Clumpy galaxies at high redshift: Insights from the NIHAO simulations

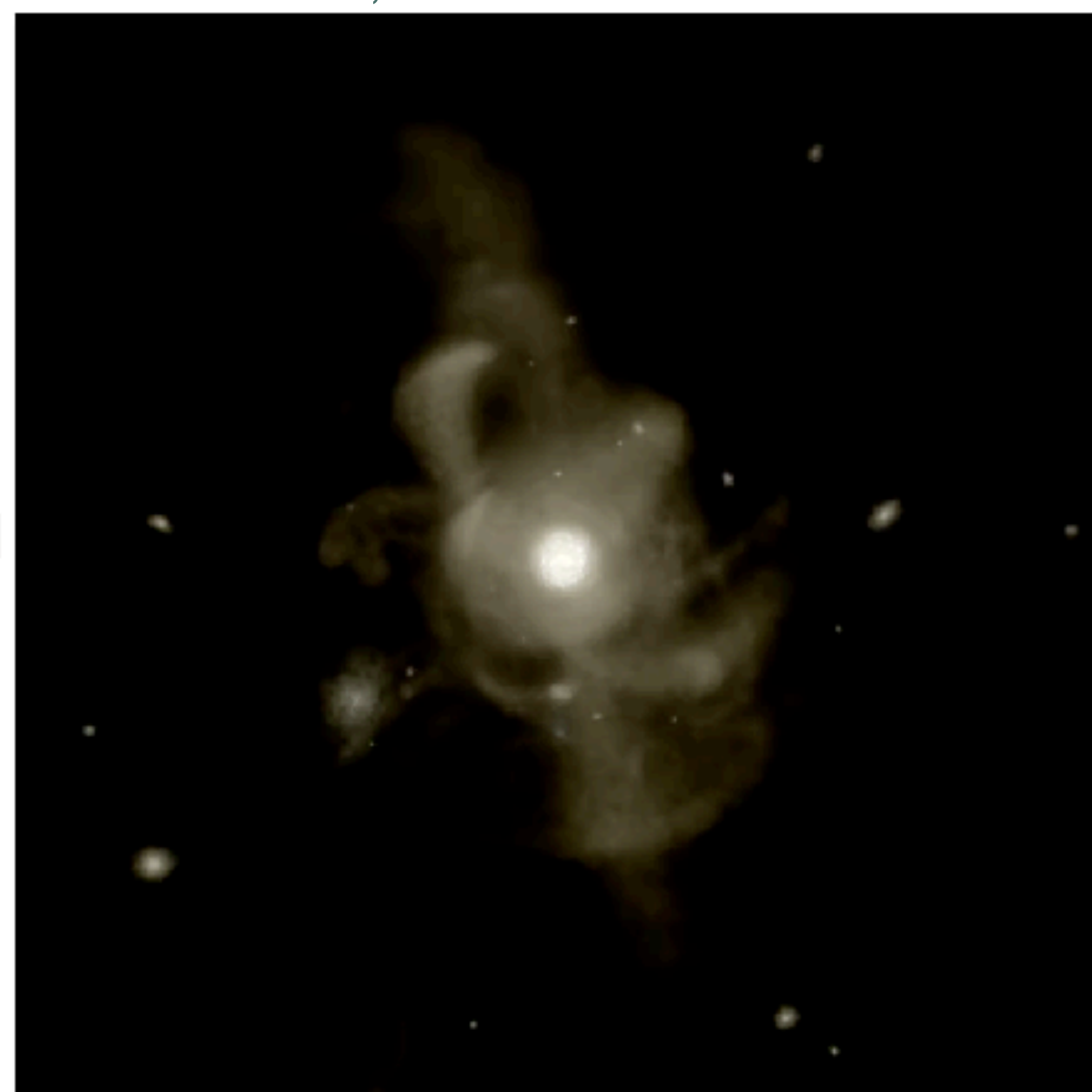
Buck et al. 2017 (MNRAS) - arXiv:1612.05277

Gas in Galaxies Valetta 6th of October

Tobias Buck

Andrea V. Macciò, Aura Obreja, Aaron A. Dutton, Hans-Walter Rix

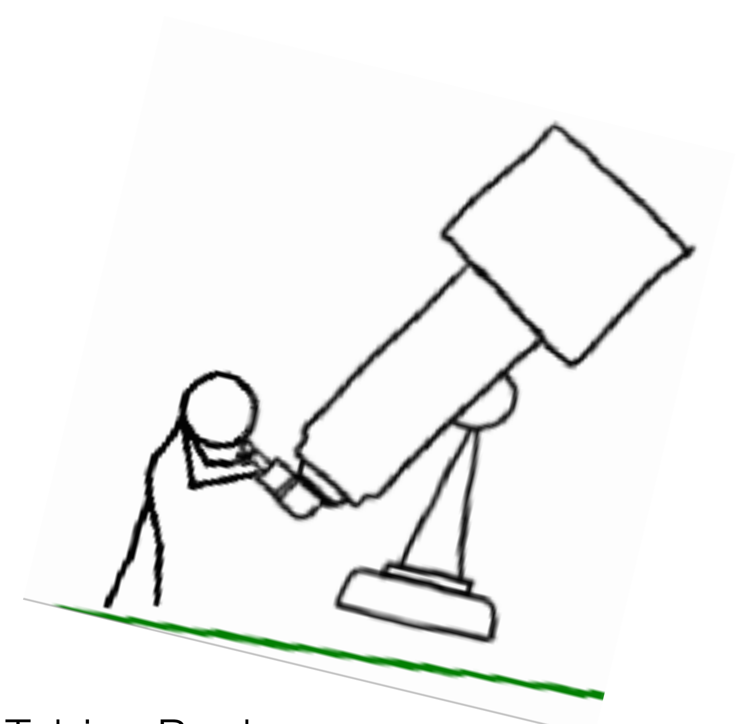
PhD student at MPIA

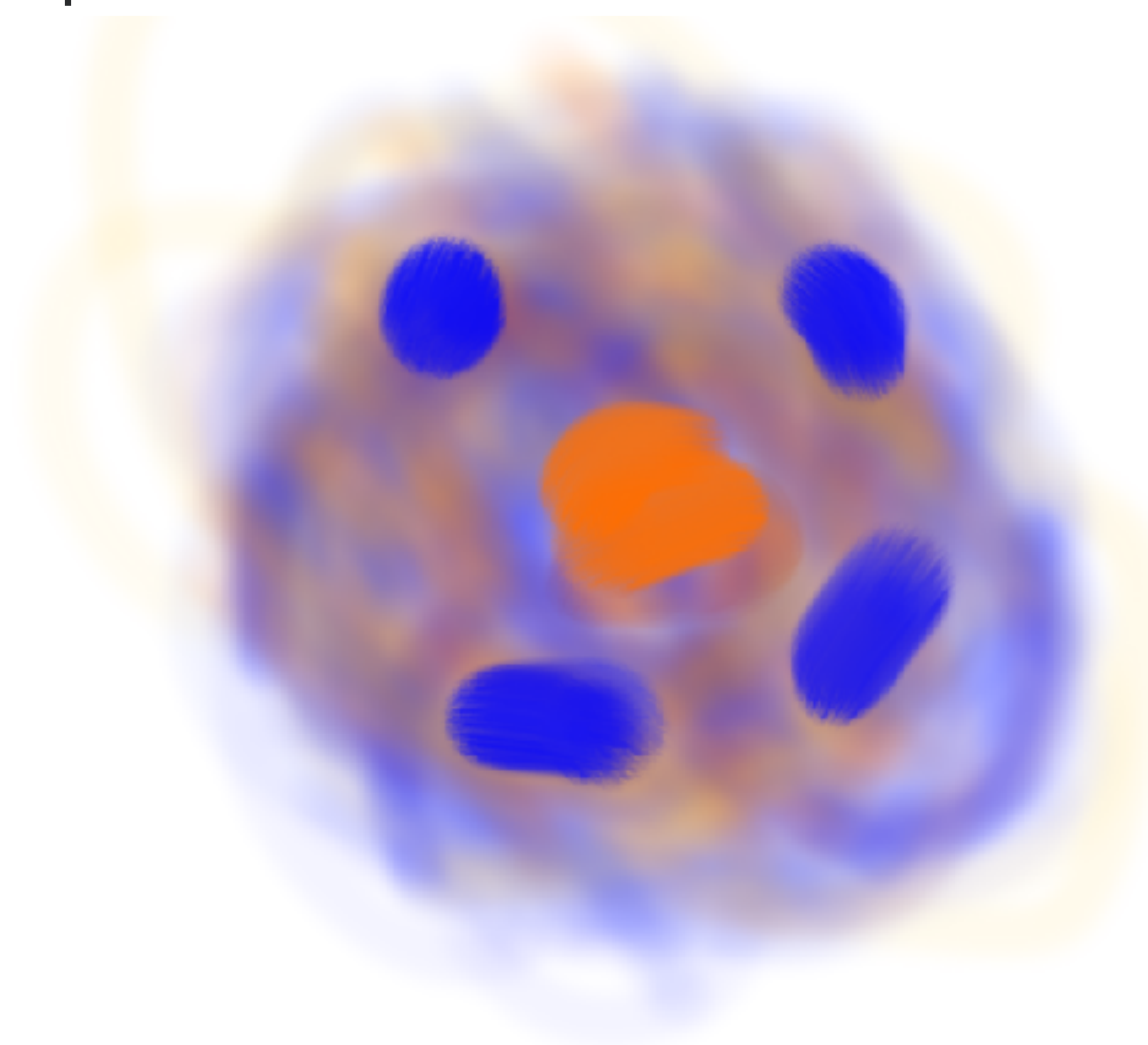


Animation by T. Buck (MPIA, NYUAD) based on NIHAO simulations

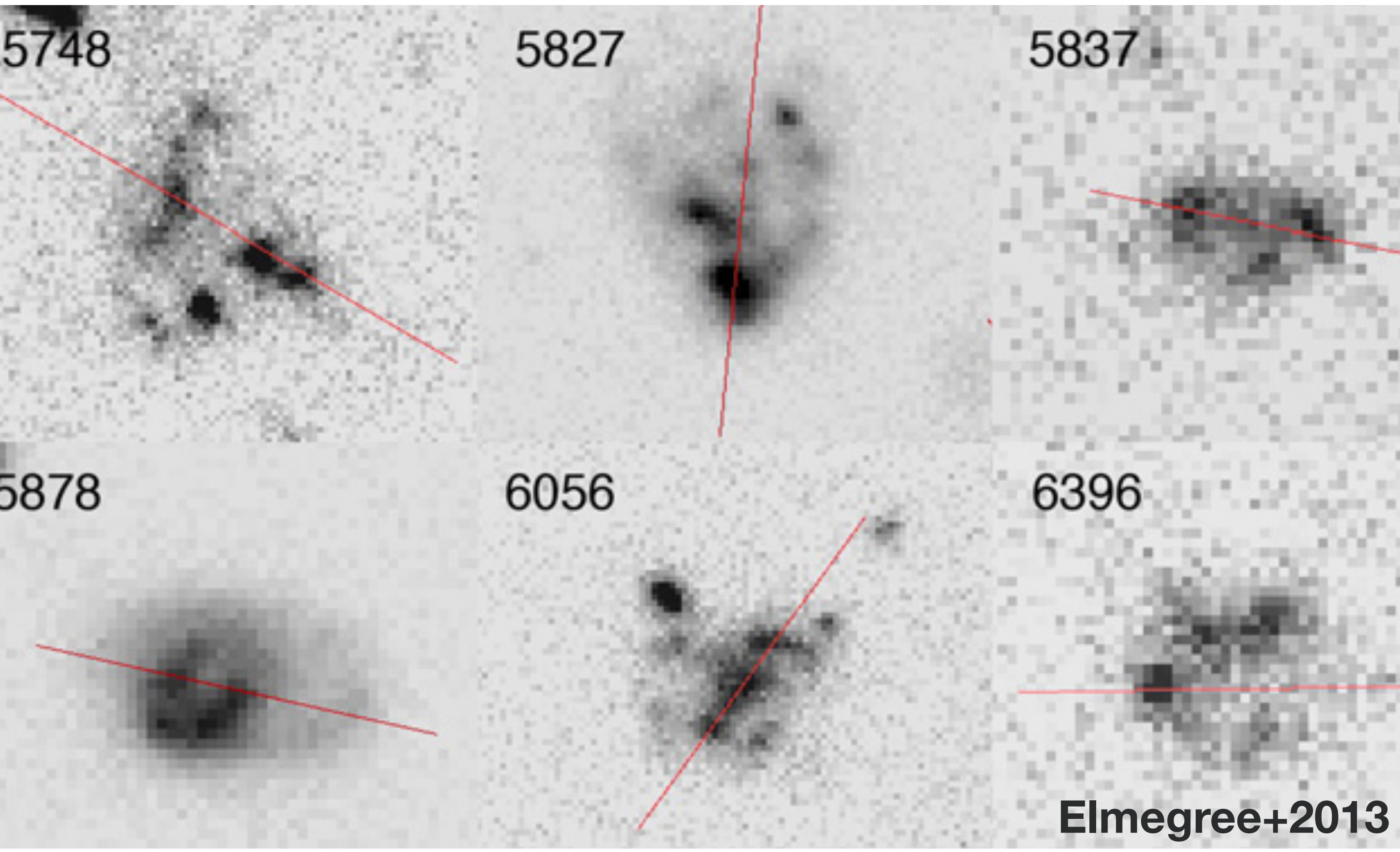
Intro: What are clumpy galaxies?

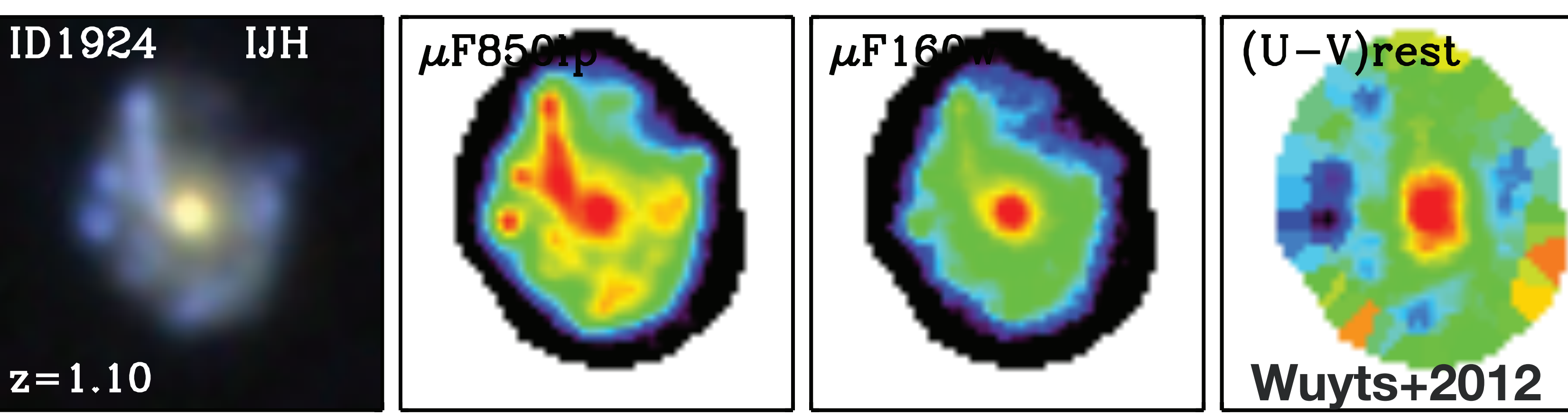
- star forming disc galaxies at redshift 0.5 - 3
- observed to have **UV-bright** / **H-alpha-bright** clumps
- clump sizes ~1 kpc, clump masses 1e8 - 1e10 Msun

