

13 April 2021

Spatially resolving the properties of lensed galaxies at $z > 3$

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CLUMPS IN HIGH-Z GALAXIES

- ▶ ~50% of **SFGs** at $z \sim 1-4$ have **clumpy UV** morphologies (e.g. *Conselice+14*)

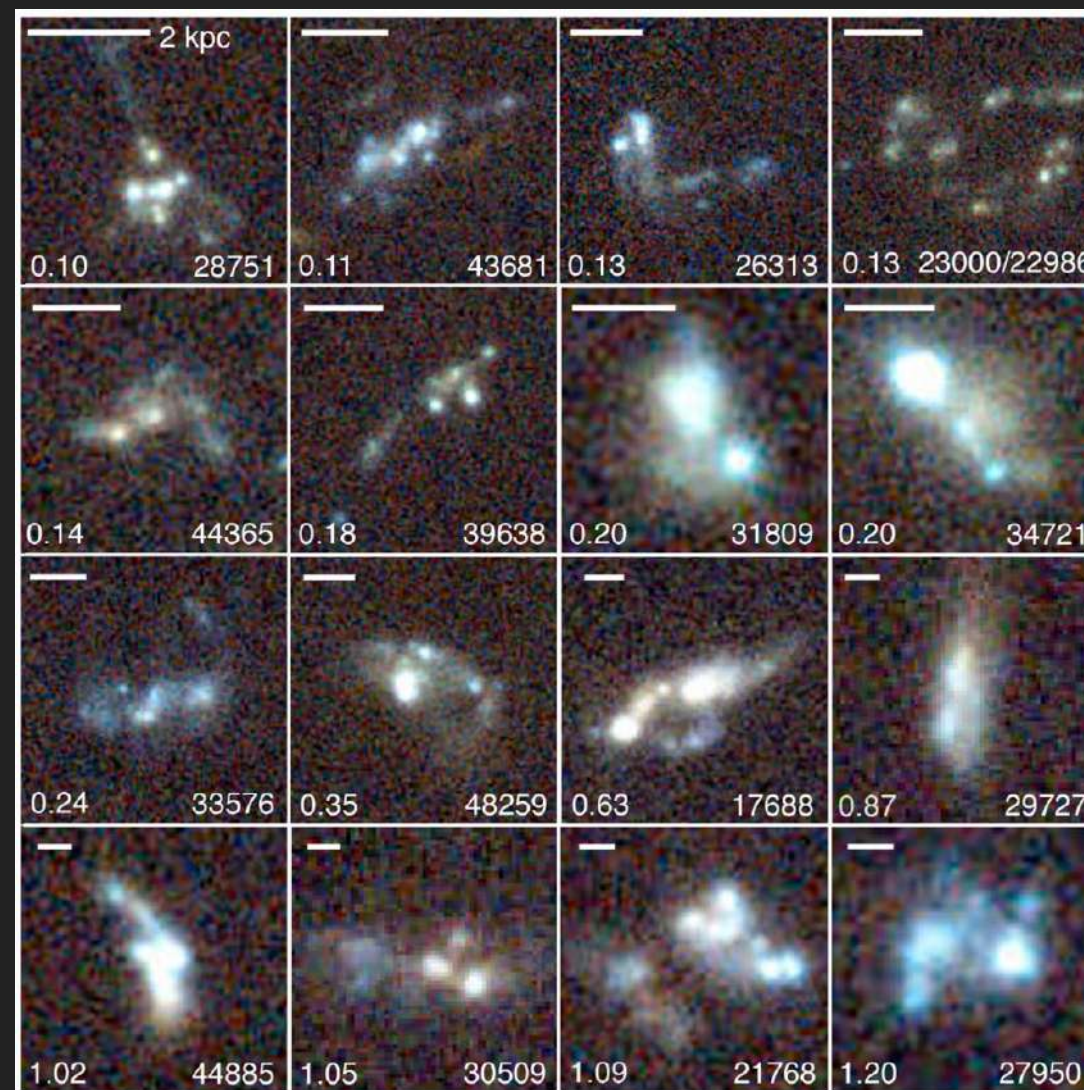


Figure from *Elmegreen+09*

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WHAT ARE CLUMPS?

- ▶ Geometrical effect of patchy dust distribution (e.g. *Buck+17*)
- ▶ Giant SF regions ($M \sim 10^8 - 10^9 M_{\odot}$, size < 1 kpc)

