

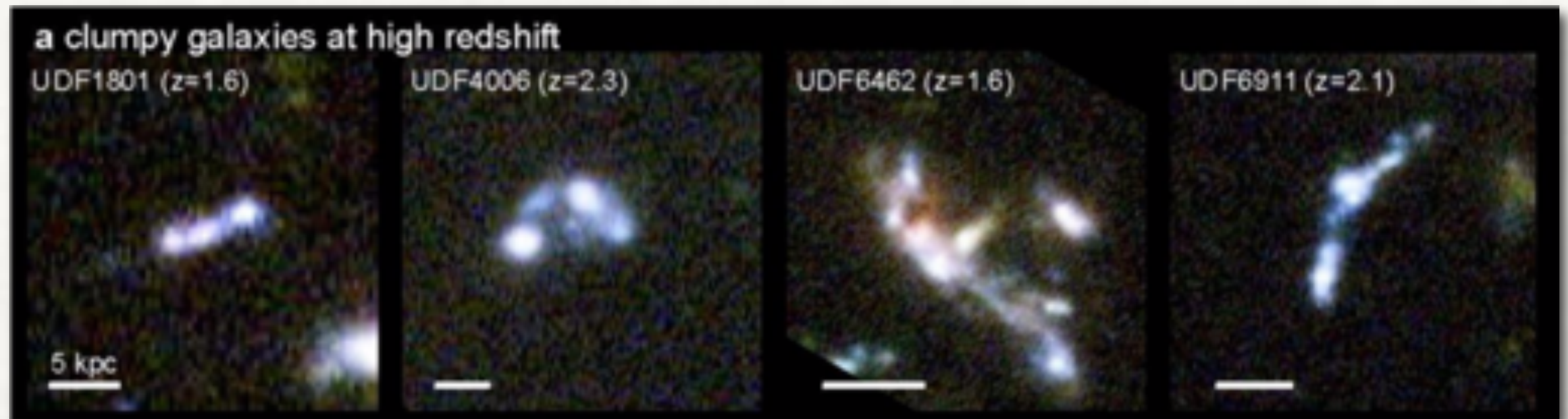
BAPTISTE FAURE - CEA SACLAY

HIERARCHICAL FRAGMENTATION IN HIGH REDSHIFT GALAXIES REVEALED BY HYDRODYNAMICAL SIMULATIONS AND STRONG GRAVITATIONAL LENSING

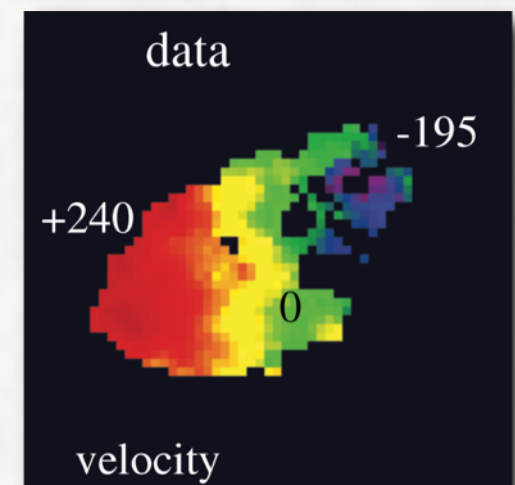
With Frédéric Bournaud, Emanuele Daddi, Jérémy Fensch,
Manuel Behrendt, Andreas Burkert, Johan Richard



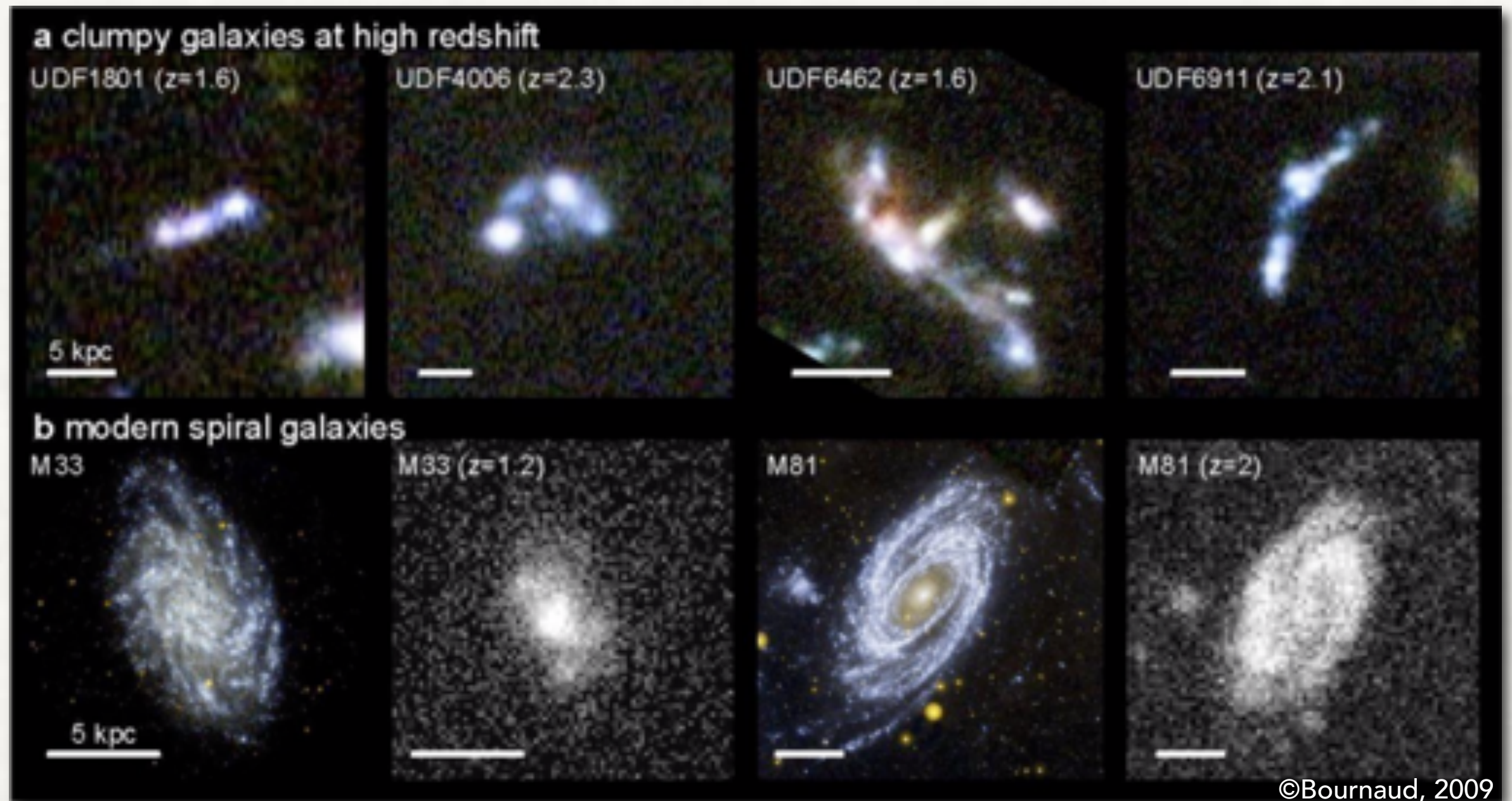
GIANT CLUMPS



- Disk like kinematics (Genzel et al, 2008)
- Giant clumps properties:
 - Mass $\sim 10^8$ and $10^9 M_{\odot}$ (Elmegreen & Elmegreen, 2005)
 - SFR $\sim 20\%$ -50% of the whole galaxy



GIANT CLUMPS



CLUMP EVOLUTION



Strong feedback effect:
Clumps are short-lived
~20 Myr

(Oklopčić et al 2016,
Hopkins et al 2015)