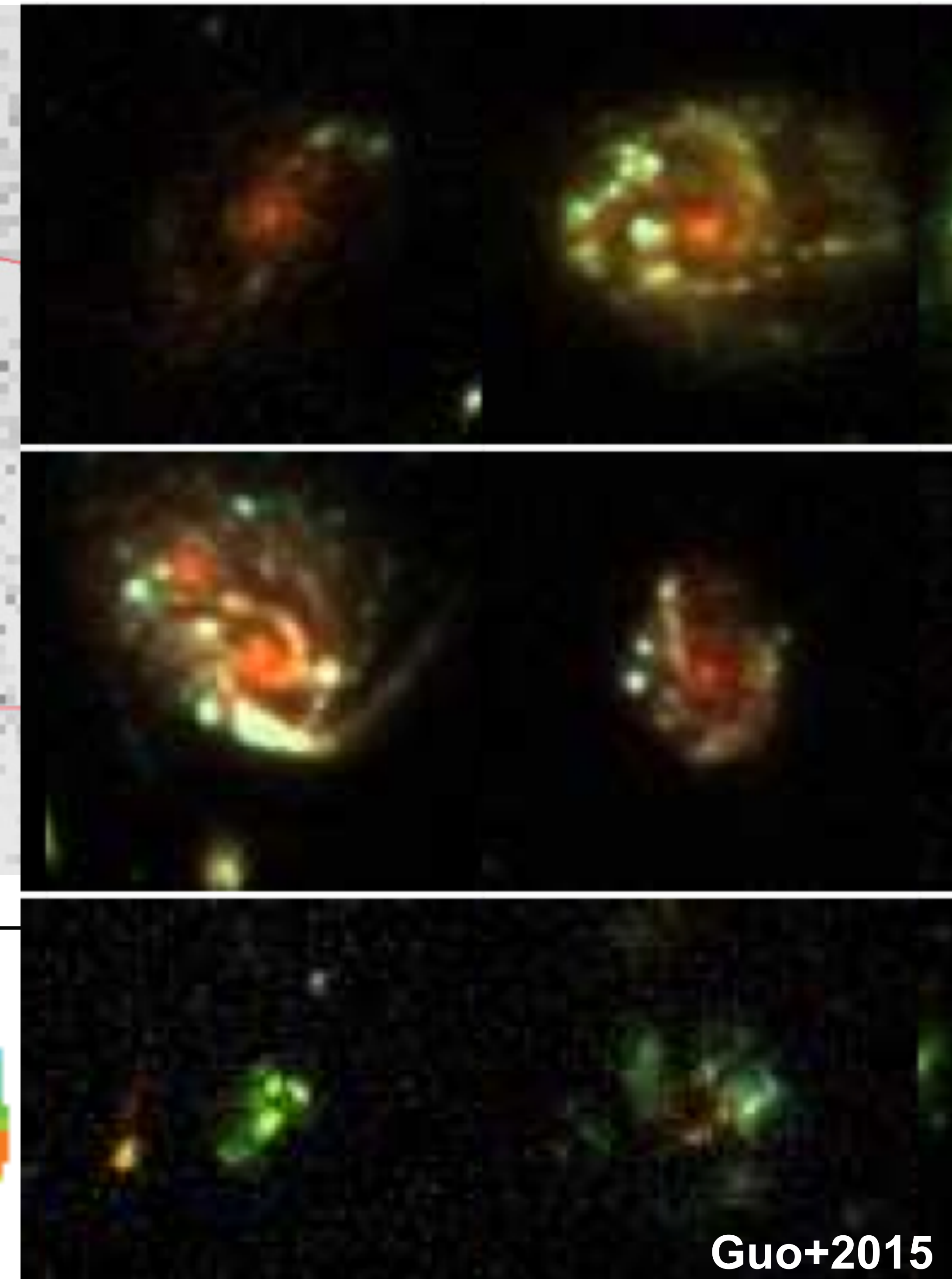




Intro: Clumpy galaxies in observations

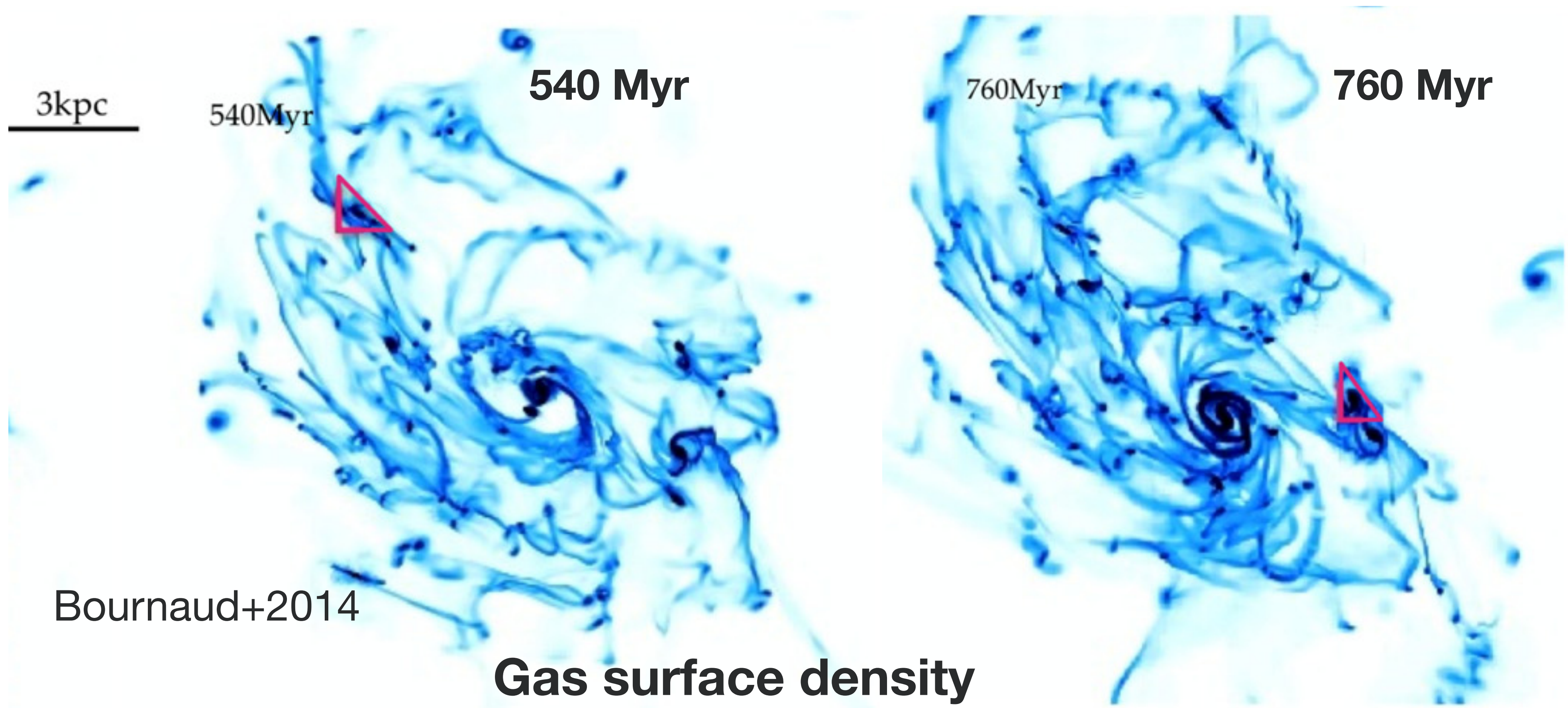






Why are clumpy galaxies interesting
previous works/simulations

- clump formation via **V**iolent **D**isc **I**nstability (Dekel+2009)
- color gradient: clump inspiral



Obs.: Genzel+2006,2009, Förster-Schreiber+2006,2011, Wuyts+2012, Elmegreen+2013, Tadaki+2014, Murata+2014, Guo+2015, Shibuya+2016

Theory: Bournaud+2007,2008,2009,2014, Dekel+2009, Ceverino+2010,2012, Mandelker+2014, Moody+2014, Tamburello+2015, Mayer+2016, Oklopcic+2017

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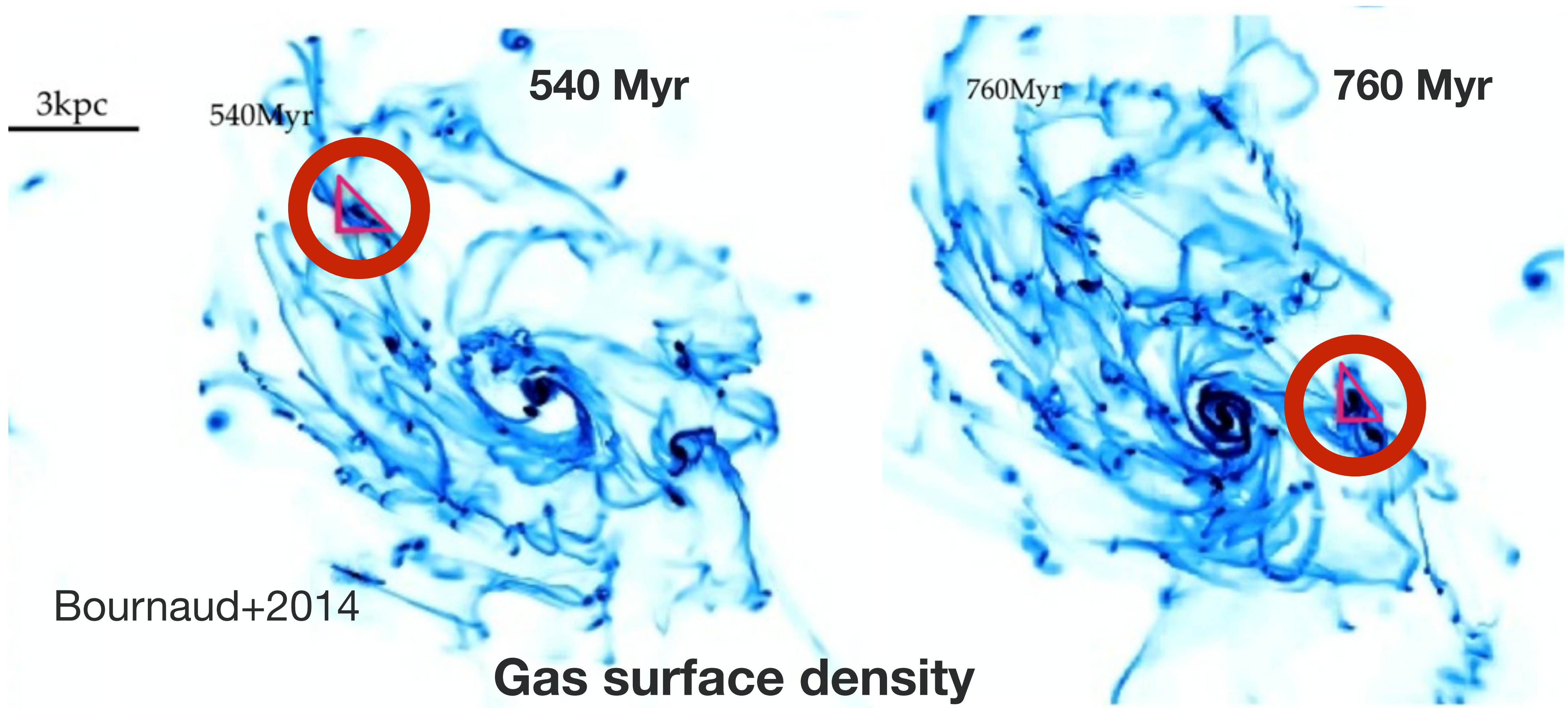

Gas surface density

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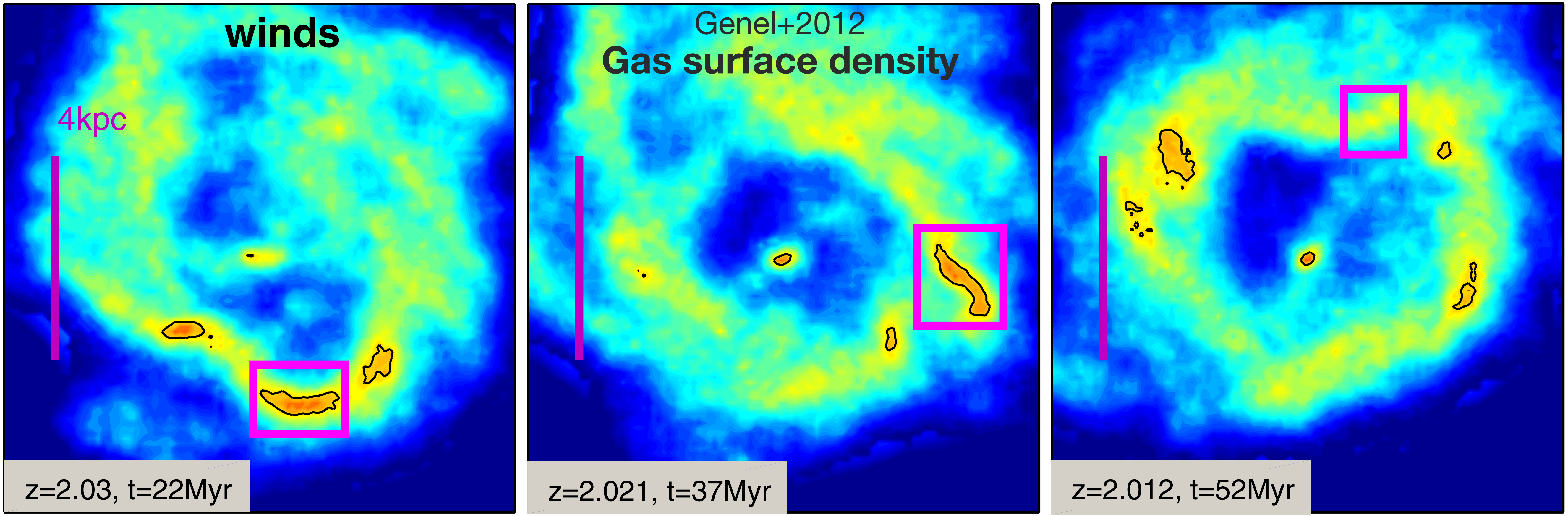

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Observed vs. simulated clumps:
some tension…

simulations disagree on fate of clumps

simulations and observations probe different things

- observations: clumps in stellar light
- most theory: clumps in gas density

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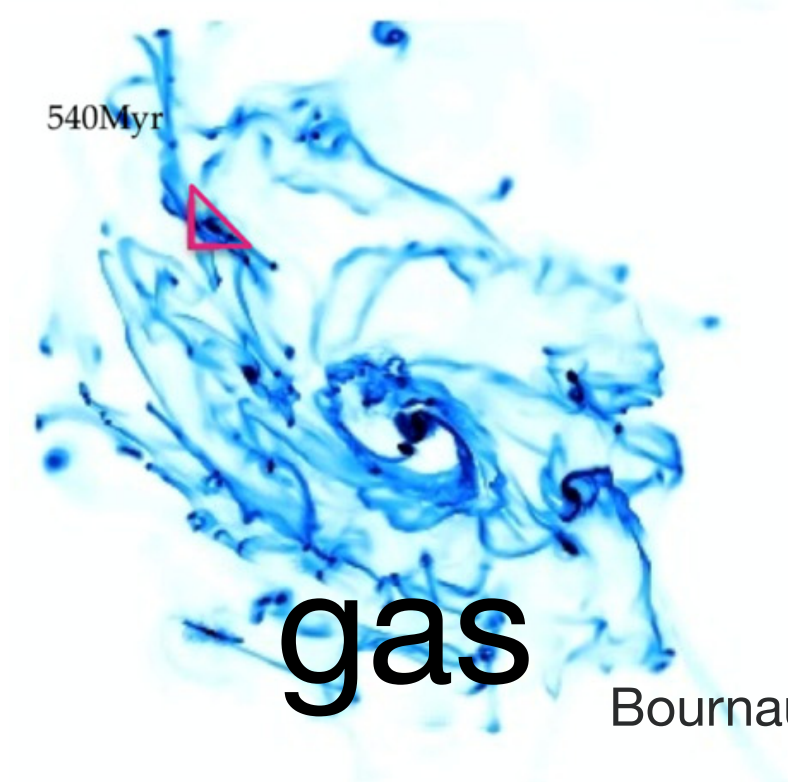
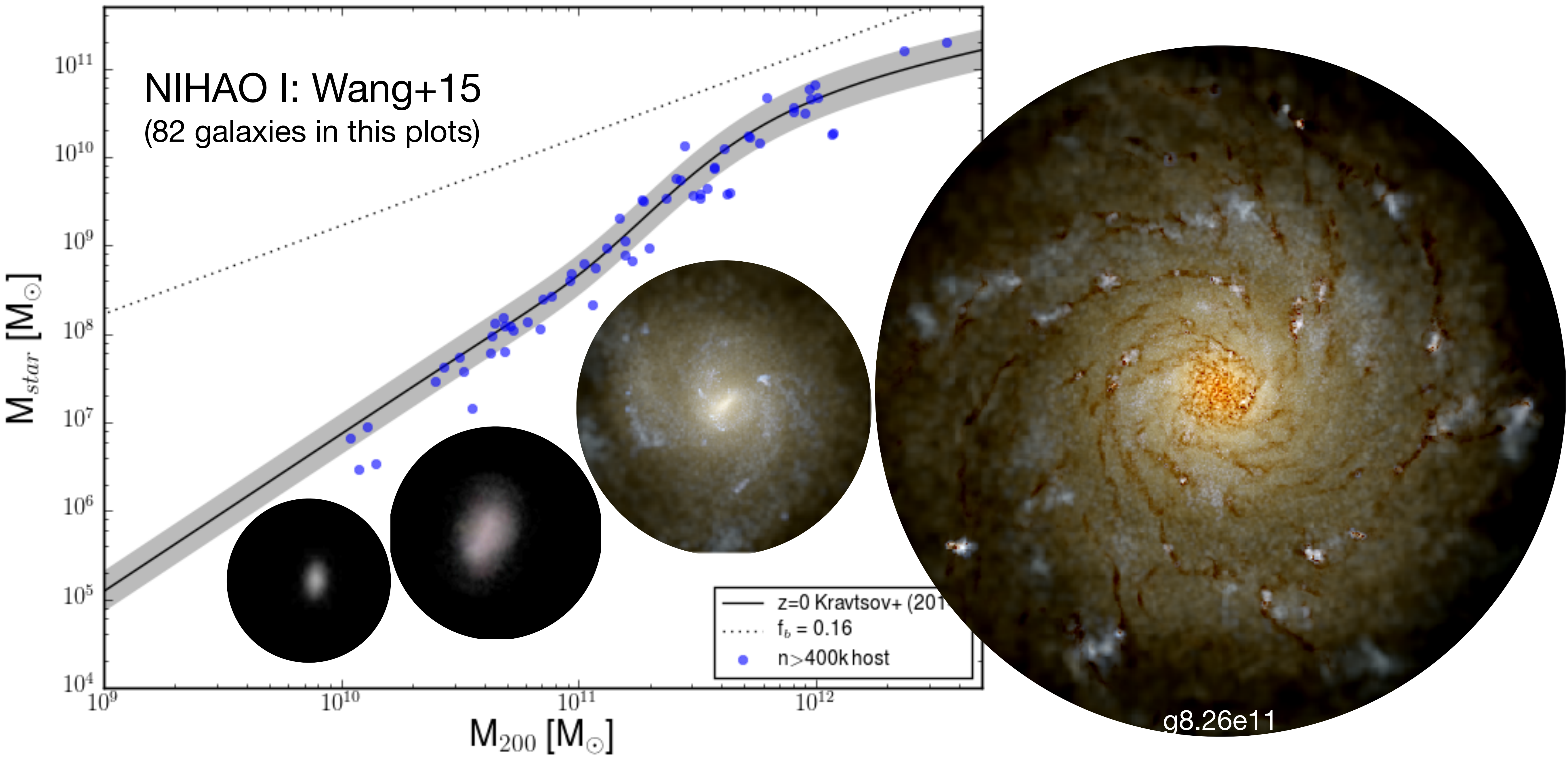


