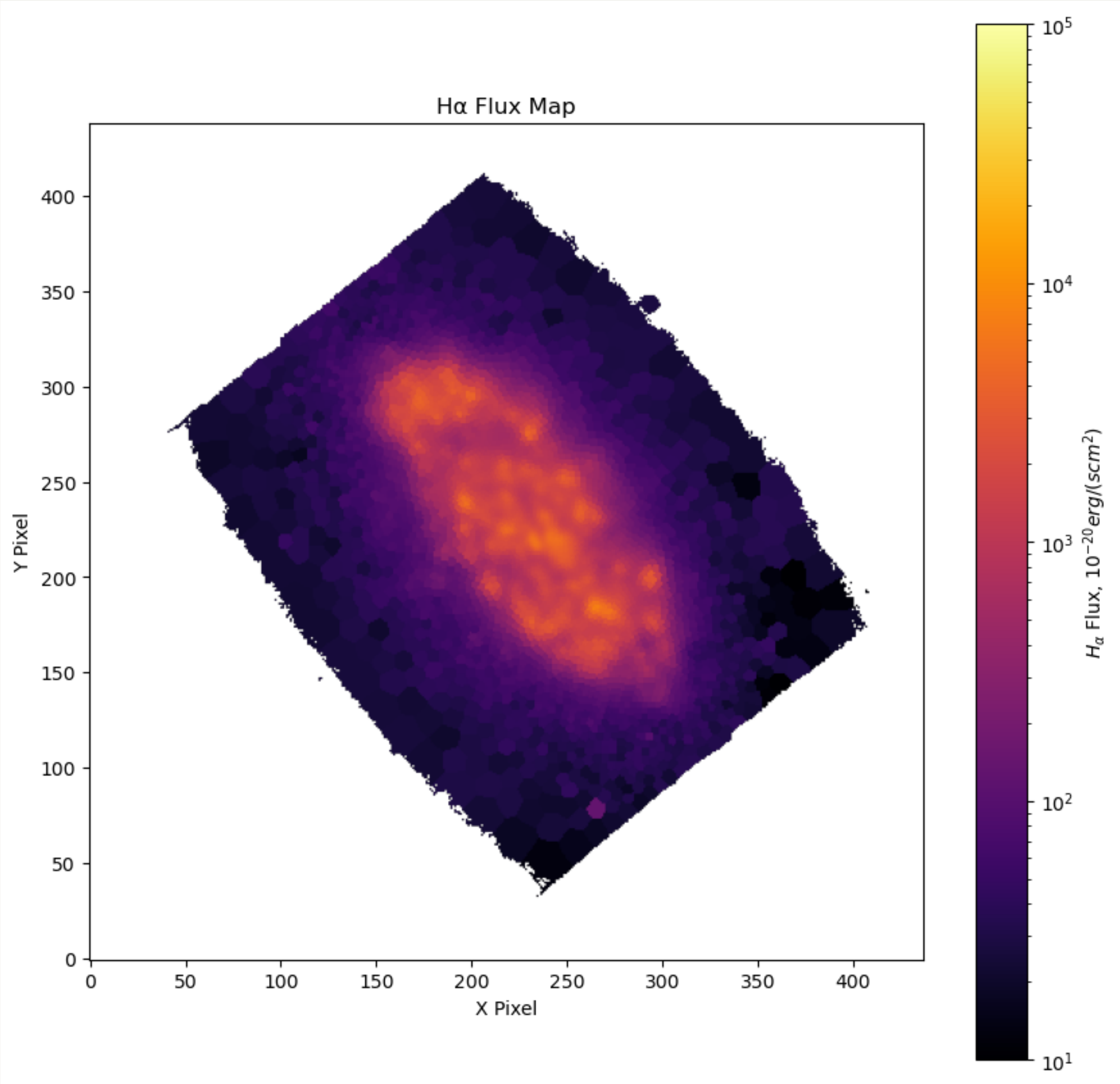



```
Number of spaxels in [N II] BPT regions:
HII: 13943, Comp: 1157, AGN: 0
Number of spaxels in [S II] BPT regions:
HII: 15100, Seyfert: 0, LINER: 0
```

Here I define a conservative SF by double-pass the ke01 citeria (red curves) in both BPT diagram. Thus, in the case that $\mathrm{flux}/\mathrm{flux}_{\mathrm{err}} \geq 15$ for Hα and Hβ, all the Hα spaxels in IC3392 are driven by SF.