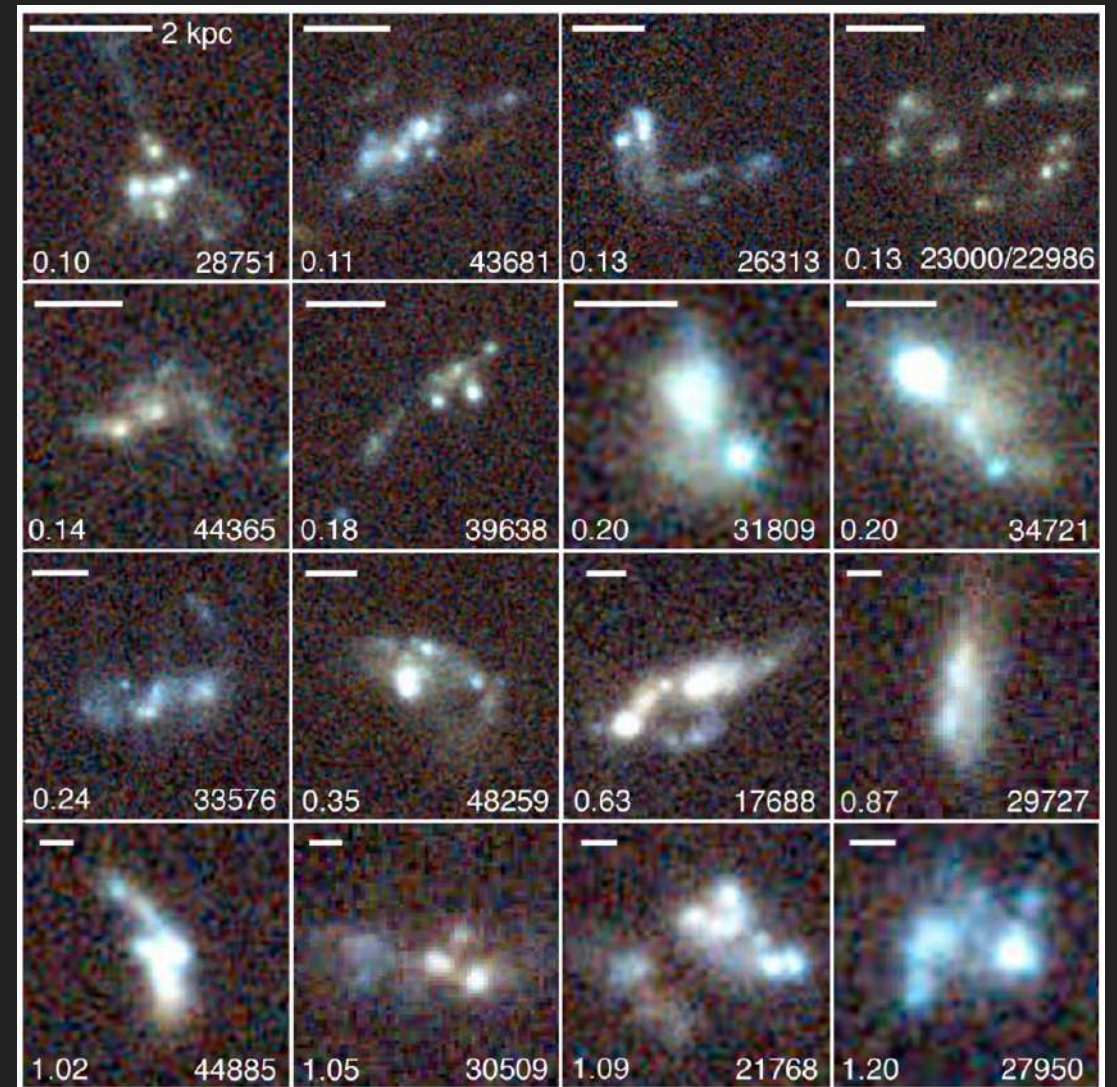


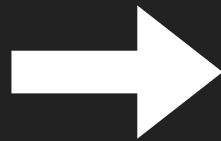
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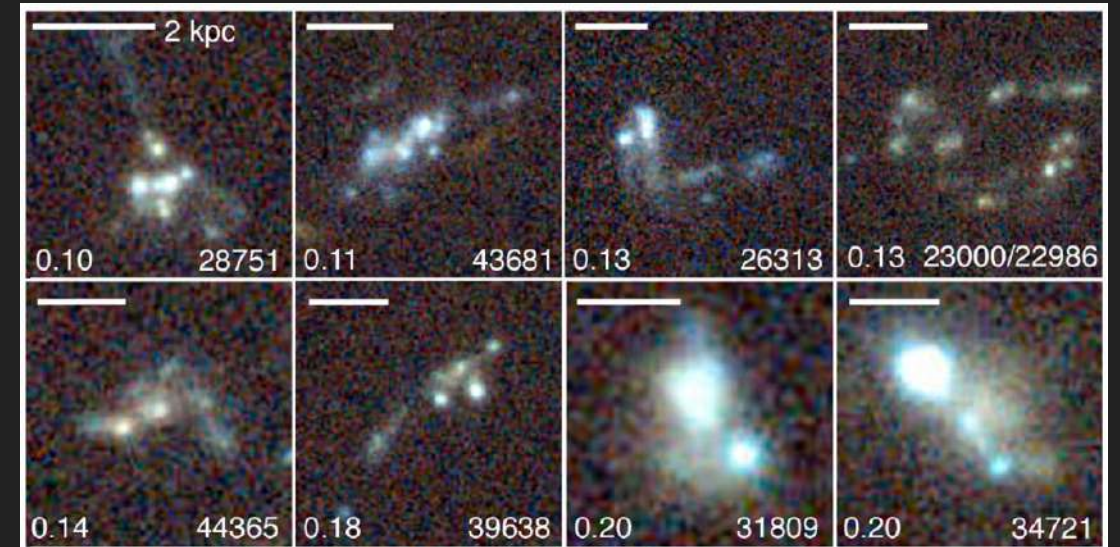


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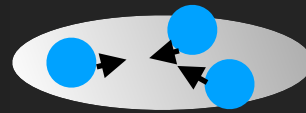
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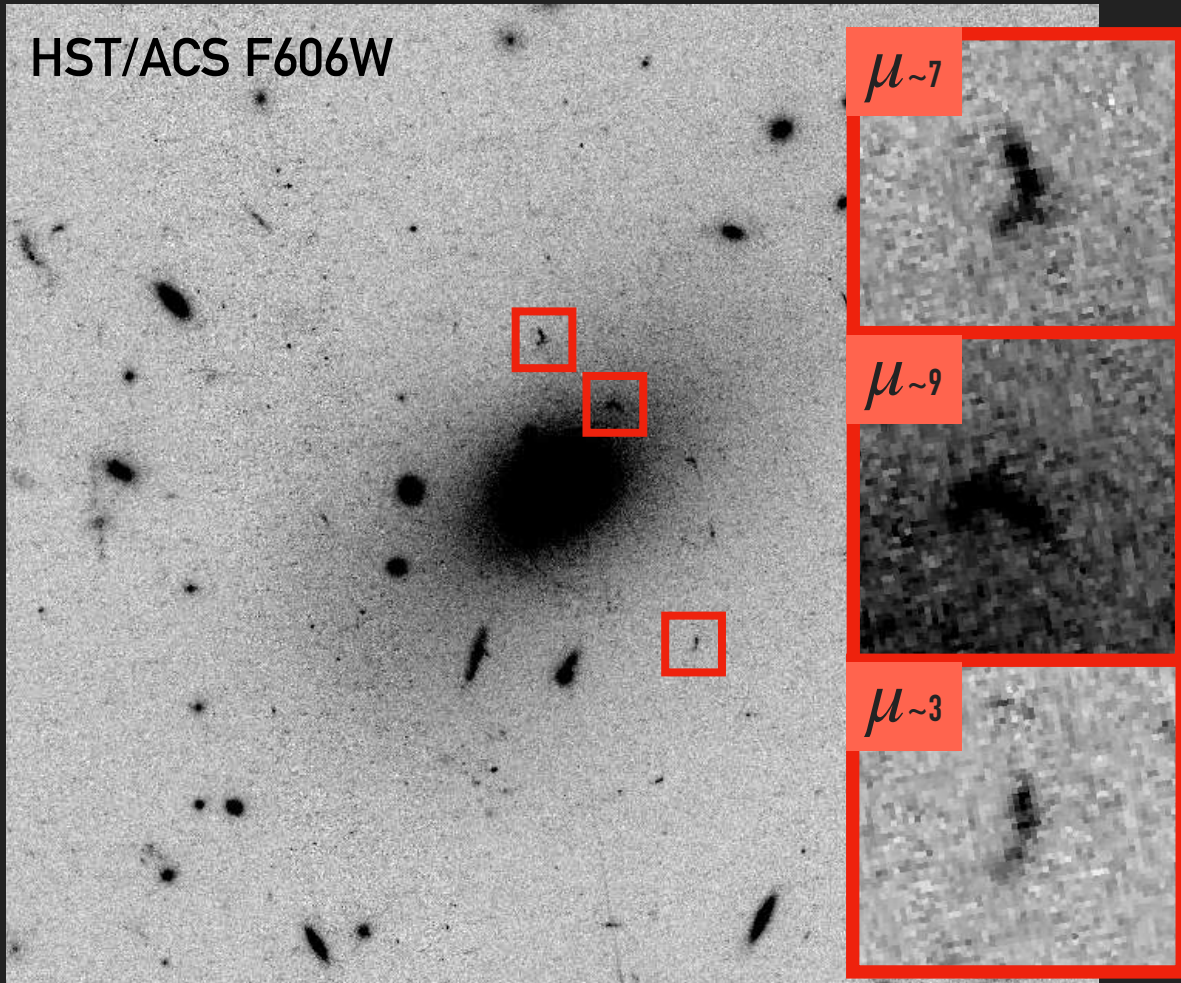


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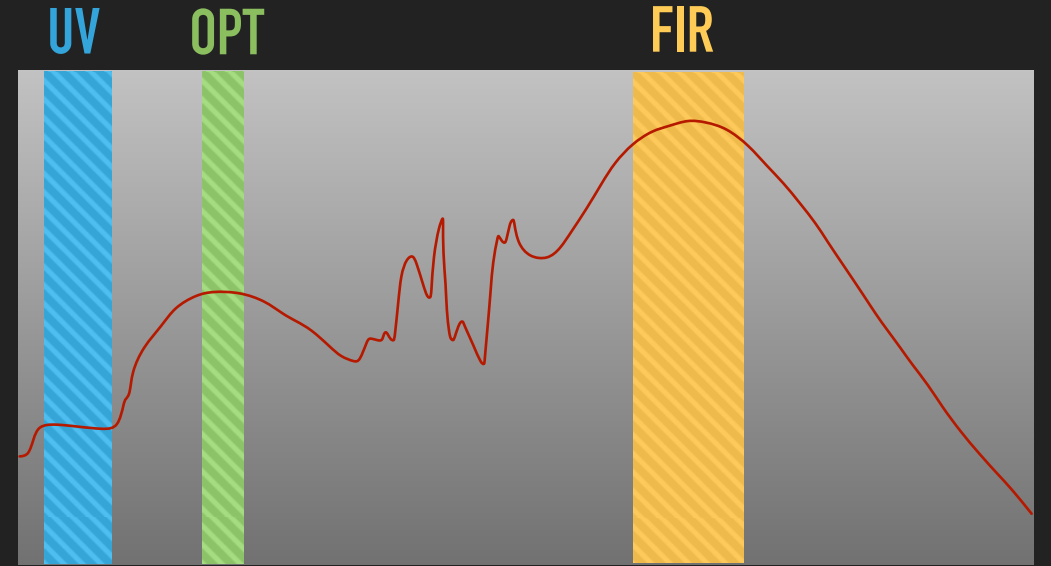
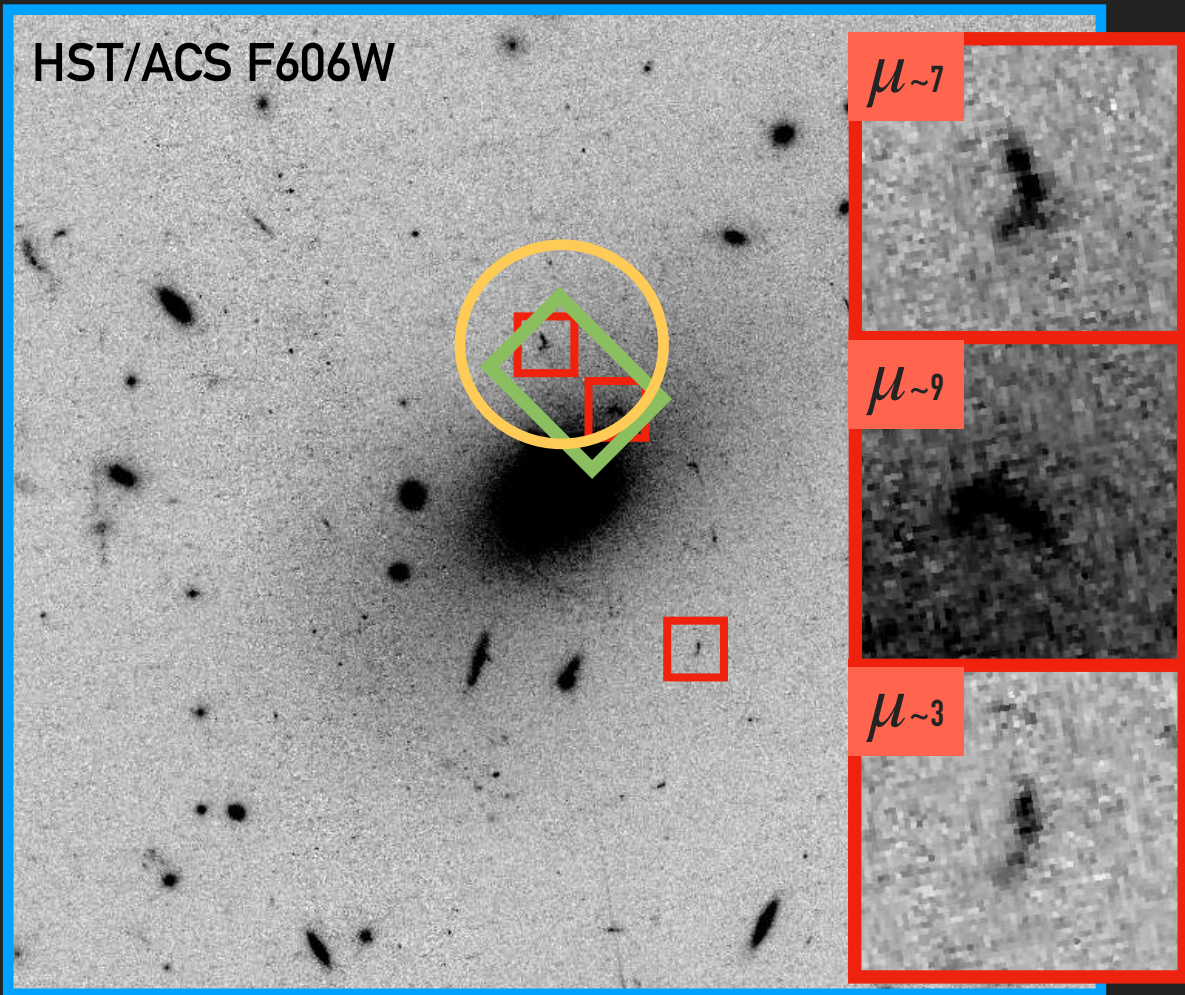
TARGET