Bournaud+2014

The NIHAO Simulation suite

90 zoom-in simulations from Milky-Way mass to dwarf galaxies scales



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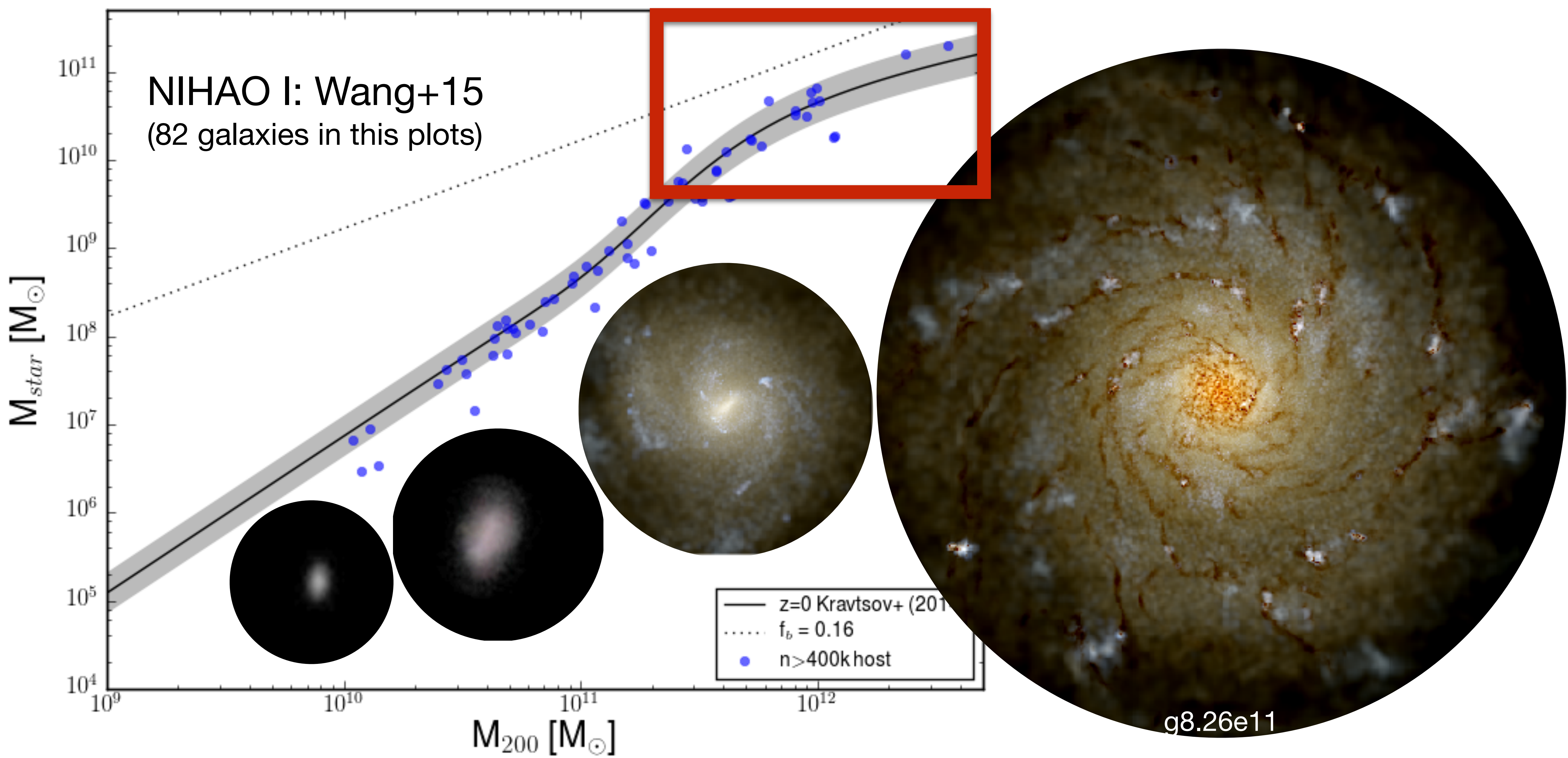

The post processing of NIHAO

19 high mass galaxies from the NIHAO sample

M_star > 1e9 M_sun at redshift z=1.5

Selection of clumps in light

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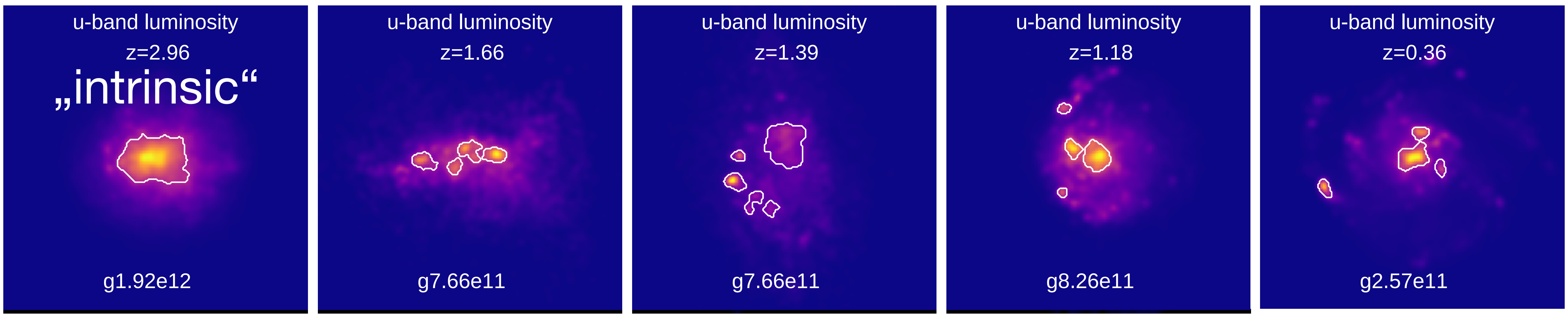
Selection of clumps in light

A. intrinsic luminosity calculated from simple stellar populations



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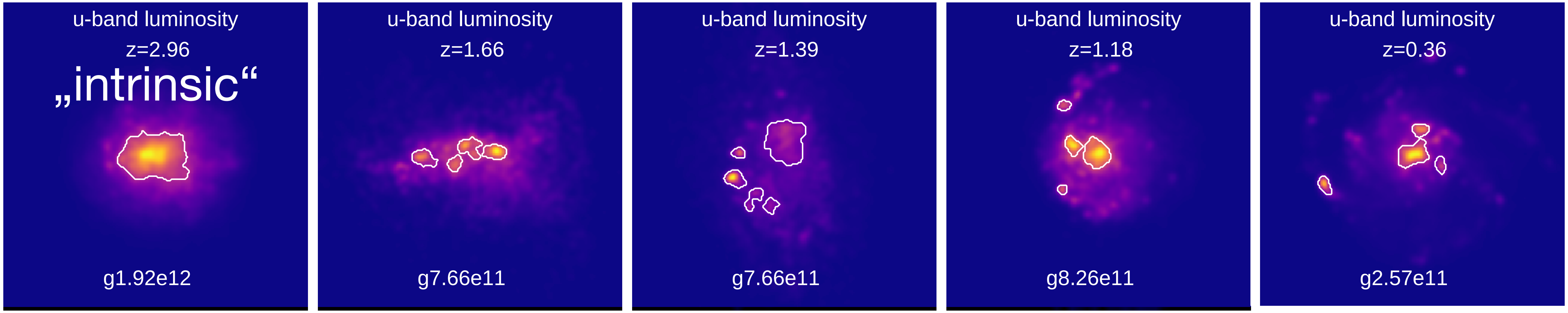
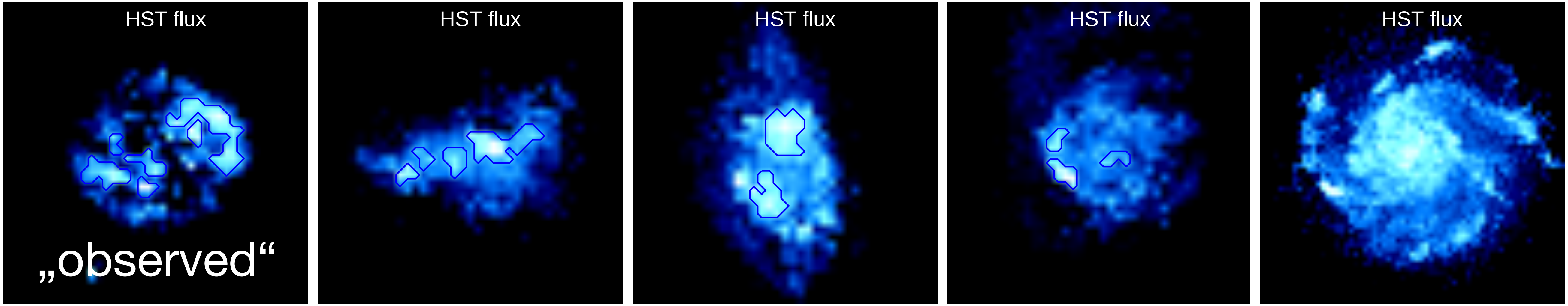
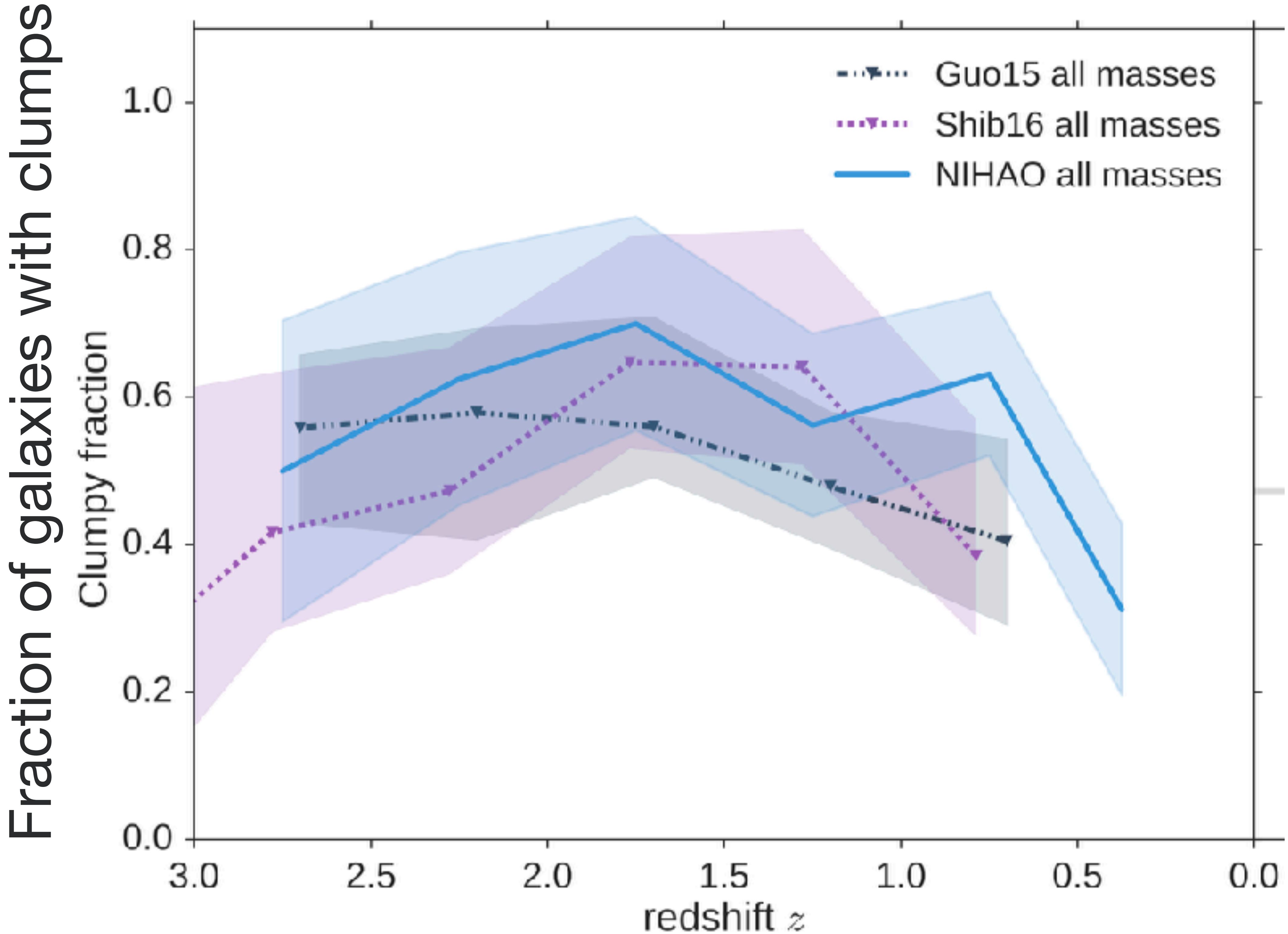


