UCDAVIS
UNIVERSITY OF CALIFORNIA

Galaxy Kinematics as a Function of Environment within the ORELSE Survey

Debora Pelliccia

UC Davis ➟ UCO/UC Santa Cruz (just moved!)

COLLABORATORS:

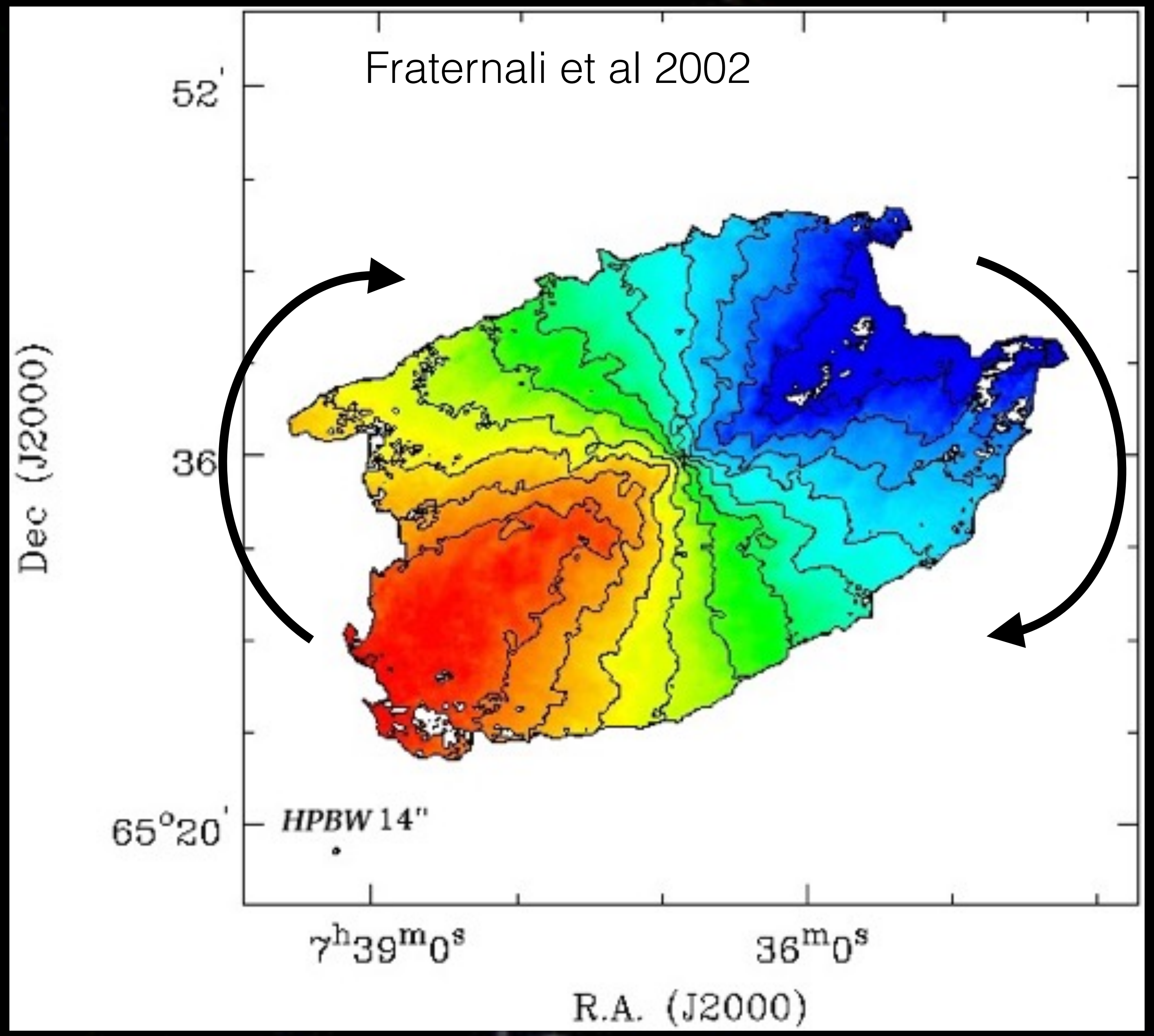
LORI LUBIN, BRIAN LEMAUX, ADAM TOMCZAK, ROY GAL, LU SHEN, BENOÎT EPINAT, LAURENCE TRESSE

eas 2020 Leiden Virtual

S14: Quenching Galaxies in the Cosmic Middle Ages

30 June - 1 July 2020

Galaxy Kinematics



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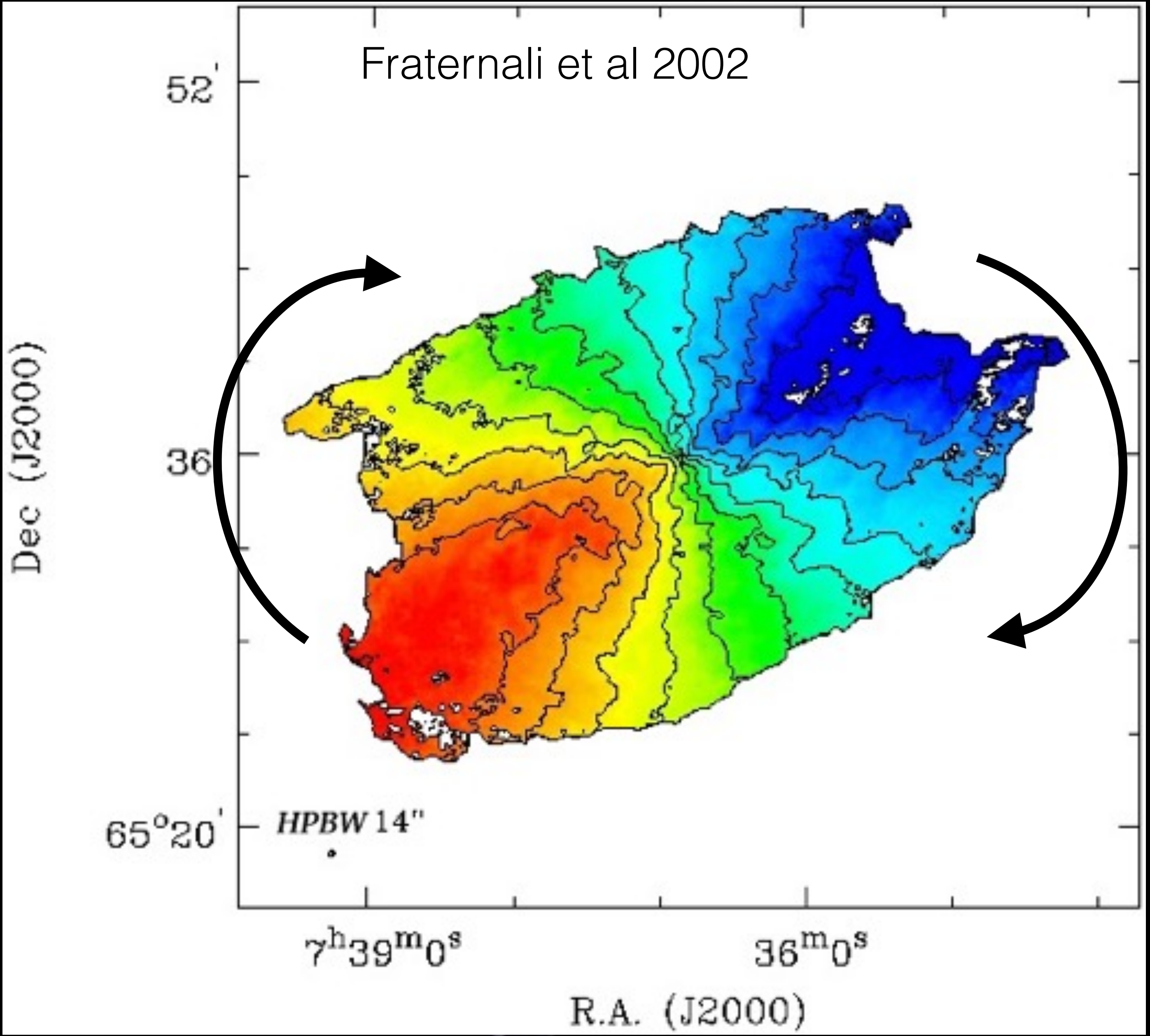

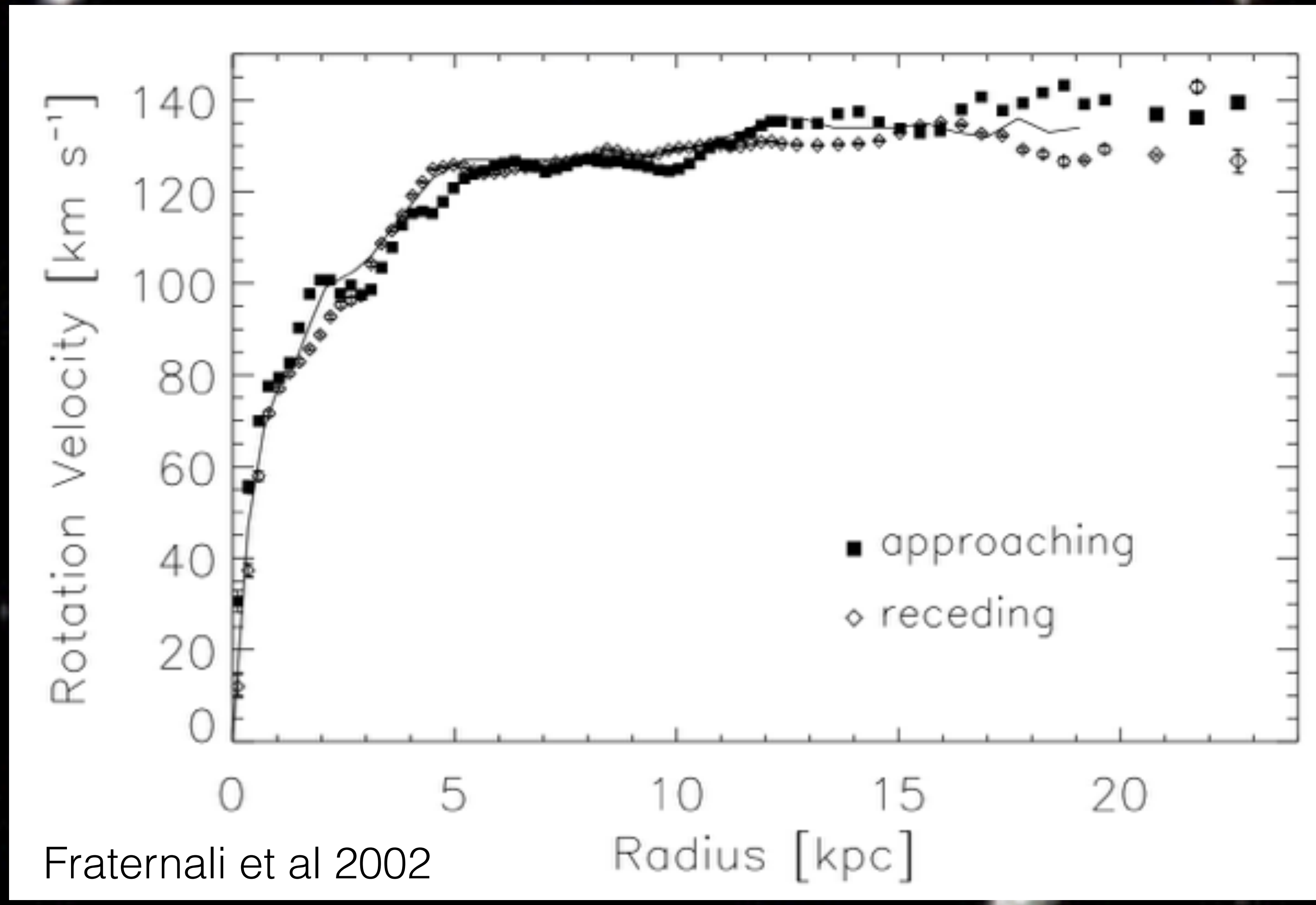

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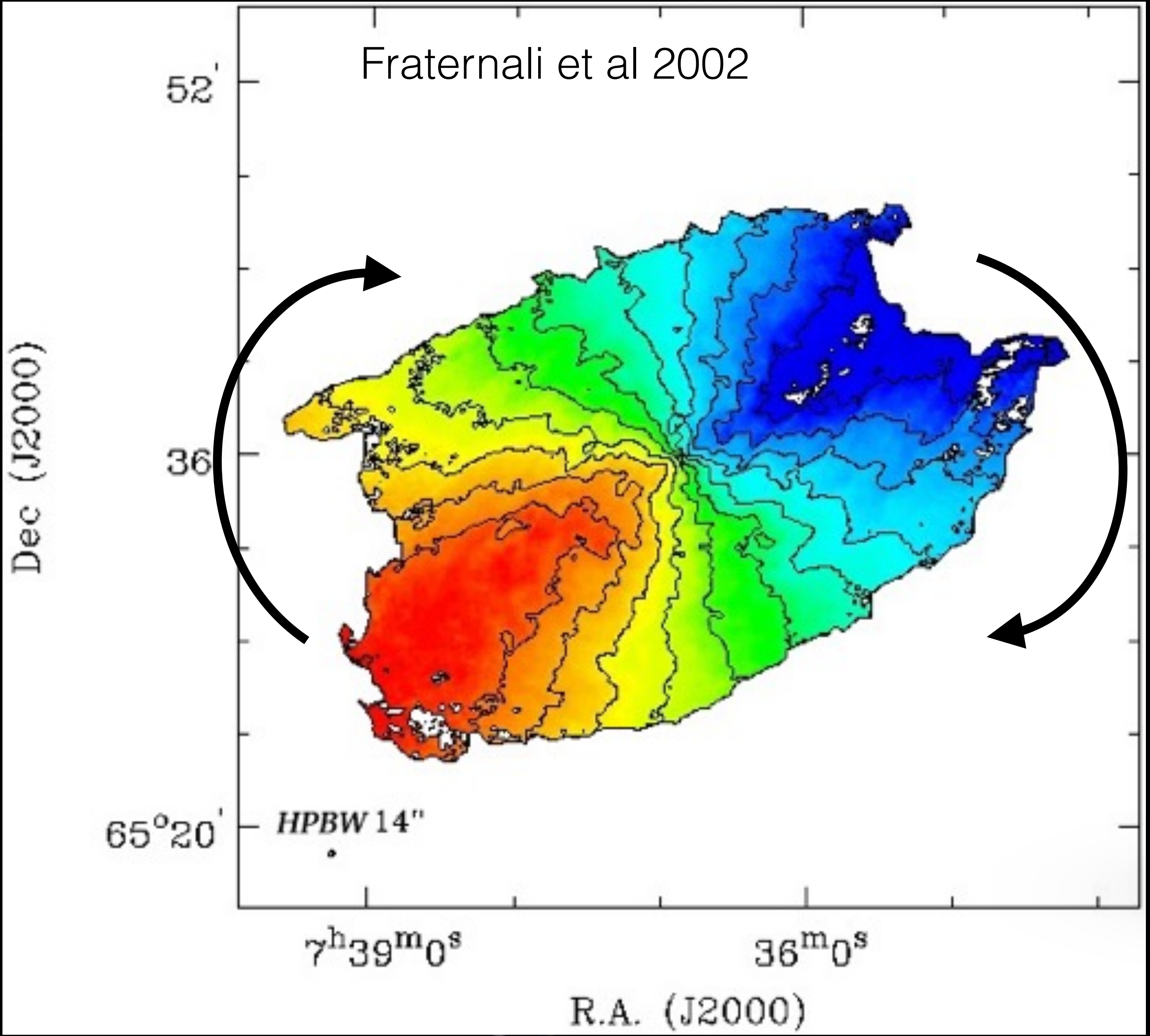
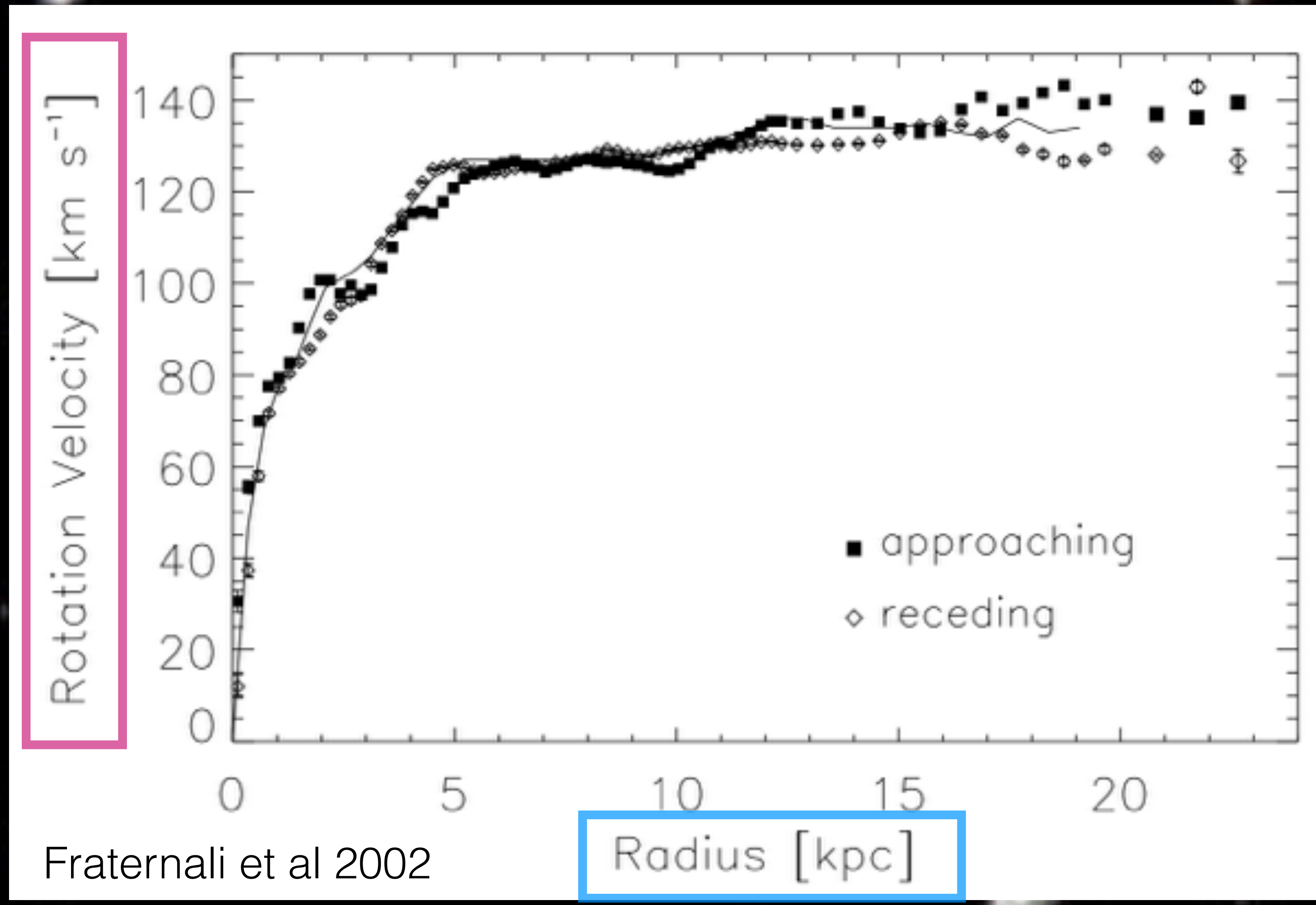