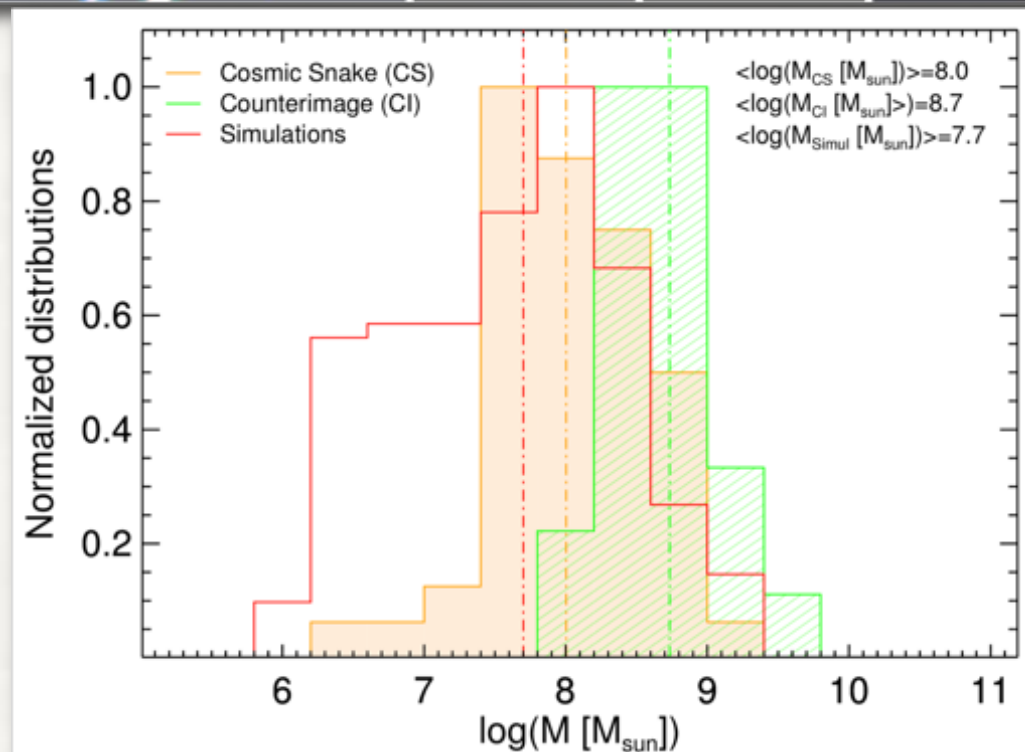
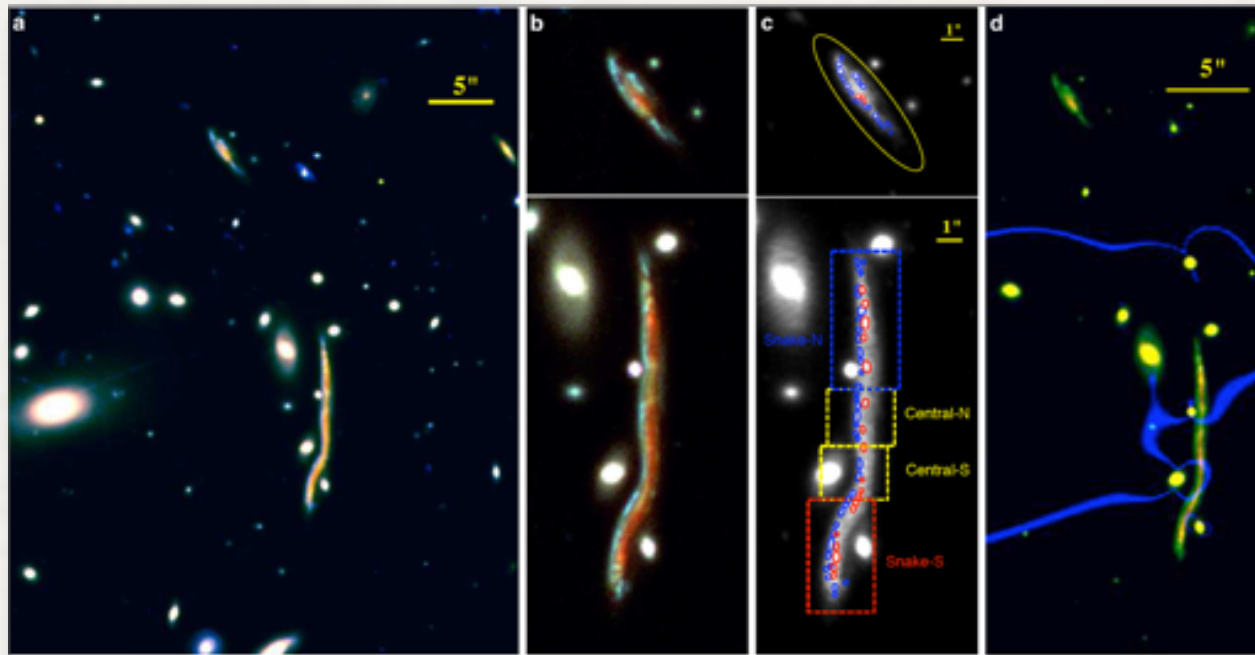


Weaker feedback effect:
Clumps are long-lived
~ 500 Myr
=> Bulge growth

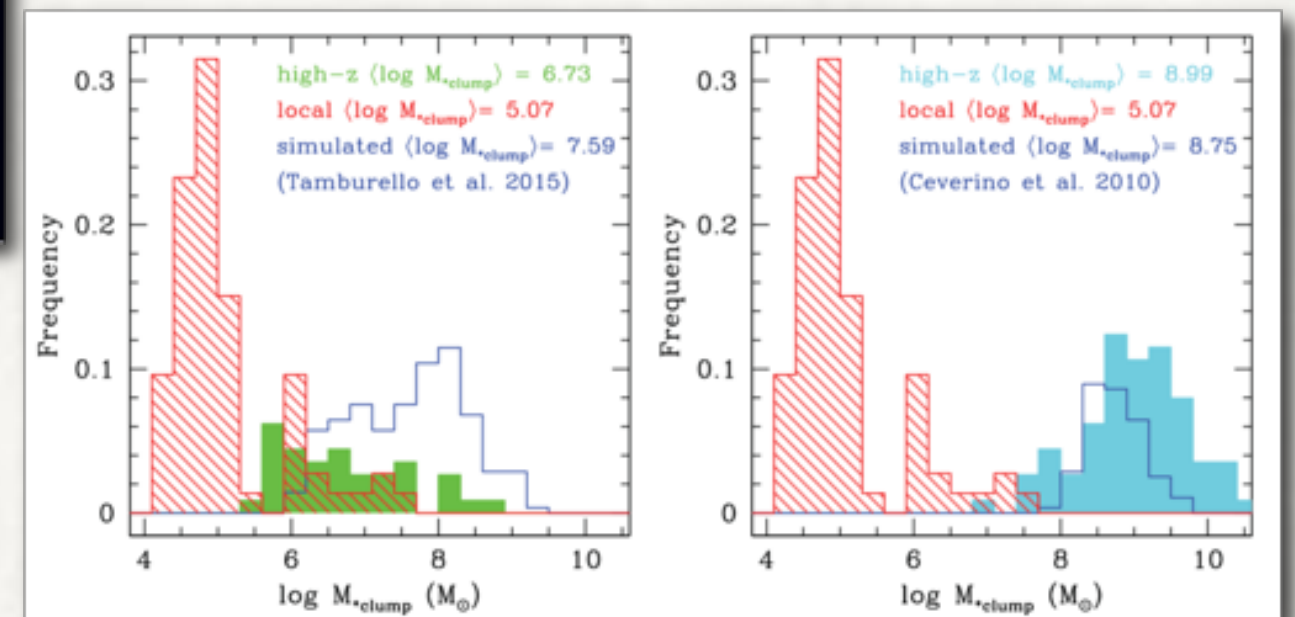
(Bournaud et al 2014,
Ceverino et al 2012,
Agertz et al 2009)