B. radiative transfer post processing with GRASIL-3D (Domìnguez-Tenreiro+2014)



The „observed“ clumpy fraction of NIHAO



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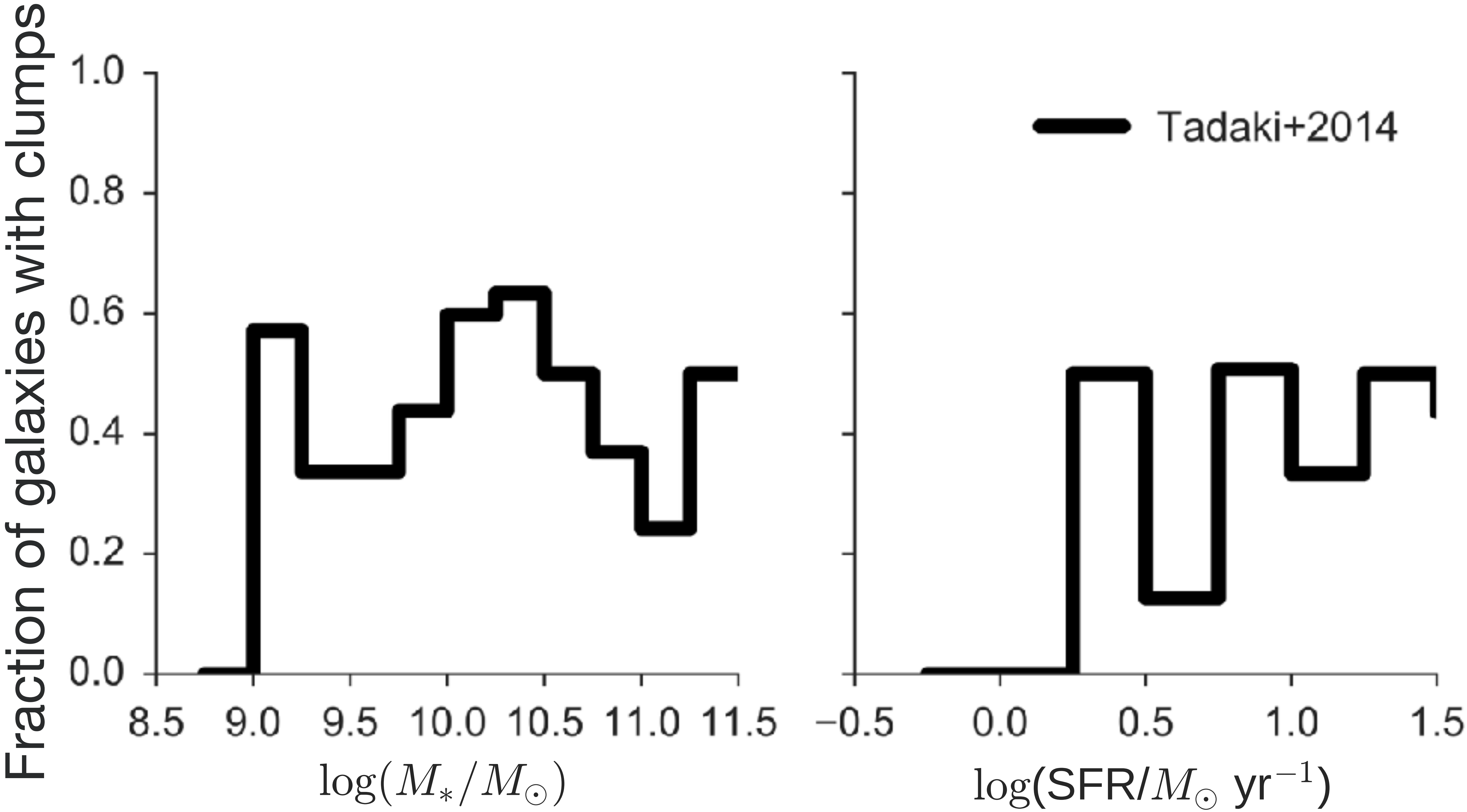

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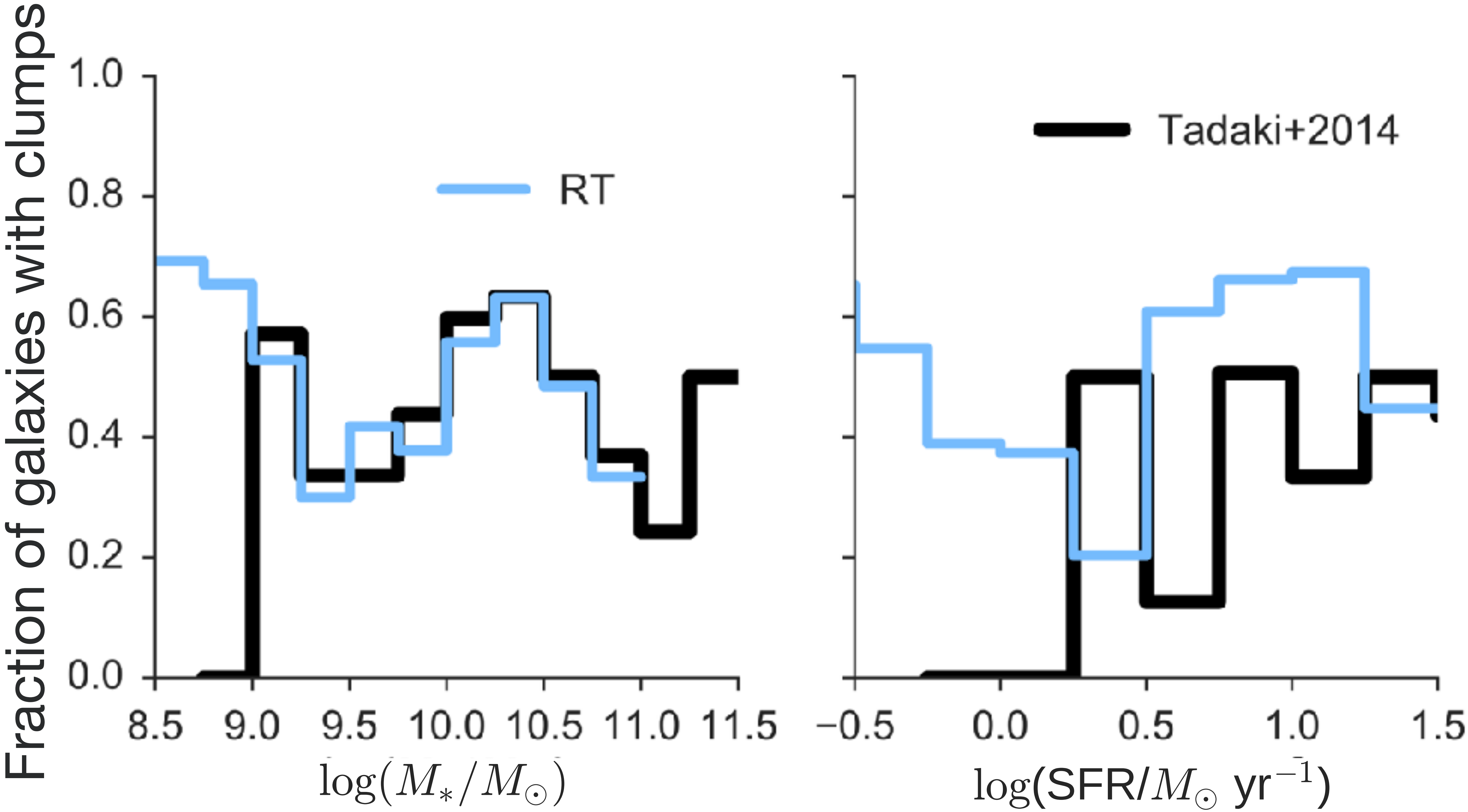

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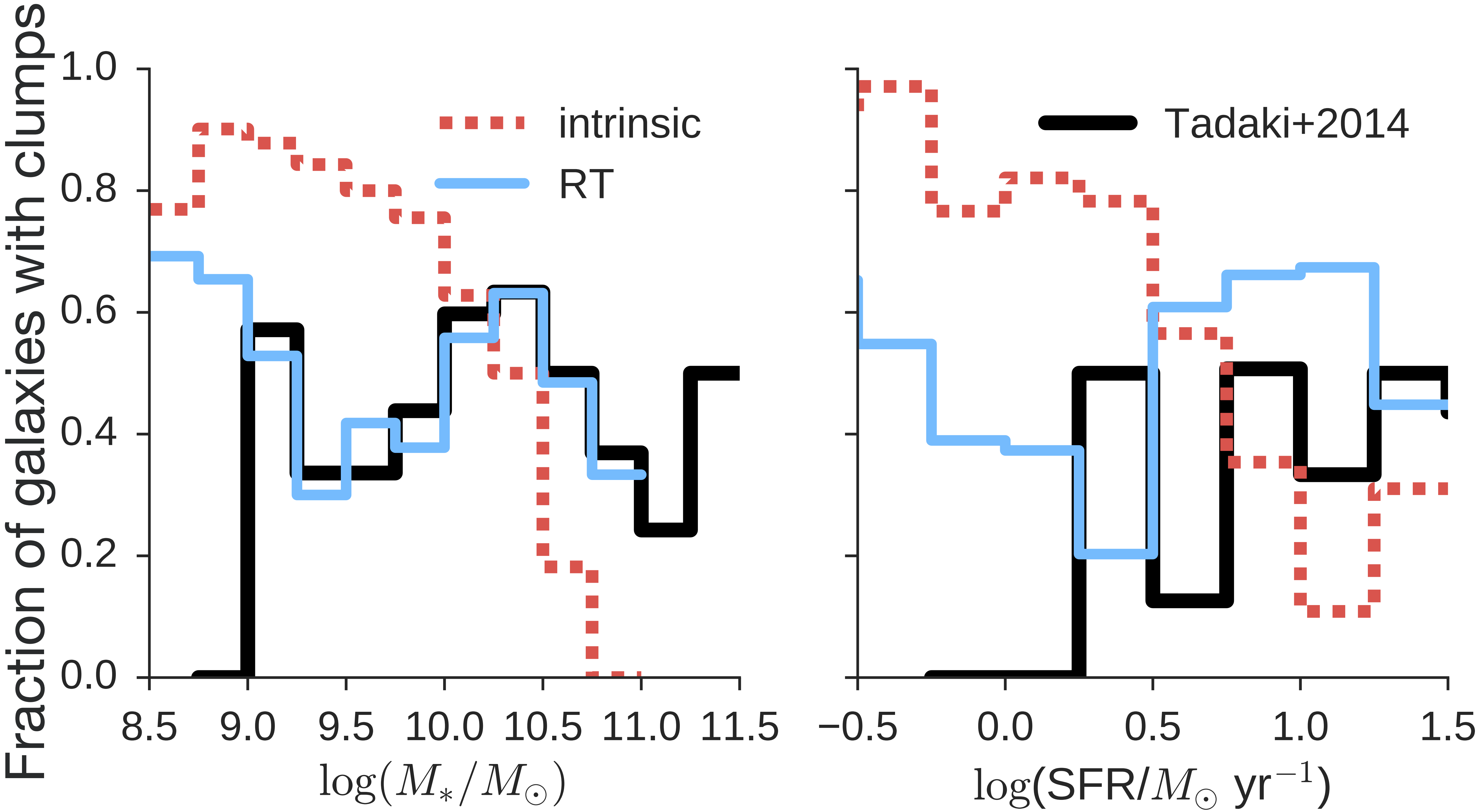
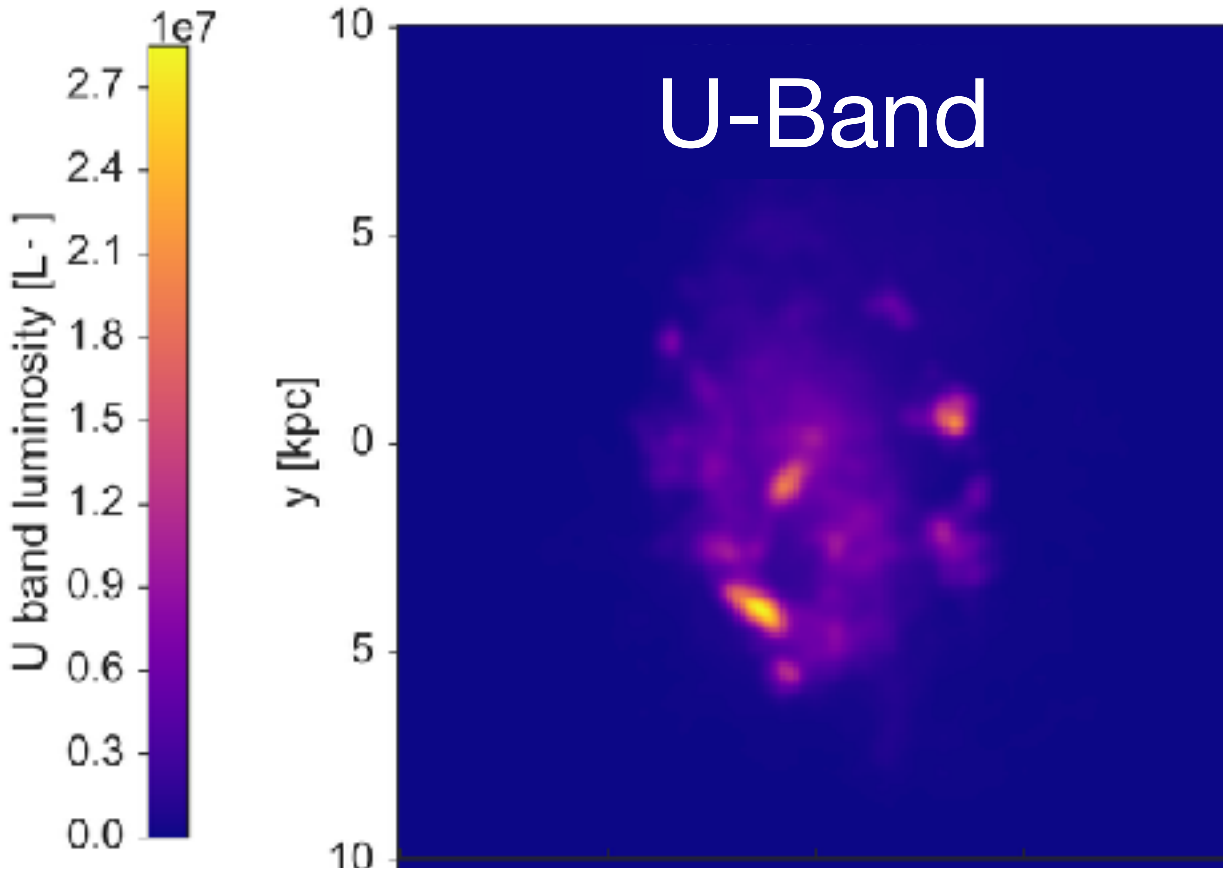


The „intrinsic" clumps of NIHAO



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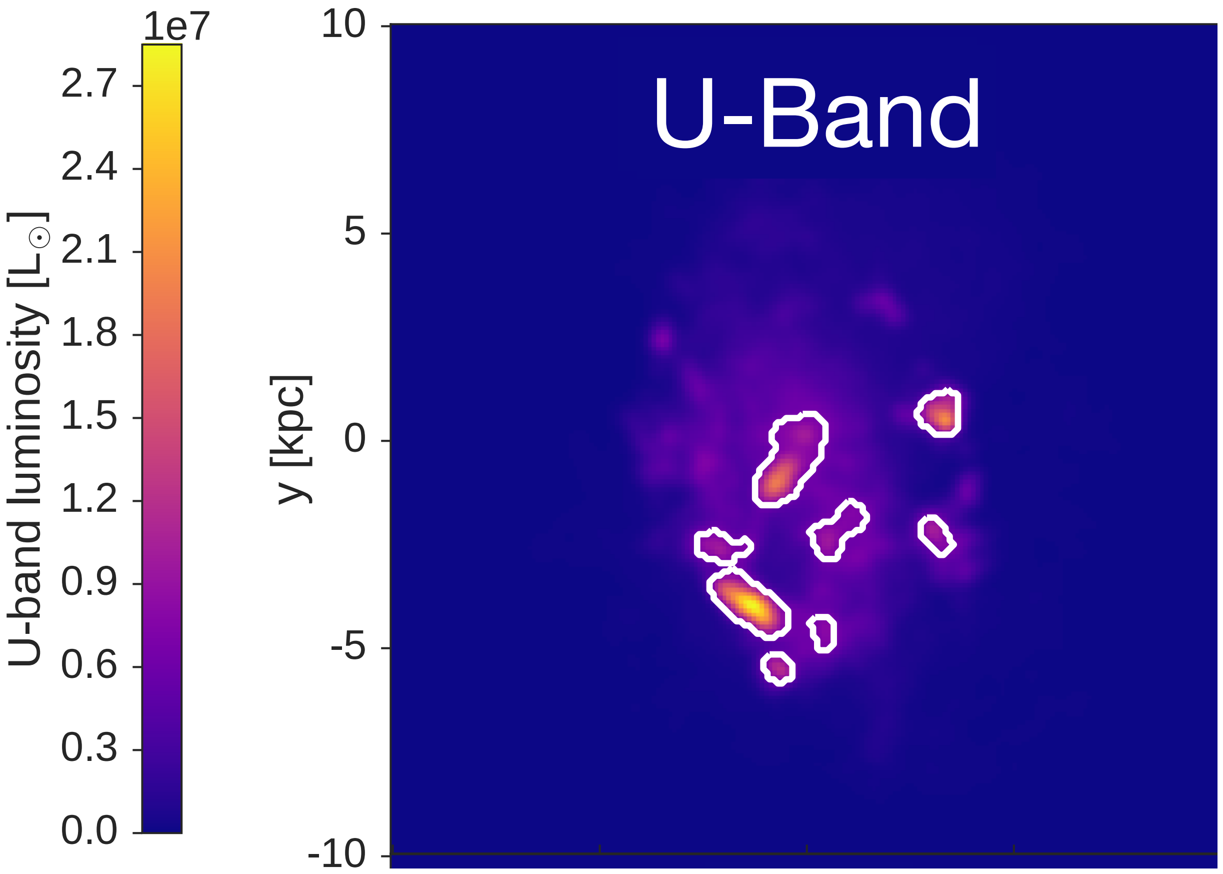