Dynamical Mass

$$\mathrm{Mass}(<R) \simeq \frac{RV^2}{G}$$



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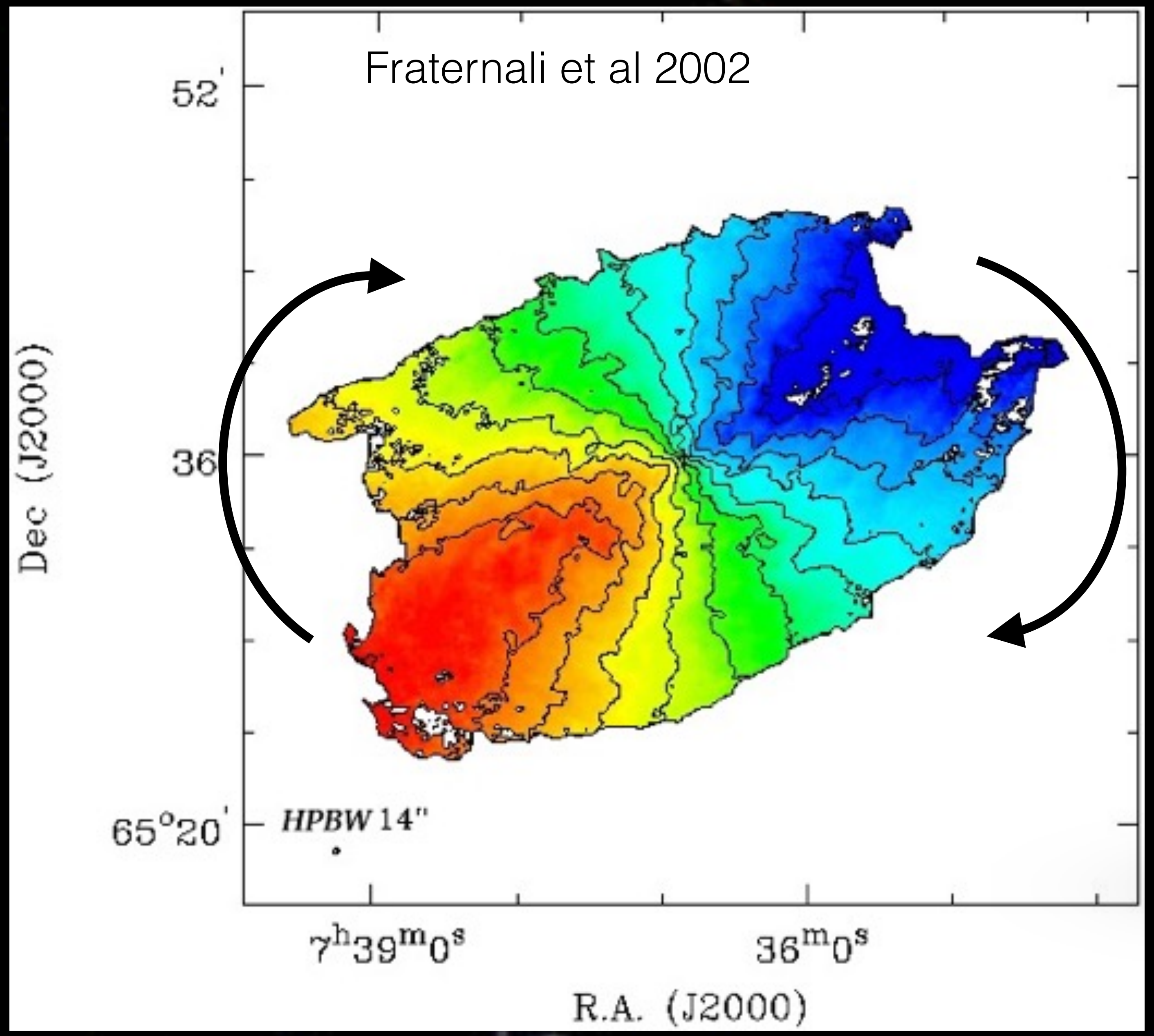

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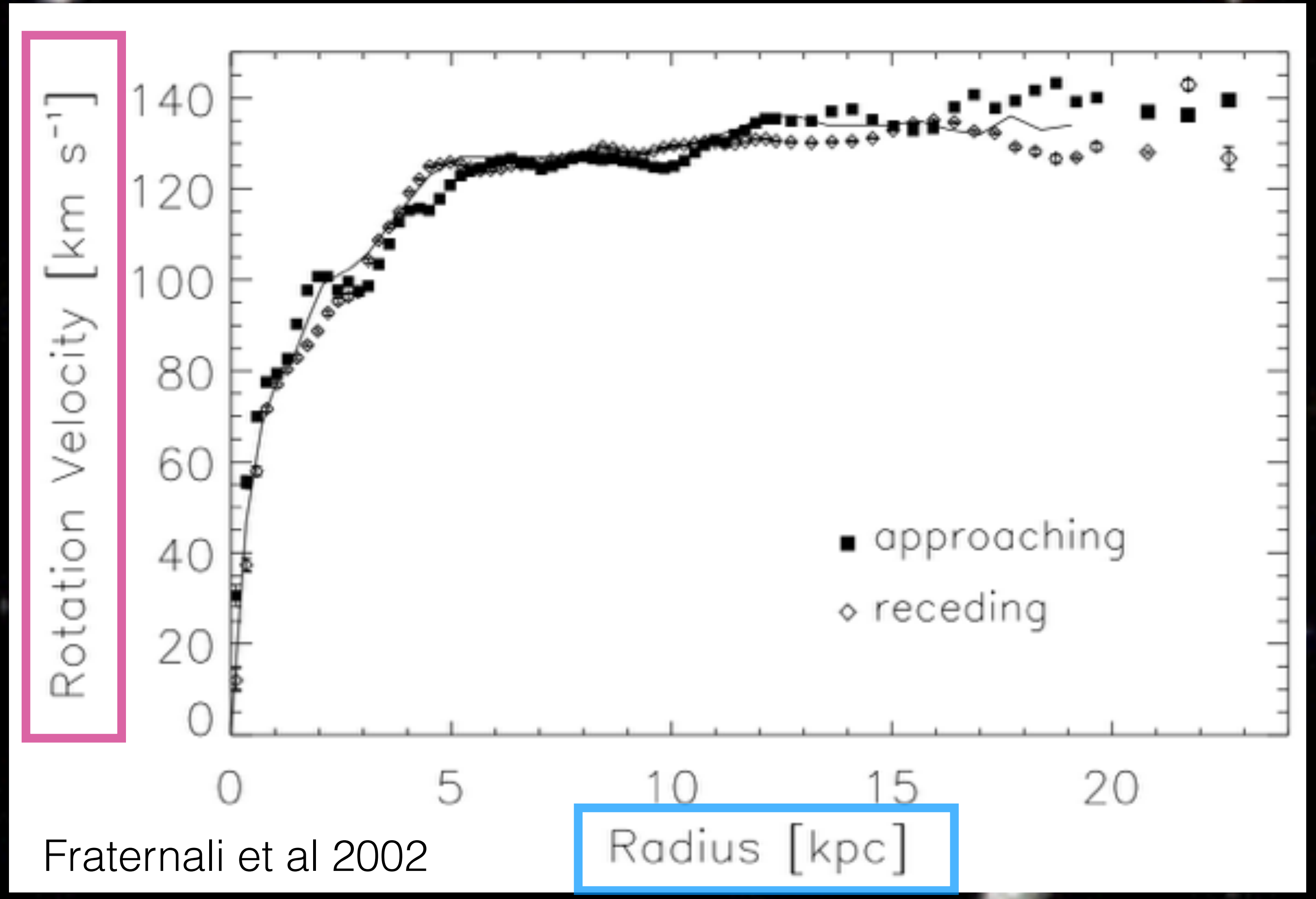
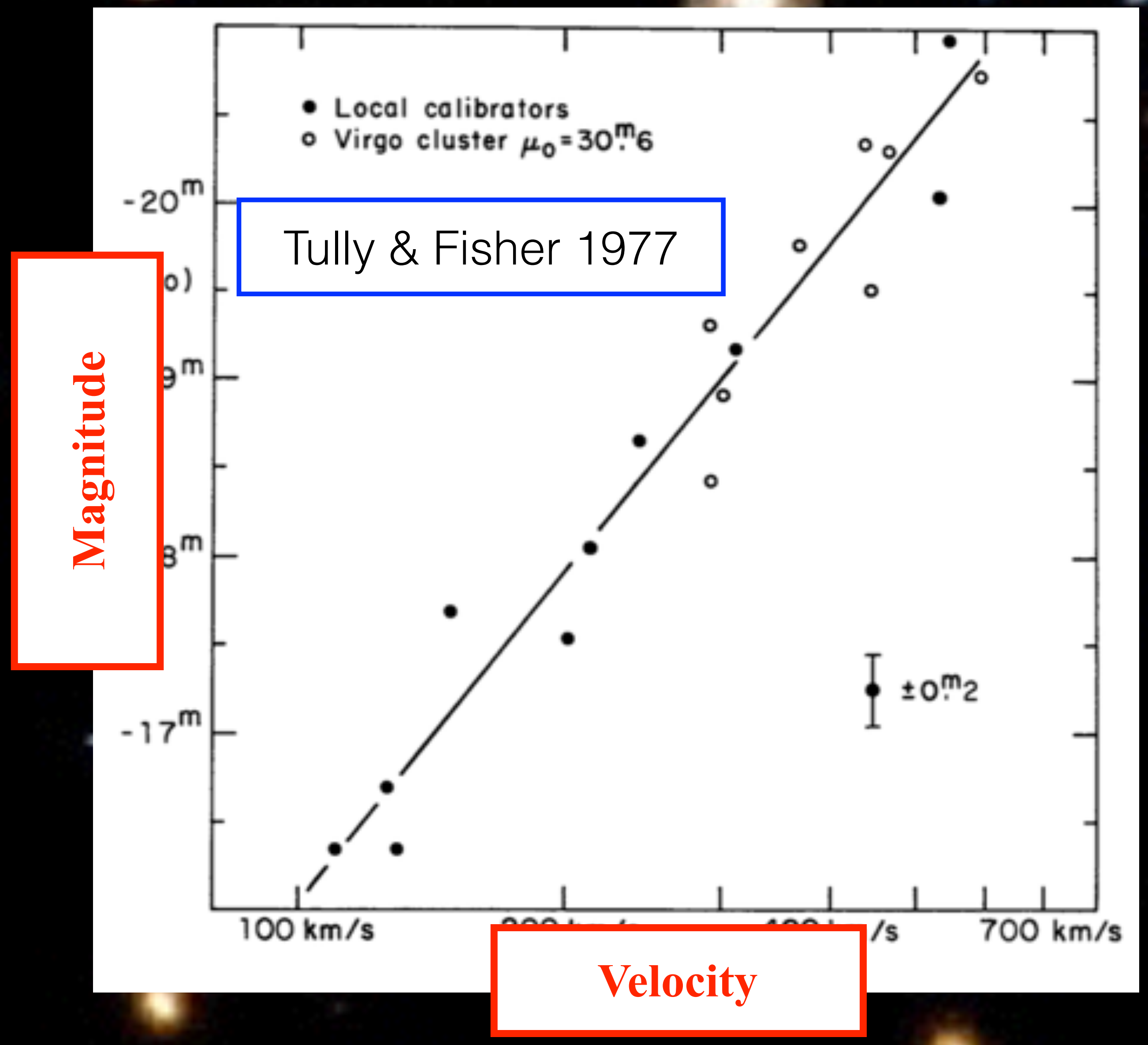
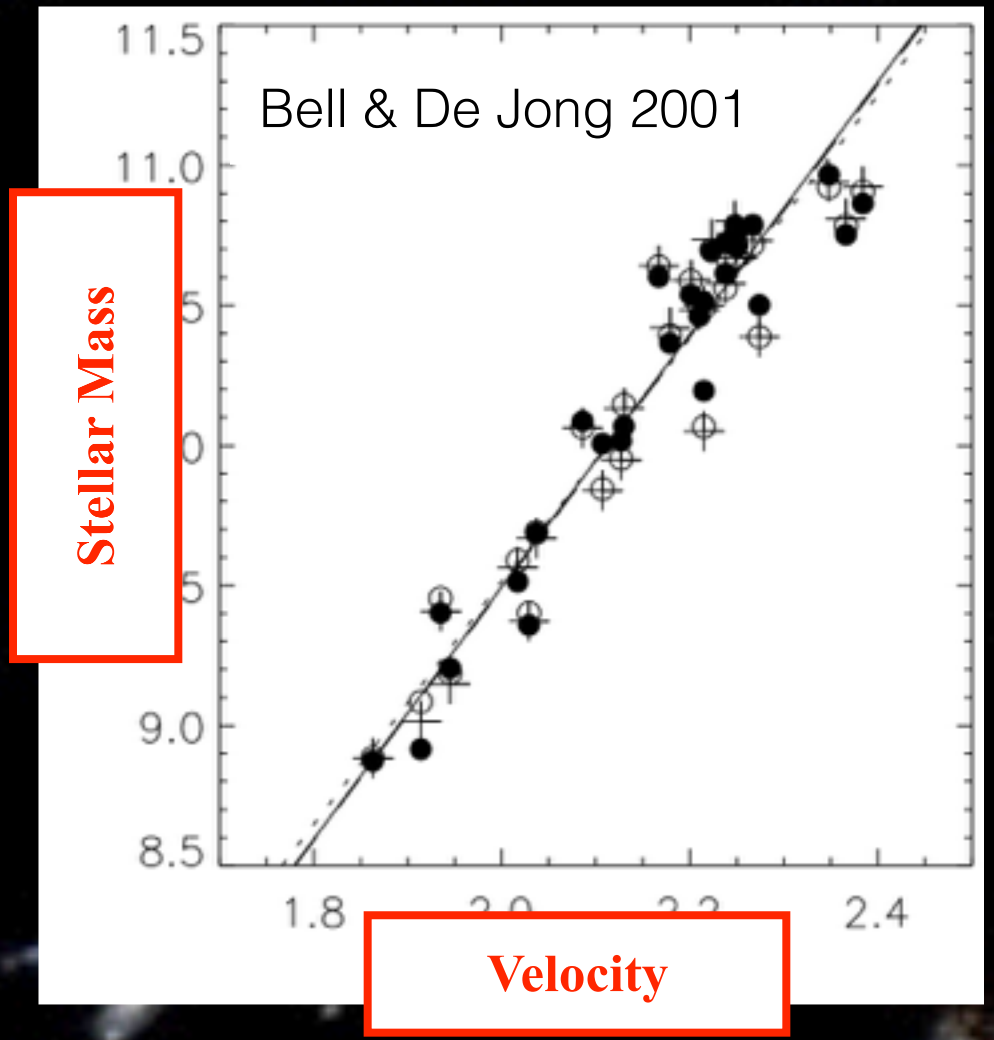
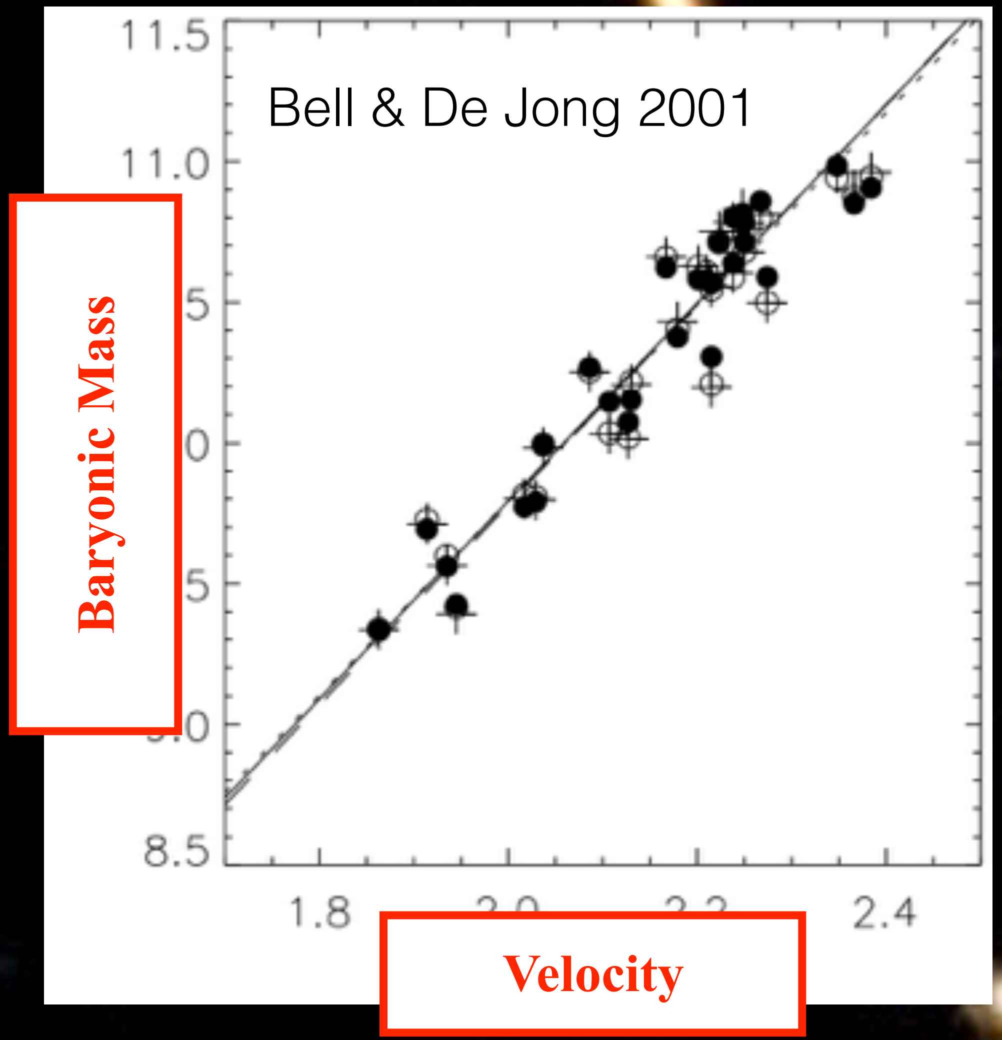


