Spatially Resolved Analysis of Bursty SFHs 3 < z < 4

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Introduction

- High redshift galaxies tend to go through bursts and quiescent periods in their star formation histories[1, 2, 3, 4]

- Simulations predict that stellar winds, SN feedback, and AGNs can drive bursty star formation[1, 2]

- There have been studies on bursty star formation with JADES data[3] and spatially resolved SED fitting[4]

- This project would combine the two ideas to study bursty star formation on a pixel-by-pixel basis

[1]Faucher-Giguére (2018)
[2]Sun et al. (2023)
[3]Dome et al. (2024)
[4]Looser et al. (2025)

Sample Selection
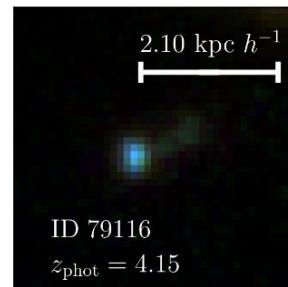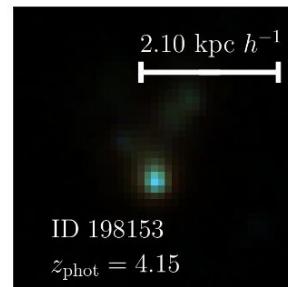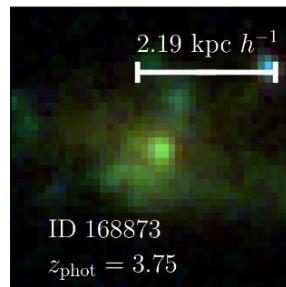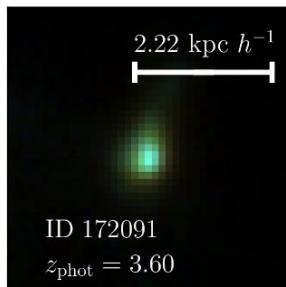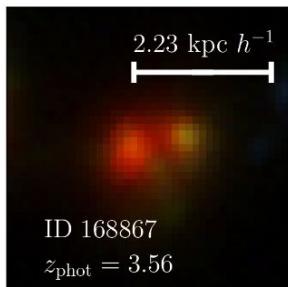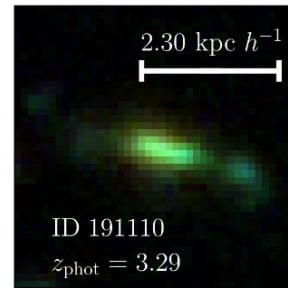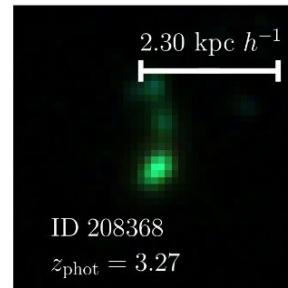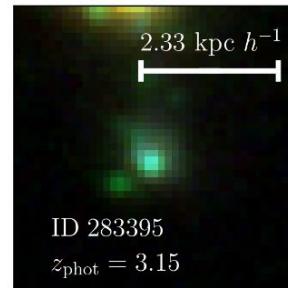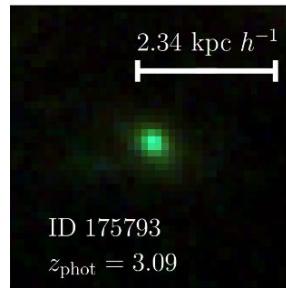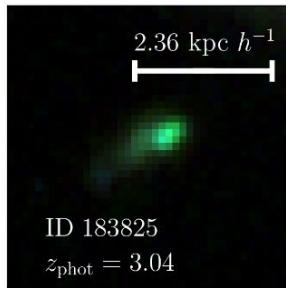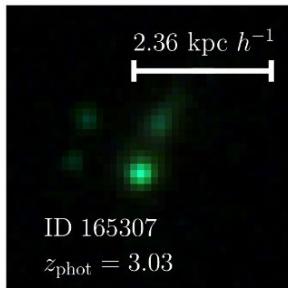
- Looser et al. (2023)[1] characterizes "burstiness" by taking a ratio of SFR averaged over last 10 Myr to SFR averaged between 10-100 Myr (before epoch of observation)