**New debate:
Do they exist at all ?**

STRONG GRAVITATIONAL LENSING



Cava et al, 2018



Dessauges-Zavadsky et al, 2015

SUB-PARSEC SIMULATIONS

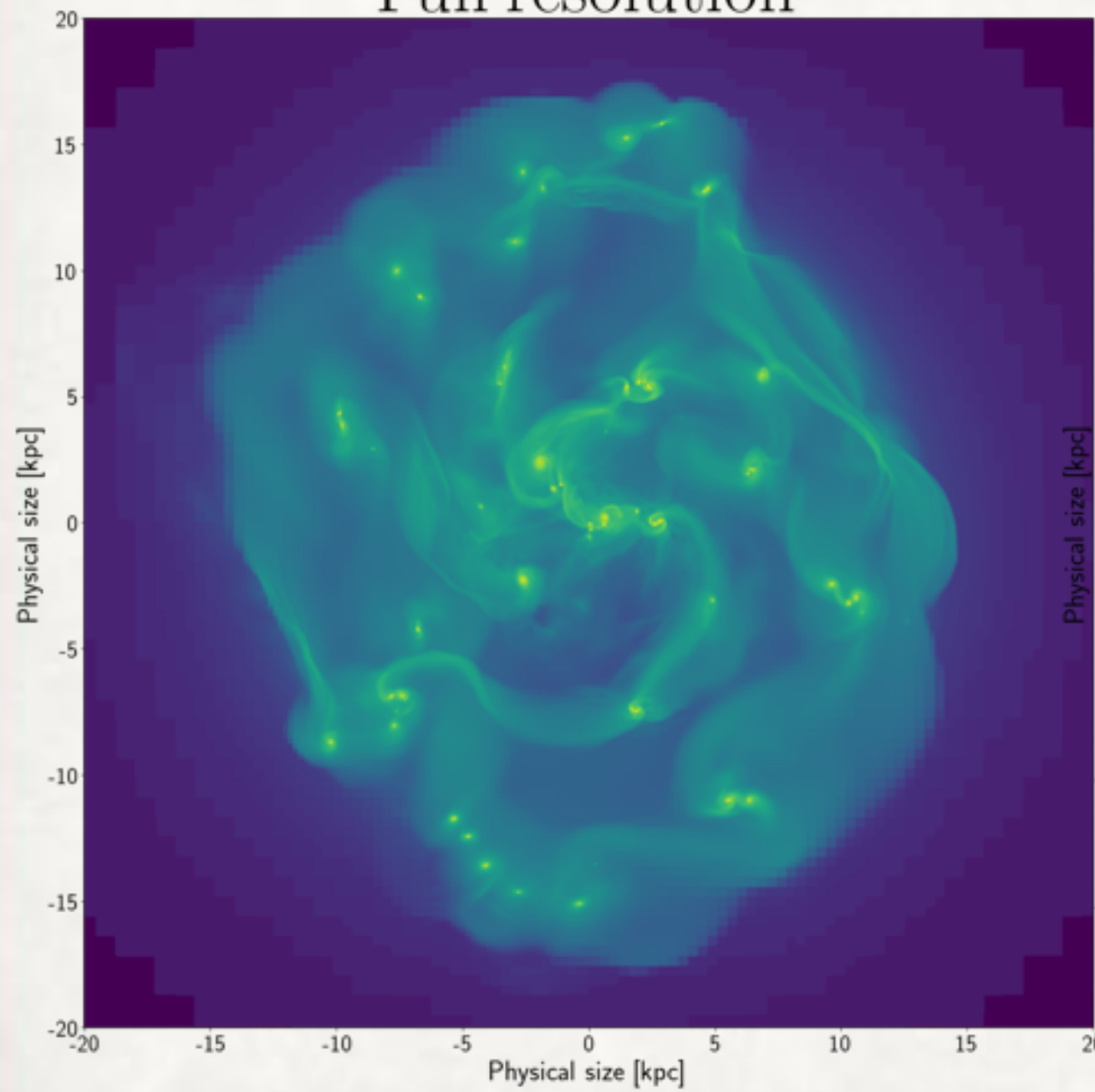
- Simulations made with RAMSES AMR Hydro code
- Stellar formation and feedback

	Simulation 1	Simulation 2	Simulation 3
Gas mass	$20 \cdot 10^9 \text{ MSun}$	$35 \cdot 10^9 \text{ MSun}$	$64 \cdot 10^9 \text{ MSun}$
Gas fraction	~50 %	~50 %	~50 %
Typical size	5 kpc	13 kpc	12 kpc
Feedback	SN+HII+Radiative	SN+HII+Radiative	SN
Max res.	1.5 pc/px	0.4 pc/px	0.2 pc/px

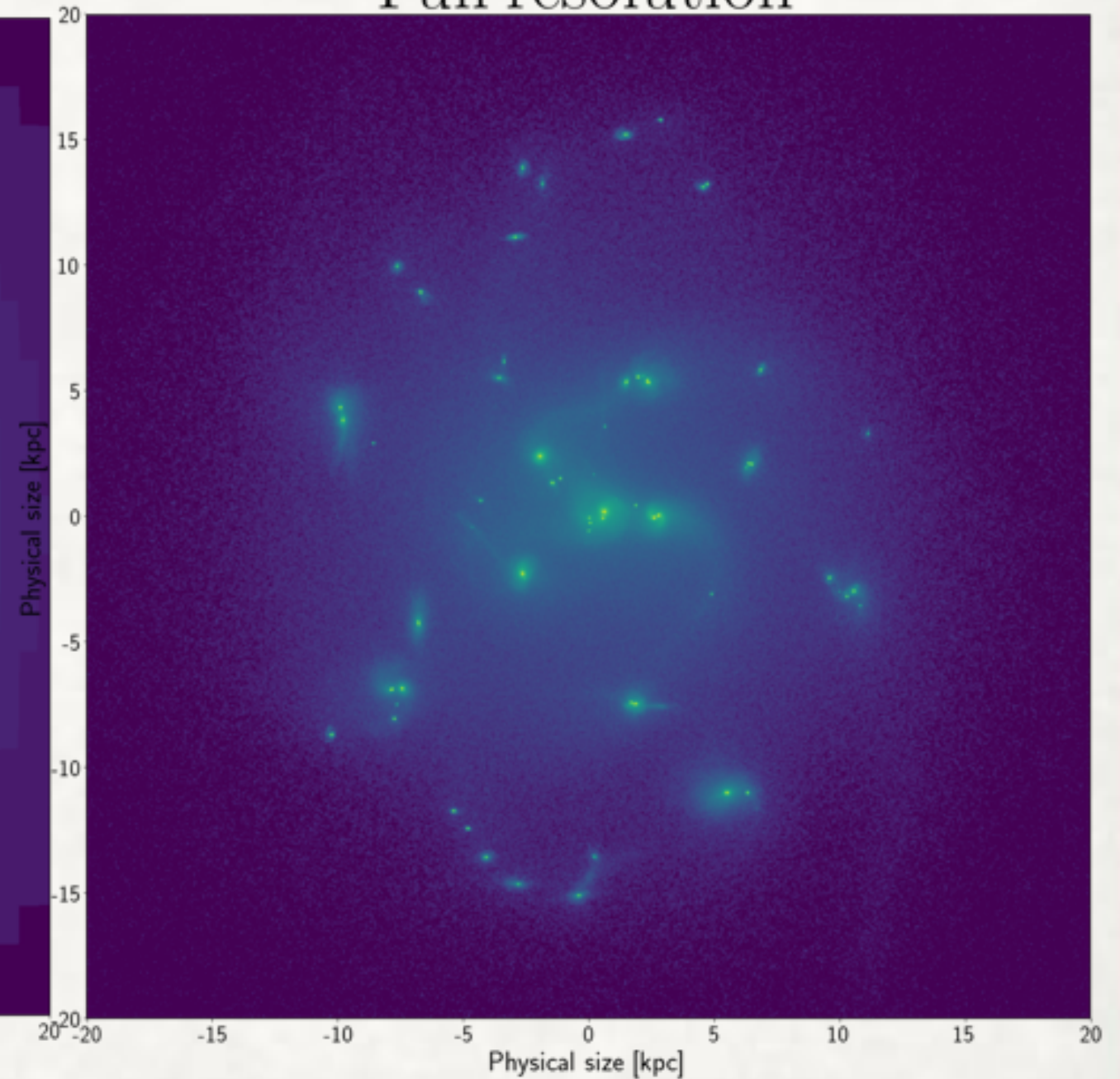
+1 from Behrendt et al, 2016
with different IC and FB