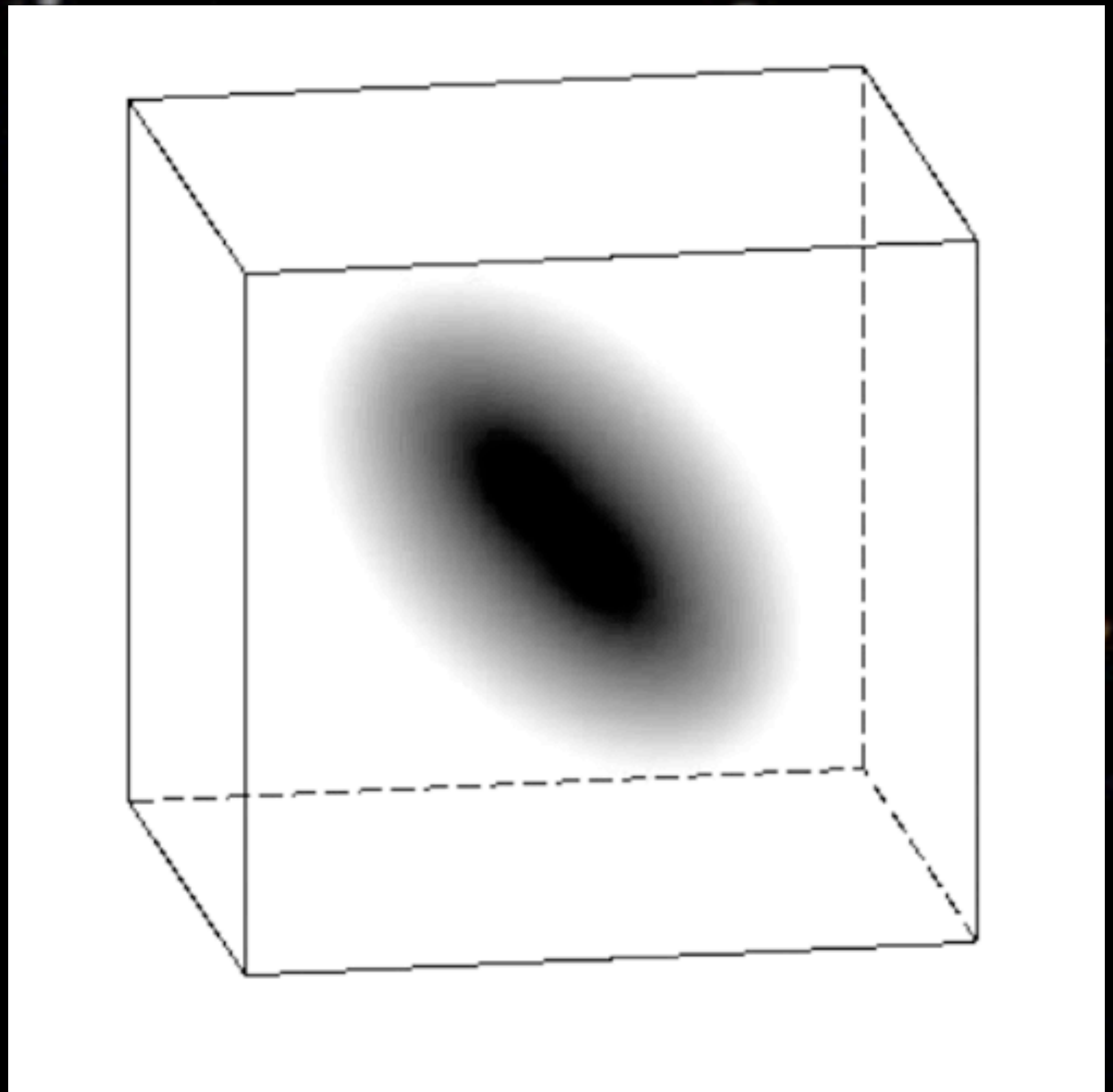






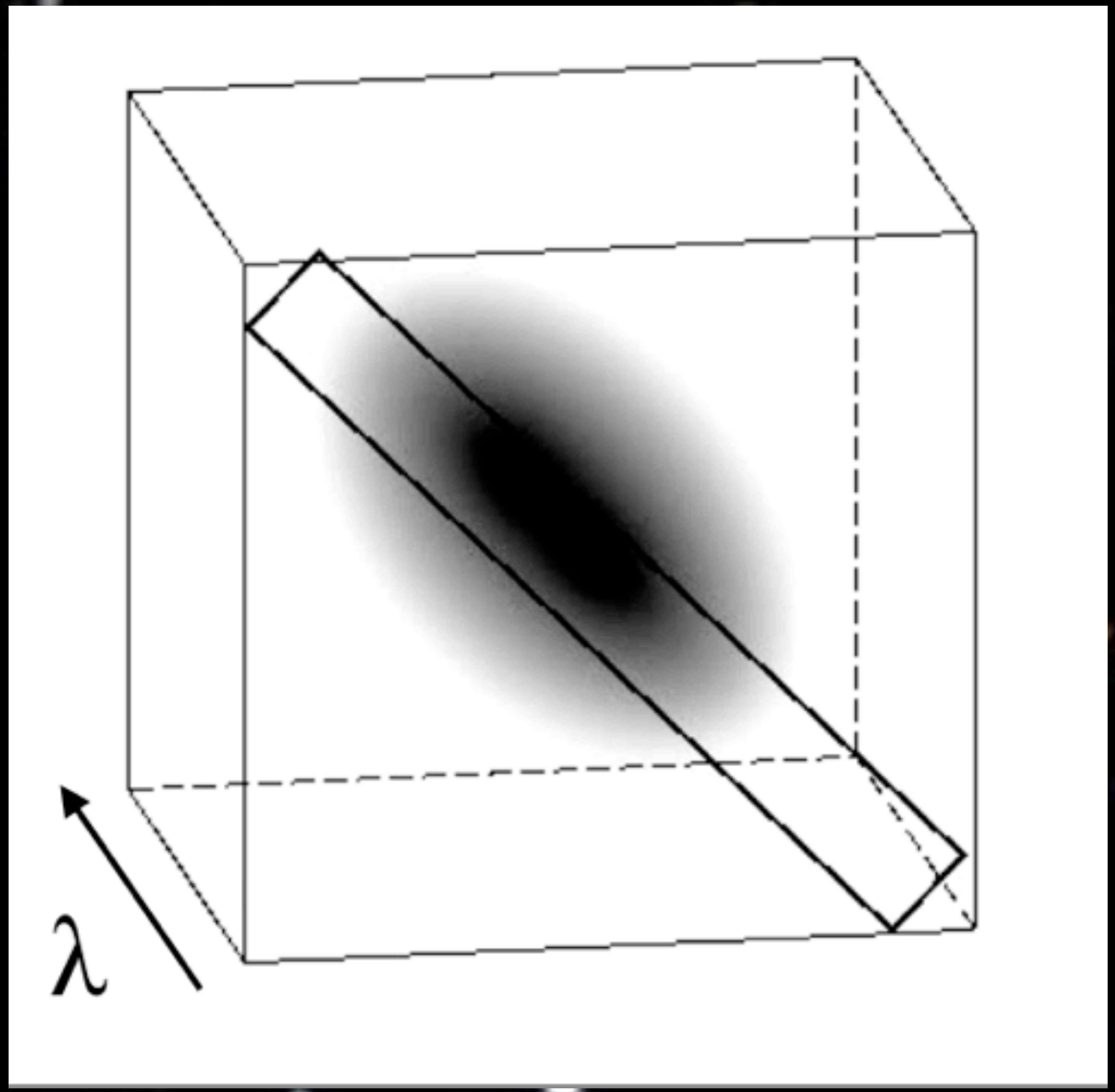
Tully-Fisher Relations

Kinematic Models



- ➤ **Intensity profile:** *Exponential disk*
- ➤ **Rotation velocity profile:** *Freeman disk*
- ➤ **Velocity disperison profile:** *constant with radius*

Kinematic Models



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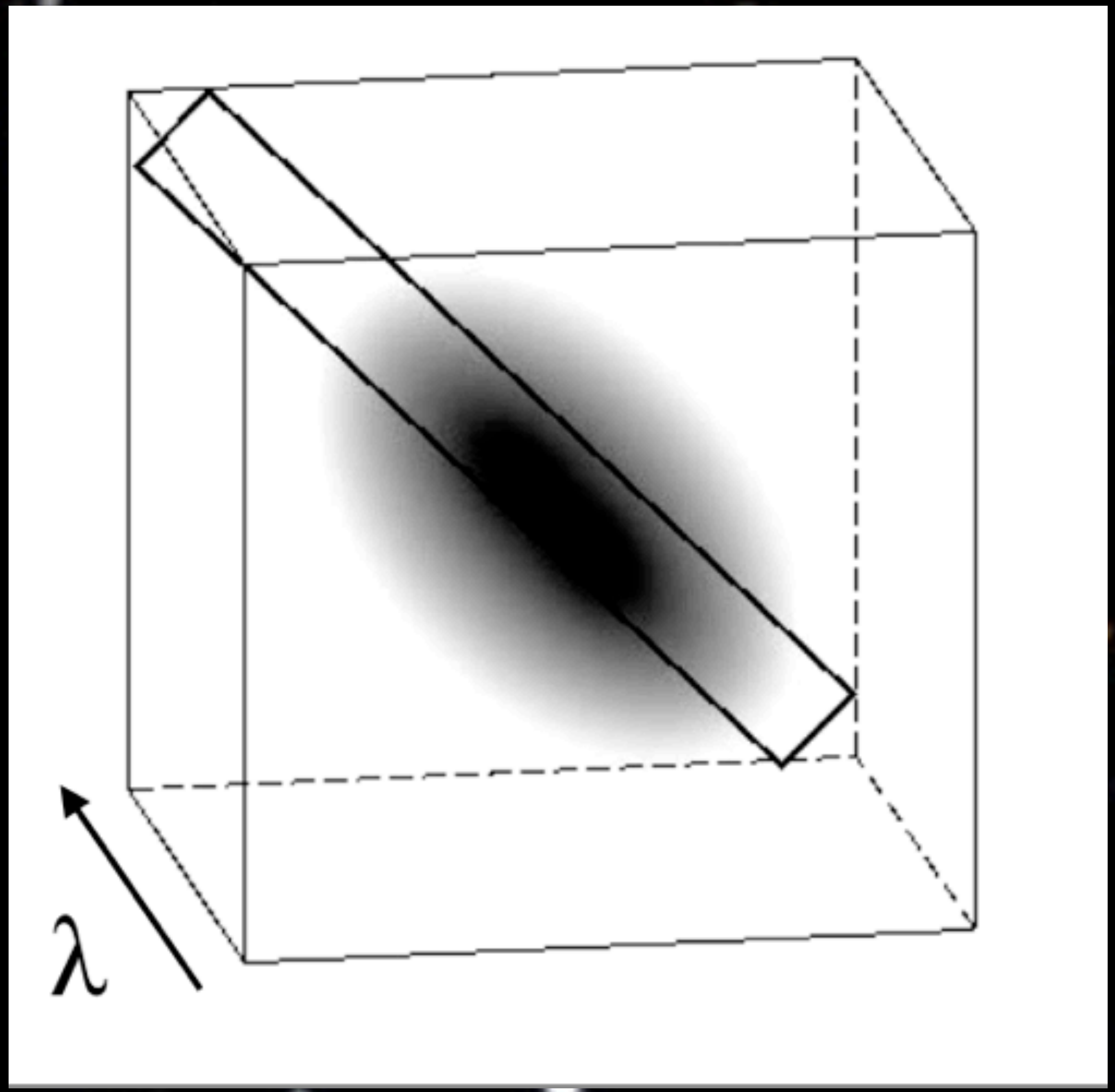