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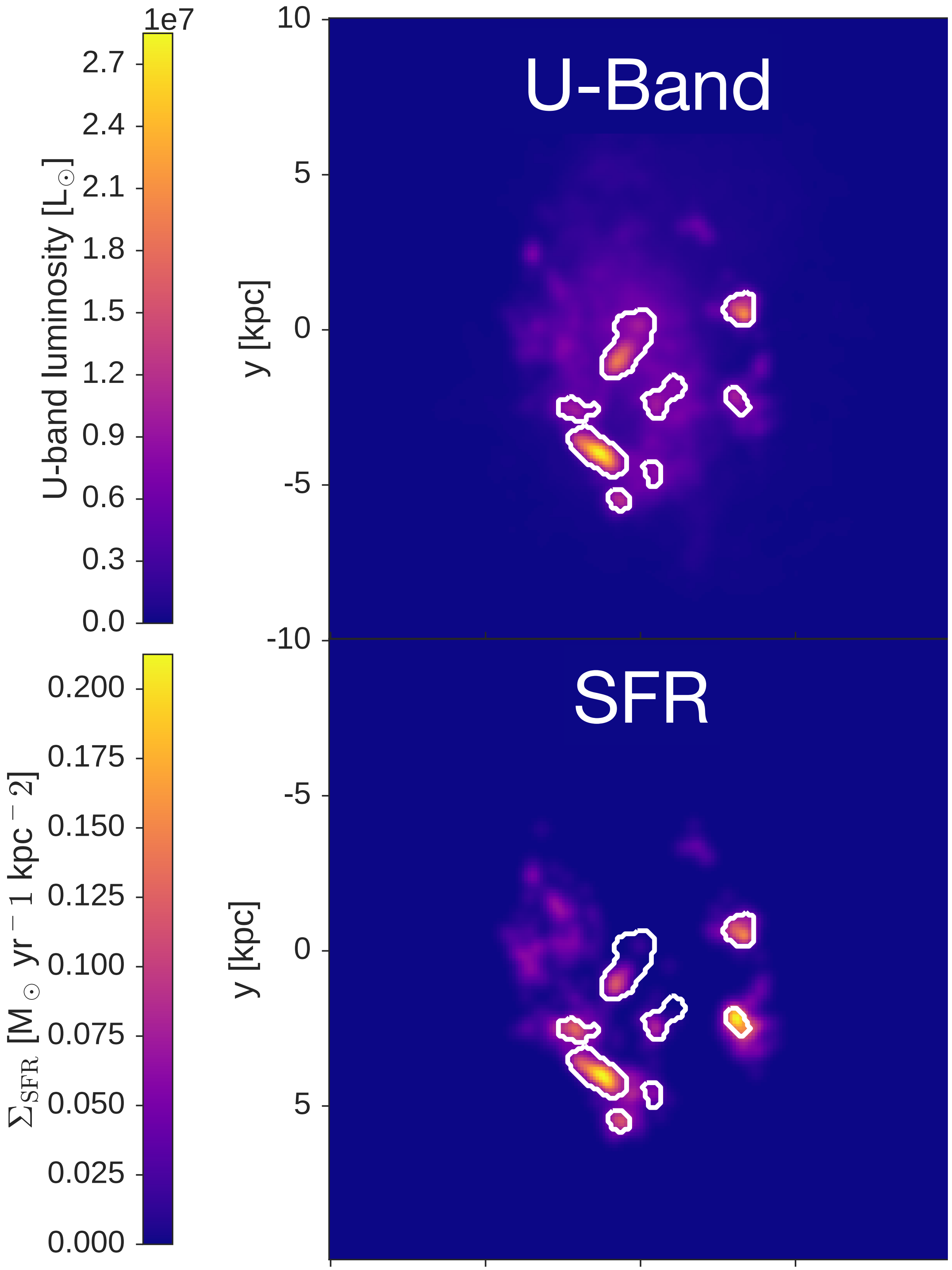

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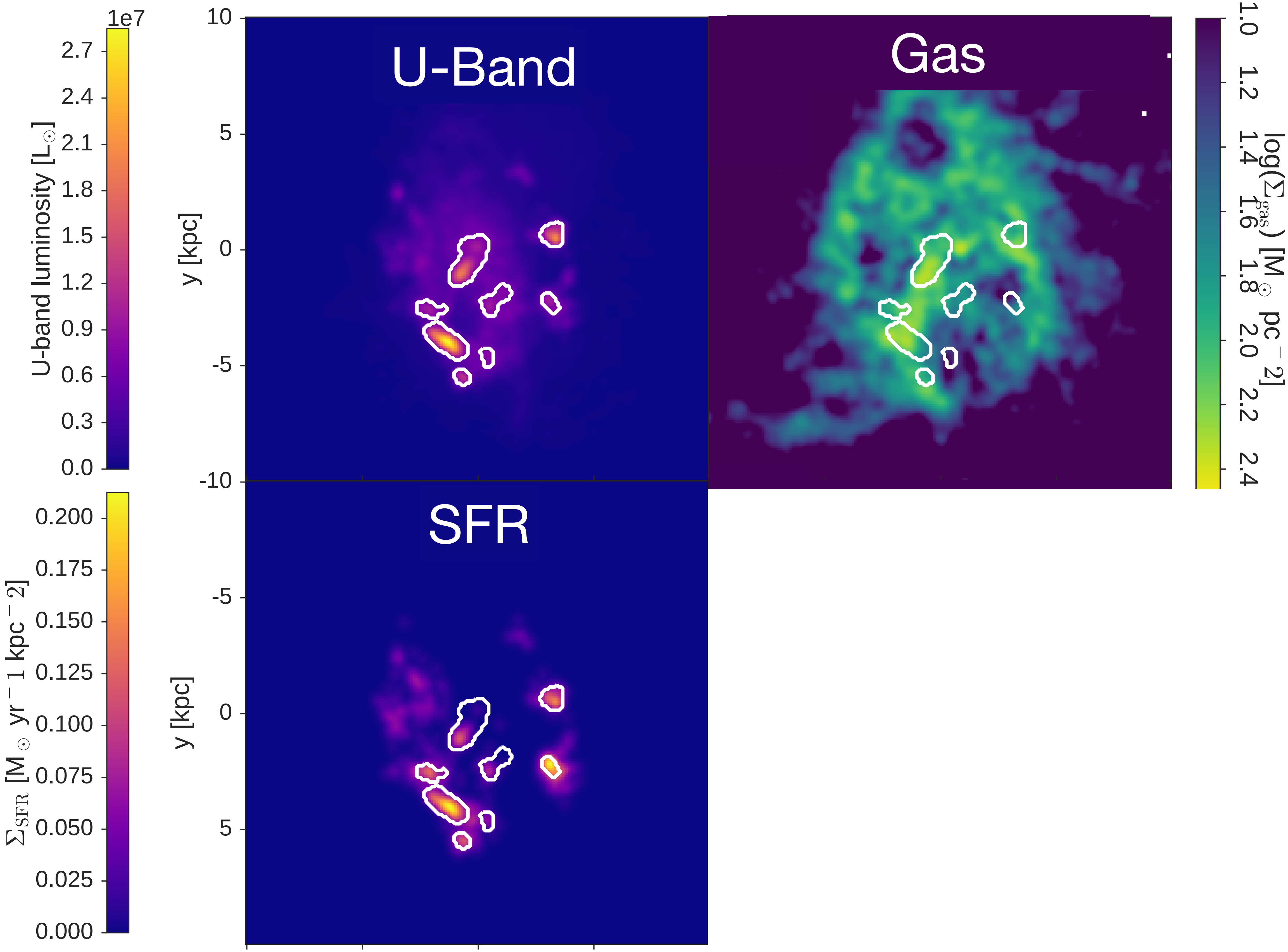

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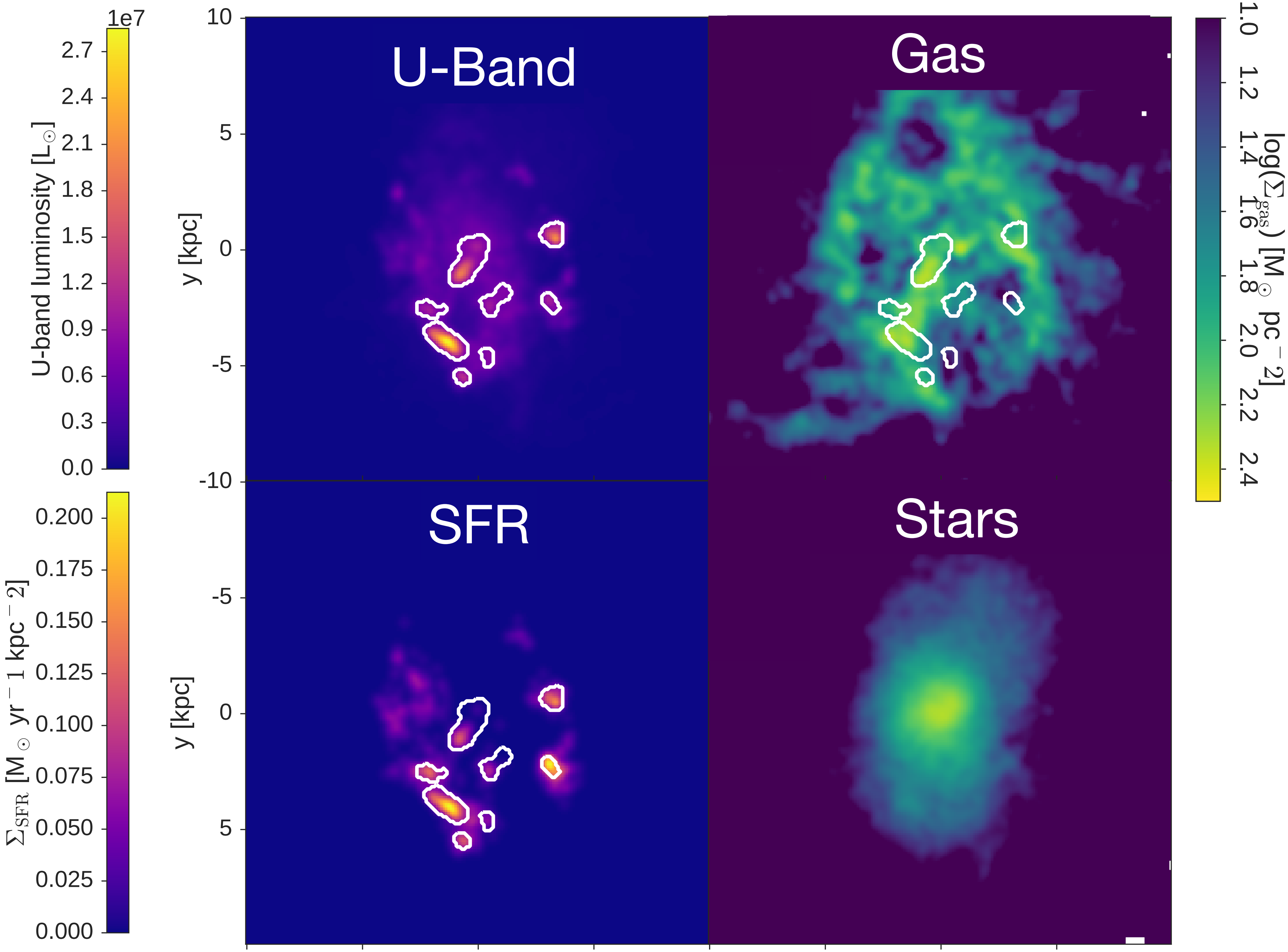

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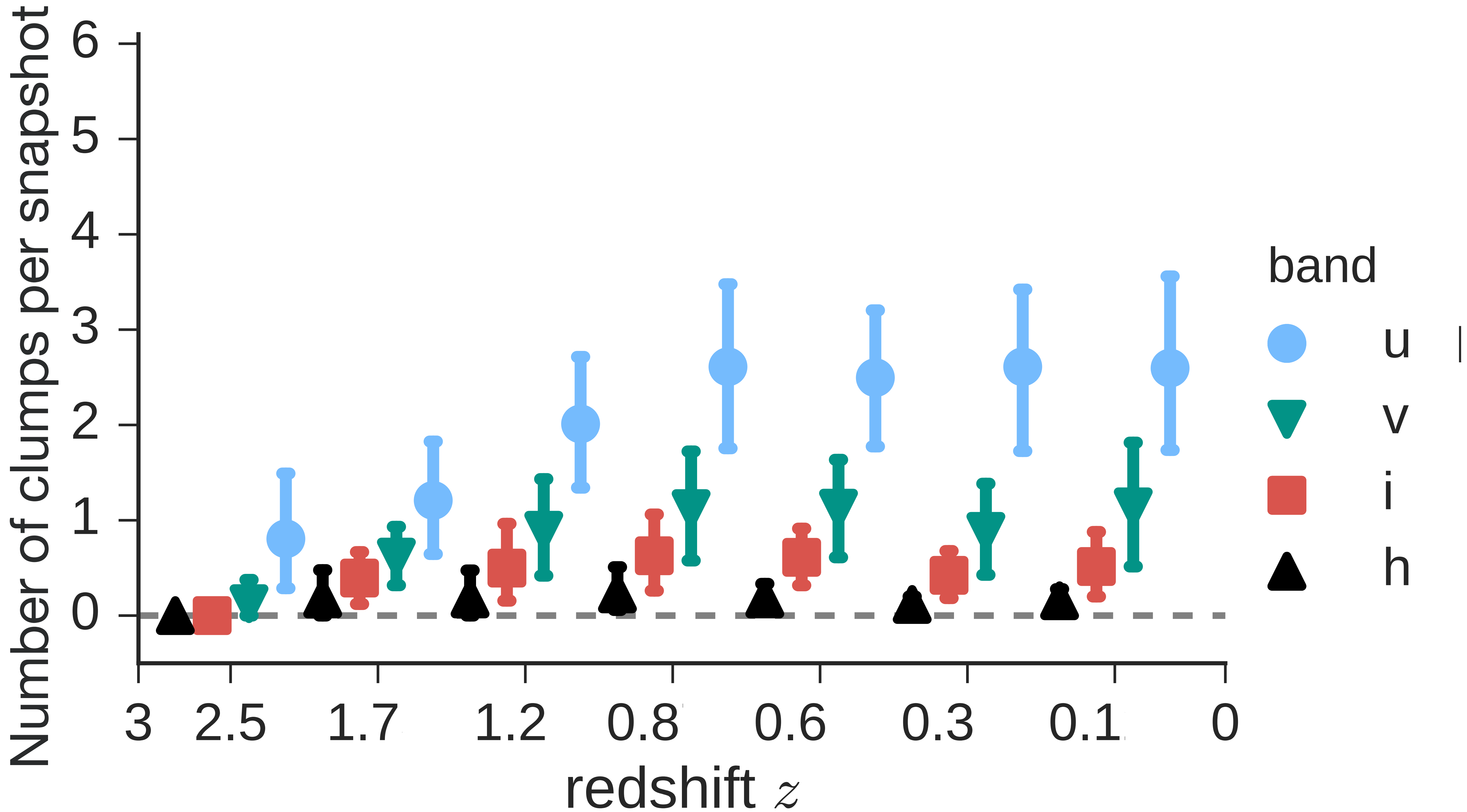