SIMULATIONS:
FULL RESOLUTION

Full resolution

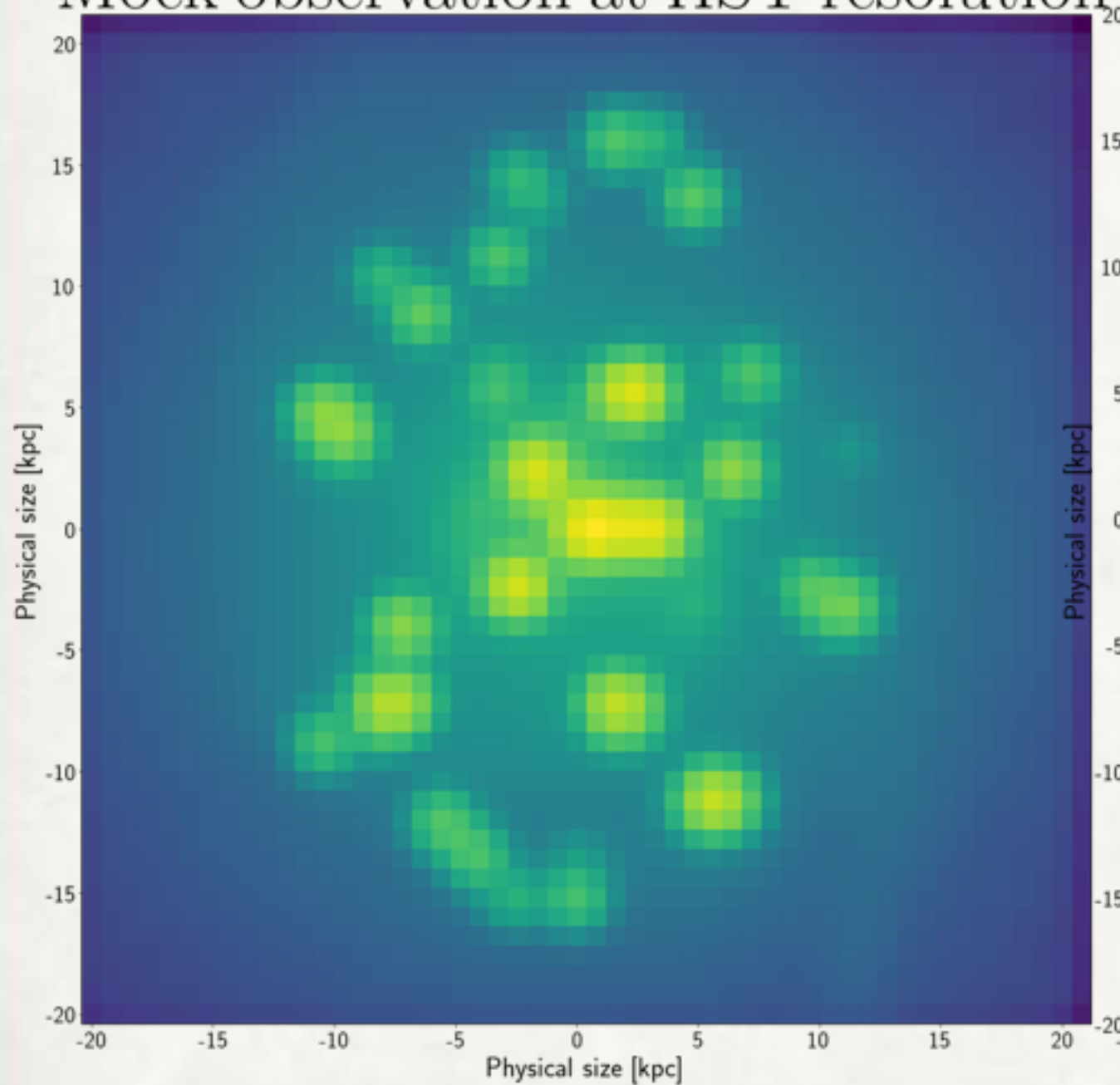


Full resolution

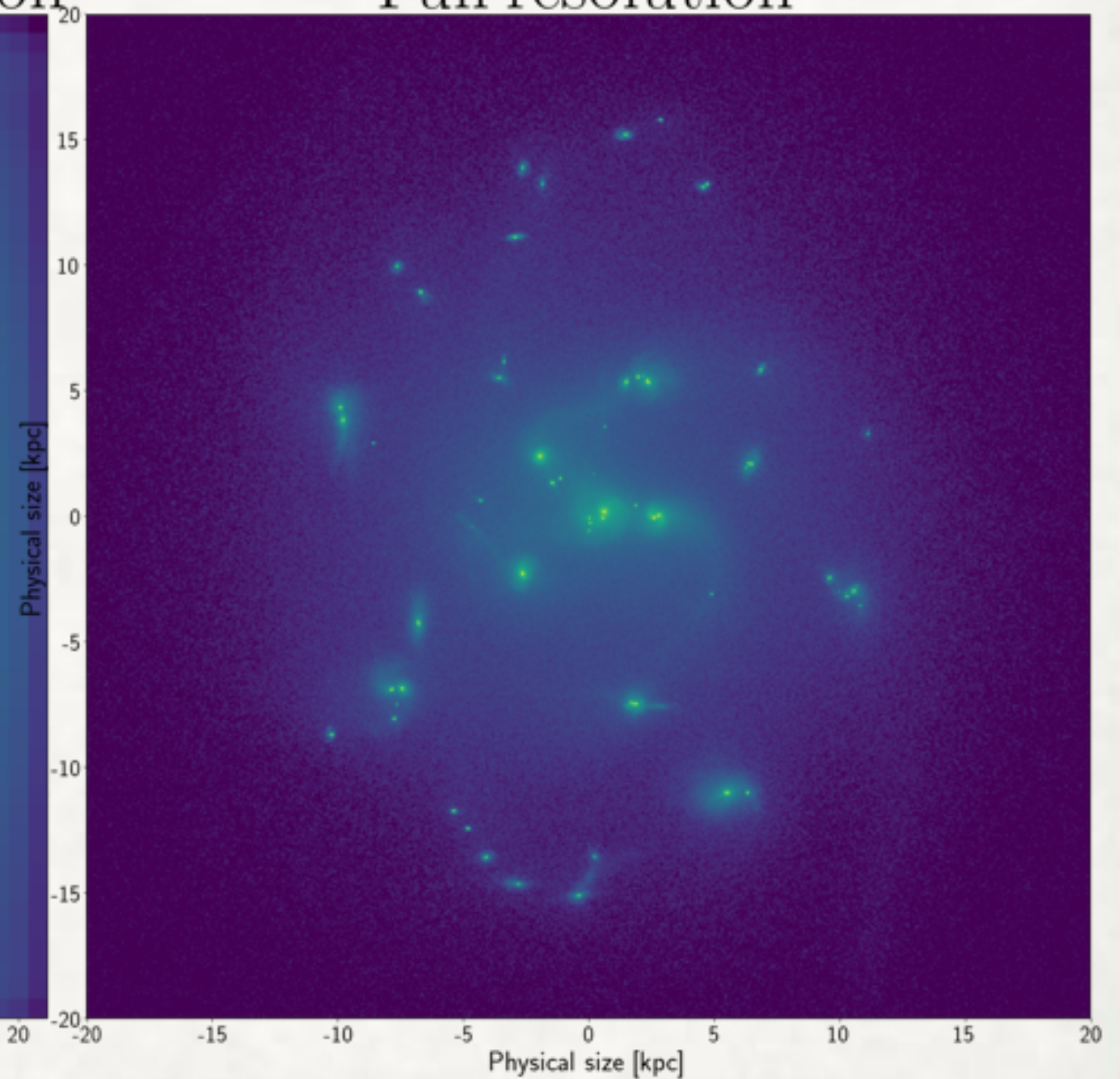


MOCK OBSERVATION VS FULL RESOLUTION SIMULATION

Mock observation at HST resolution