- Convolution with spatial and spectral resolution

- Re-binning to match observations' sampling

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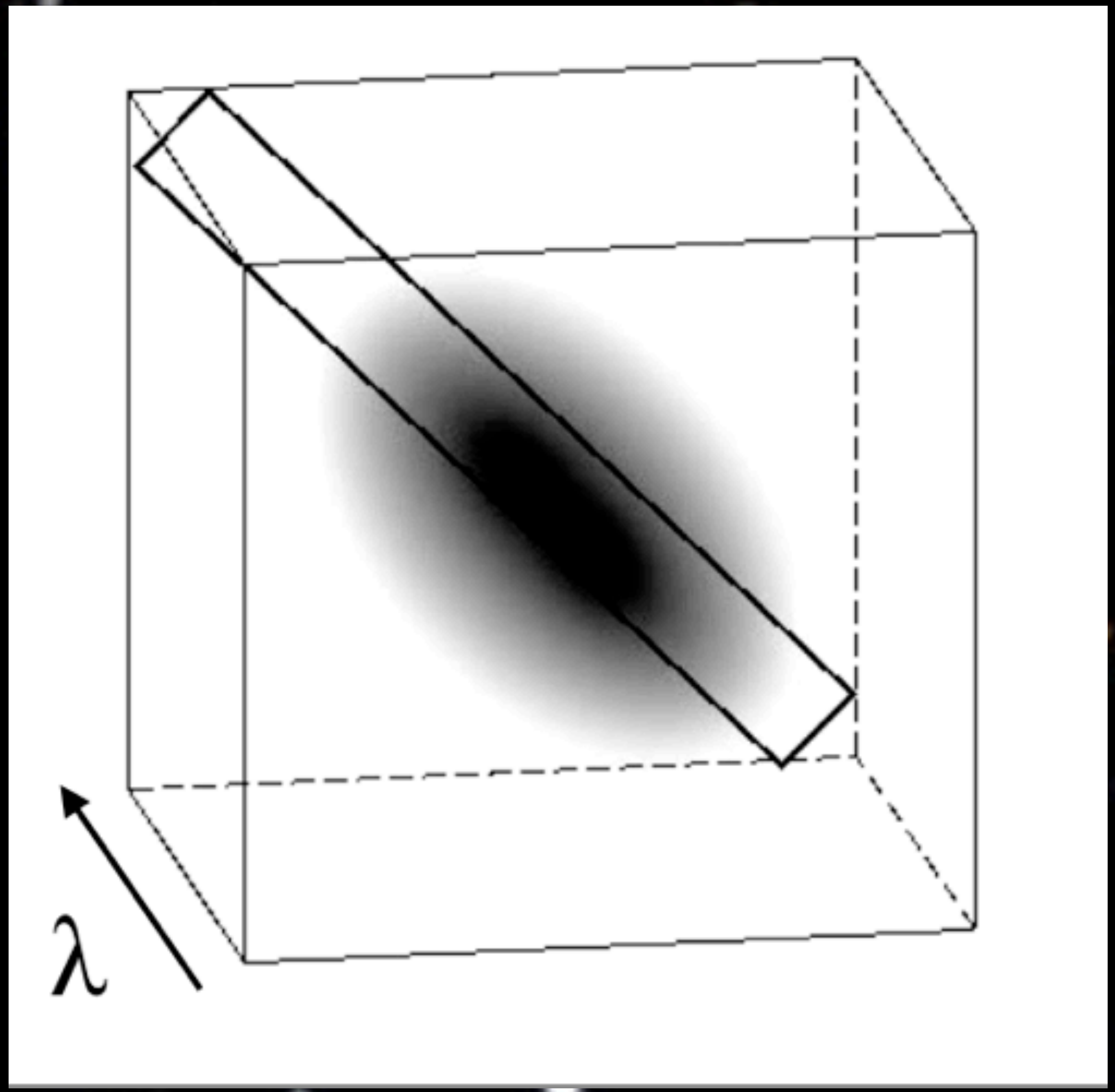

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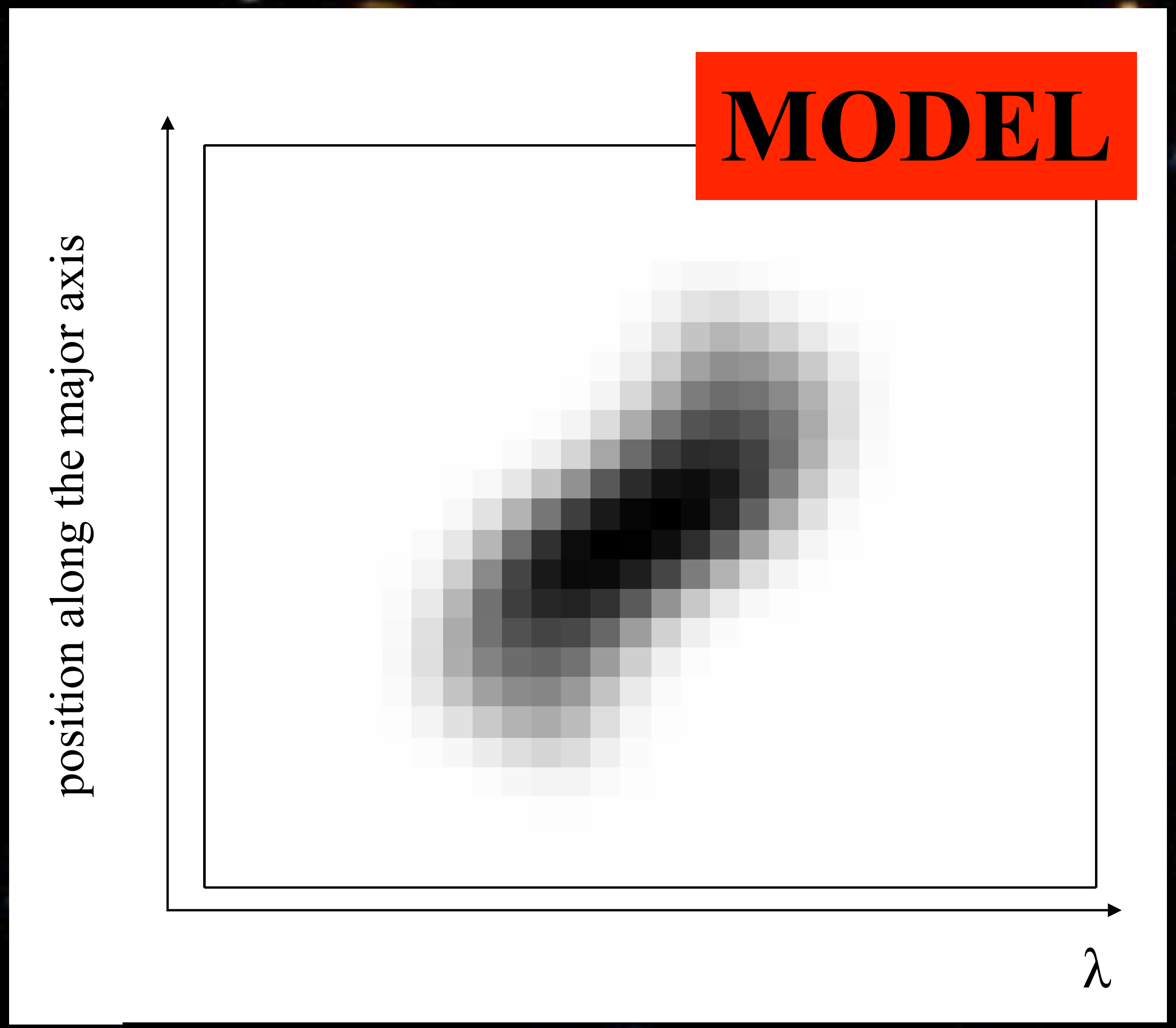

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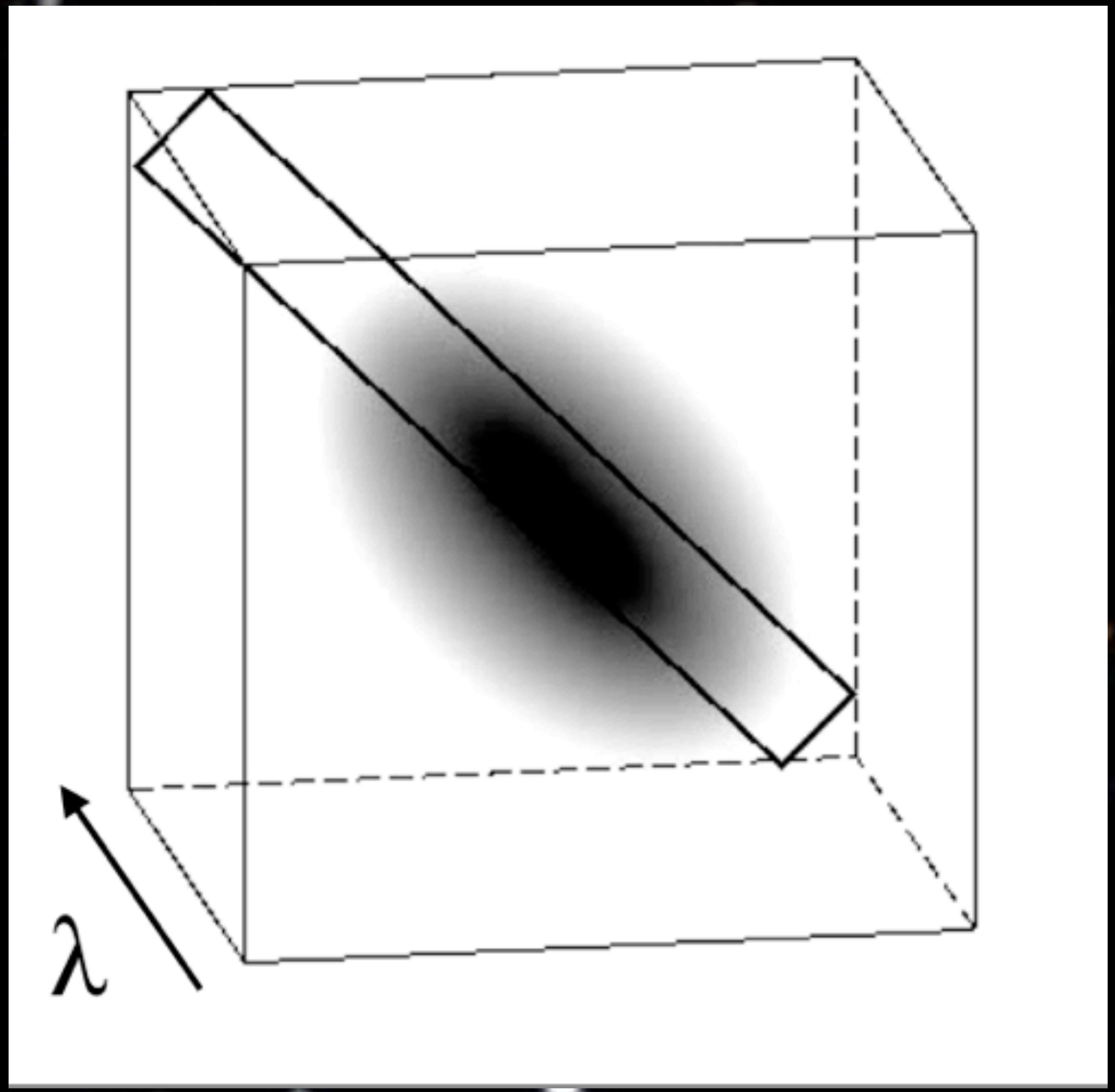

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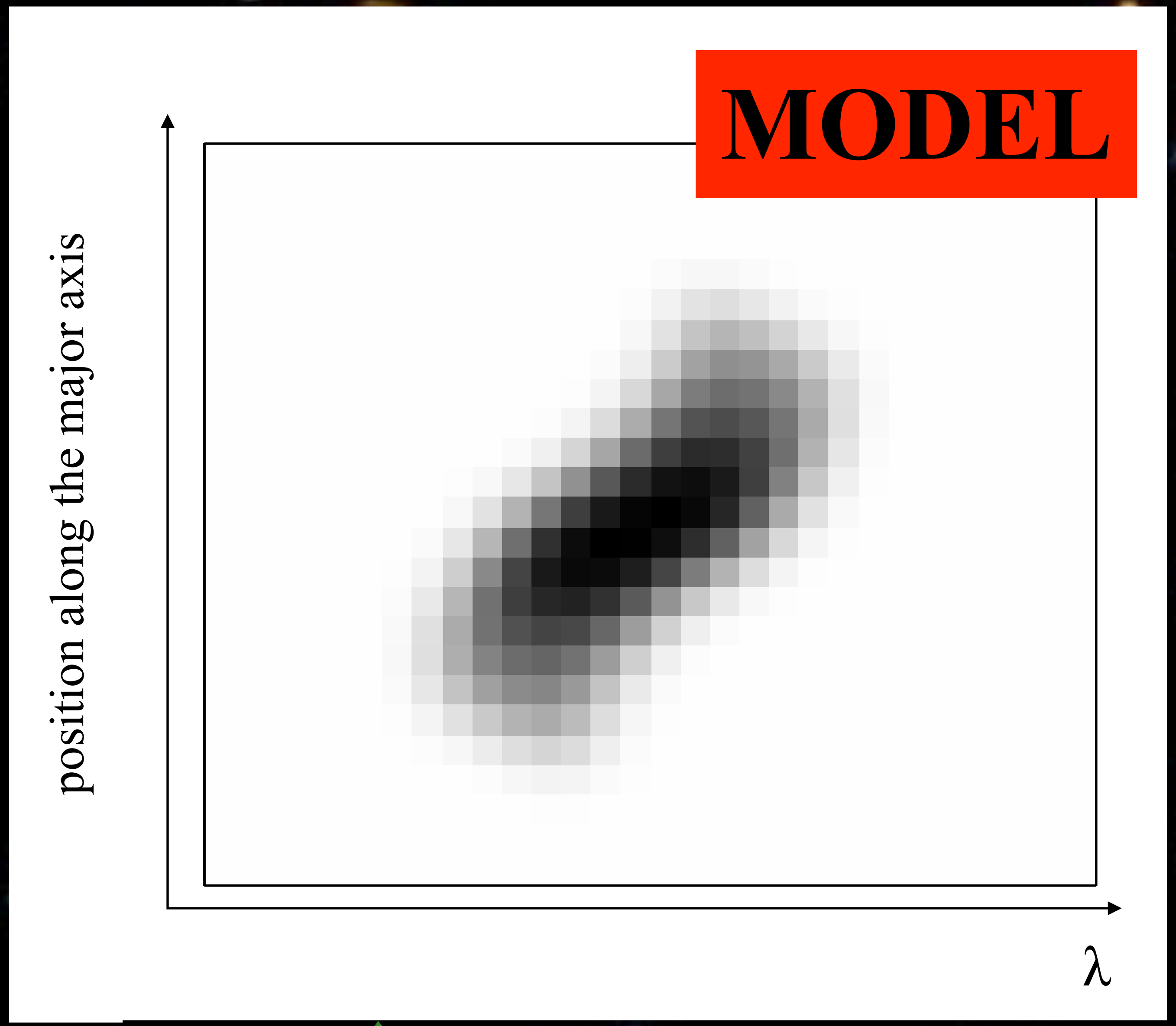
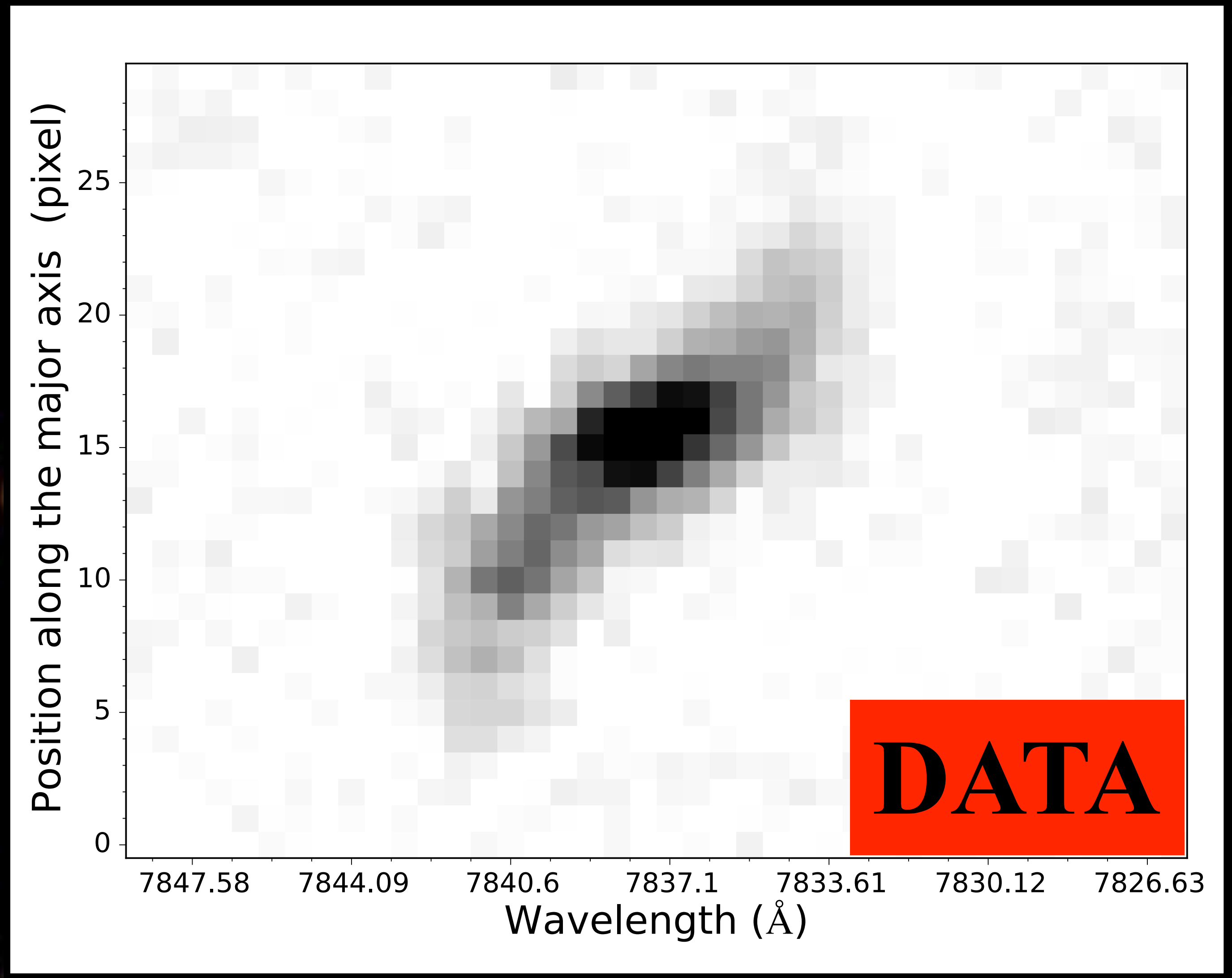