lensed line-emitting galaxy at $z \sim 3.4$
(from [Livermore+15](#))



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DATASET

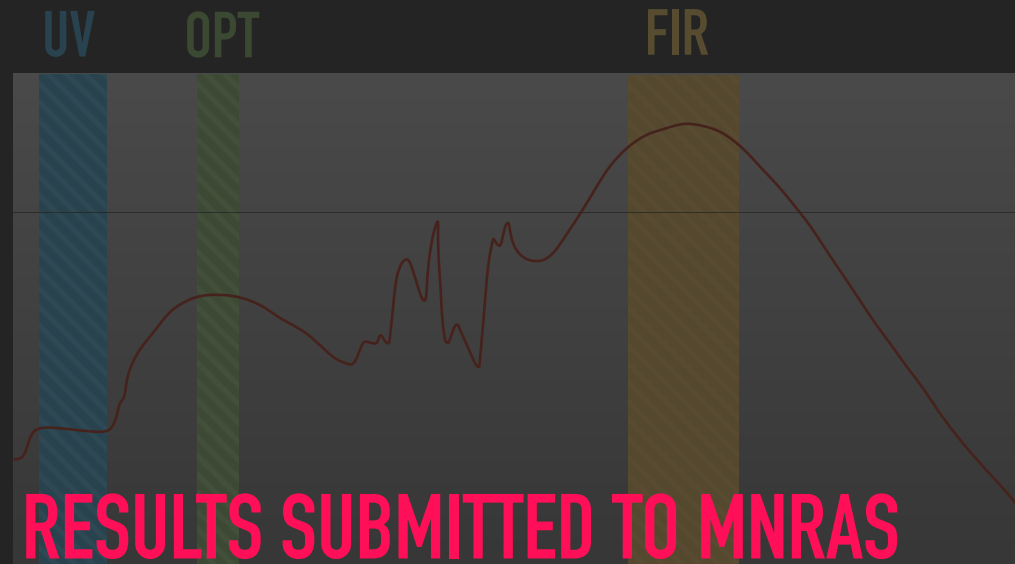
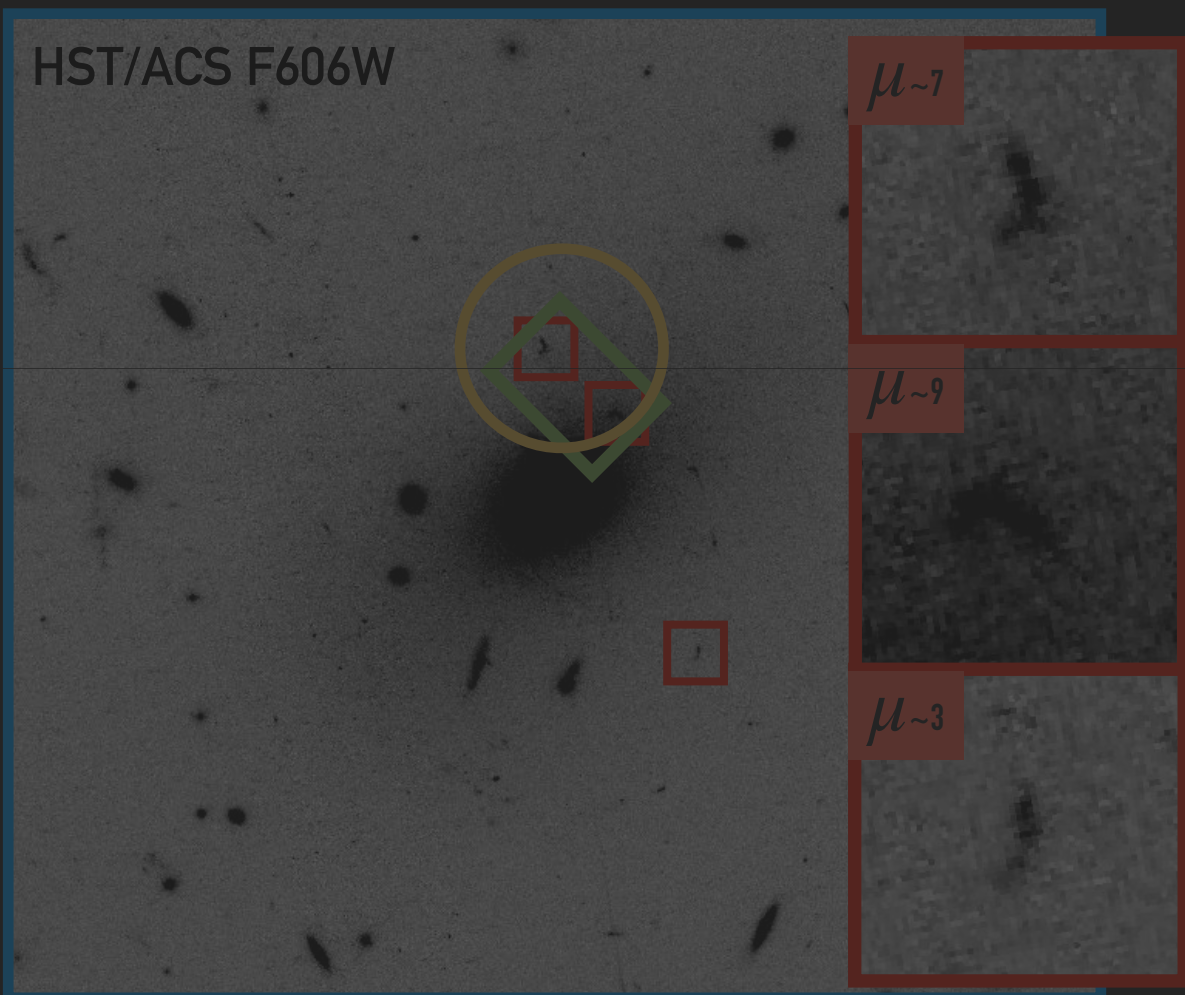
		t_{exp}	PSF
UV	MUSE WFM+AO (PI: A. ZANELLA)	5h	0.4"
	HST/ACS WFC F606W (PI: G. SMITH)	15m	0.13"
OPT	SINFONI (K BAND) (PI: M. SWINBANK)	5h	0.6"
FIR	ALMA (BAND 8) (PI: E. IANI)	2h	0.2"