- Photometric redshift range: 3 < z < 4 (to reflect range in Mosleh et al.)[5]

- Using a similar ratio of 10 Myr/100 Myr from the JADES GOODS-S Prospector catalog[6,7], there are 227 objects with a ratio >8

- Since we want spatially resolved objects, we require the semi-major axis be >5 pixels (>0.15 arcsec) which leaves us with 11 objects

[5]Mosleh et al. (2025)
[6]Simmonds et al. (2024a)
[7]Simmonds et al. (2024b)

False-Color RGBs of Galaxies in Sample

2.36 kpc h^{-1}	2.36 kpc h^{-1}	2.34 kpc h^{-1}	2.33 kpc h^{-1}	2.30 kpc h^{-1}	2.30 kpc h^{-1}
ID 165307 $z_{\rm phot} = 3.03$	ID 183825 $z_{\rm phot} = 3.04$	ID 175793 $z_{\rm phot} = 3.09$	ID 283395 $z_{\rm phot} = 3.15$	ID 208368 $z_{\rm phot} = 3.27$	ID 191110 $z_{\rm phot} = 3.29$

|				
2.23 kpc h^{-1}	2.22 kpc h^{-1}	2.19 kpc h^{-1}	2.10 kpc h^{-1}	2.10 kpc h^{-1}
ID 168867 $z_{\rm phot} = 3.56$	ID 172091 $z_{\rm phot} = 3.60$	ID 168873 $z_{\rm phot} = 3.75$	ID 198153 $z_{\rm phot} = 4.15$	ID 79116 $z_{\rm phot} = 4.15$
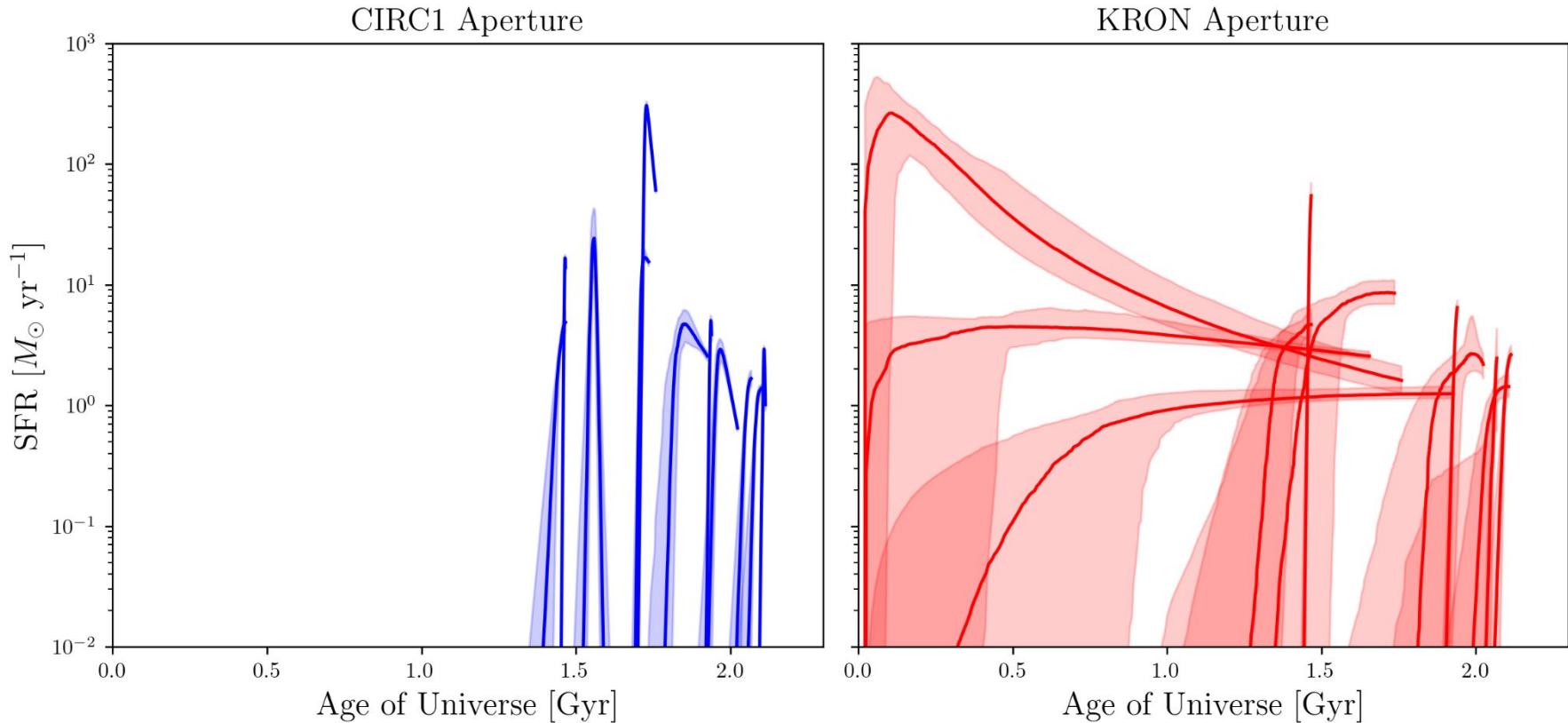
F356W/
F200W/
F115W
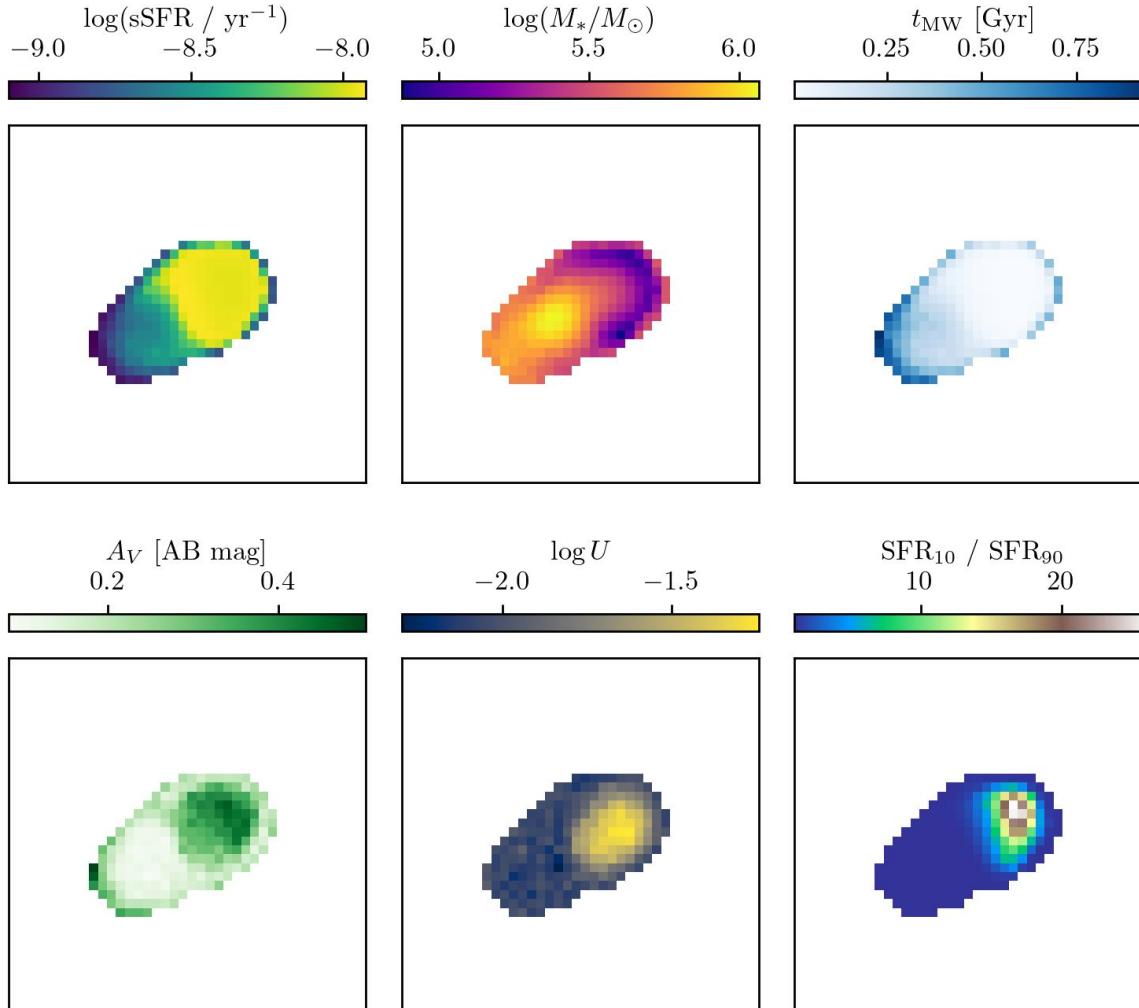
BAGPIPES Methodology