Comparison
with the observations
χ^2 minimization



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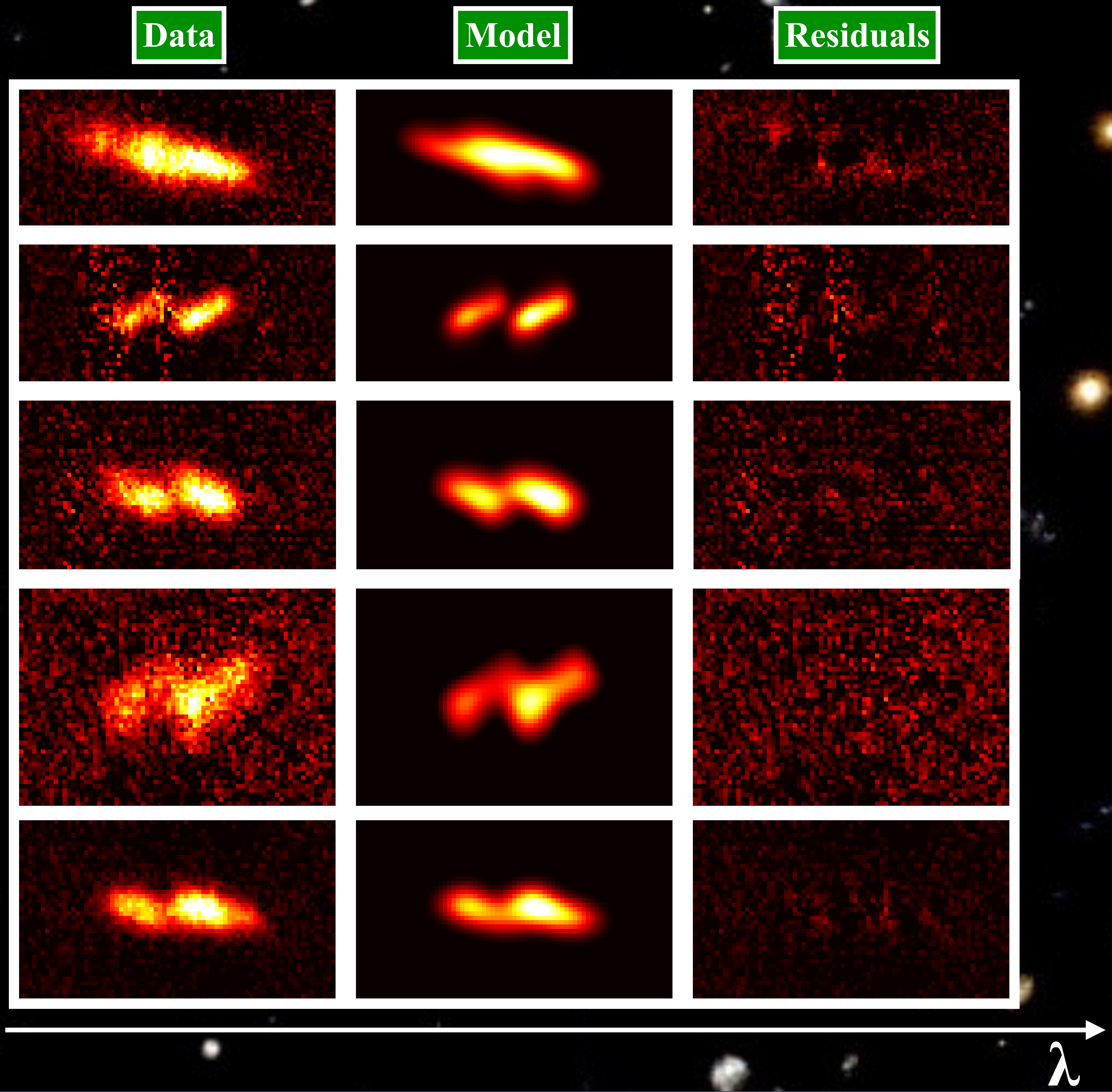

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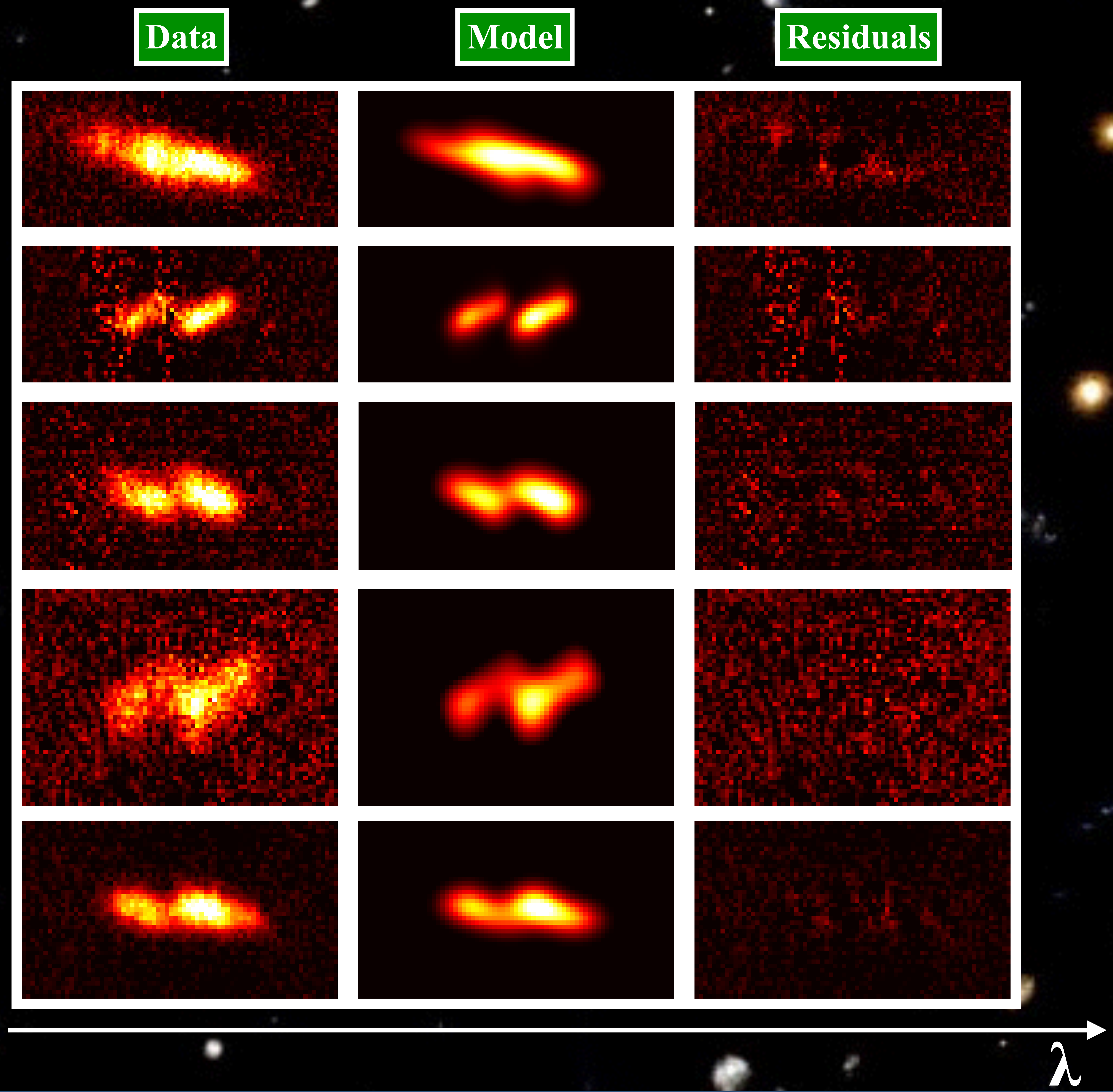
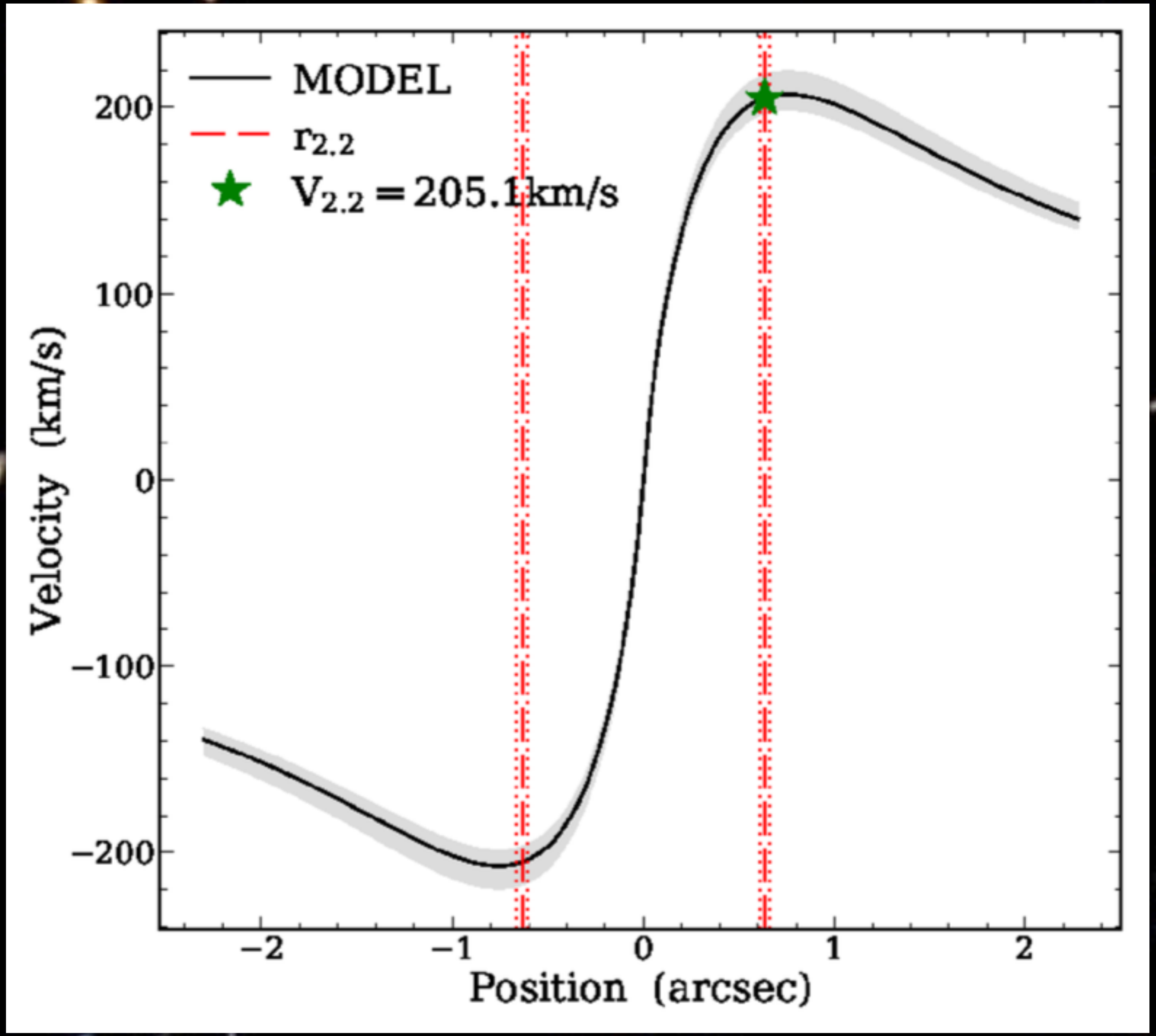


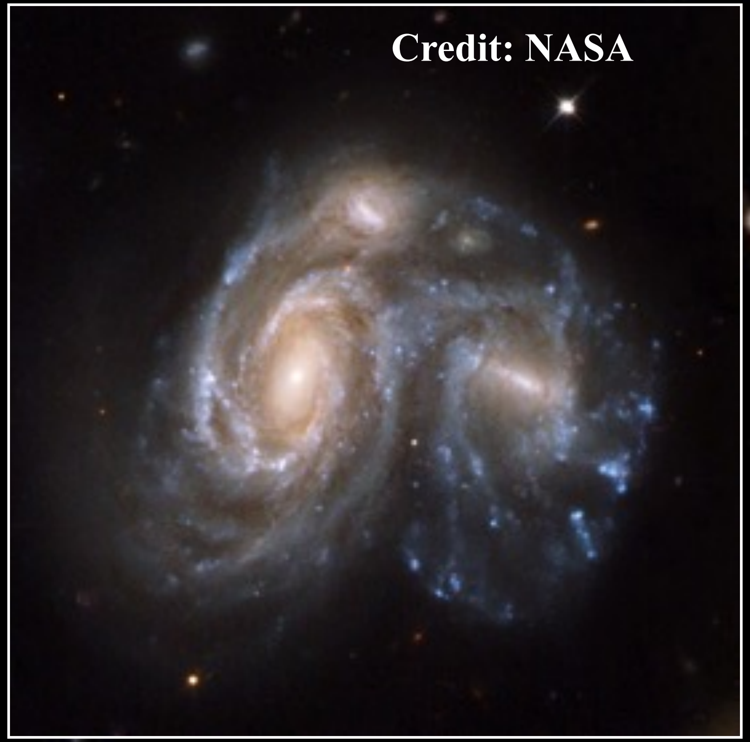


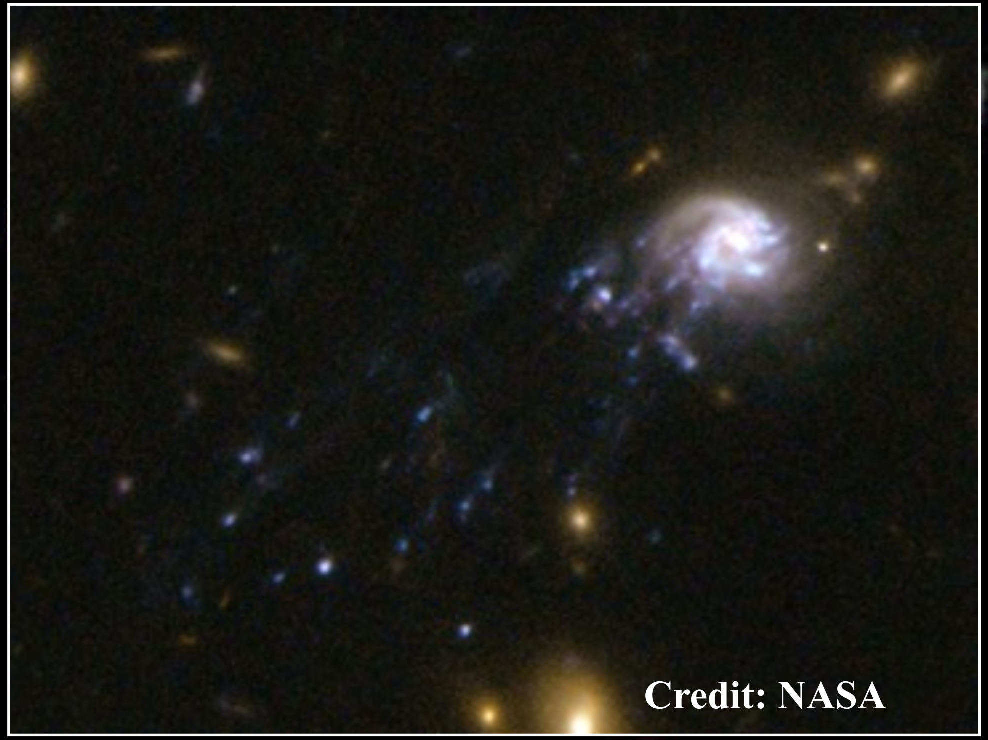
Environment

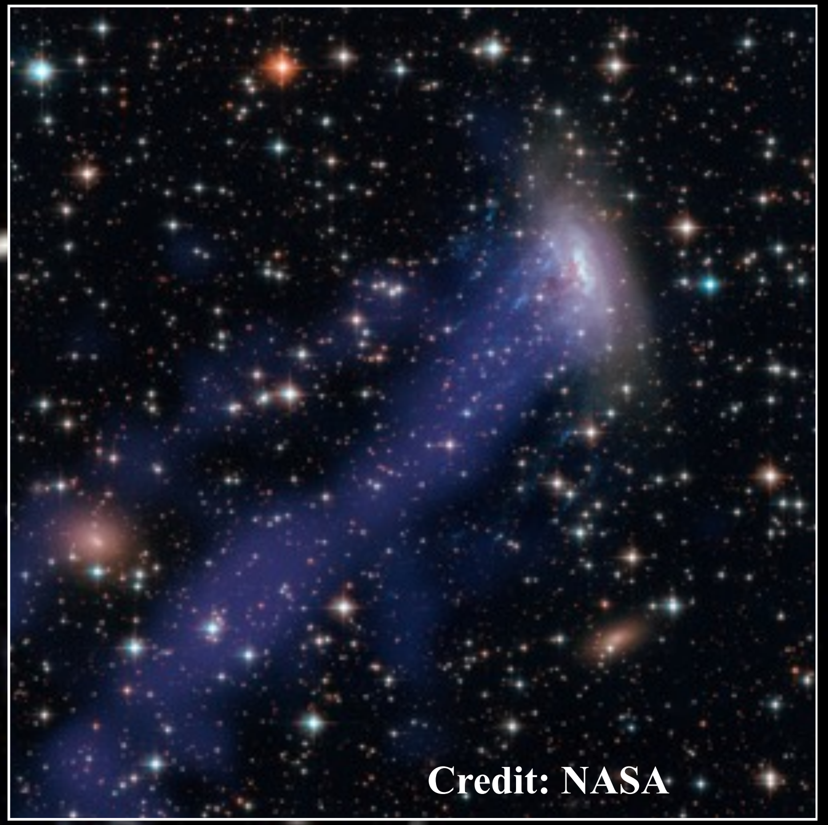
Galaxy-Galaxy Interactions
Merger - Harassment