ON-GOING

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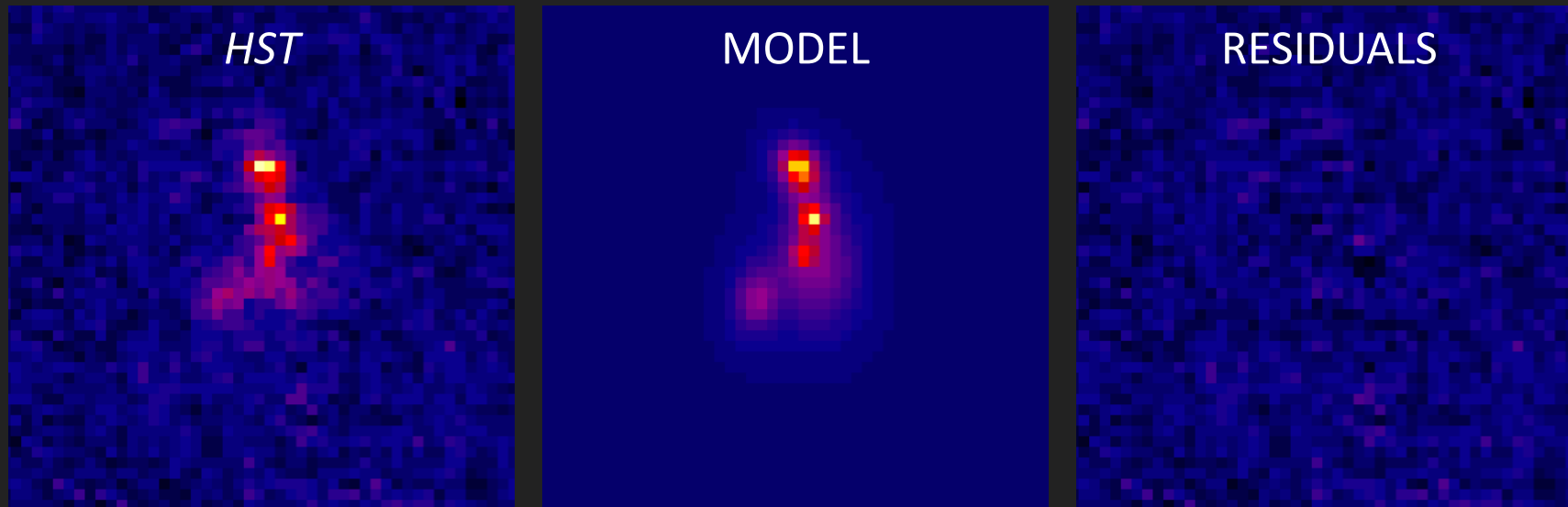
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GALAXY MORPHOLOGY

- ▶ UV continuum composed of:
 - ▶ 4 clumps (PSF-like, $\lesssim 0.13''$) \rightarrow 60%
 - ▶ Diffuse component (Sérsic) \rightarrow 40%

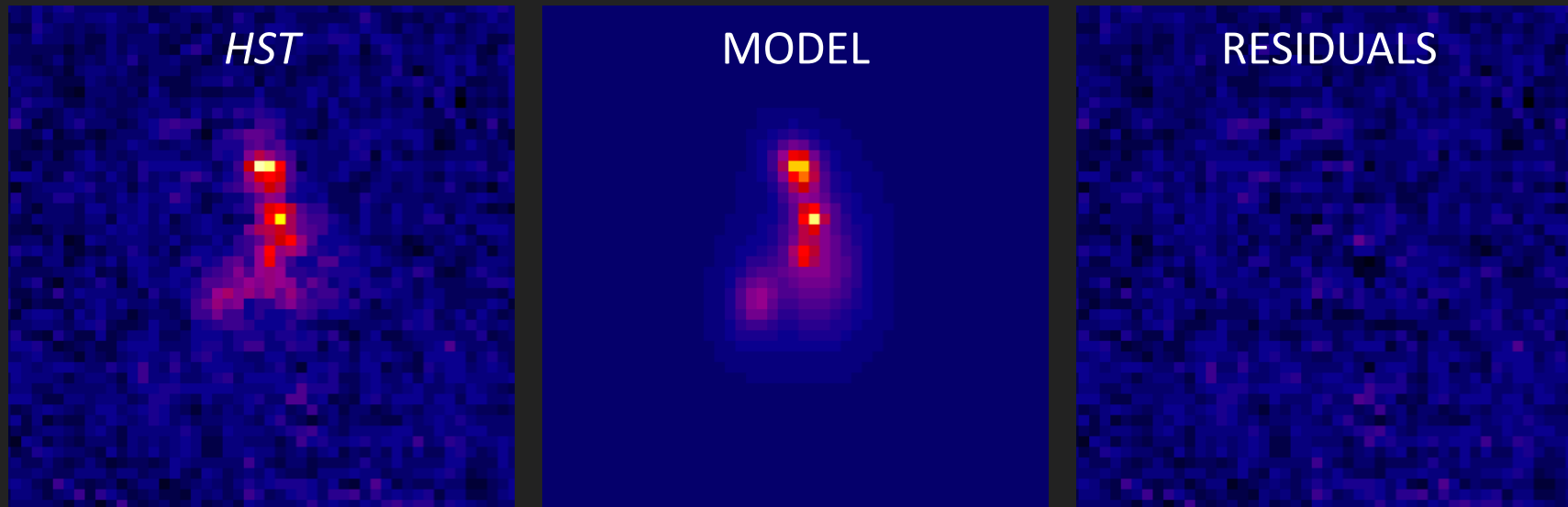
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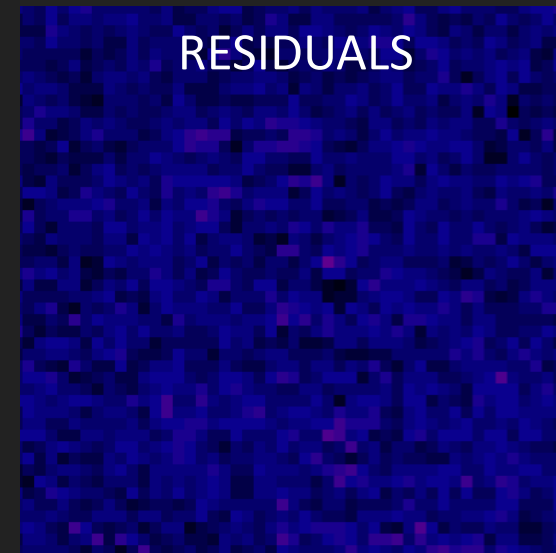
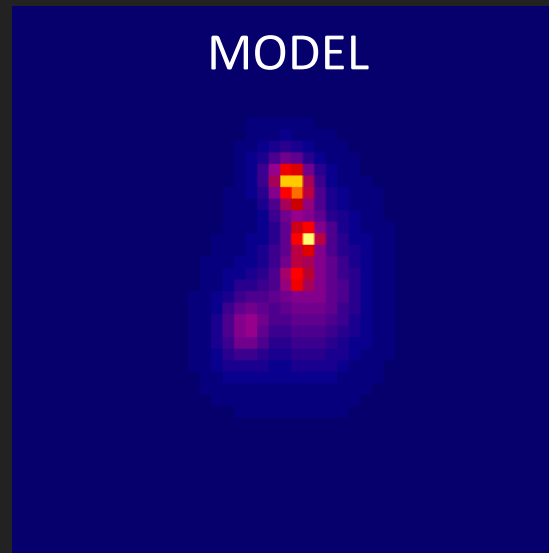
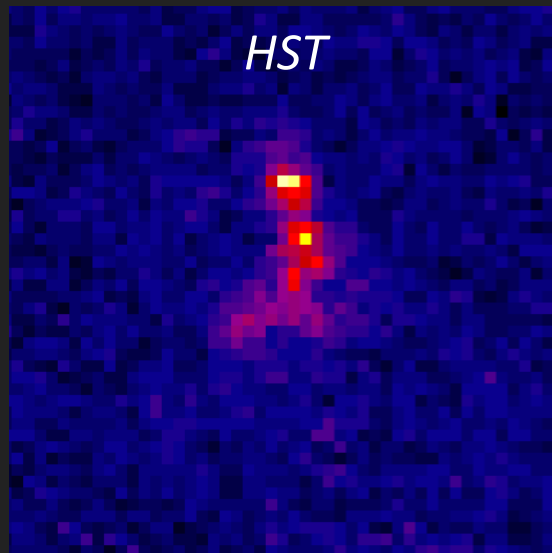