- Use the double power law (DPL) parametric form of SFH, shown below
- Use same priors and models as Mosleh et al. (2025)[5] for DPL parameterization
- Select pixels that belong to the central object using SExtractor segmentation maps and have SNR>3 in at least one filter
- Run on both integrated photometries and individual pixels for comparisons
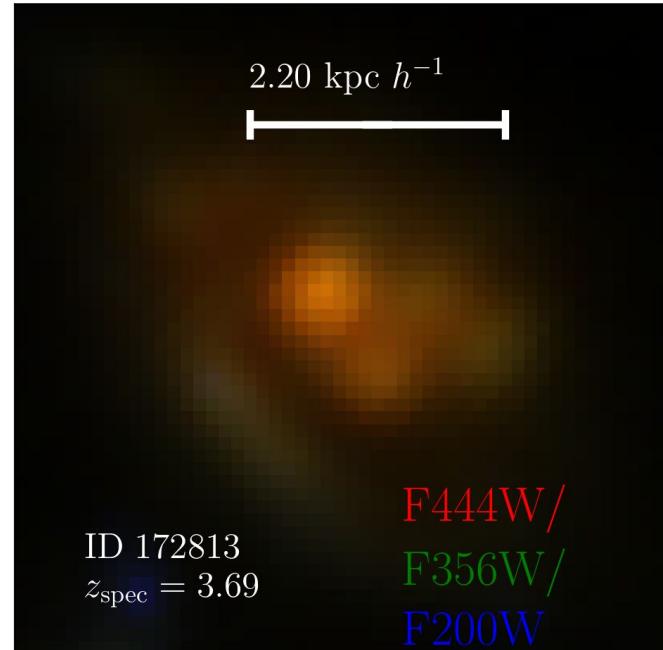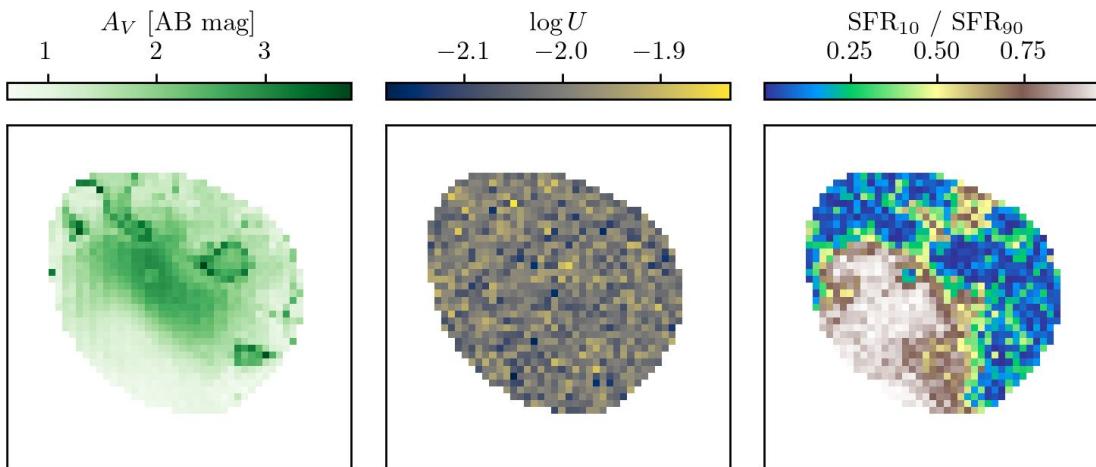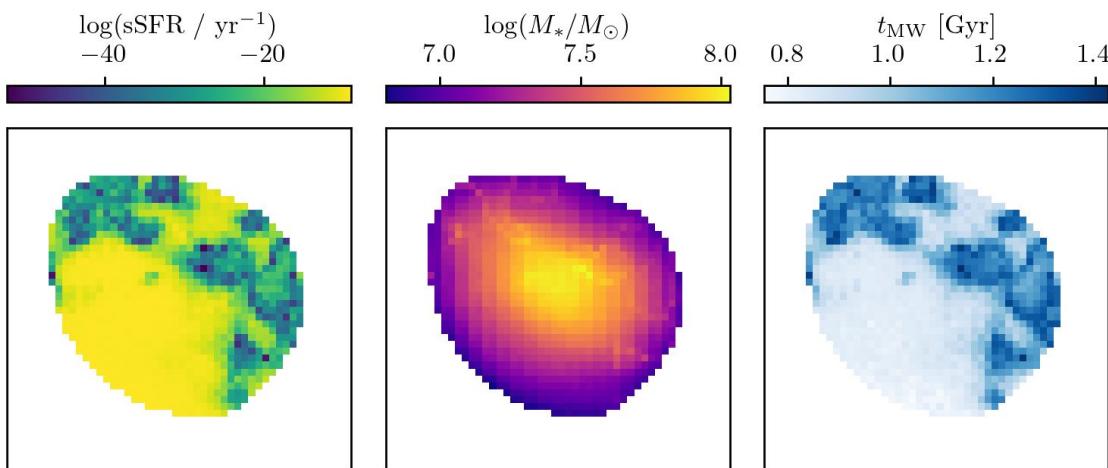
$$\text{SFR}(t) \propto \left[\left(\frac{t}{\tau} \right)^{\alpha} + \left(\frac{t}{\tau} \right)^{\beta} \right]^{-1}$$