Tidal interactions

Ram pressure stripping



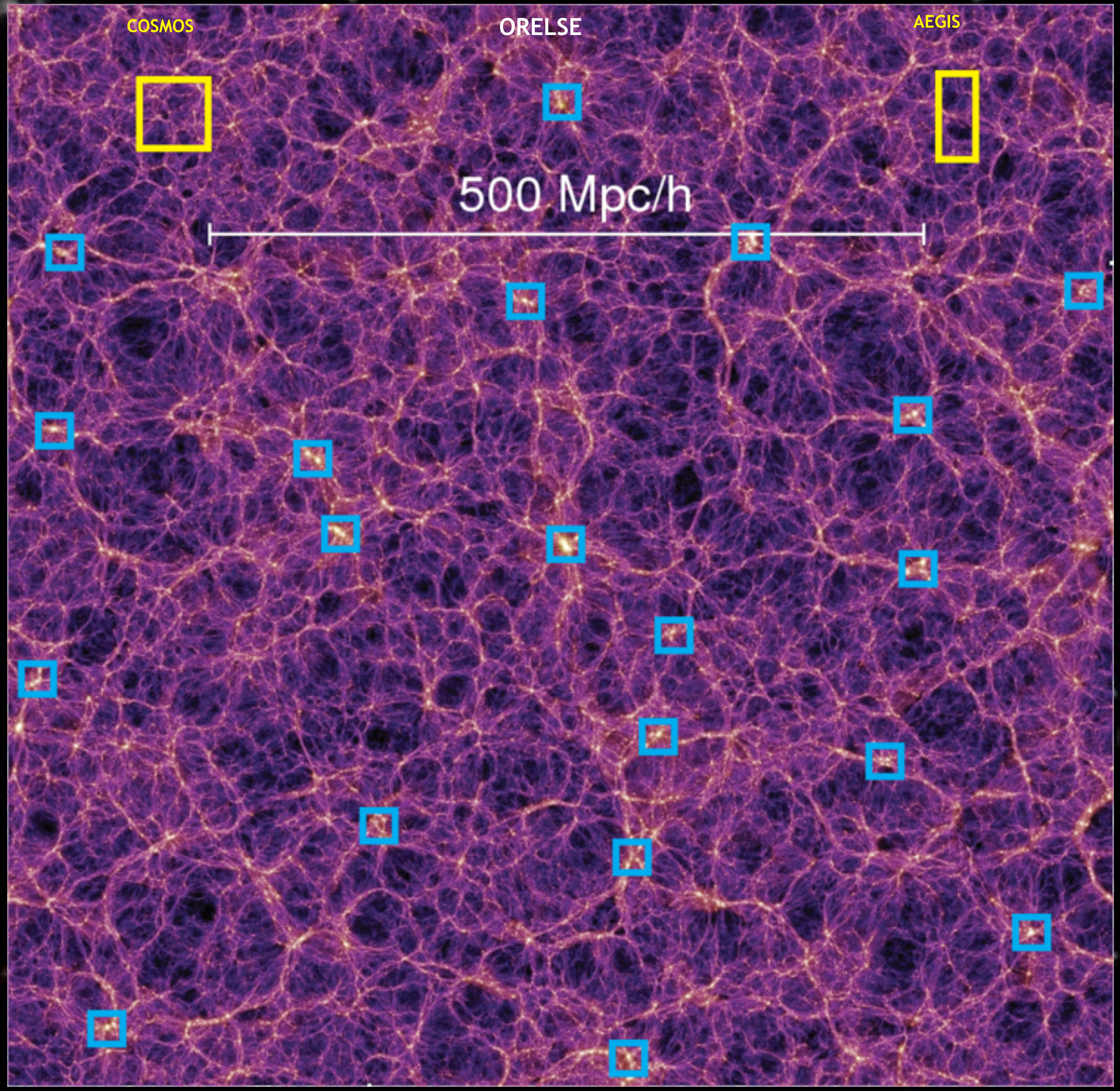




The ORELSE Survey

Observations of Redshift Evolution in Large Scale Environments

(P.I. Lori Lubin)



Mapping and characterizing galaxy properties in ~16 fields which contain LSSs at $0.6 < z < 1.3$.

Wealth of information:

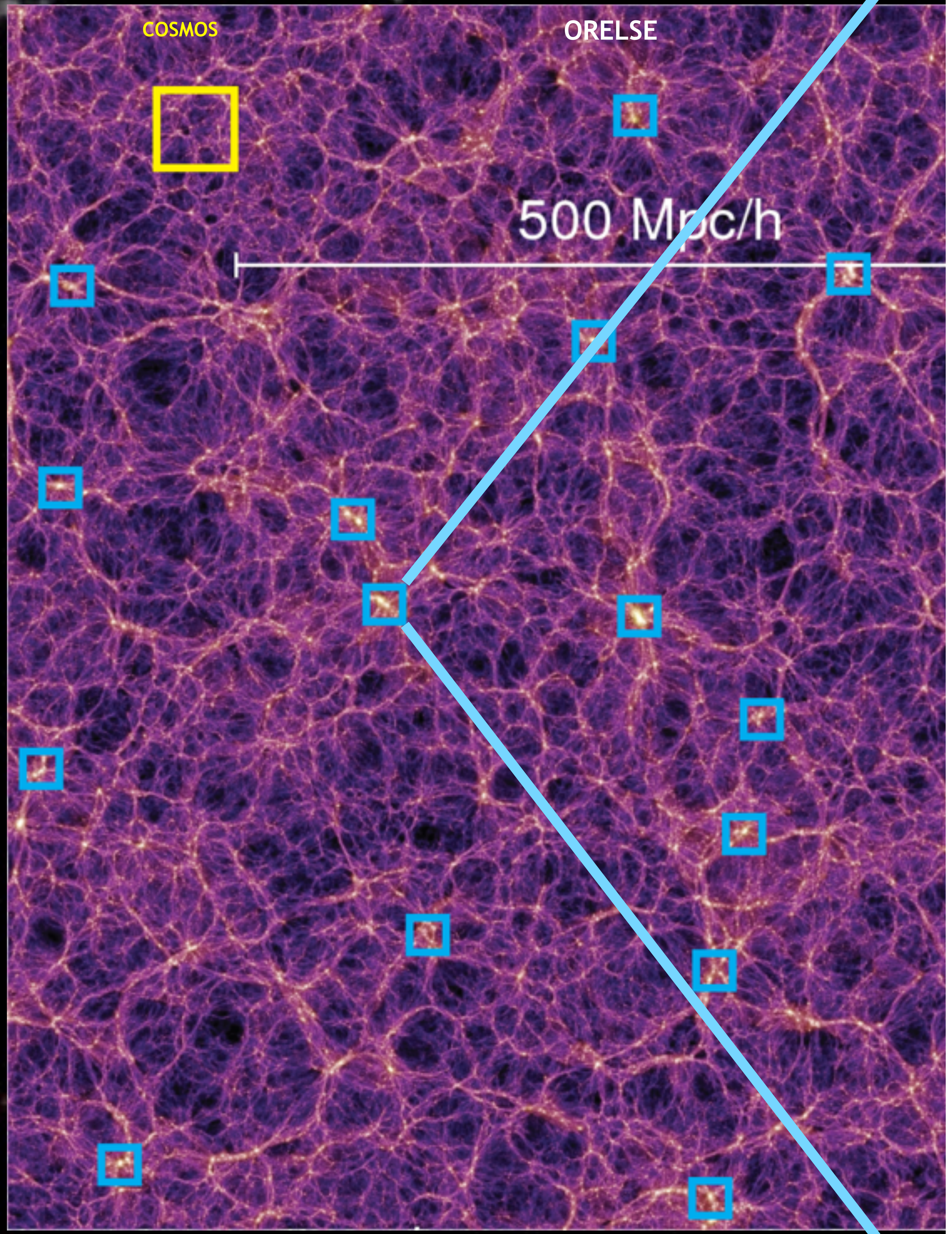
- Deep >10-band optical/near-IR and multi-wavelength (Spitzer/Chandra/VLA/Herschel) imaging.
- Keck/DEIMOS high-resolution (R=5000) spectroscopy (500–2500 spectra per field).

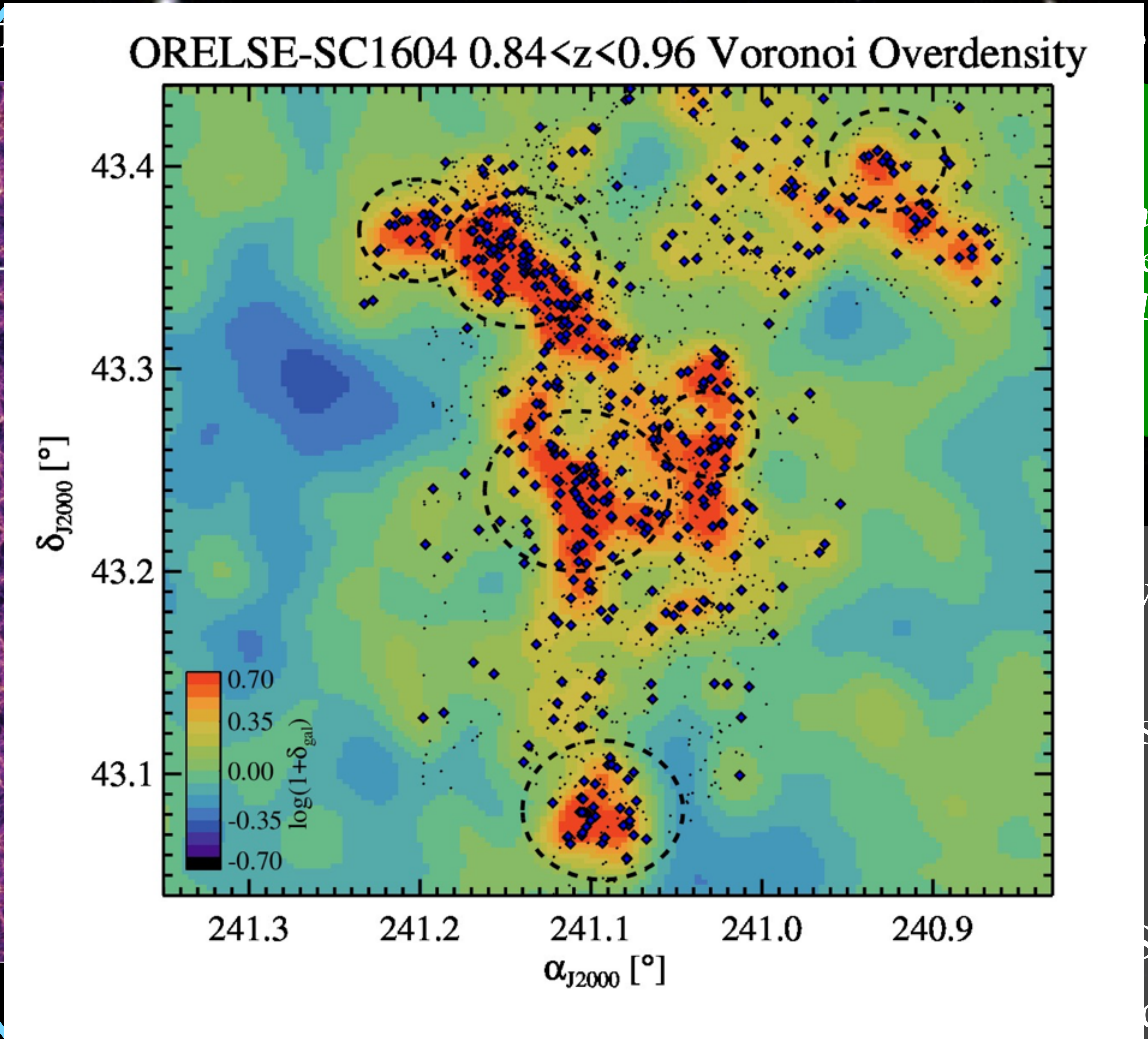
✔ 100-500 spectroscopically confirmed LSS members per field.

✔ A total of 50 clusters and groups identified across all fields.

The ORELSE Survey

Observations o





nd characterizing galaxy
es in ~16 fields which
LSSs at $0.6 < z < 1.3$.

wavelength

spectroscopy

S members per field.
d across all fields.

The ORELSE-SC1604 Kinematic Sample

<u>144 star-forming galaxies</u>

<u>at 0.6<z<1.3:</u>

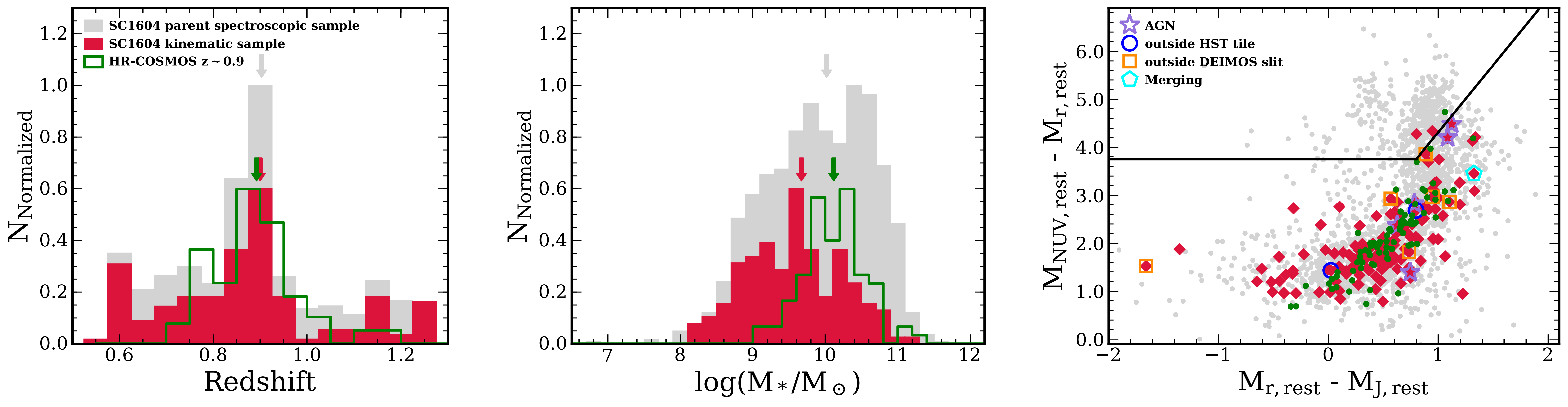
✗ [OII]/[OIII]/Hβ emission line

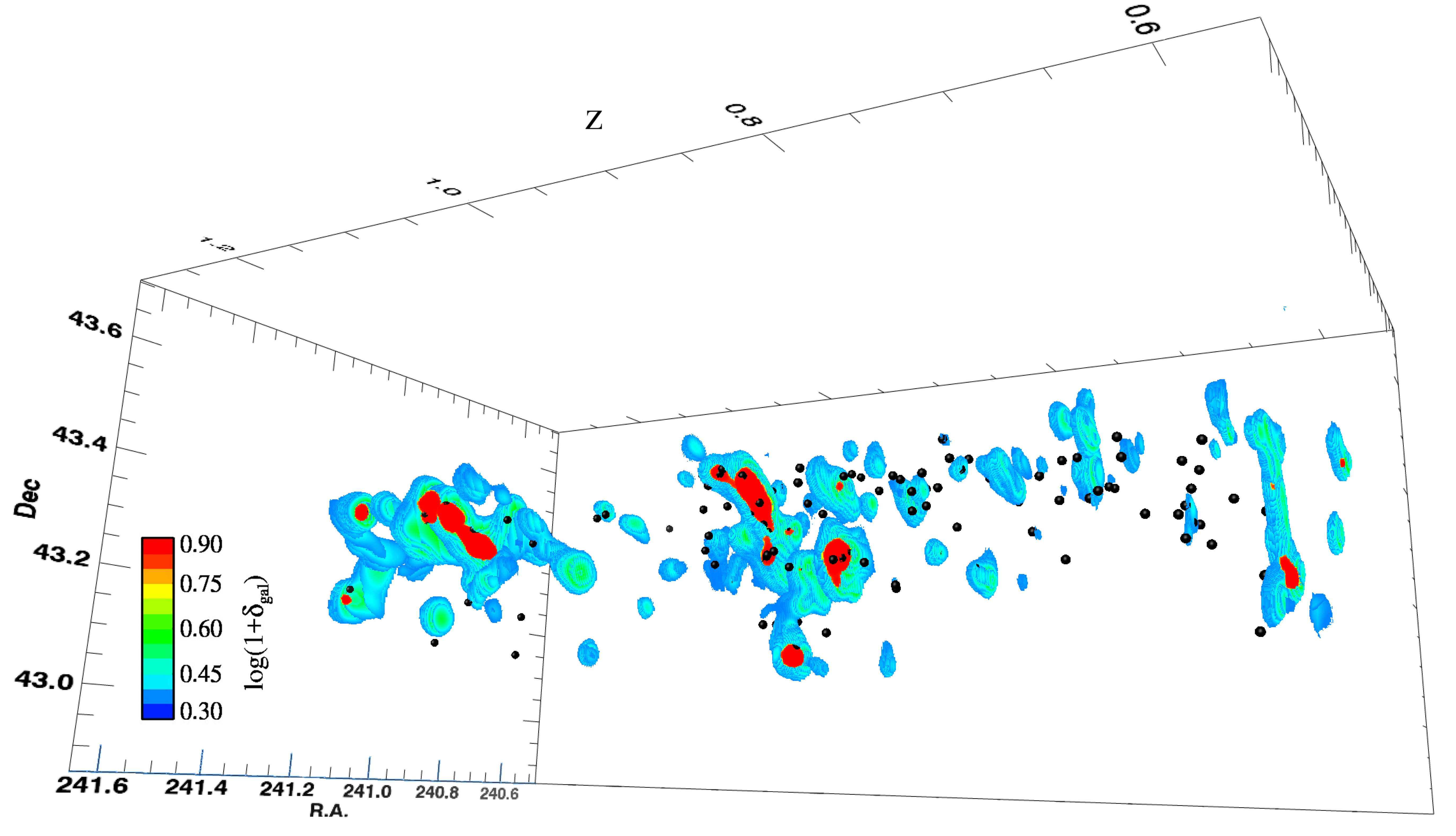
✗ HST/ACS imaging

✗ Incl & PA optimal for kinematic extraction

✗ Local environment measurements $log(1+\delta_{gal})$

✗ Global environment measurements $\eta = (R_{proj}/R_{200})\times(|\Delta v|/\sigma_v)$