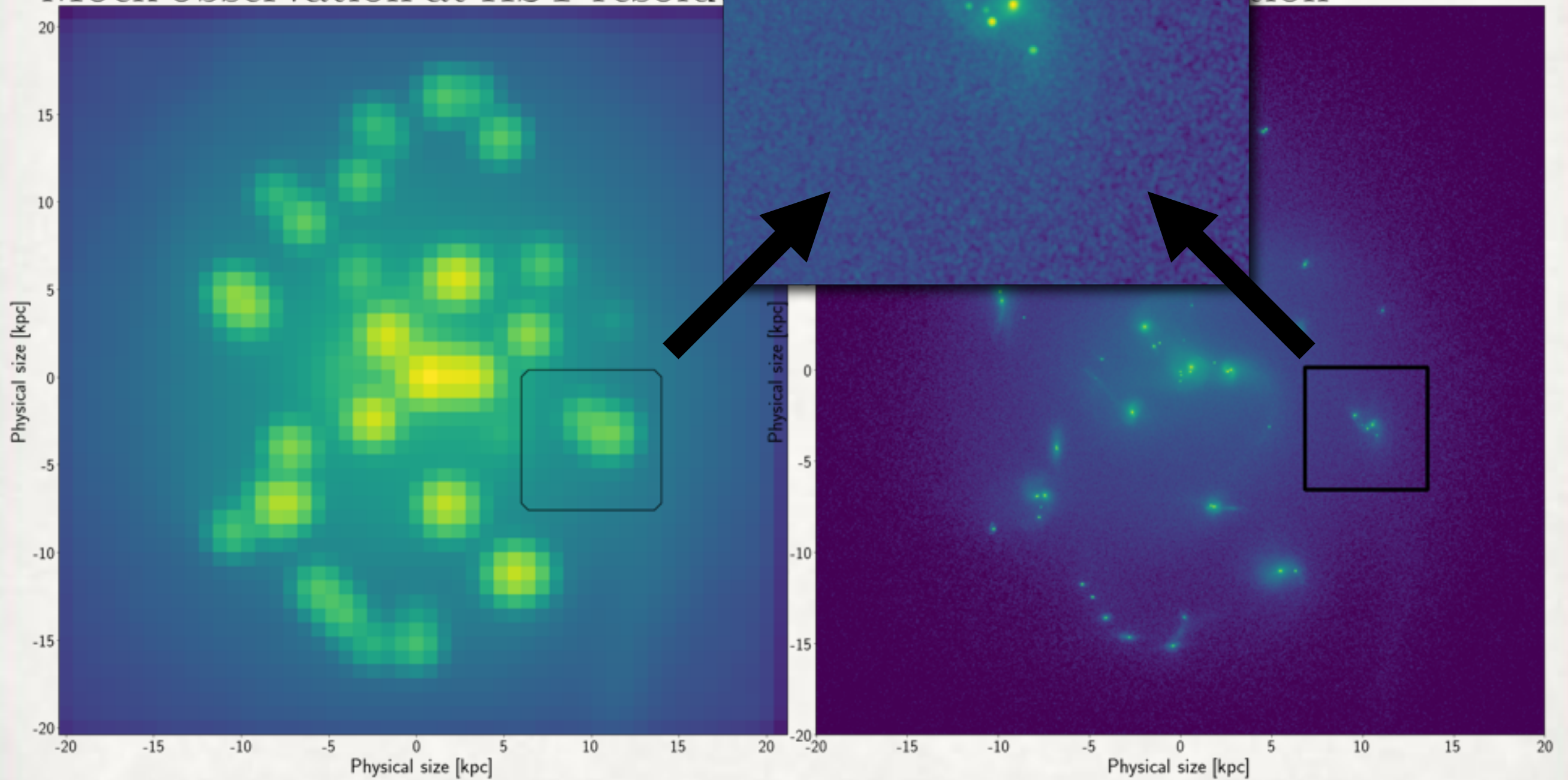


Full resolution



MOCK C
FULL RESOL

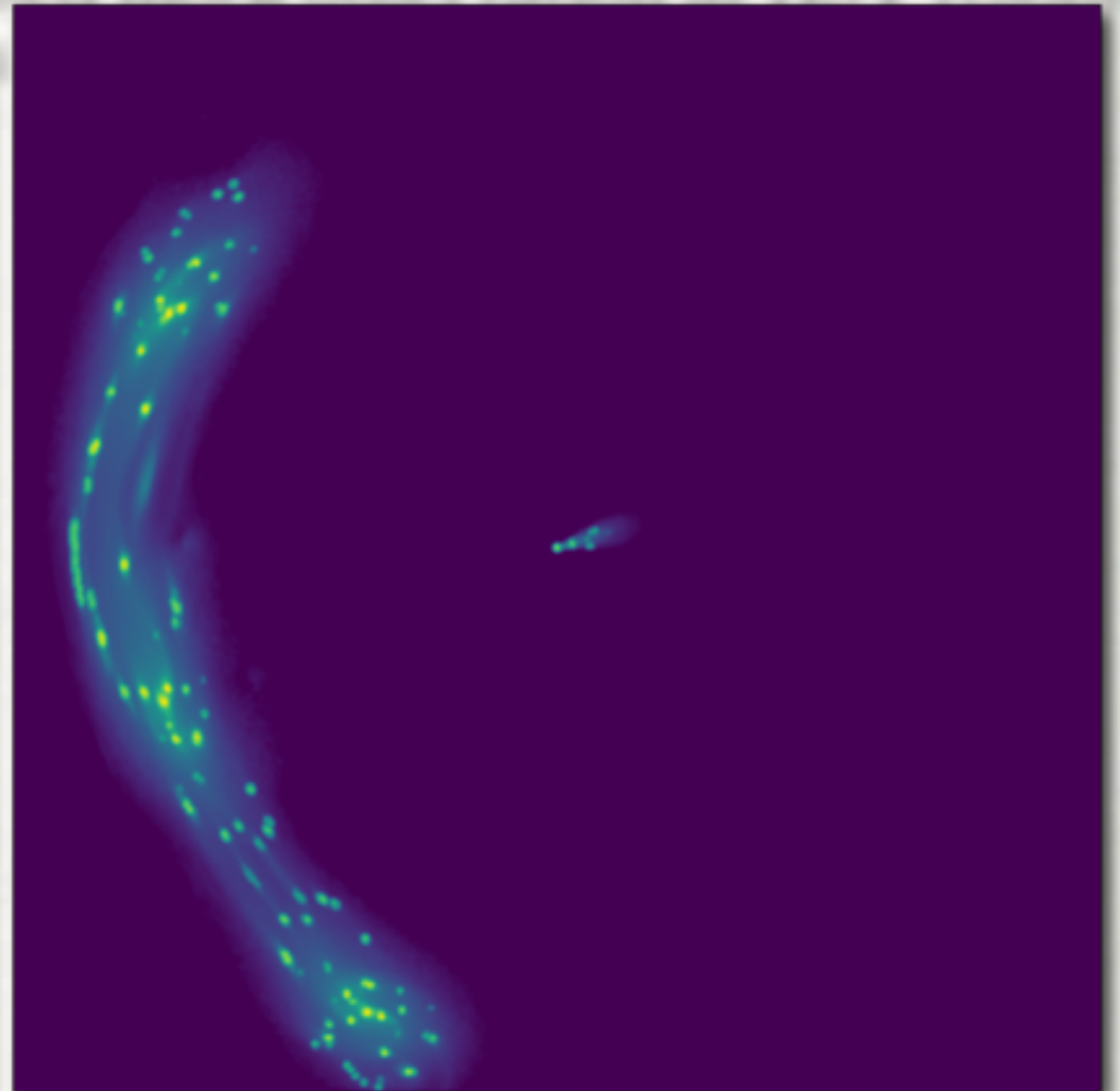
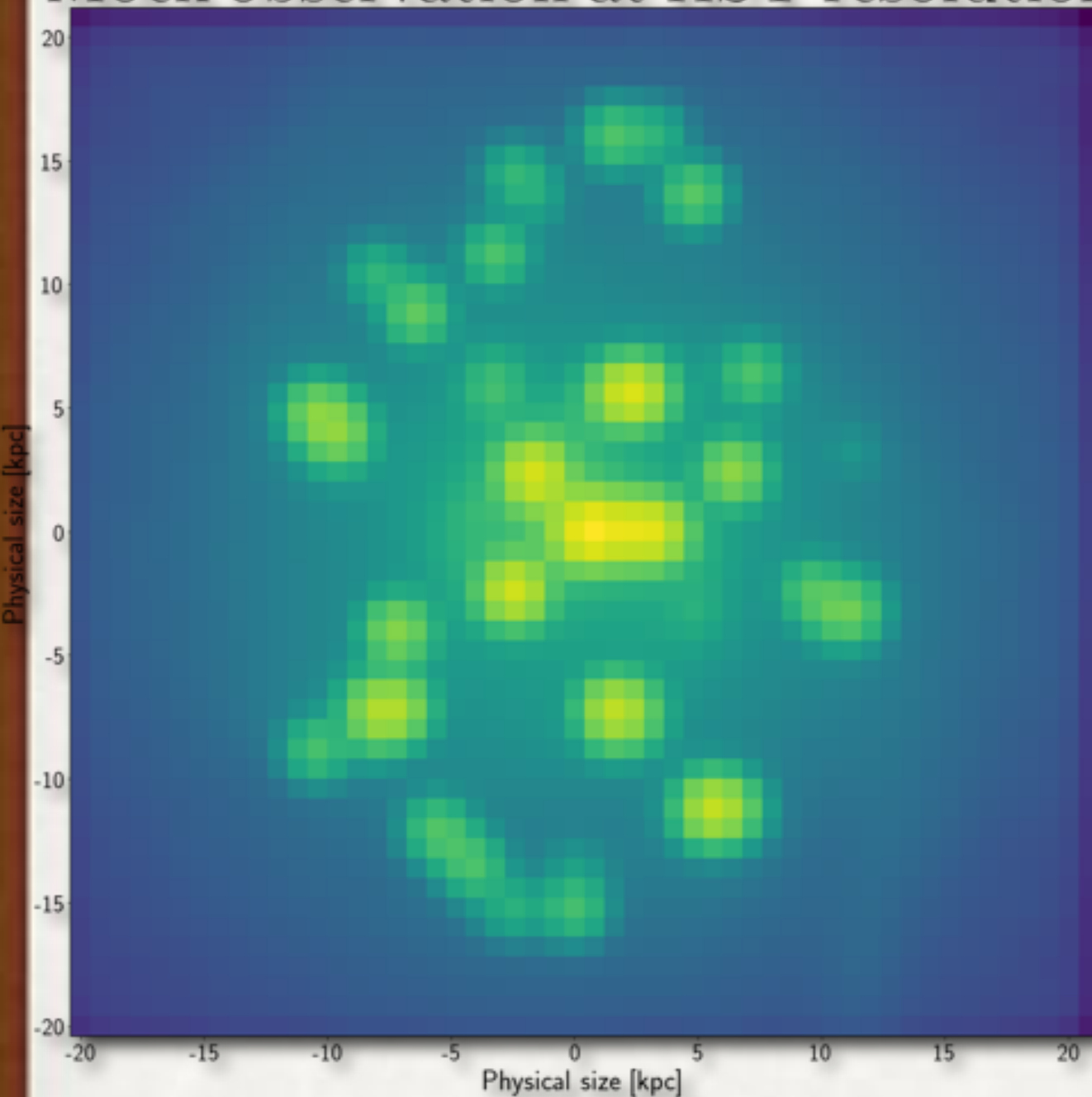
Mock observation at HST resolution