SFHs From Integrated Photometry

- Maps of spatially resolved properties measured by BAGPIPES for JADES ID 183825

- Shows that the burst occurs in the upper right region of the galaxy, but the stellar mass is concentrated in the lower left region

- This analysis would be performed for the other galaxies in the sample

log(sSFR / yr^{-1}) -40 -20

log($M_*/M_\odot$) 7.0 7.5 8.0

t_{MW} [Gyr] 0.8 1.0 1.2 1.4

A_V [AB mag] 1 2 3

$\log U$ -2.1 -2.0 -1.9

SFR$_{10}$ / SFR$_{90}$ 0.25 0.50 0.75

2.20 kpc h^{-1}

ID 172813
$z_{\mathrm{spec}} = 3.69$

F444W/
F356W/
F200W

log(sSFR / yr^{-1}) −7.98 −7.96
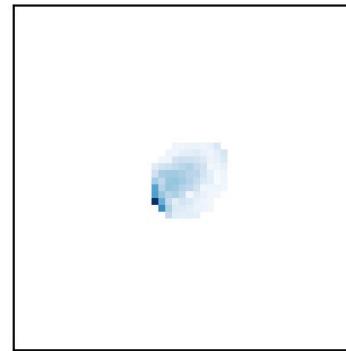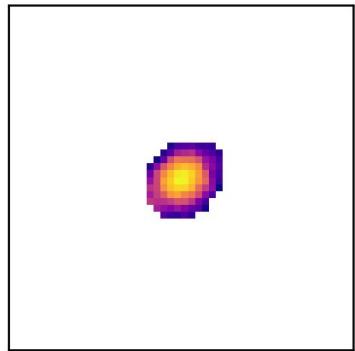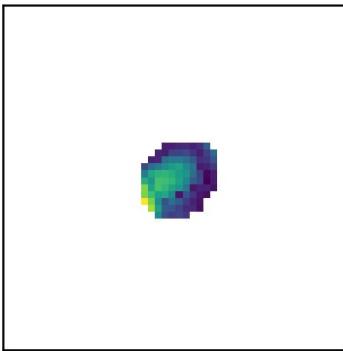
log($M_*/M_\odot$) 5.75 6.00 6.25