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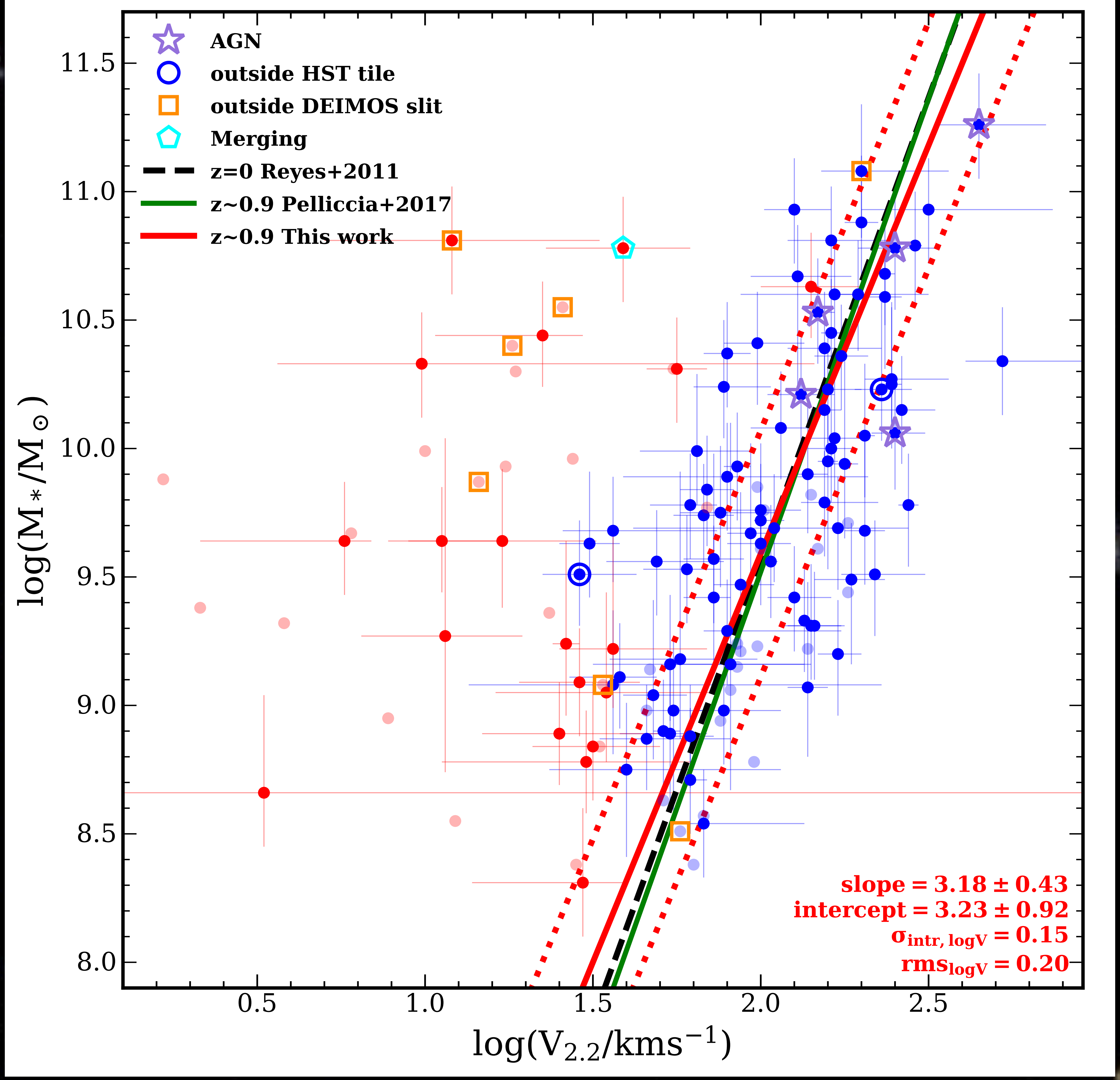
The ORELSE-SC1604 Stellar-Mass Tully-Fisher



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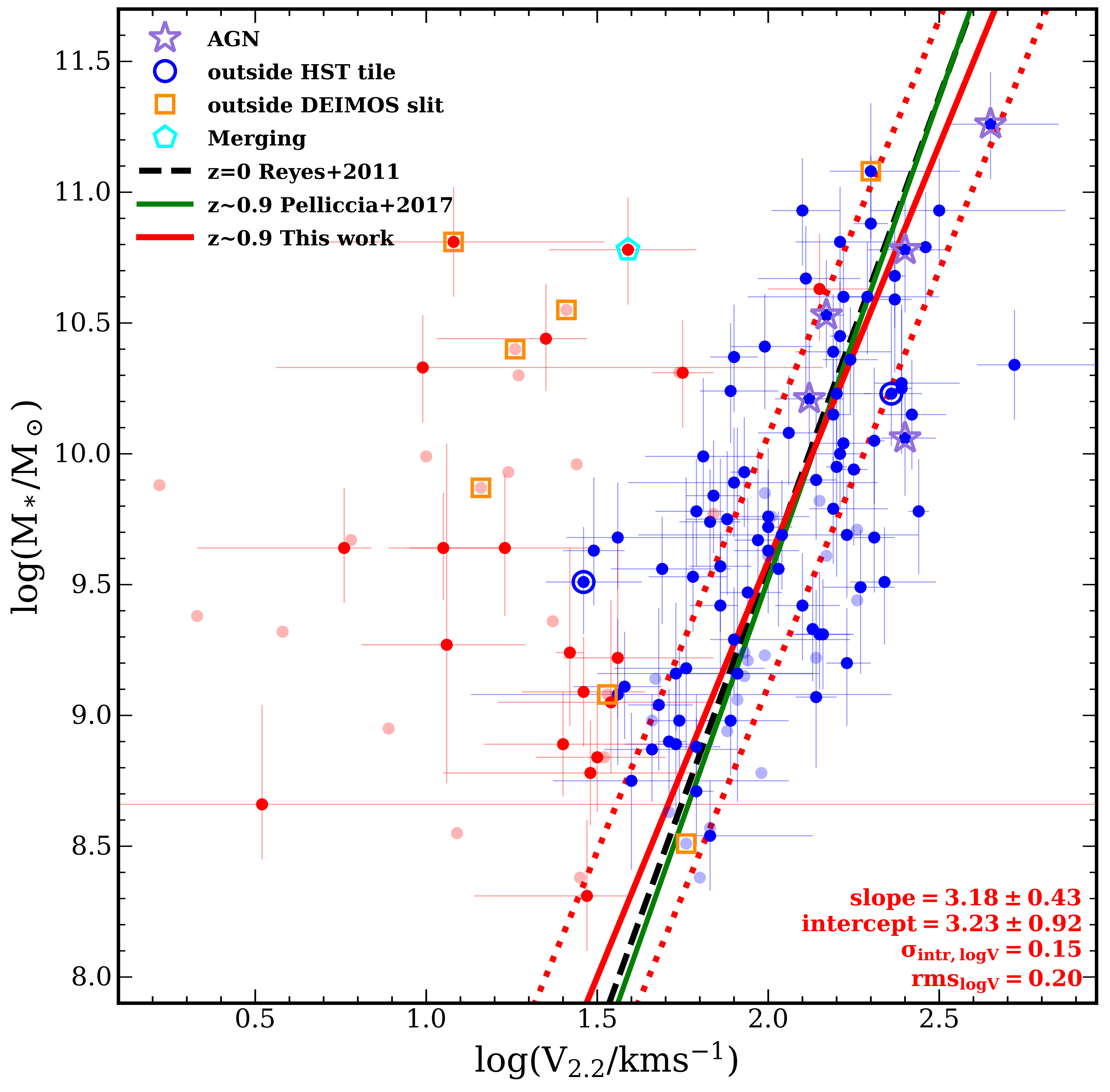

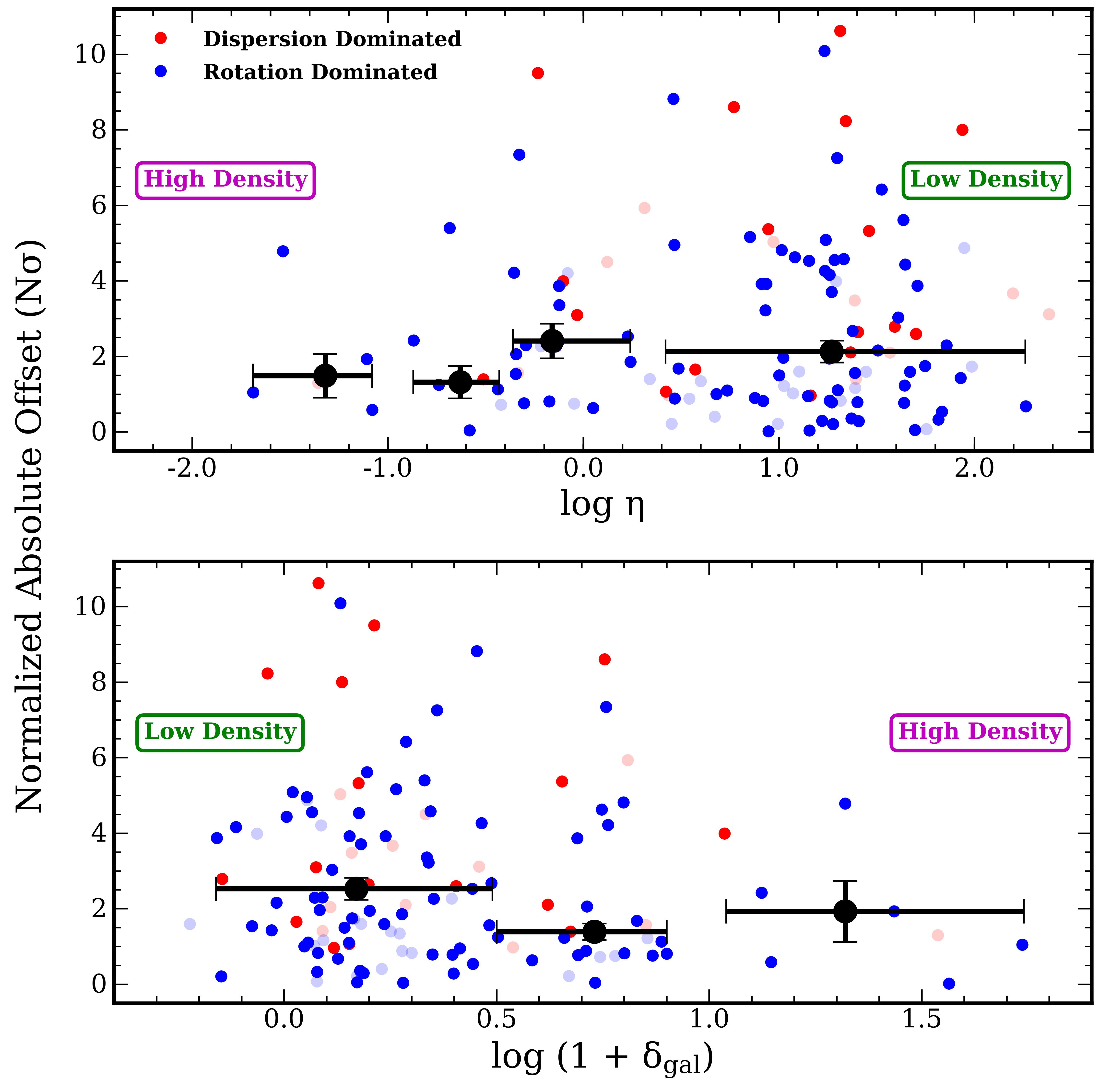

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The ORELSE-SC1604 B-band Tully-Fisher

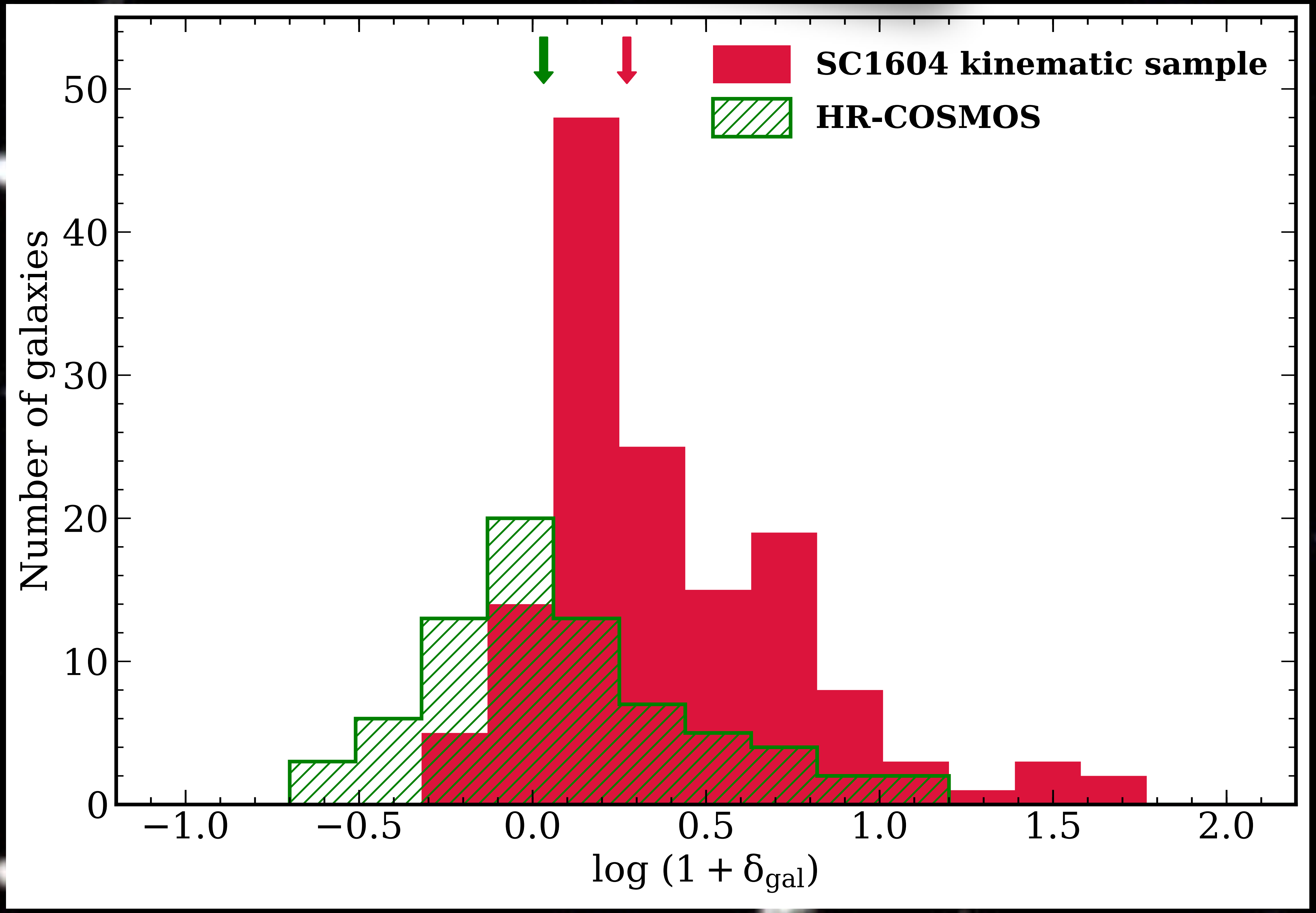
HR-COSMOS (Pelliccia+2017)