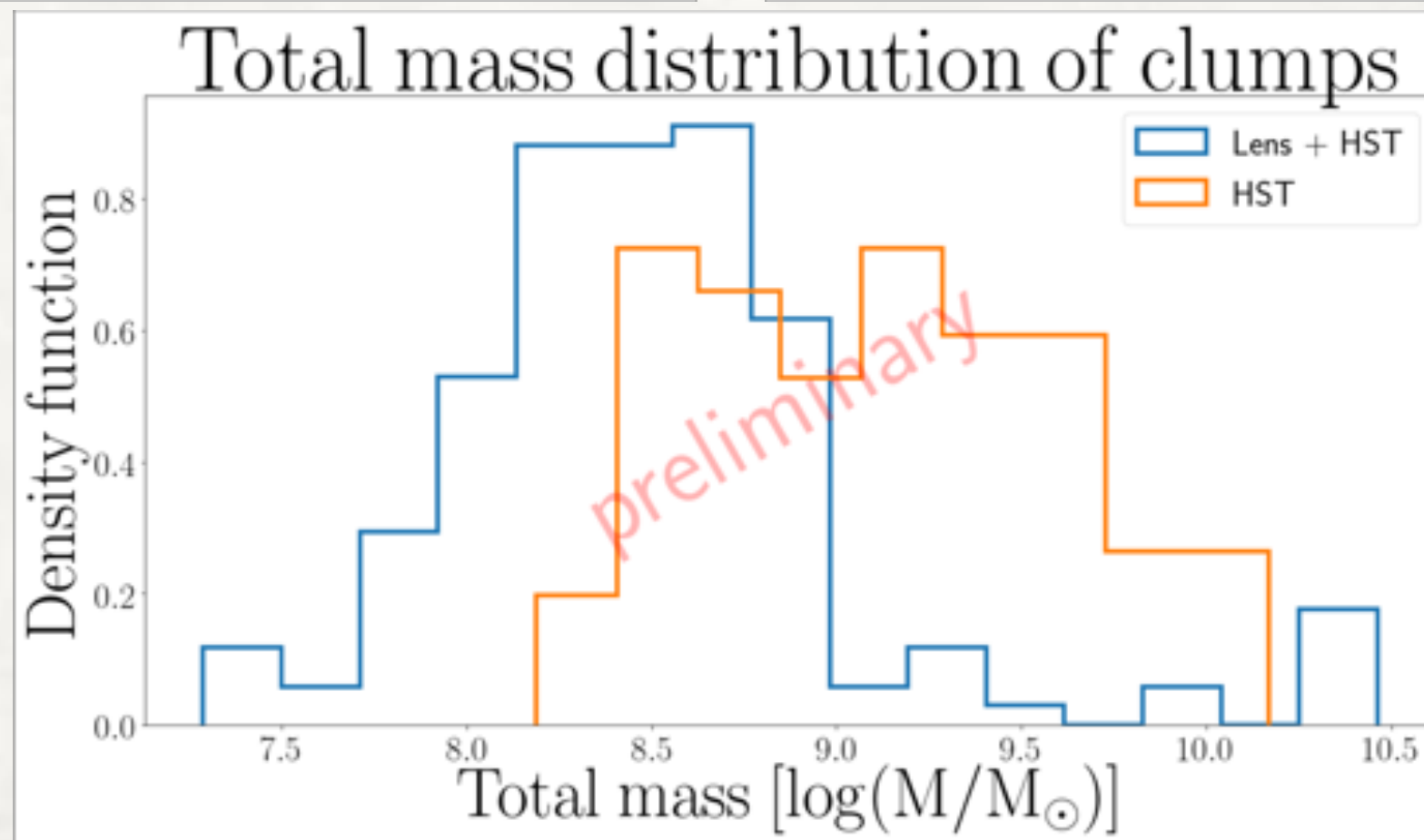
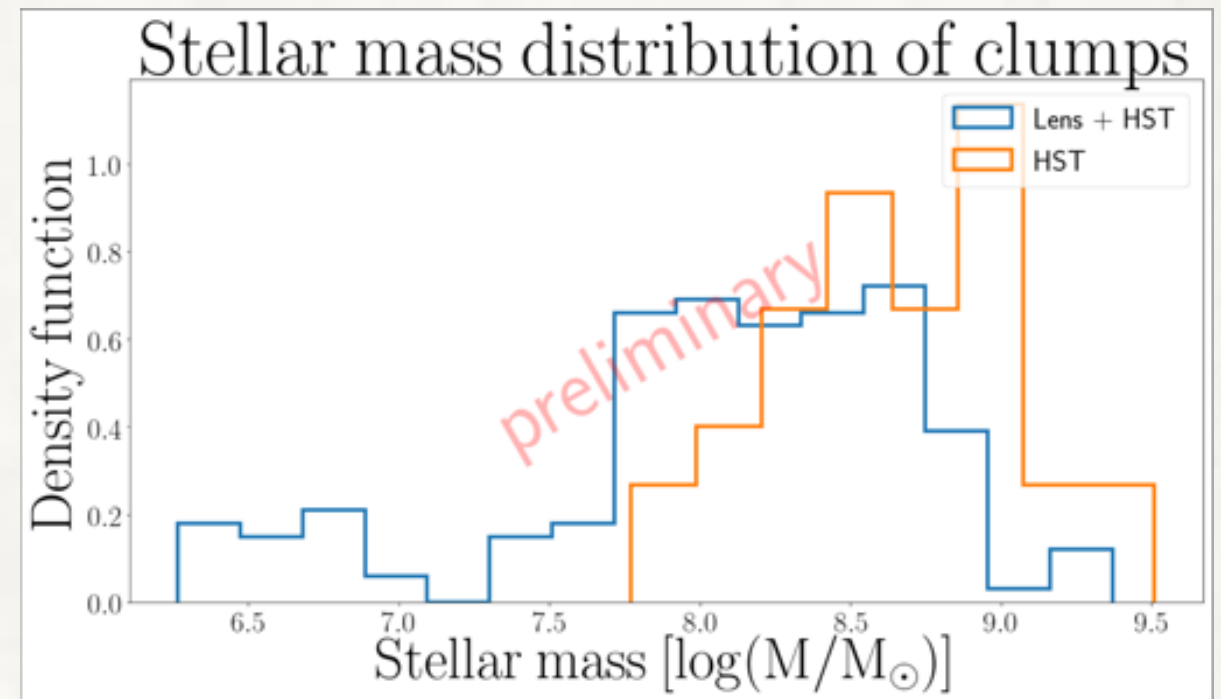
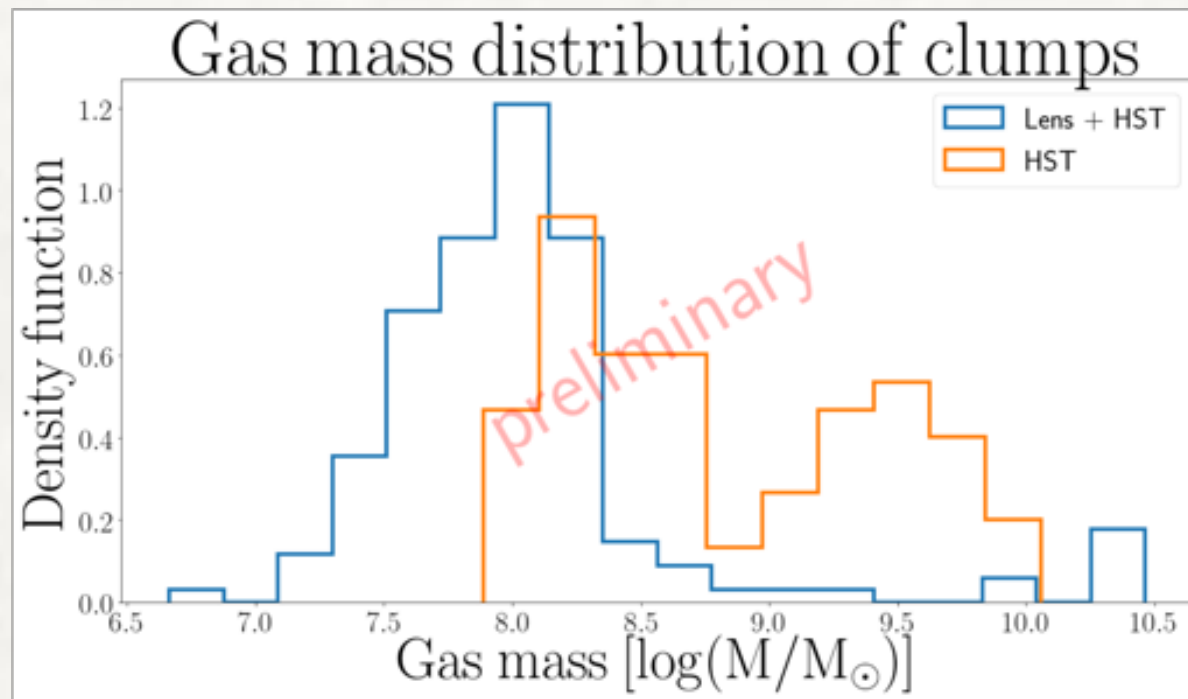
GRAVITATIONAL LENSING