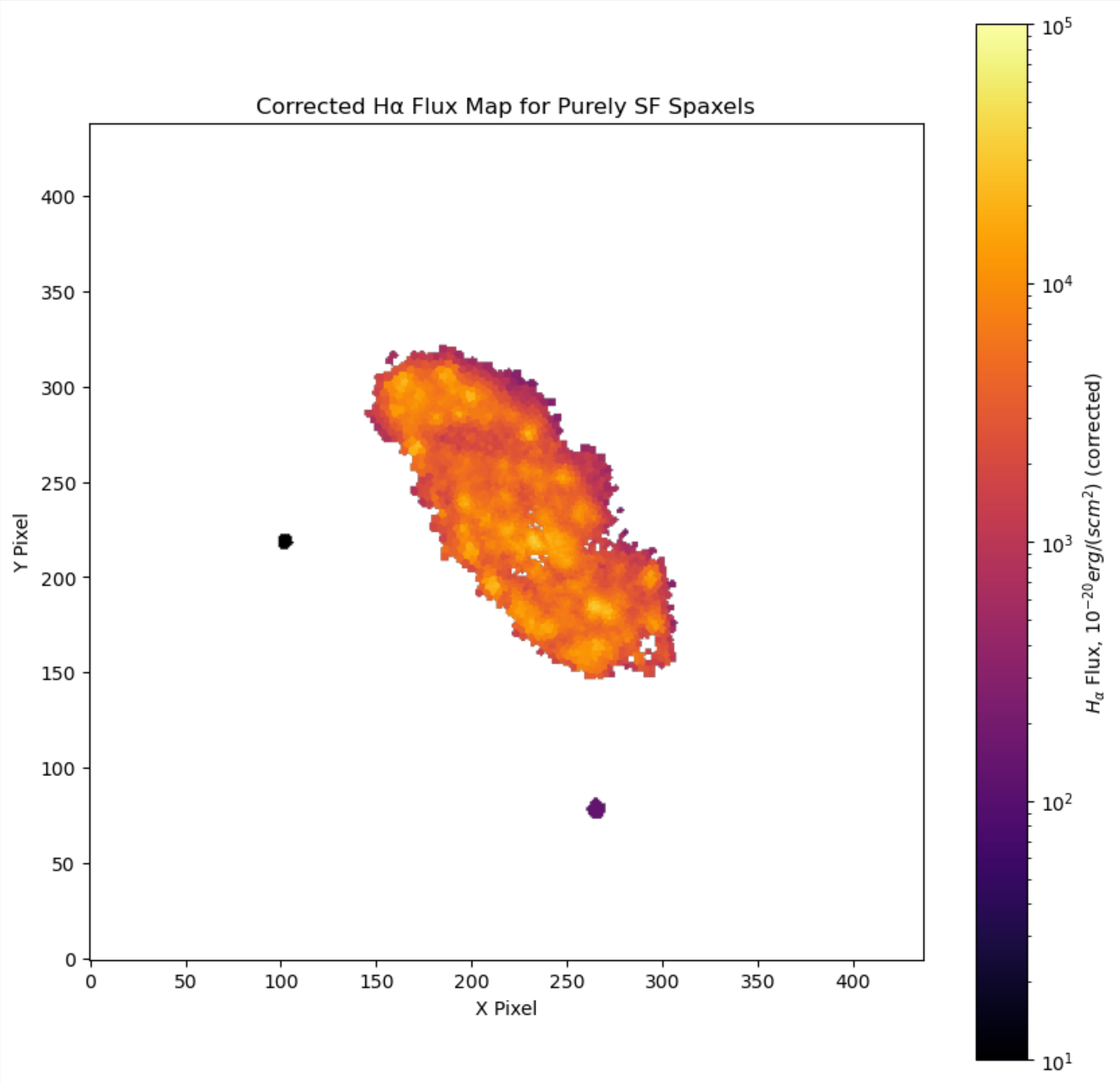
SFR

Below is the raw Hα map

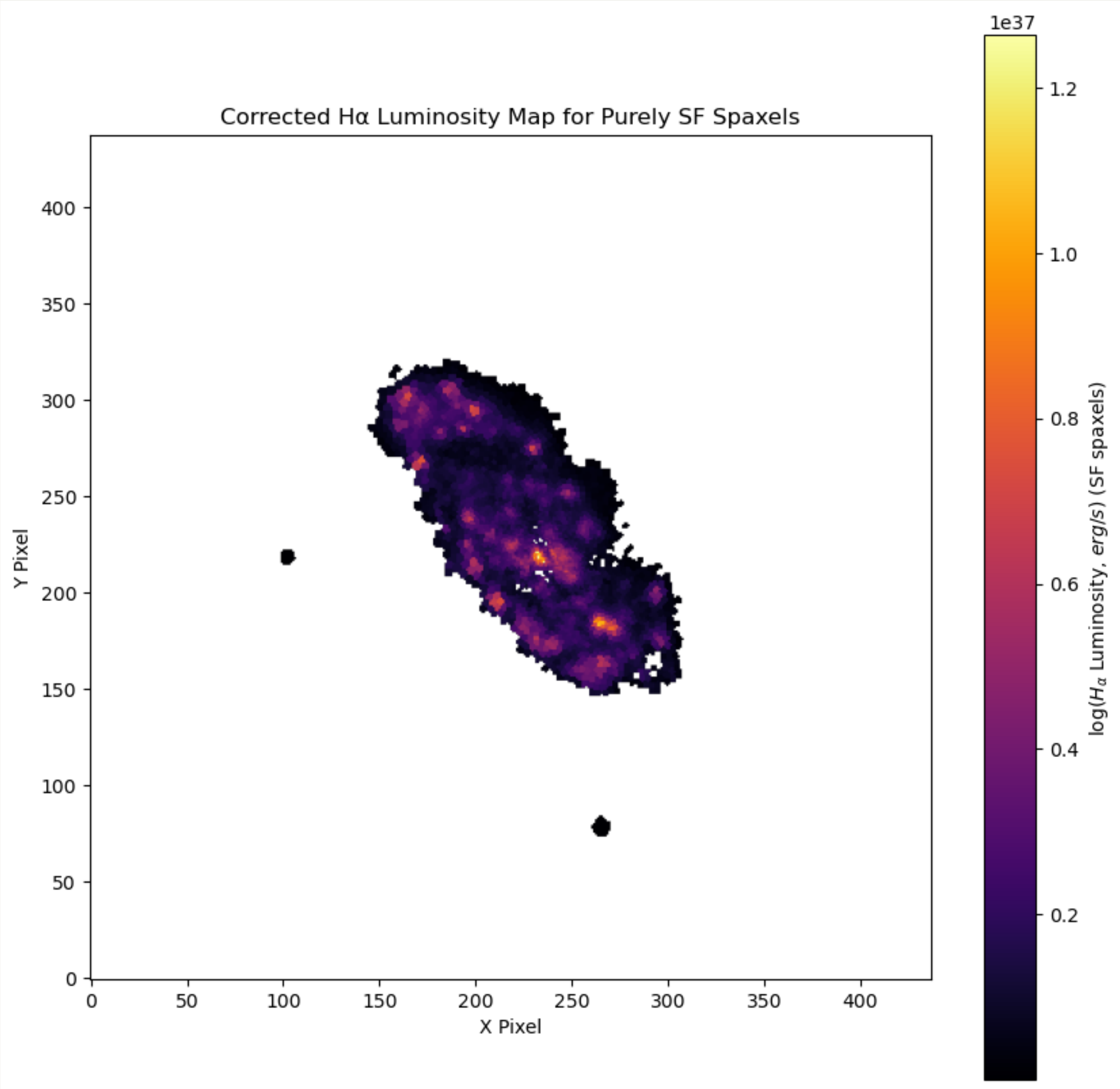


First I apply the extinction correction for Hα flux (same as Belfiore et al. 2023):

$$L_{H_{\alpha,corr}} = L_{H_\alpha} 10^{0.4 k_{H_\alpha} E(B-V)} \tag{2}$$



Now assume the distance at 16.5 Mpc, I can construct the Hα luminosity map:

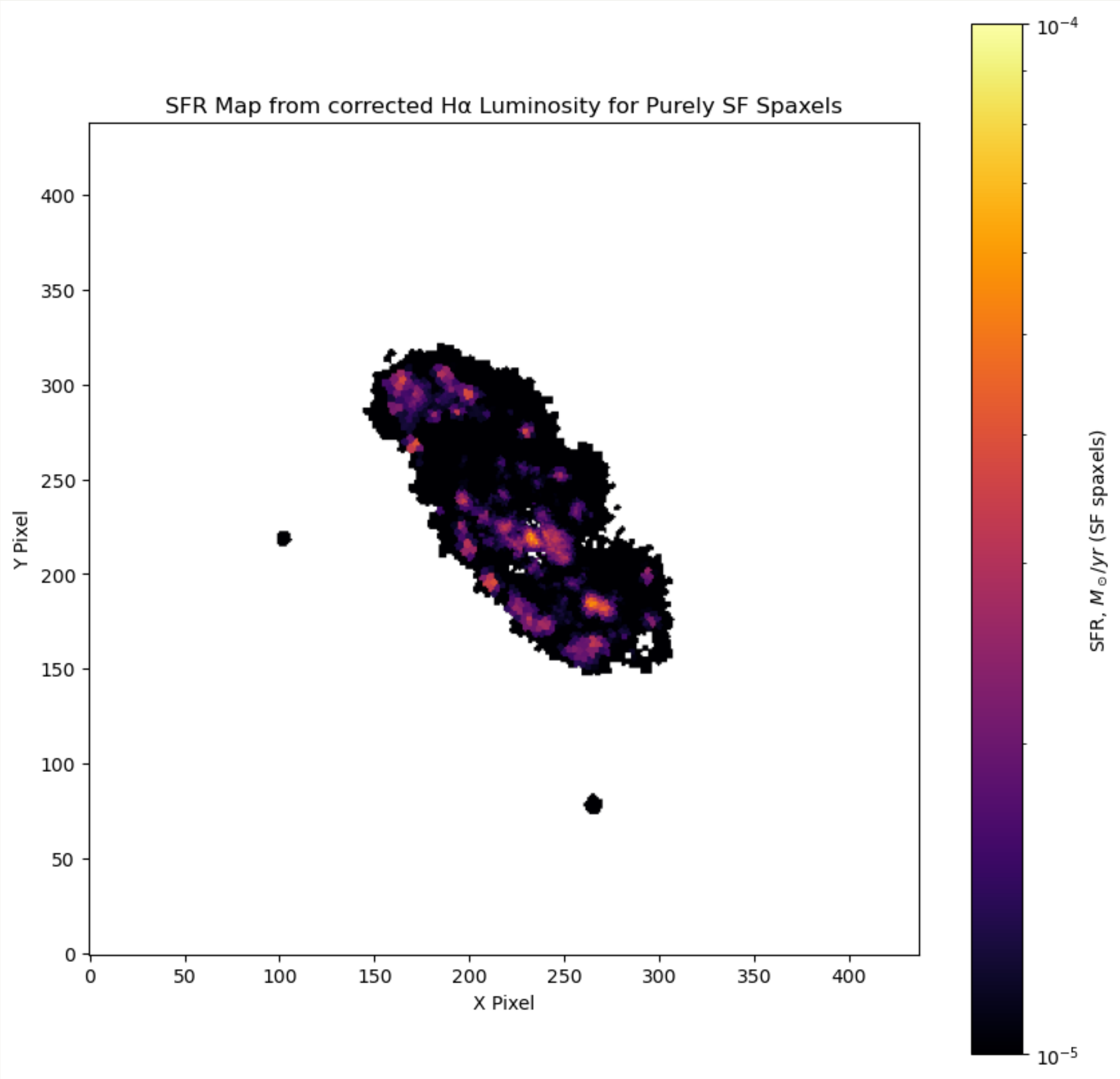



```
Total corrected Hα Luminosity for purely SF spaxels: 2.70e+40 erg / s
```

To convert Hα luminosity to SFR, I adopt the same approach as equation 3 in Belfiore et al. 2023:

$$SFR[M_{\odot}/yr] = C_{H_\alpha} L_{H_{\alpha,corr}} [erg/s] \tag{3}$$

with $C_{H_\alpha} = 5.3 \times 10^{-42}$ from Calzetti et al. 2007.




```
Total SFR from corrected Hα Luminosity for purely SF spaxels: 0.14
M_sun/yr or log(SFR) = -0.84 M_sun/yr
```

Check

By table 7 of Koopmann 2001, IC3392 have Hα flux in $\log(-12.60)$ $erg/s/cm^2$, while I have $\log(-12.08)$ $erg/s/cm^2$ for extinction corrected SF region and $\log(-12.70)$ $erg/s/cm^2$ for raw data.

In Leroy et al. 2019, the SFR of IC3392 is $\log(-1.30) M_\odot/yr$ from UV + IR emissions, while I have $\log(-0.84) M_\odot/yr$ from Hα emissions.