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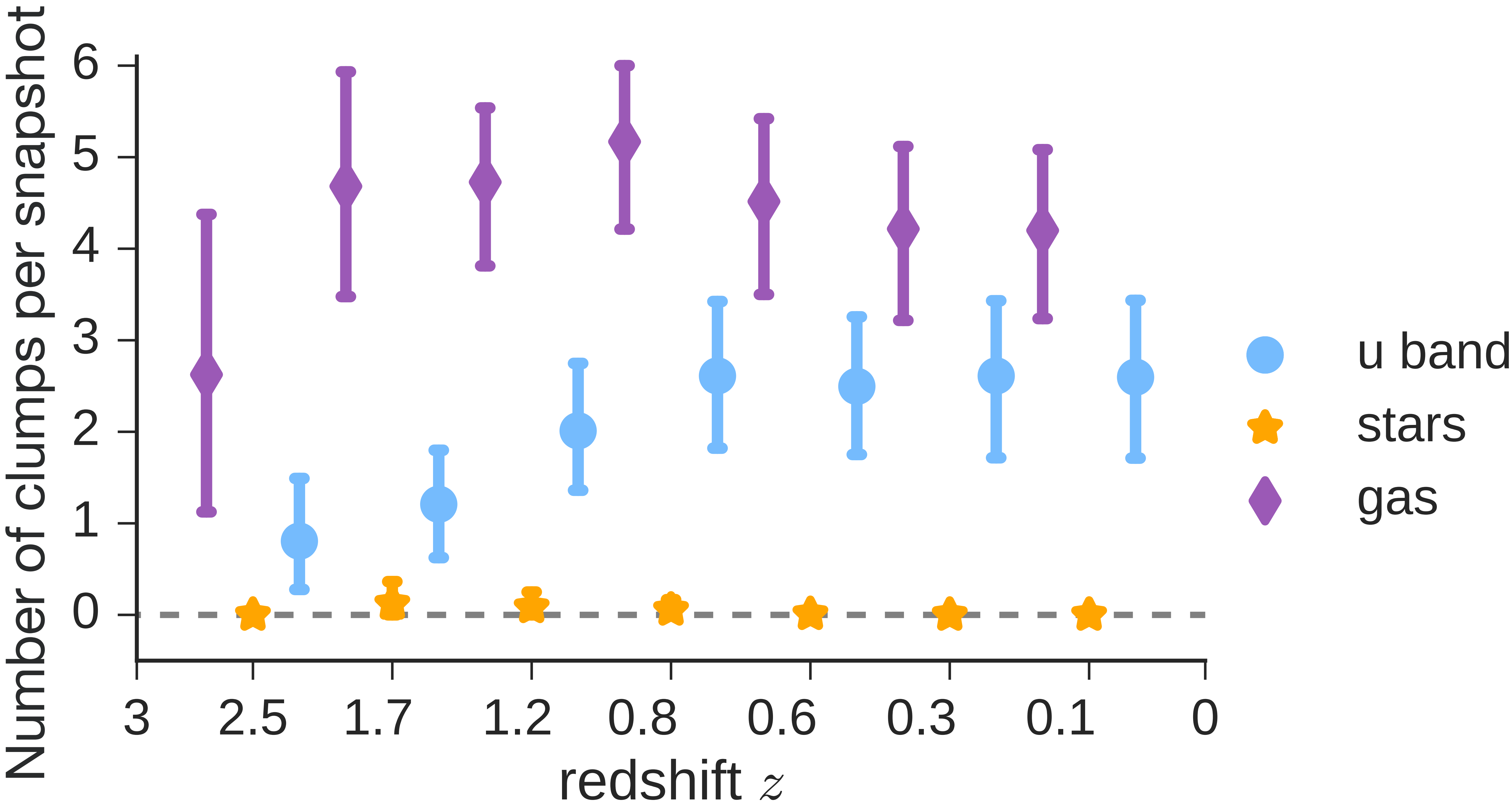

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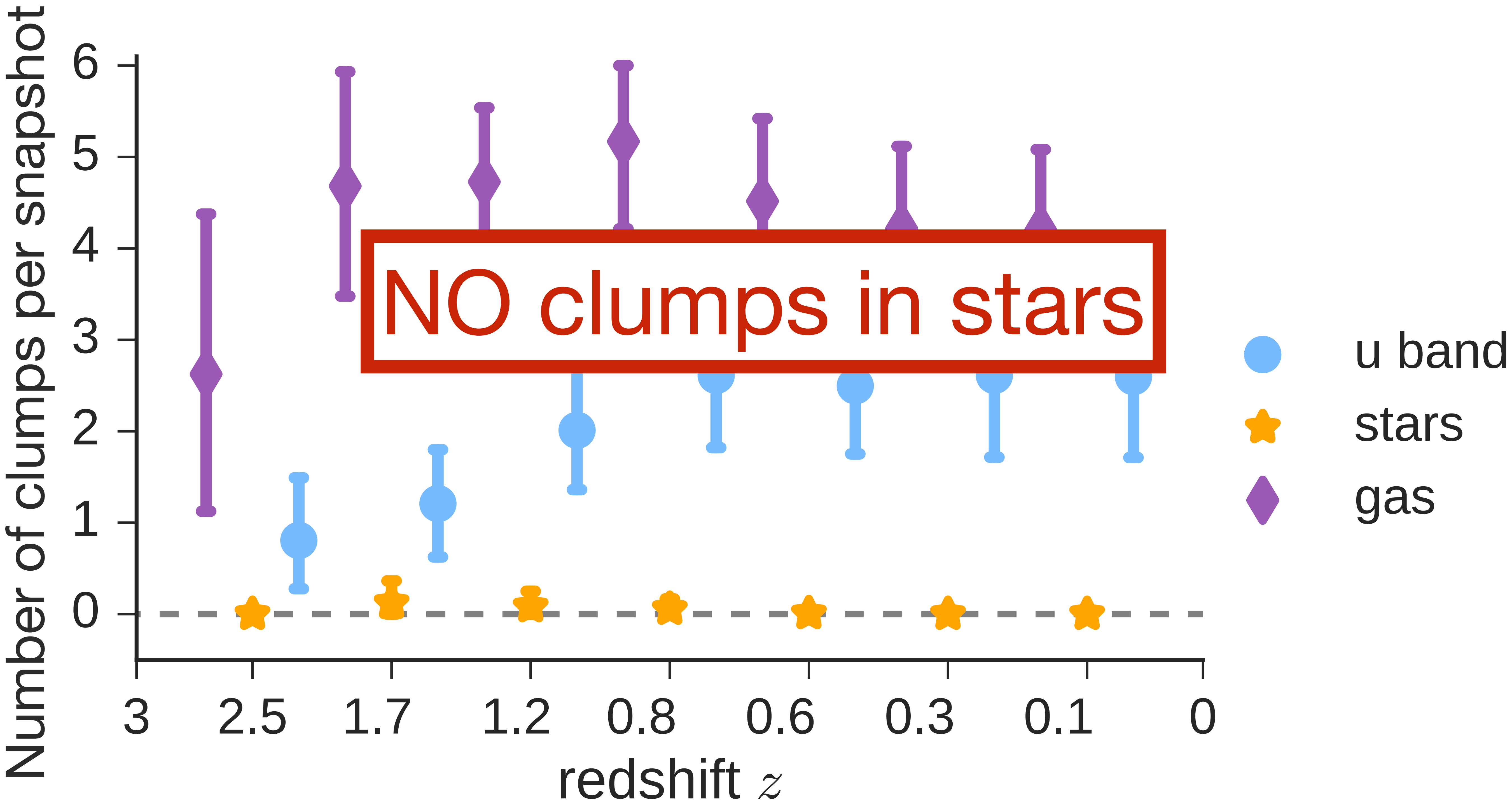
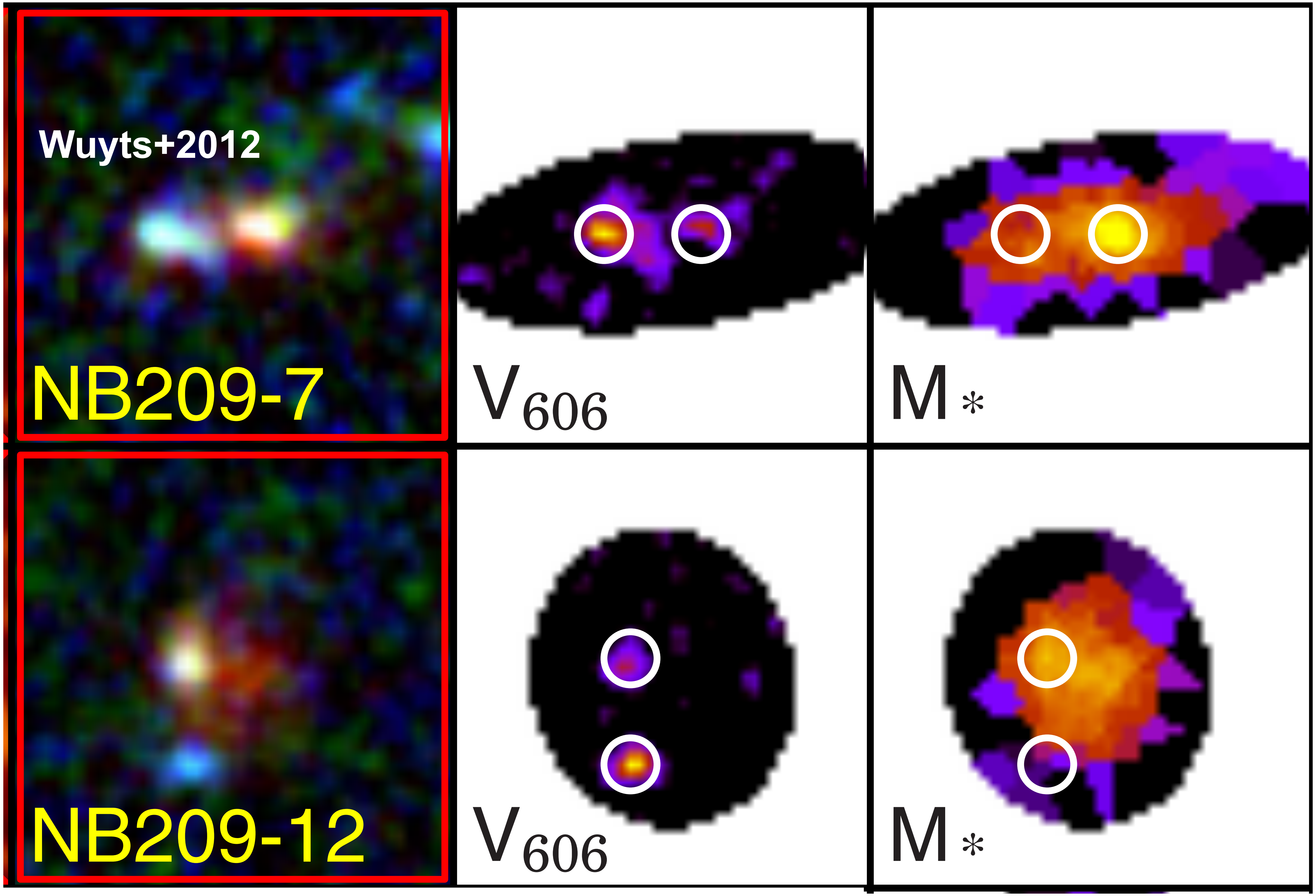


Stellar mass maps of observations



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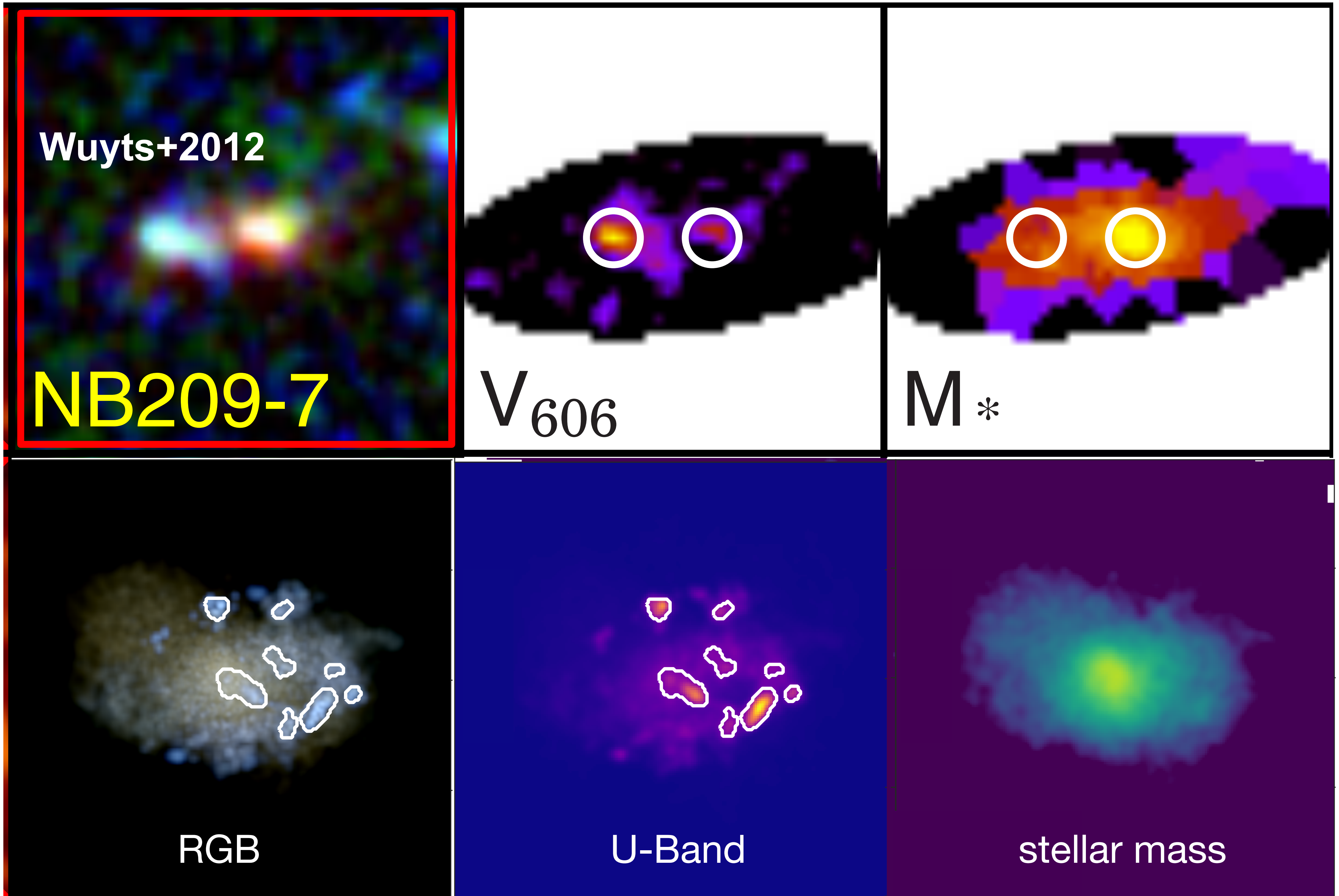

Conclusions

Clumpy galaxies in NIHAO:

- agree well with observed relations
- are ONLY present in stellar light
- can NOT be found in stellar mass
- are not long lived and do not contribute to bulge growth

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Extra Material

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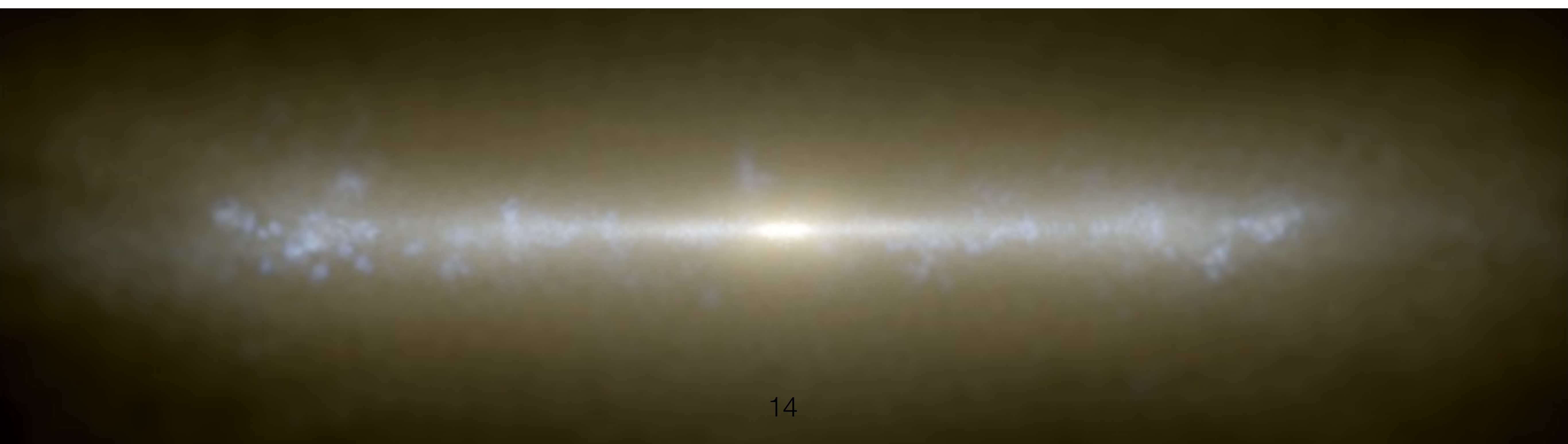