t_{MW} [Gyr] 0.005 0.010 0.015

A_V [AB mag] 0.2 0.3
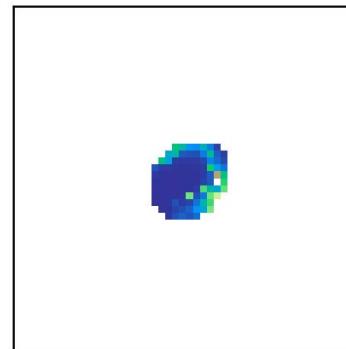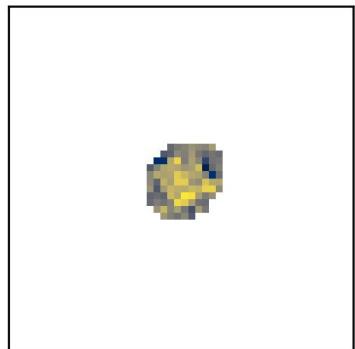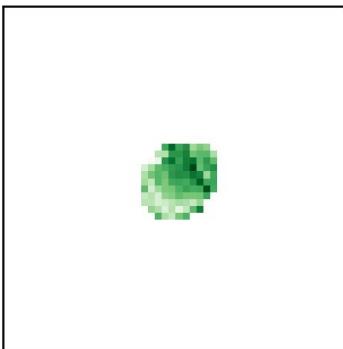
log U −2.0 −1.8 −1.6
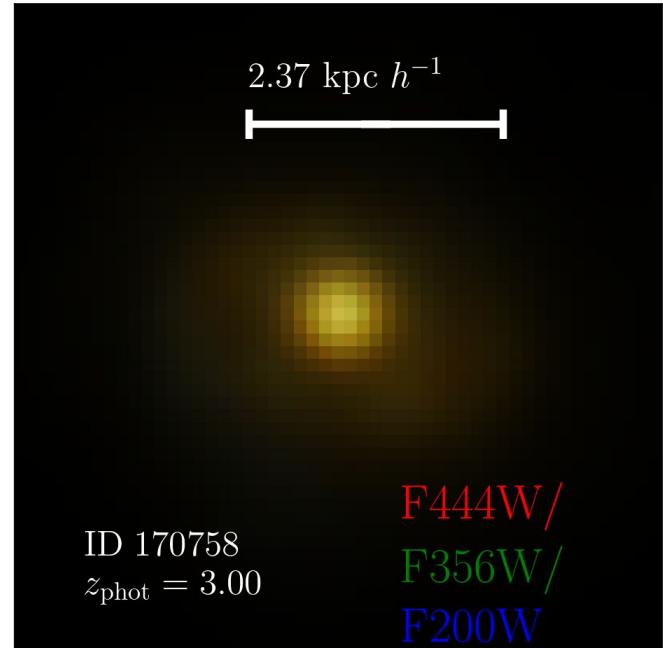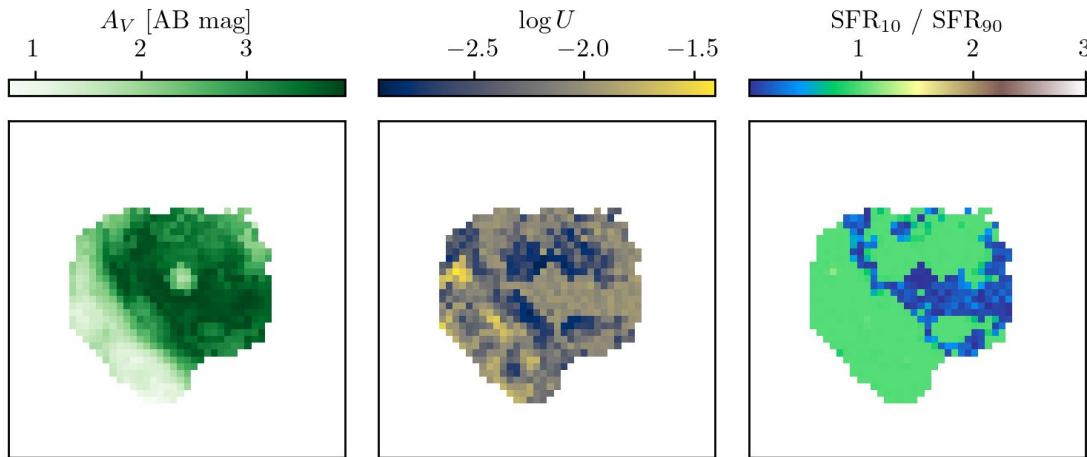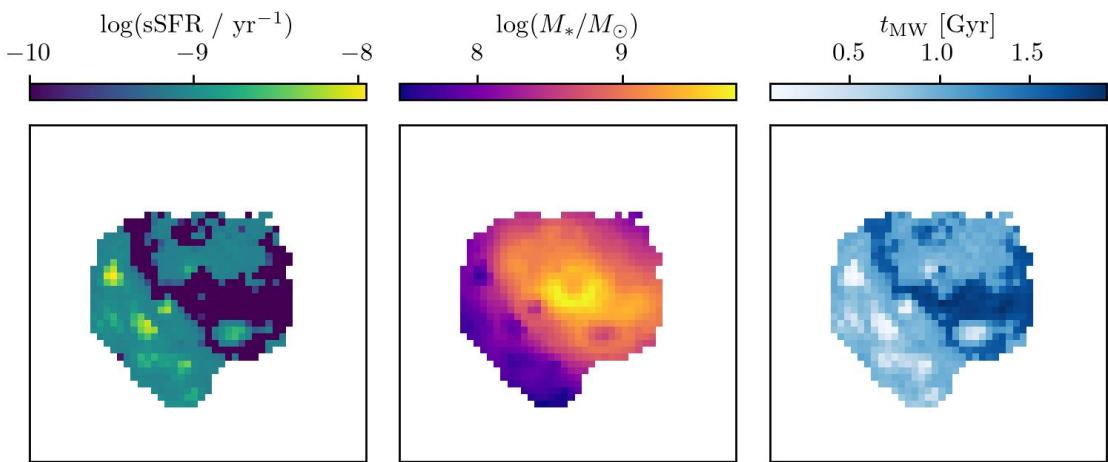
SFR$_{10}$ / SFR$_{90}$ 500 1000