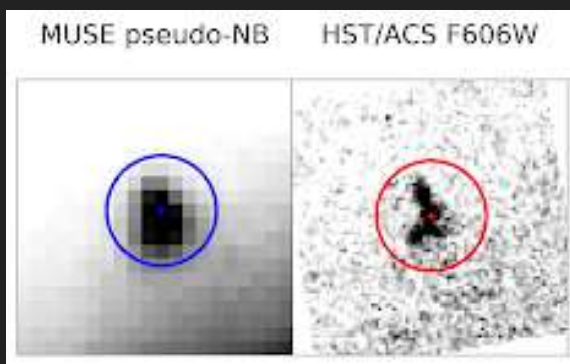
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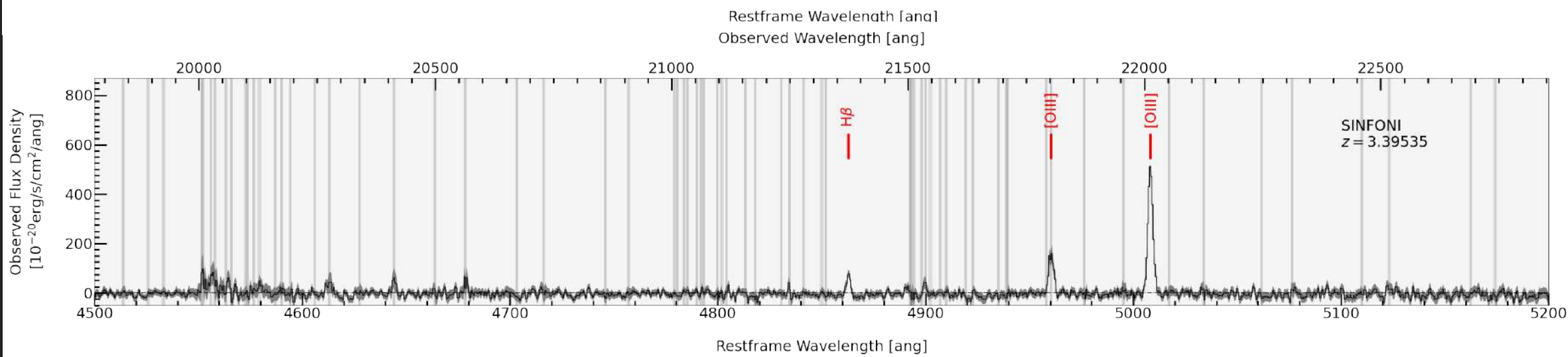
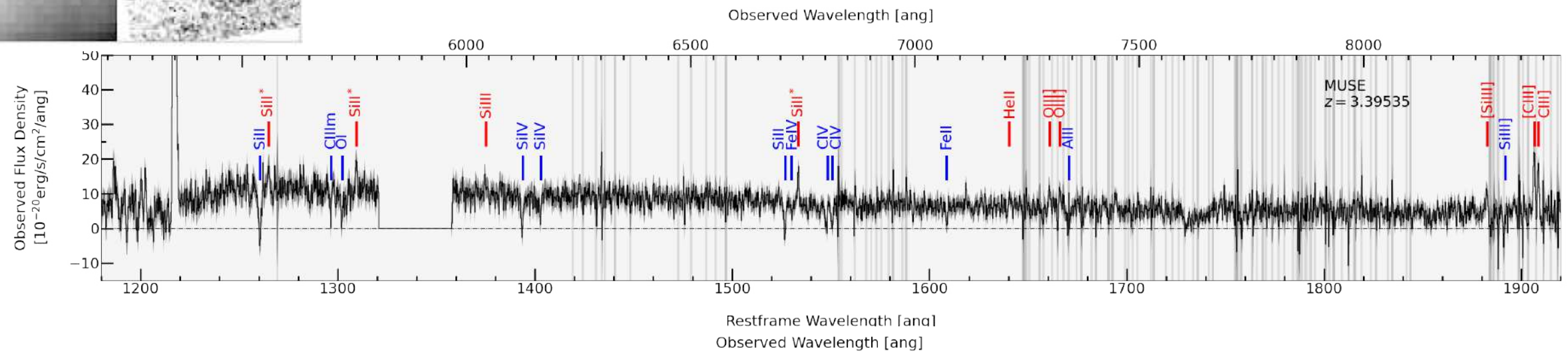
**OUR TARGET'S CLUMPS
HAVE SMALL SIZE AND
LOW MASS**





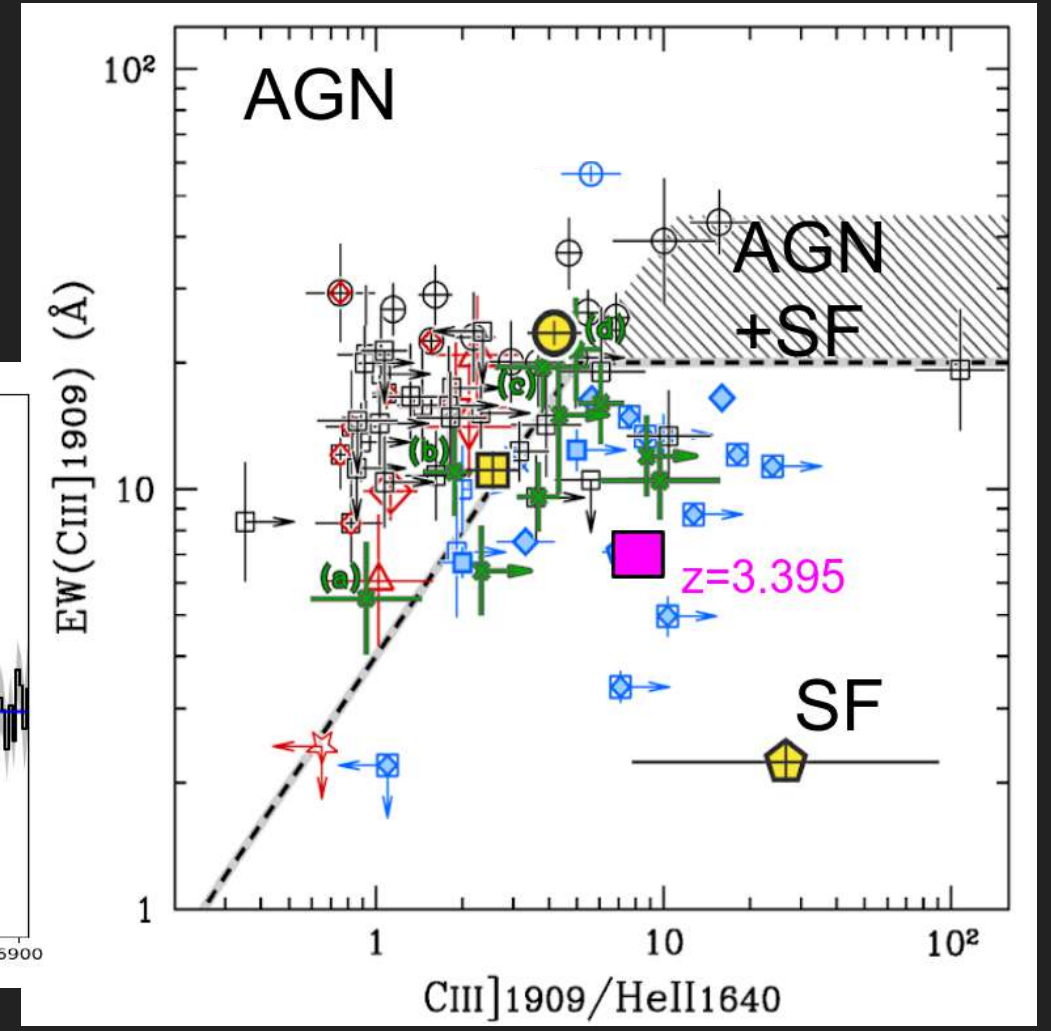
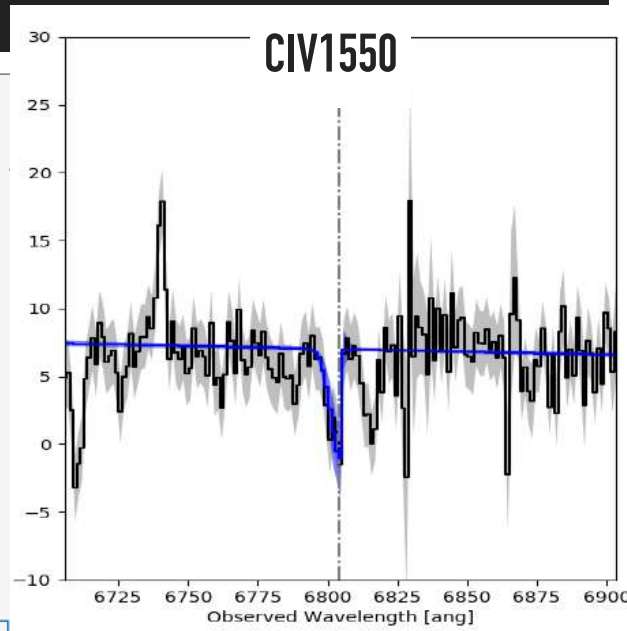
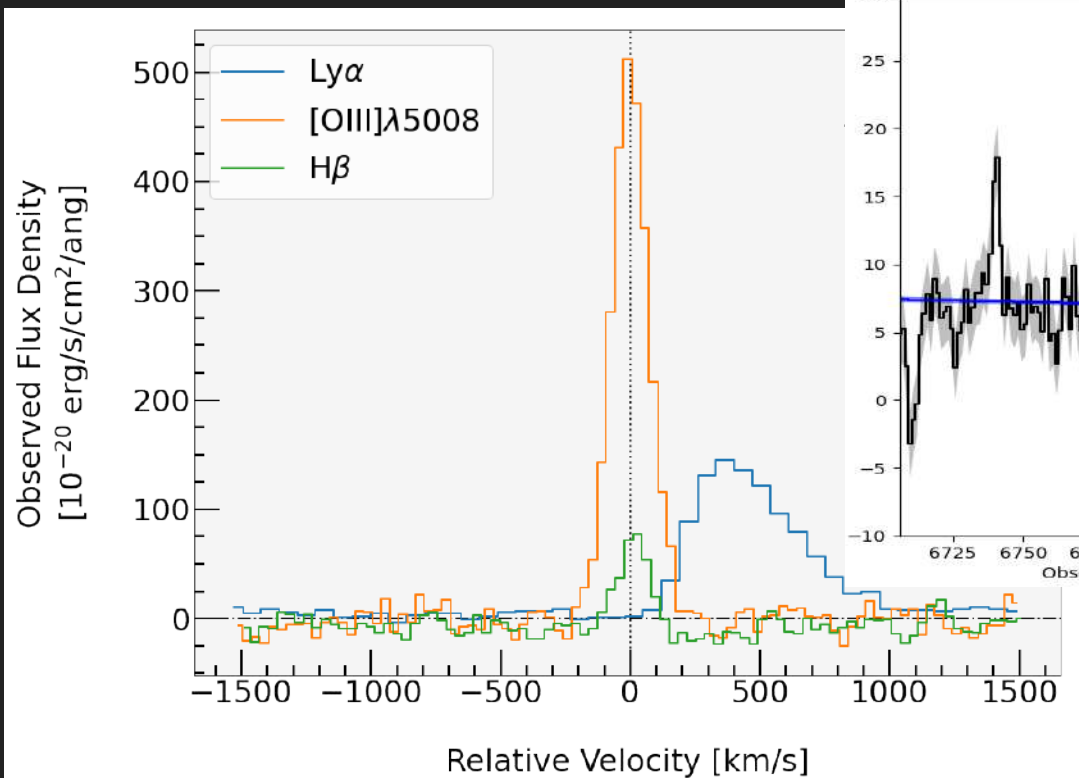
UV