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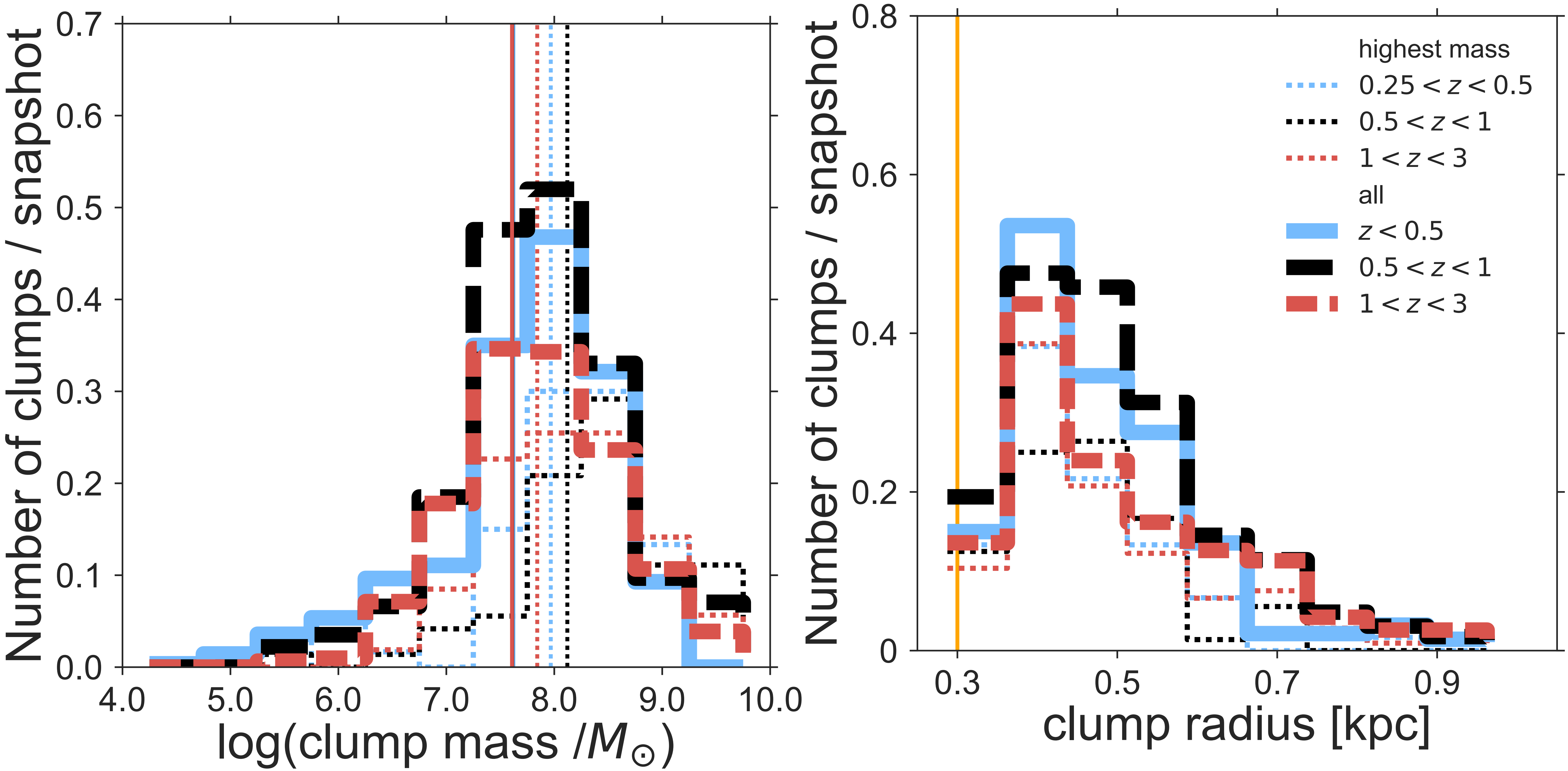

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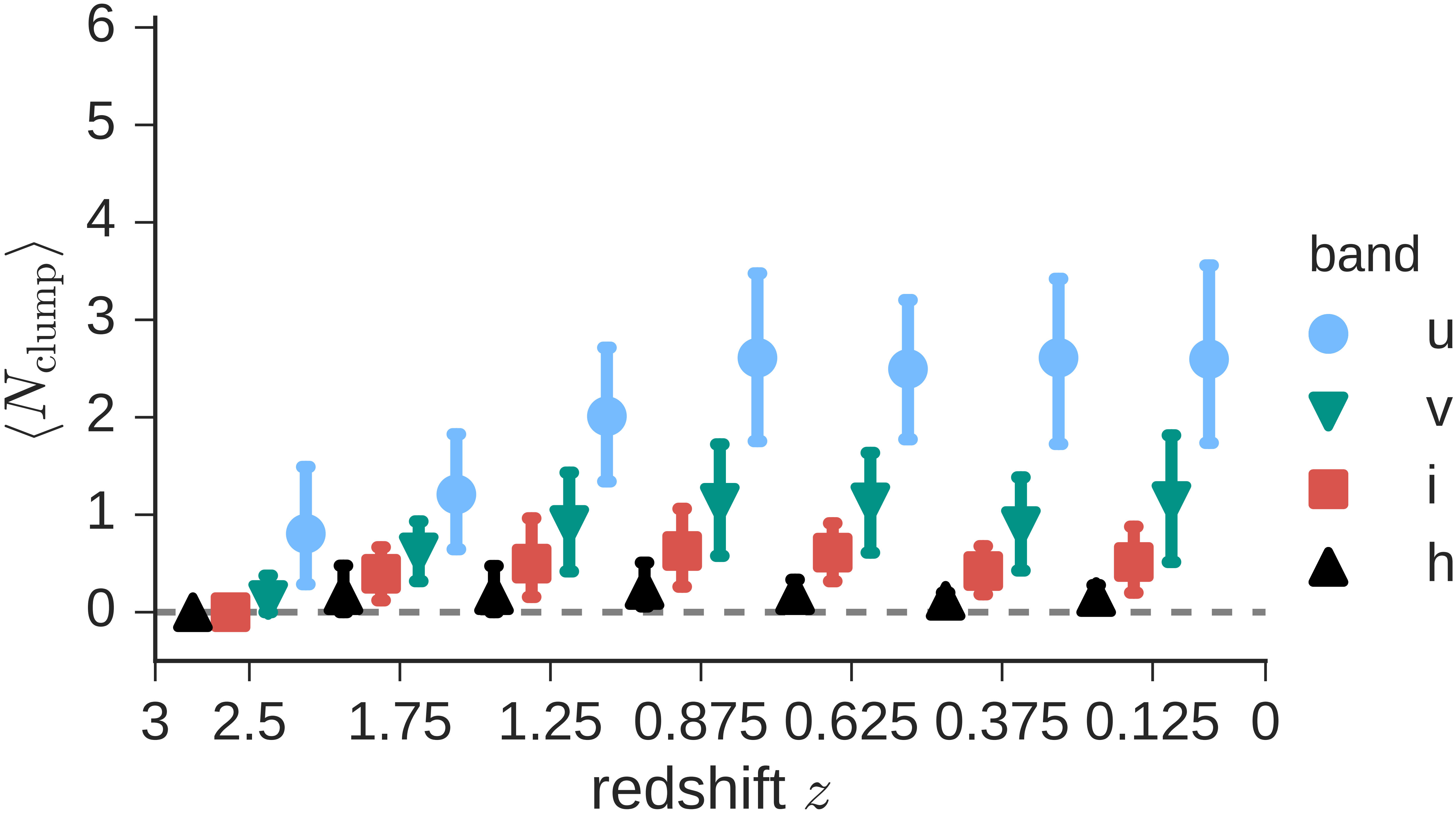
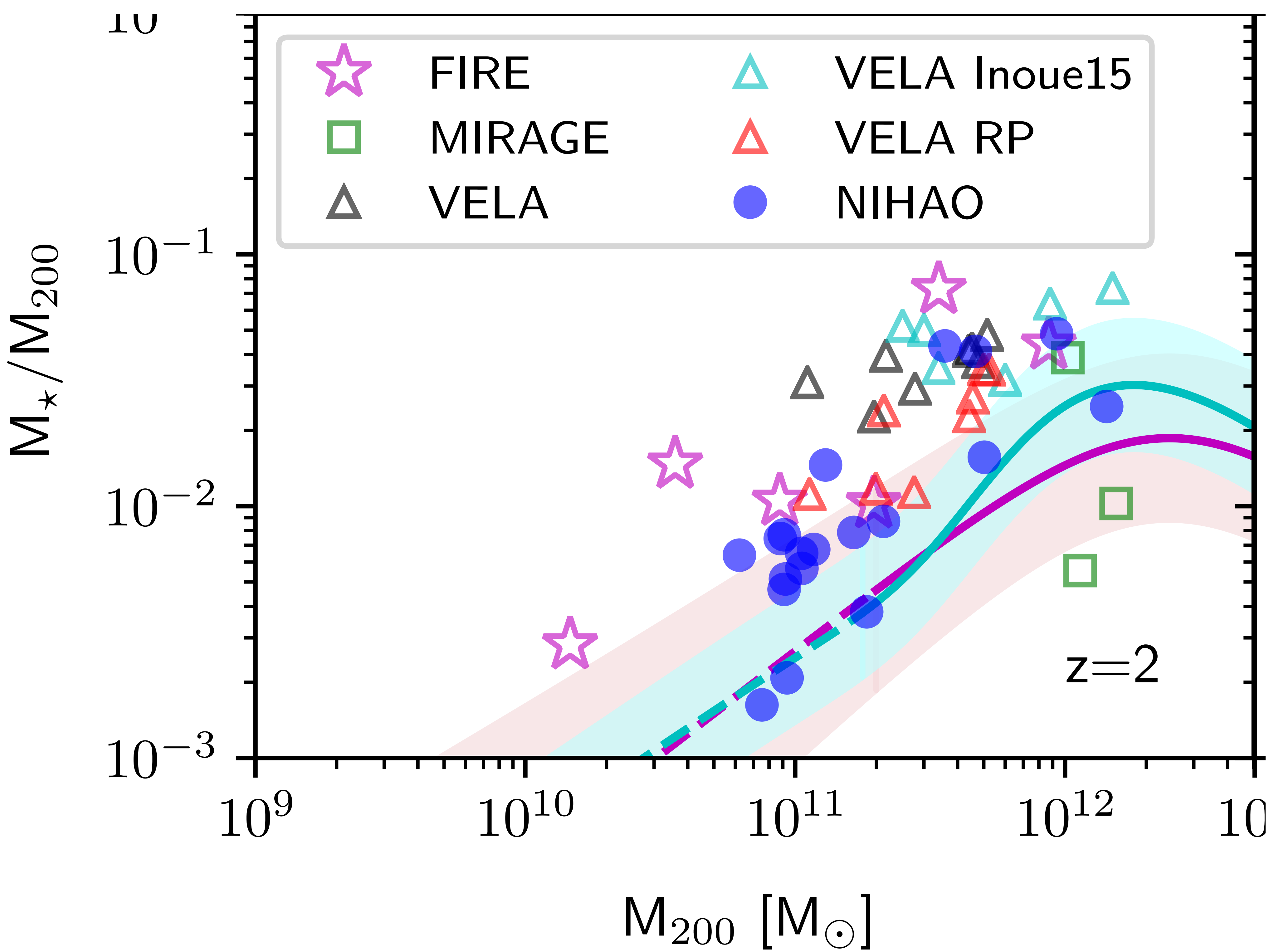


Differences to other Simulations



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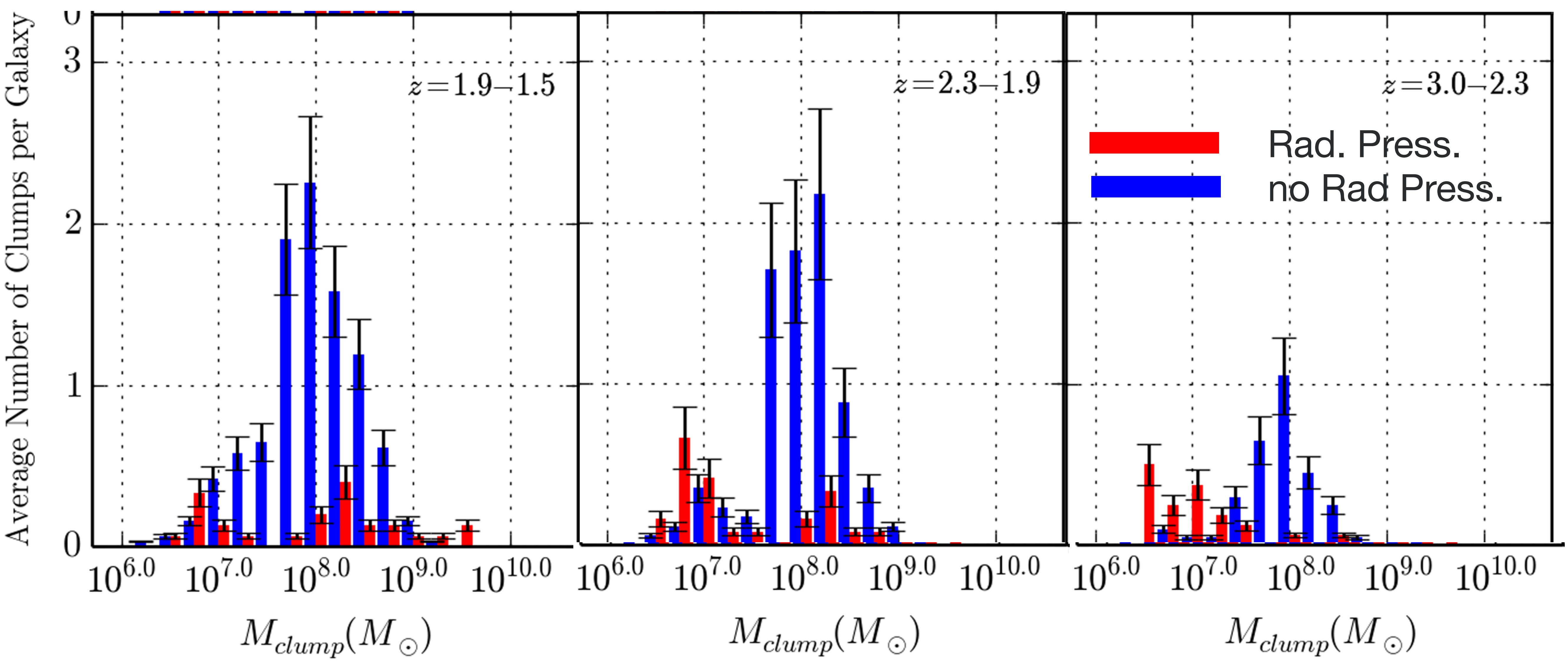