Lensed mock observation at HST resolution

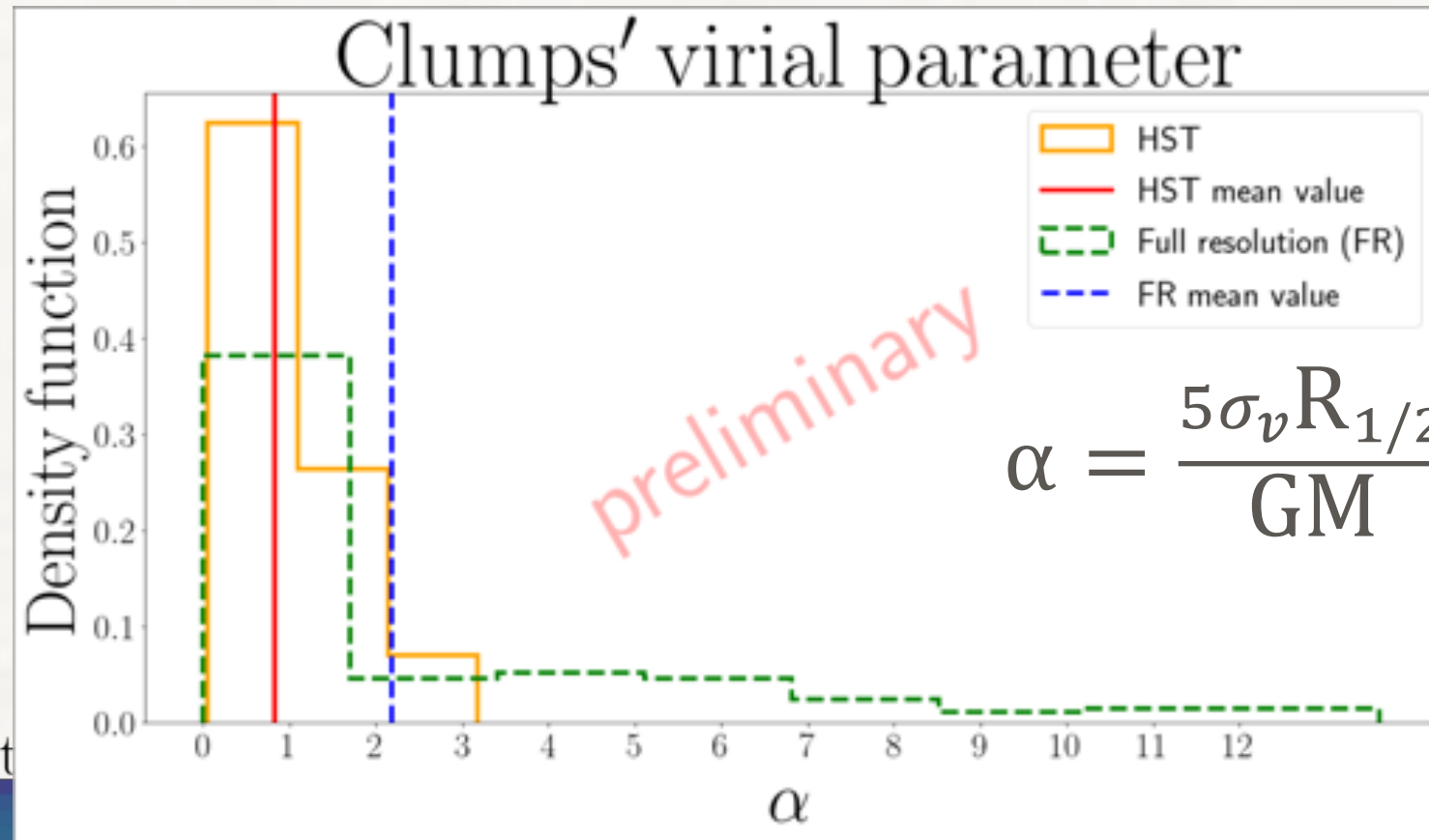
Mock observation at HST resolution



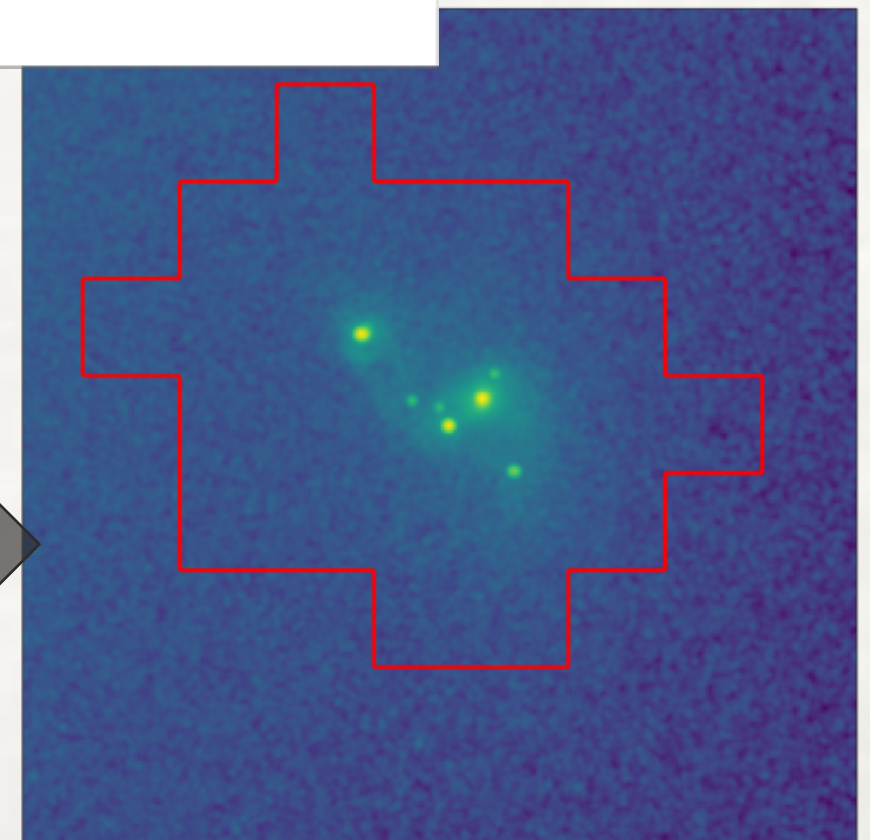
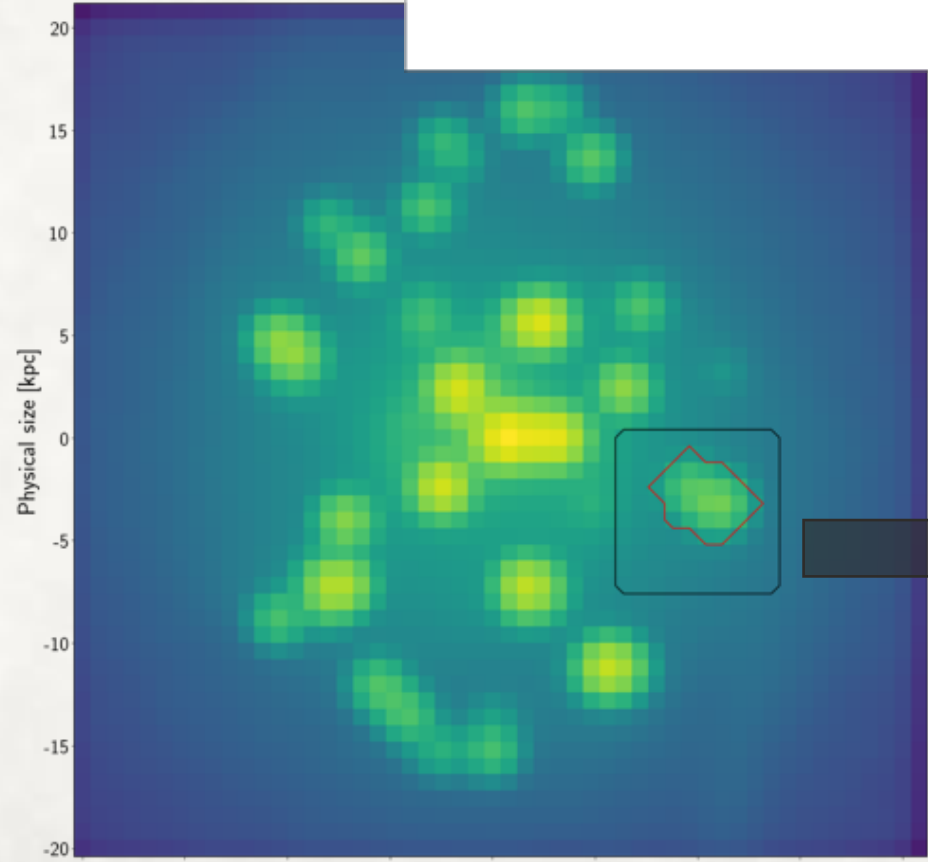
MASS DISTRIBUTION



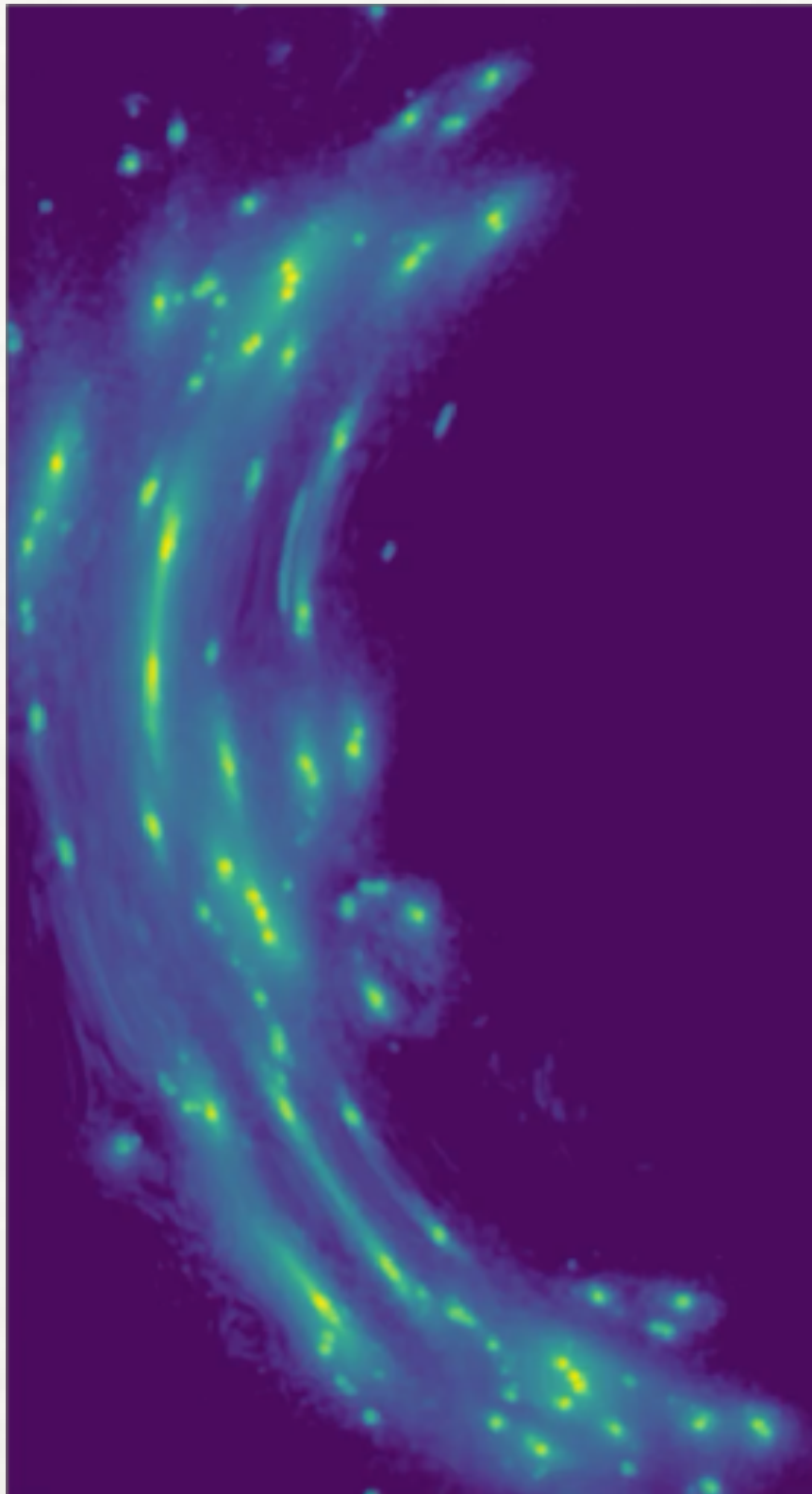
VIRIAL PARAMETER



Mock observat



TAKE HOME MESSAGE



- Giant clumps not detected in strongly lensed clumpy galaxies
- Presence of sub-clumps separated by lensing
- Giant clumps have a physical existence (ie they are gravitationally bound)
- Futur work on physical properties of giant clumps and sub-clumps