OPT



CLUMPS NATURE

- ▶ UV diagnostic diagram confirm target is **star-forming** (narrow lines, no NV1240, CIV1550 in absorption)



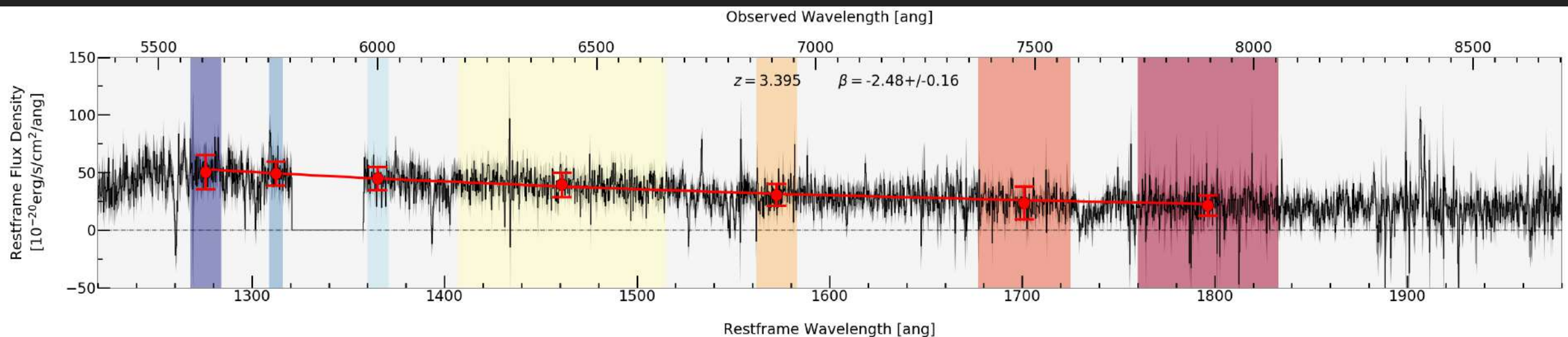
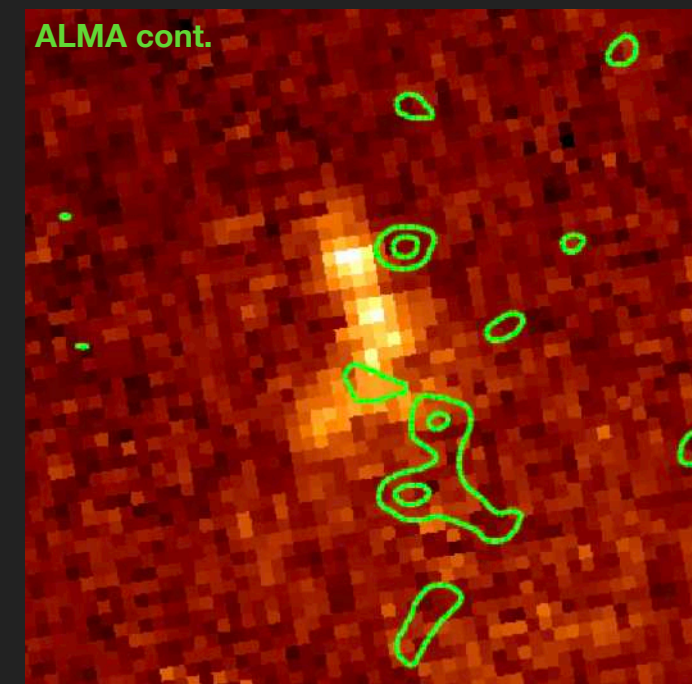
Adapted from *Nakajima+18*

CLUMPS NATURE

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- ▶ From UV β -slope (e.g. *Calzetti+94* + *Meurer+99*)

$$E(B - V)_{con} = 0$$

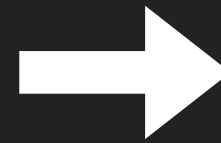
$$E(B - V)_{con} = \frac{1.99\beta + 4.43 \pm 0.55}{k(0.16\mu m)}$$



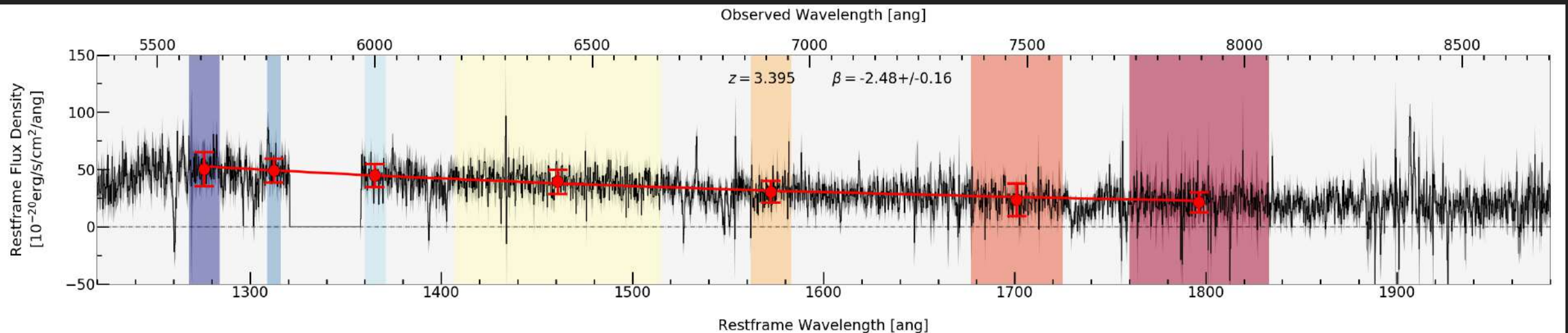
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**OUR TARGET'S CLUMPS ARE
STAR-FORMING REGIONS**



CLUMPS LIFETIME

$$t_{clumps} \simeq \frac{M_{gas}}{\dot{M}}$$

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From **Schmidt-Kennicutt relation**