1.54 kpc h^{-1}
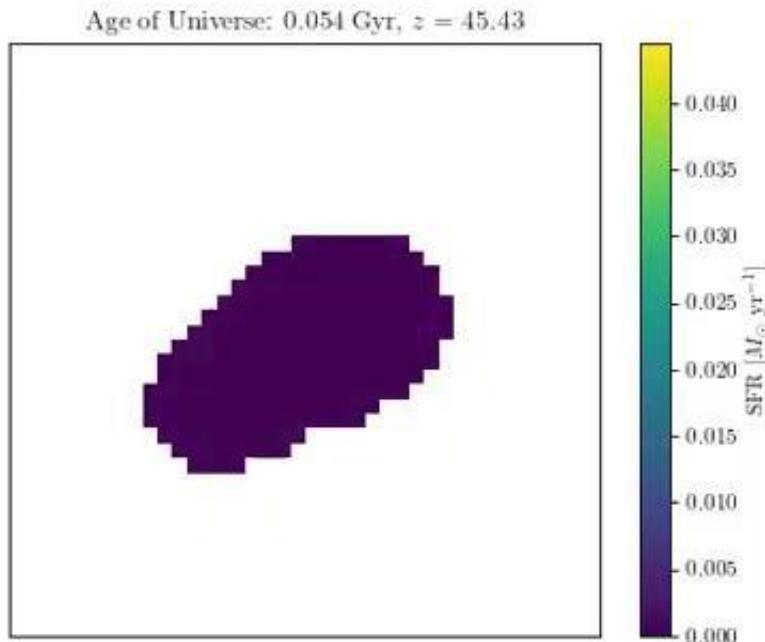
ID 117602
$z_{\mathrm{spec}} = 7.43$

F444W/
F356W/
F200W

log(sSFR / yr^{-1})

log($M_*/M_\odot$)

t_{MW} [Gyr]

A_V [AB mag]

$\log U$

SFR$_{10}$ / SFR$_{90}$

2.37 kpc h^{-1}

ID 170758
$z_{\mathrm{phot}} = 3.00$

F444W/
F356W/
F200W

SFH Movie (JADES ID 183825)

Age of Universe: 0.054 Gyr, $z = 45.43$

Shows star formation histories for each pixel fit by BAGPIPES