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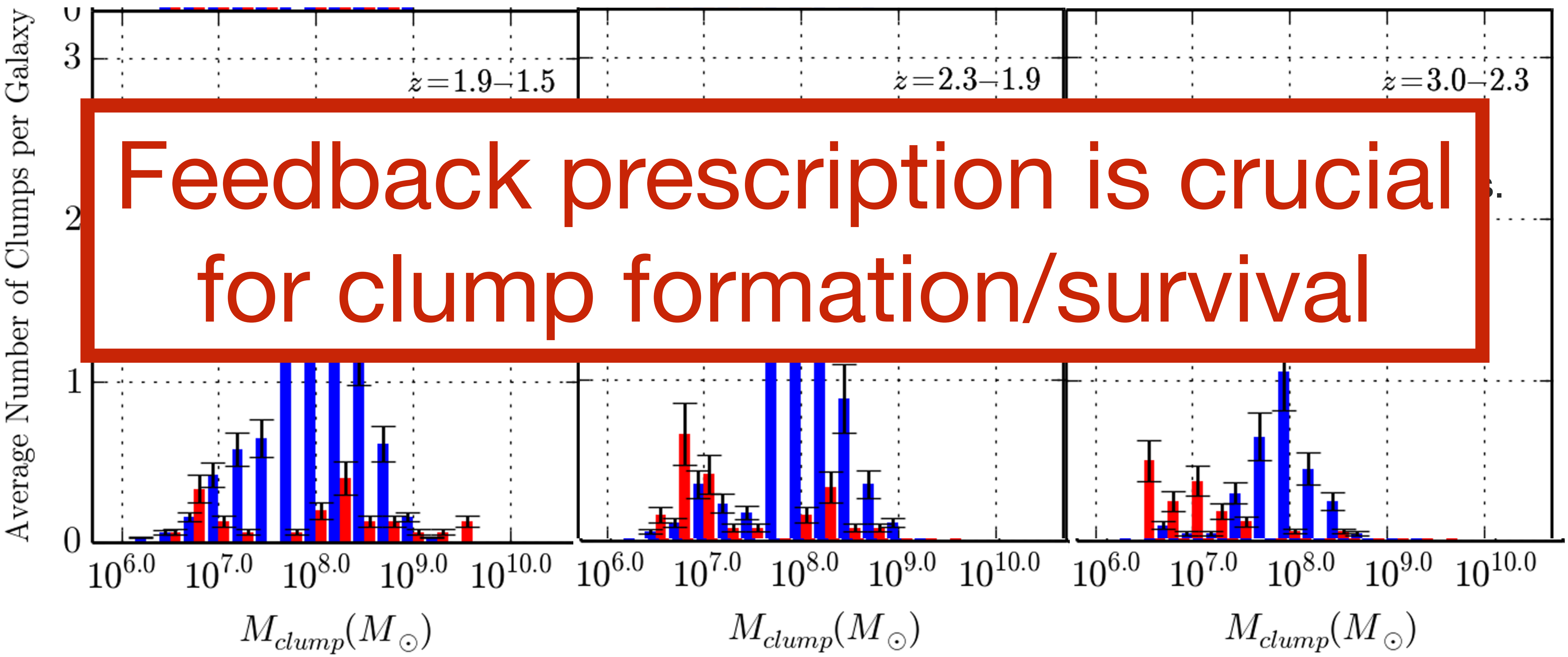
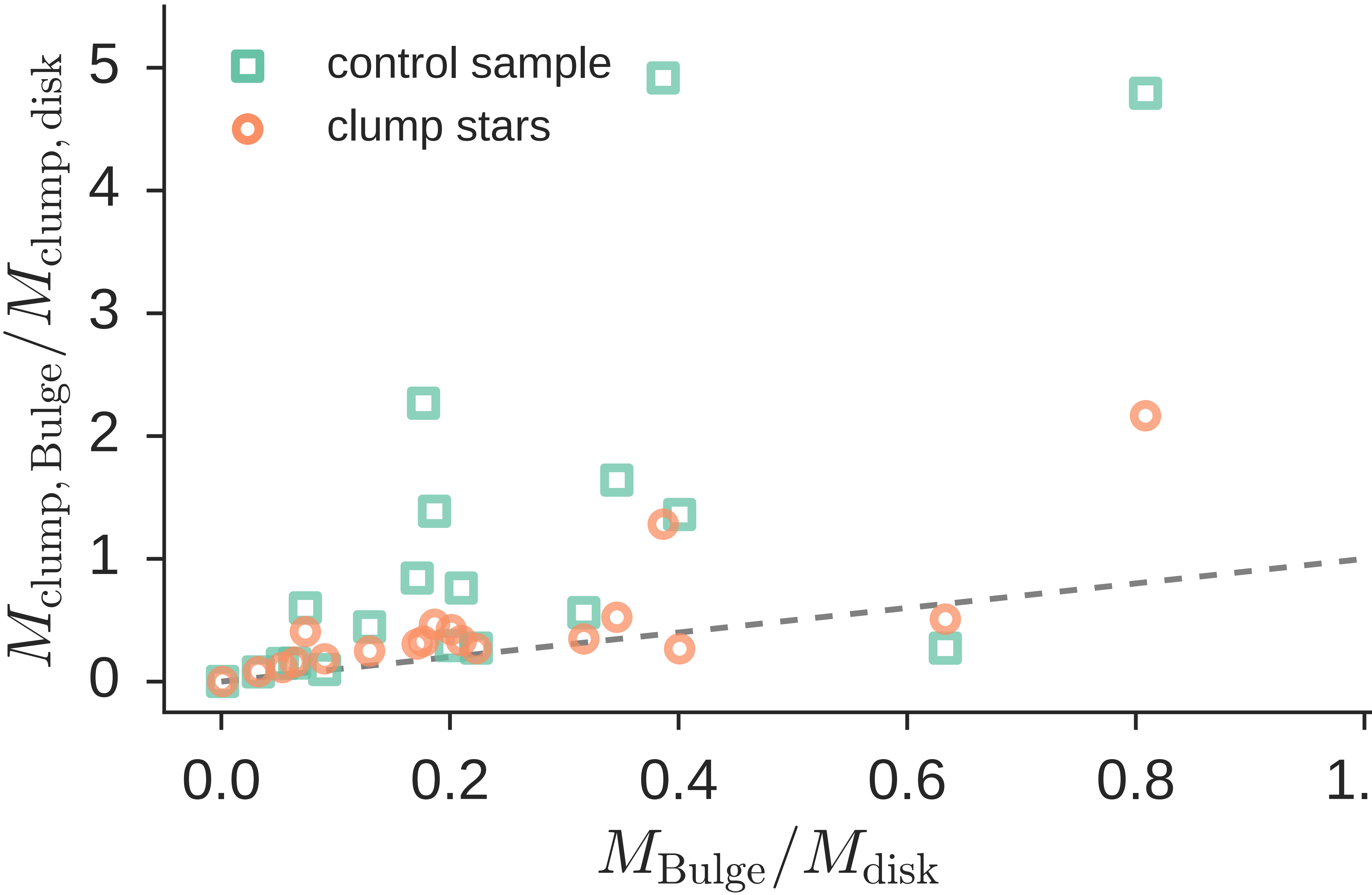
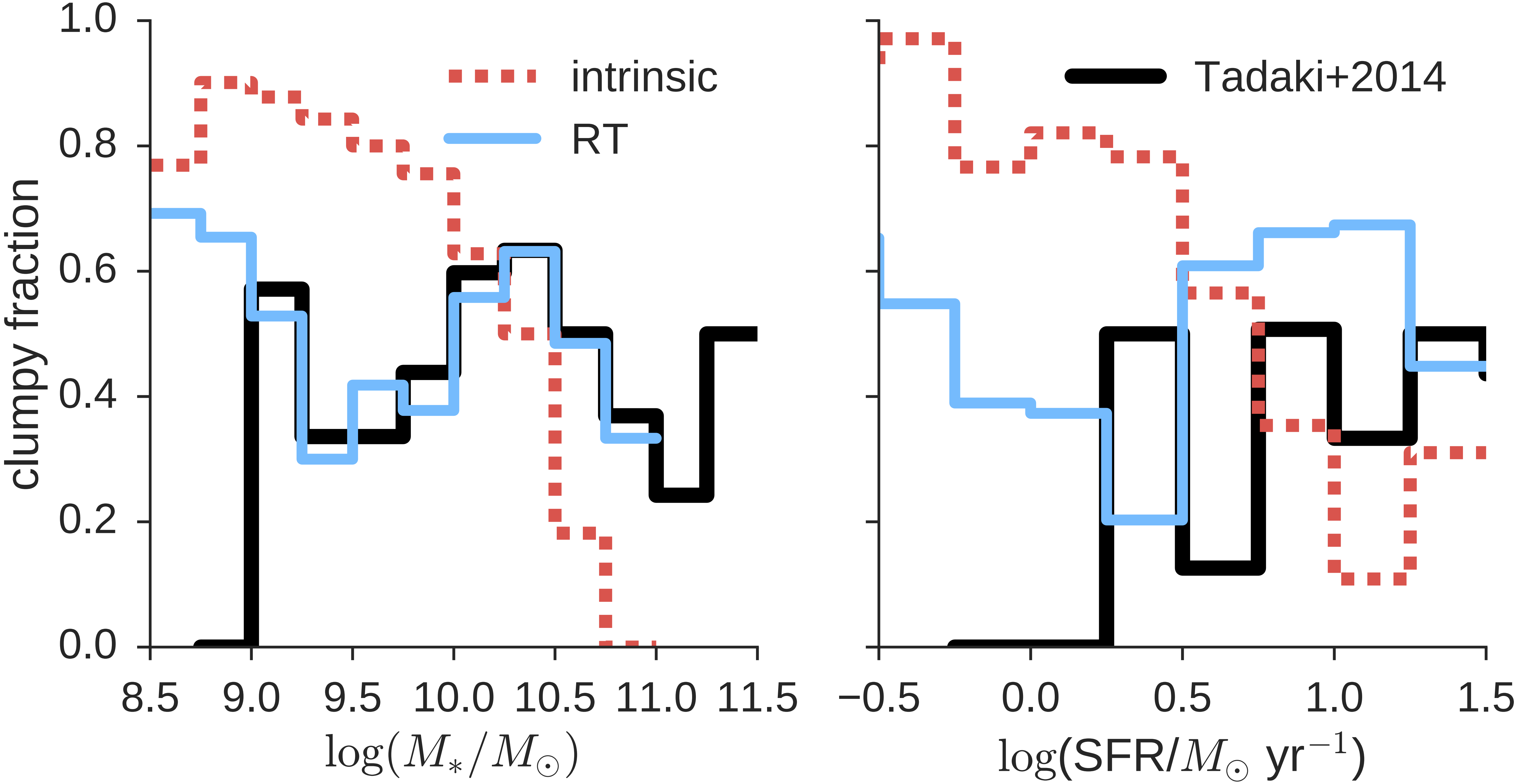


Feedback prescription is crucial
for clump formation/survival

The fate of „intrinsic“ clumps in NIHAO



The „observed“ clumpy fraction of NIHAO - correlation with galaxy property



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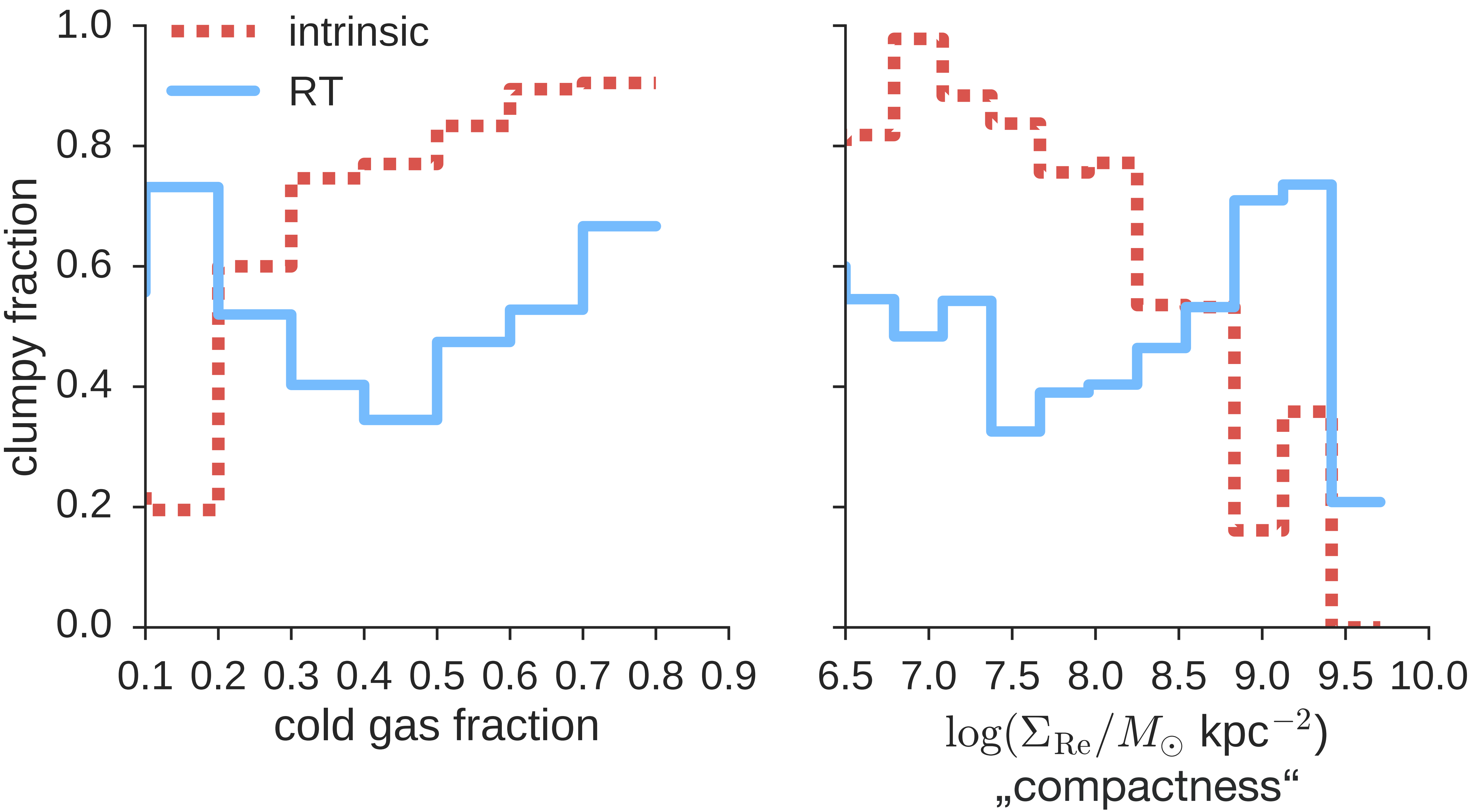
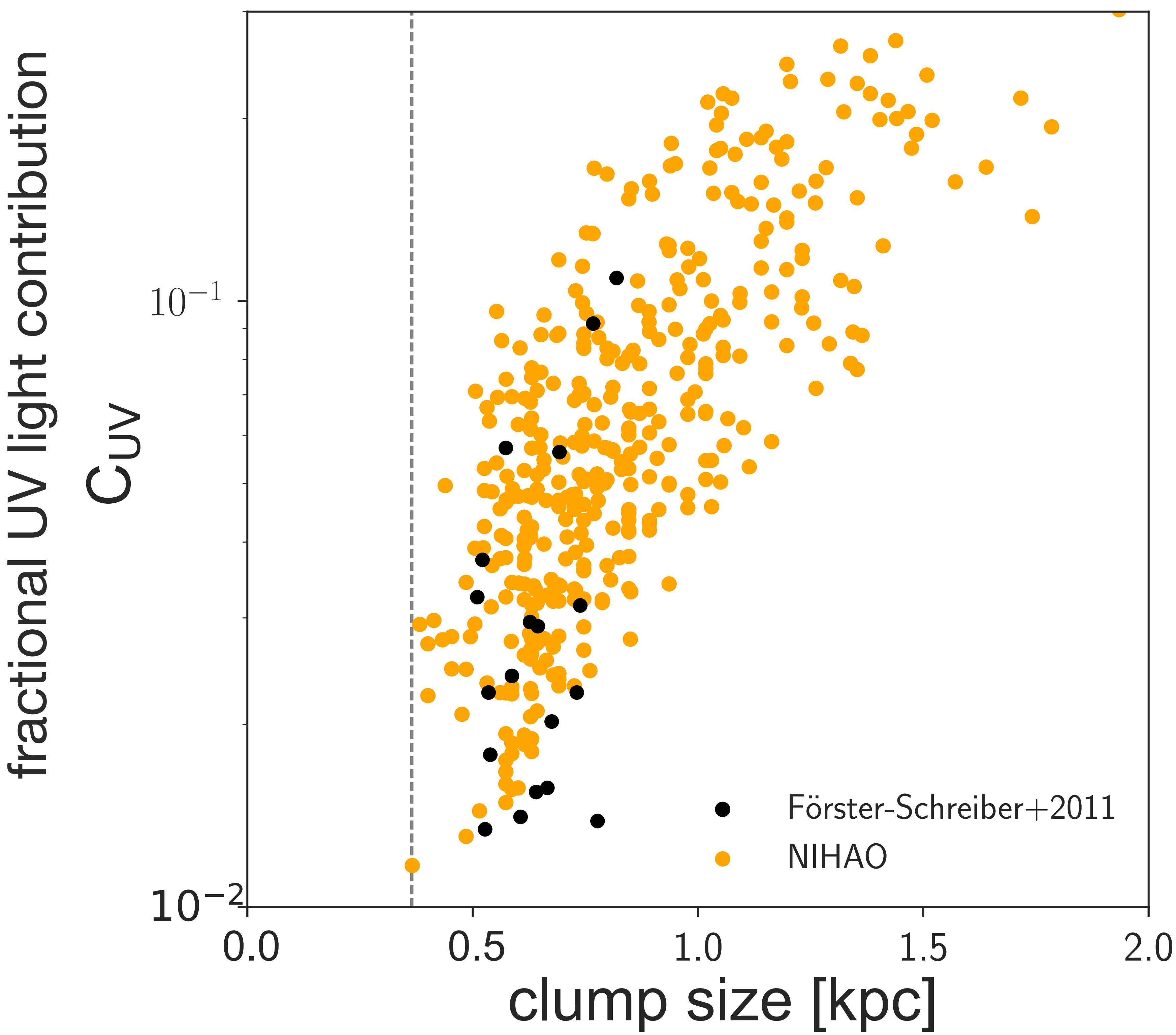


The „observed“ clump properties of NIHAO



The Gas fraction of NIHAO