If MS: $M_{gas} \simeq 1.1 \cdot 10^{10} M_{\odot}$

If SB: $M_{gas} \simeq 7.2 \cdot 10^8 M_{\odot}$

From **Sargent+14**

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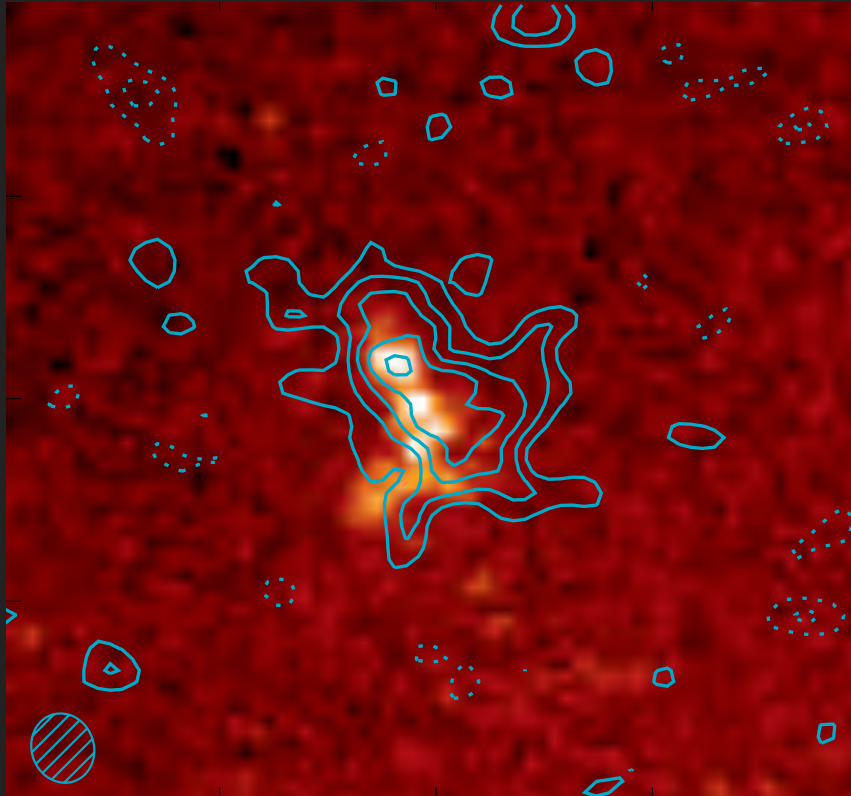
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From:

- literature (Zanella+15,+19; Bournaud+15)
- ALMA (from L([CII]158m), e.g. Zanella+18, Madden+20, Dessauges-Zavadsky+20)



CLUMPS LIFETIME

For homogeneous gas dist.
(*Pettini+00*)

$$t_{clumps} \simeq \frac{M_{gas}}{\dot{M}}$$

$$\dot{M} = \frac{\xi \cdot N_{HI} \cdot m_{HI} \cdot v_{exp}}{x}$$

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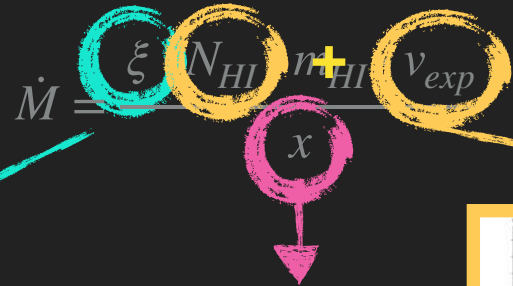
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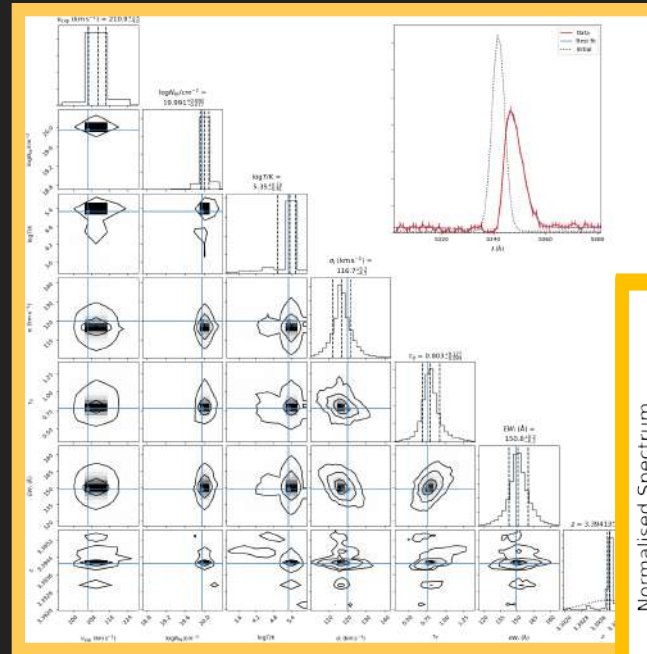
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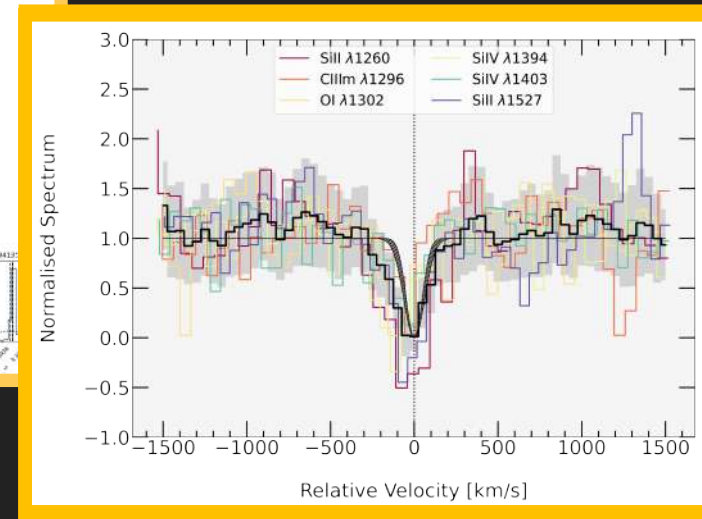
From Ly α modelling

Outflow geometry, $\xi(r, \theta) = S^2/V$

- ▶ Spherical
- ▶ Bi-conical
- ▶ Double spherical sector



tlac code (*Gronke+14*)



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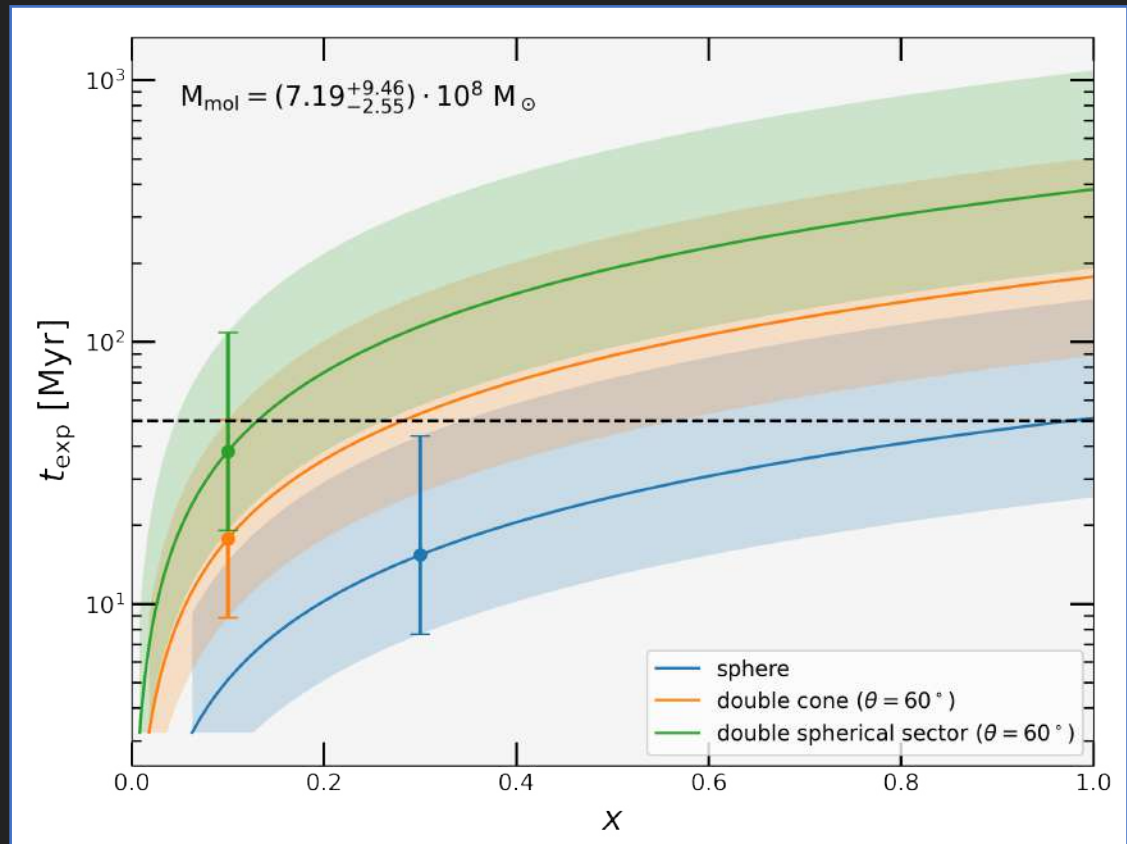
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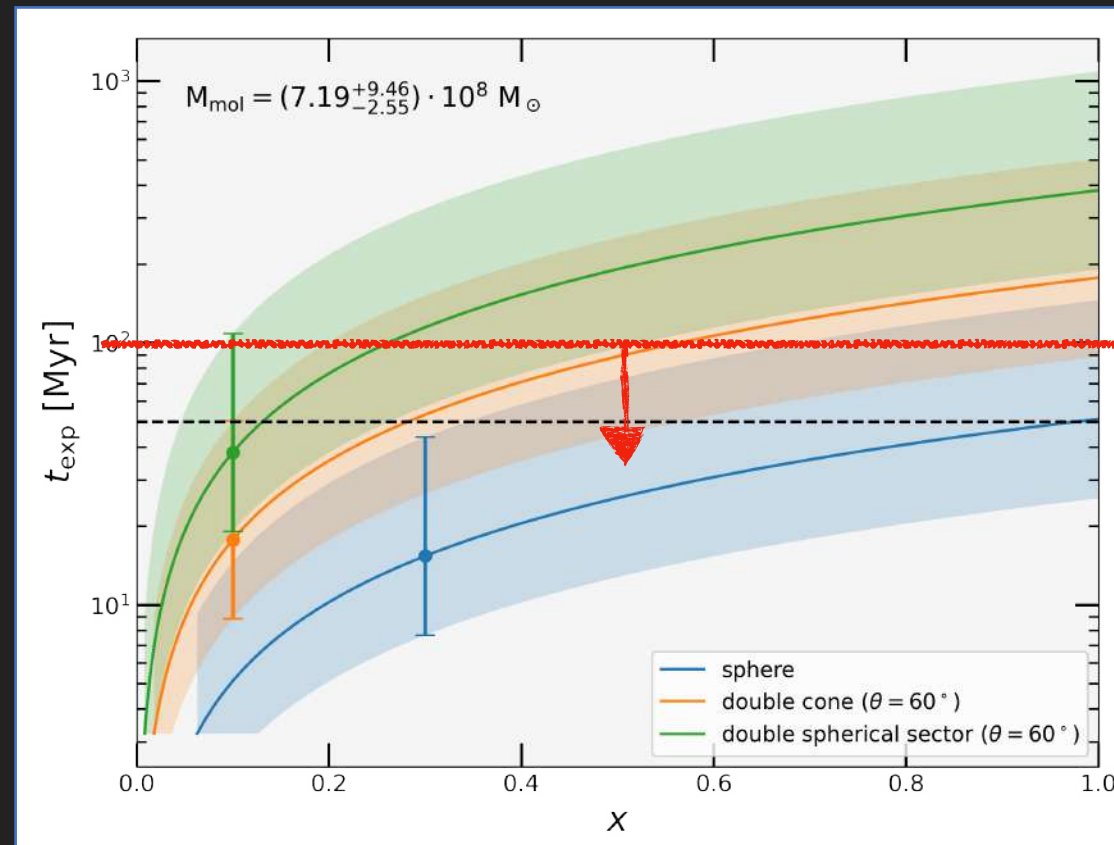
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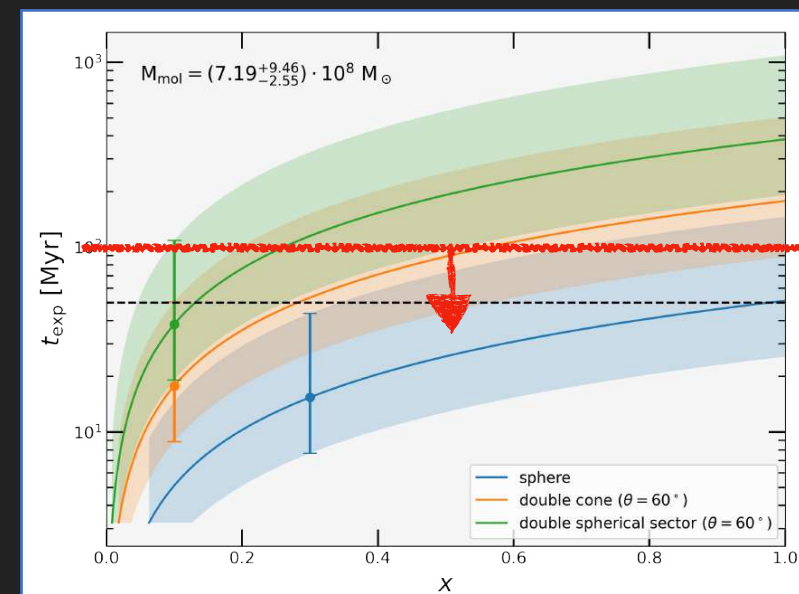
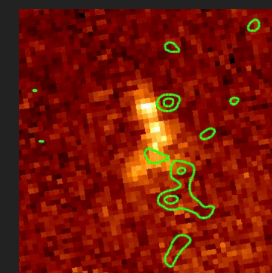
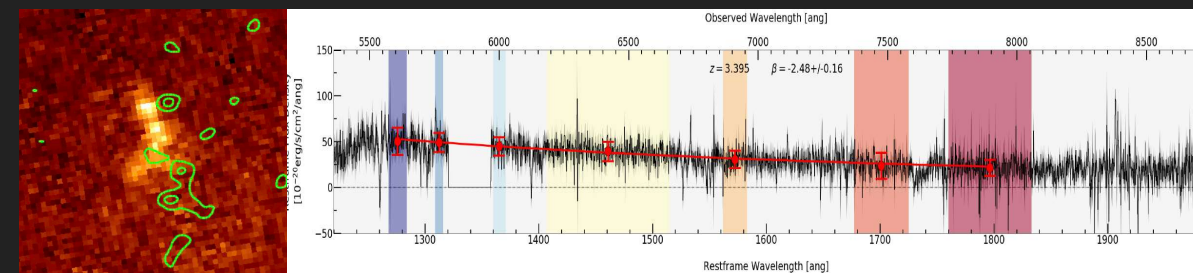
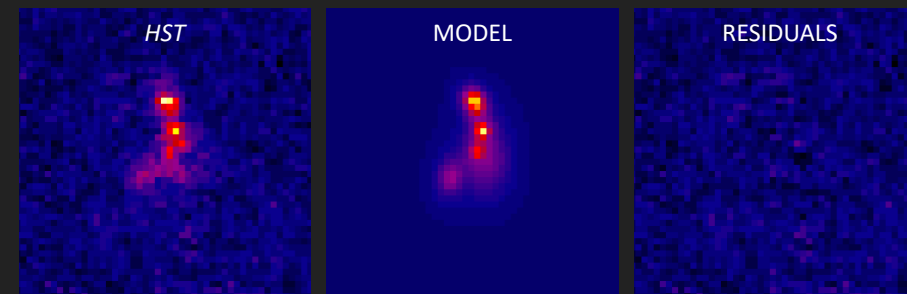
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**OUR TARGET'S CLUMPS
EXPEL THEIR GAS
CONTENT IN < 100 MYR**

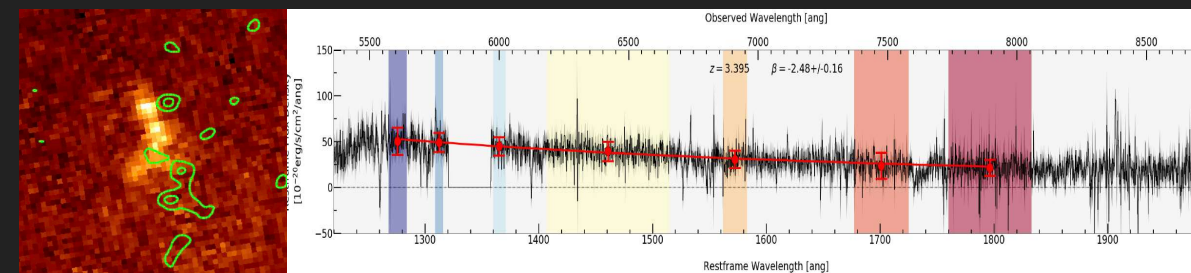
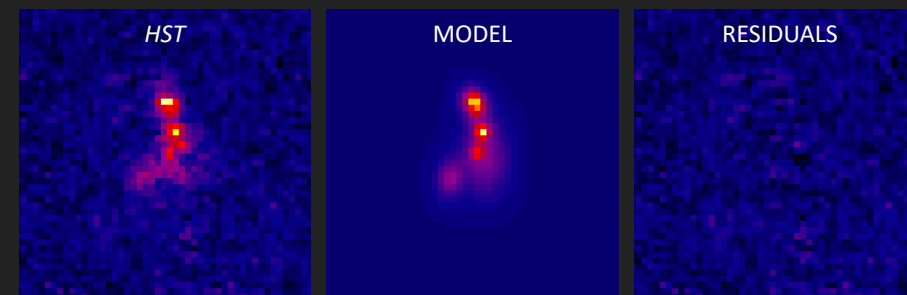
TAKE-HOME MESSAGES

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- ▶ Clumps are difficult to study because of the current spatial resolution (waiting for JWST and HARMONI);
- ▶ Need of multi-wavelength dataset;
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FUTURE STEPS

- ▶ Simulate our target galaxy to understand how clumps form, if they are short-living (under which stellar feedback recipes) and which impact they have on the host;
- ▶ Apply our study to a statistical sample.