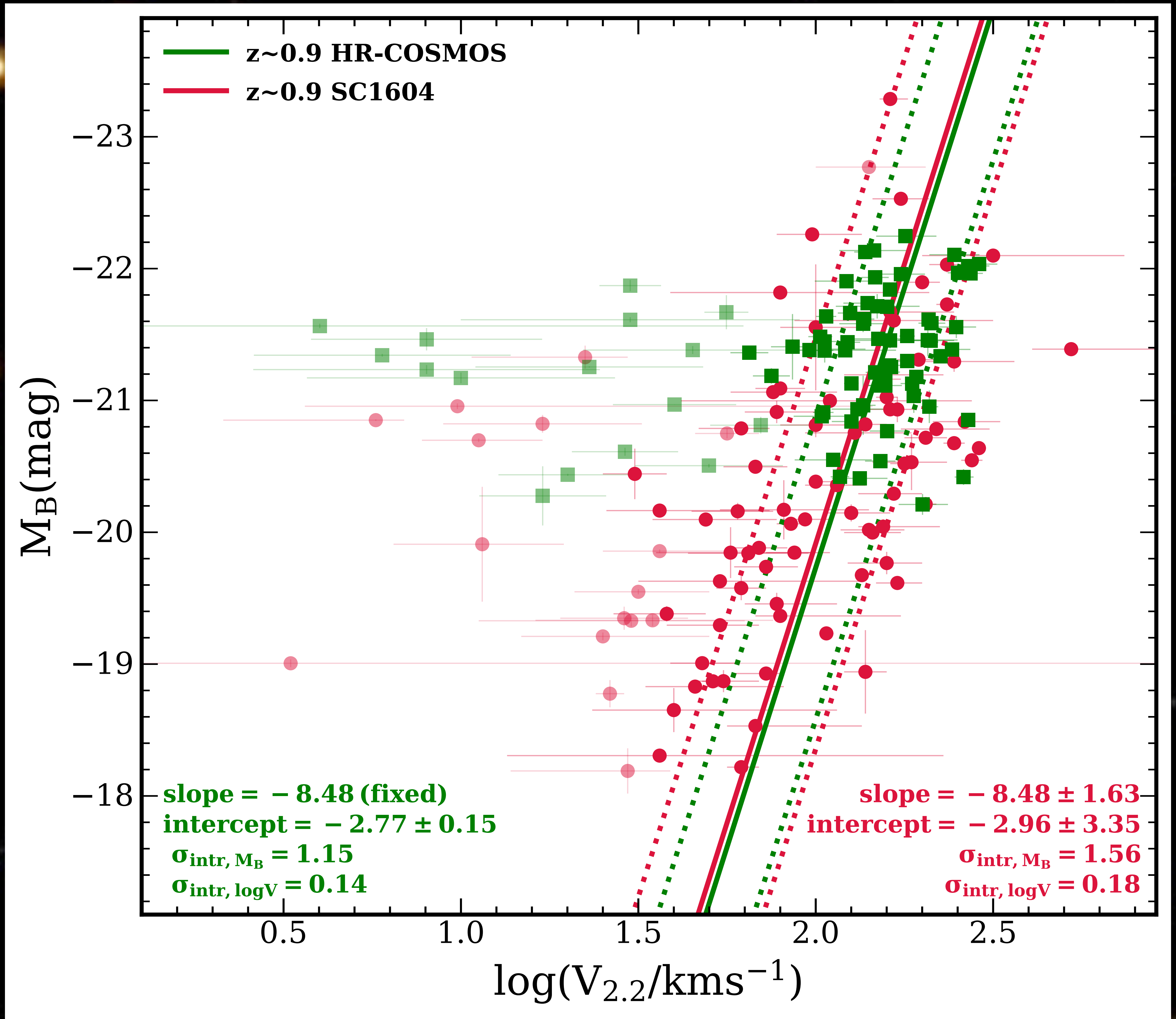
82 star-forming galaxies at z~0.9 in COSMOS

✗ VLT/VIMOS spectra

✗ HST/ACS imaging

✗ Local environment measurements (Scoville+2013)





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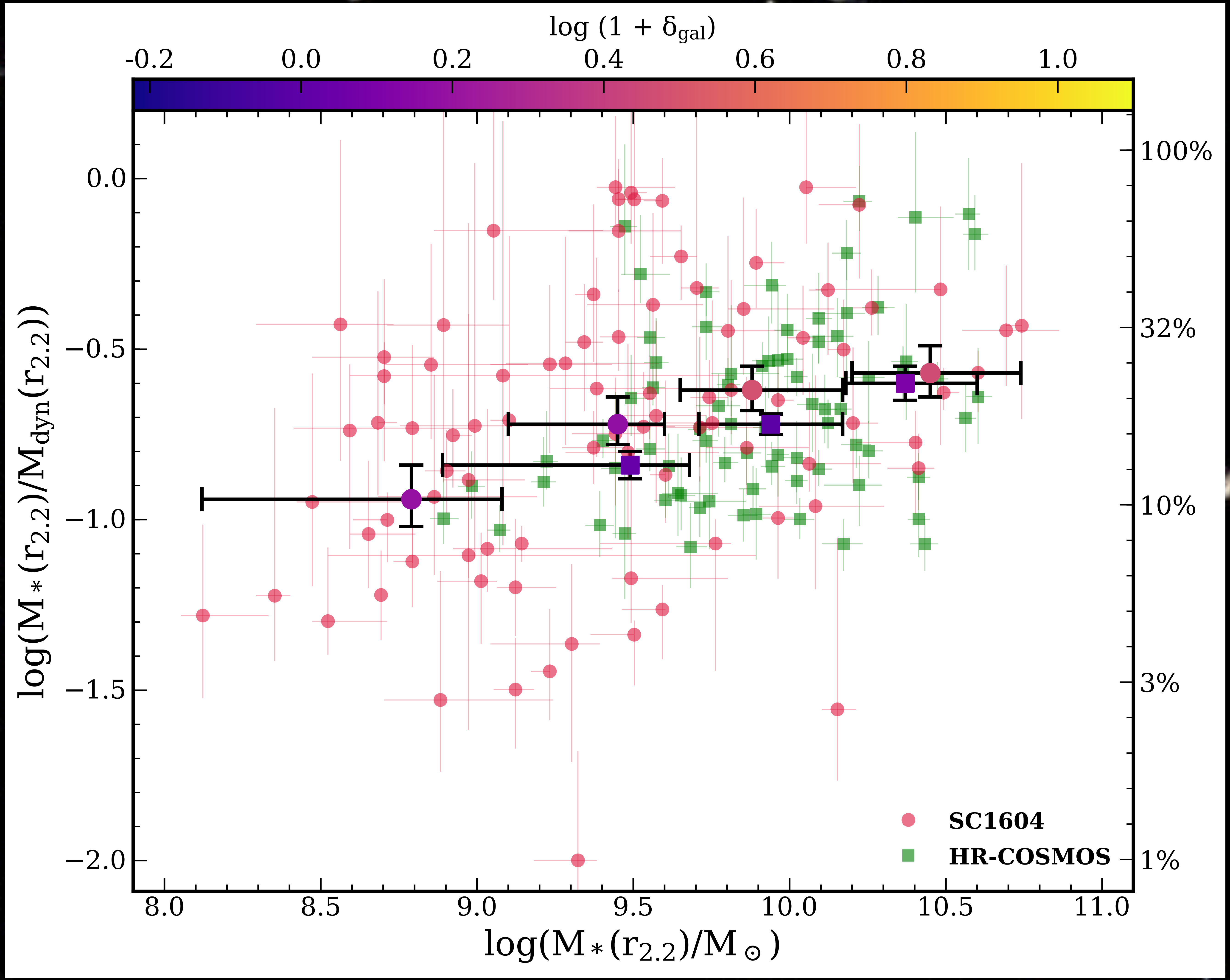
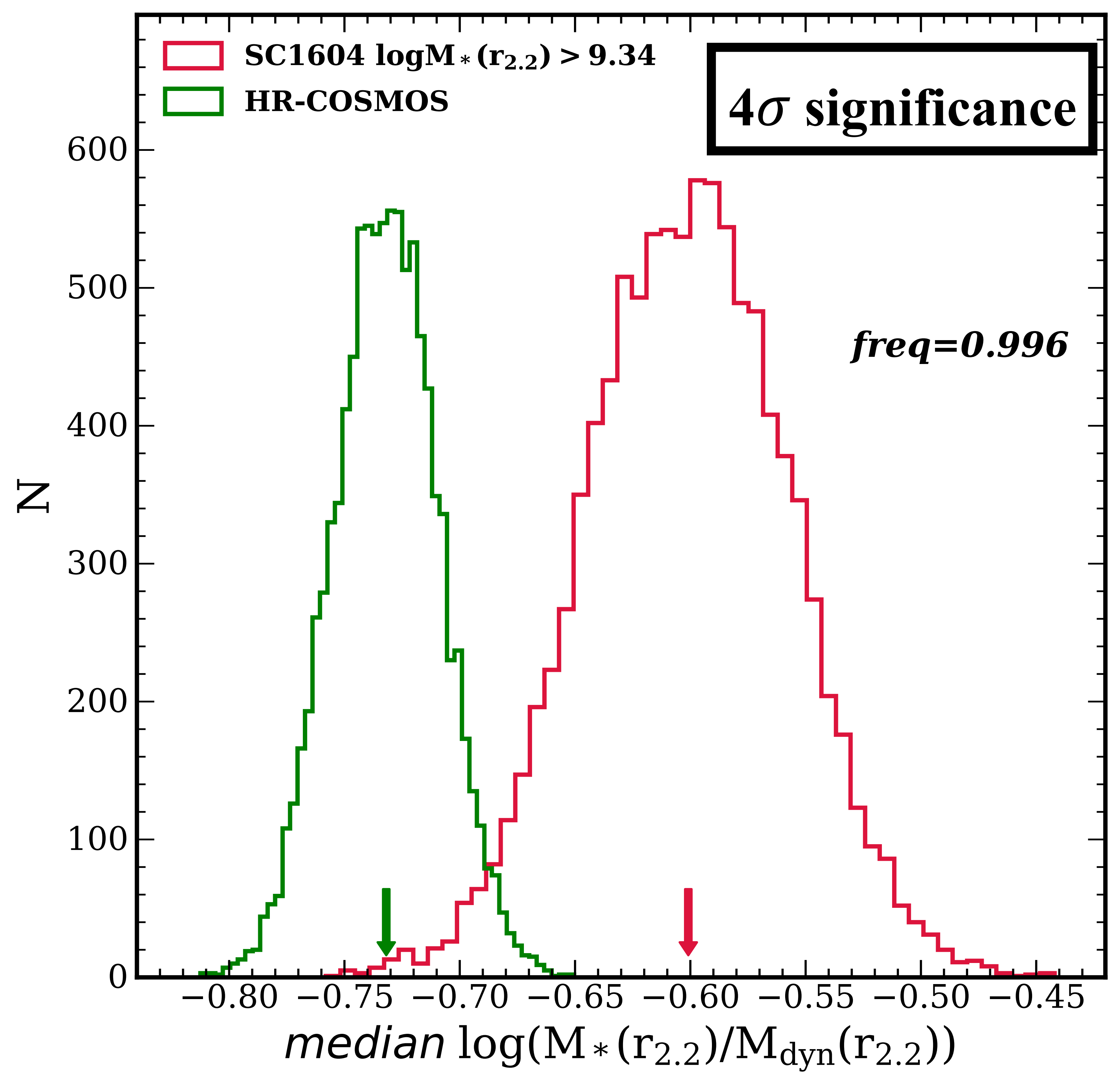
Stellar-to-Dynamical Mass Ratio



$$M_{dyn}(r_{2.2}) = \frac{r_{2.2} \times V_{circ}^2(r_{2.2})}{G}$$

$$V_{circ}(r_{2.2}) = \sqrt{V_{2.2}^2 + 2.2\sigma^2}$$



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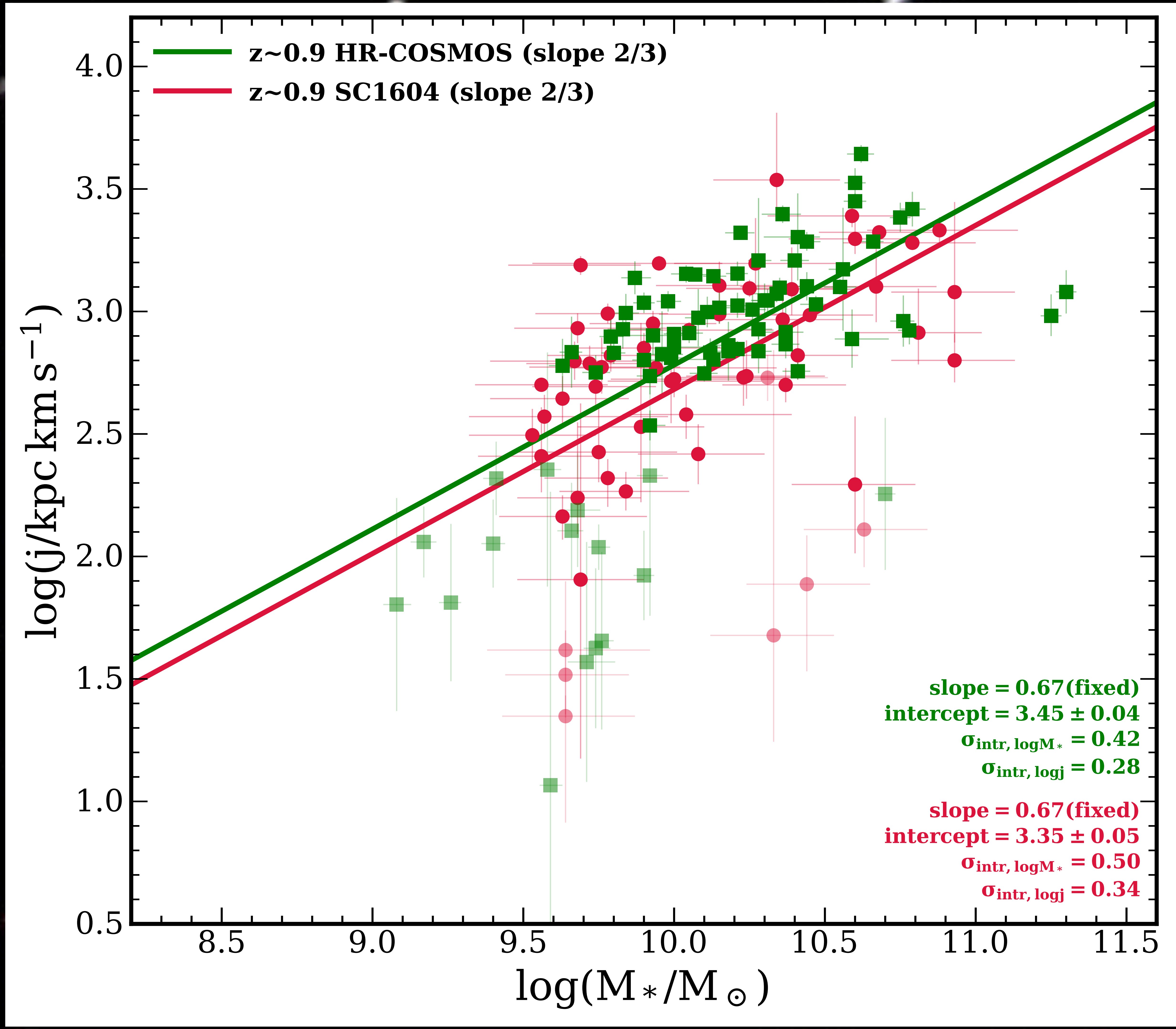
Specific Angular Momentum



Theory

$$\lambda = \frac{J_{DM}\,|E|^{1/2}}{G\,M_{DM}^{5/2}} \qquad \langle\lambda\rangle = 0.035 \quad \text{(Maccio+2008)}$$

$$j_{DM} \propto \lambda\, M_{DM}^{2/3} \qquad (j_{DM} = J_{DM}/M_{DM})$$

$$\frac{j_*}{km\,s^{-1}kpc} \propto \lambda\, f_j\,(f_b f_*)^{-2/3} \left(\frac{H(z)}{H_0}\right)^{-1/3} \left(\frac{M_*}{10^{11}M_\odot}\right)^{2/3}$$

$$j_* = 2 \times r_s \times V_{2.2}$$

Pelliccia et al. 2019

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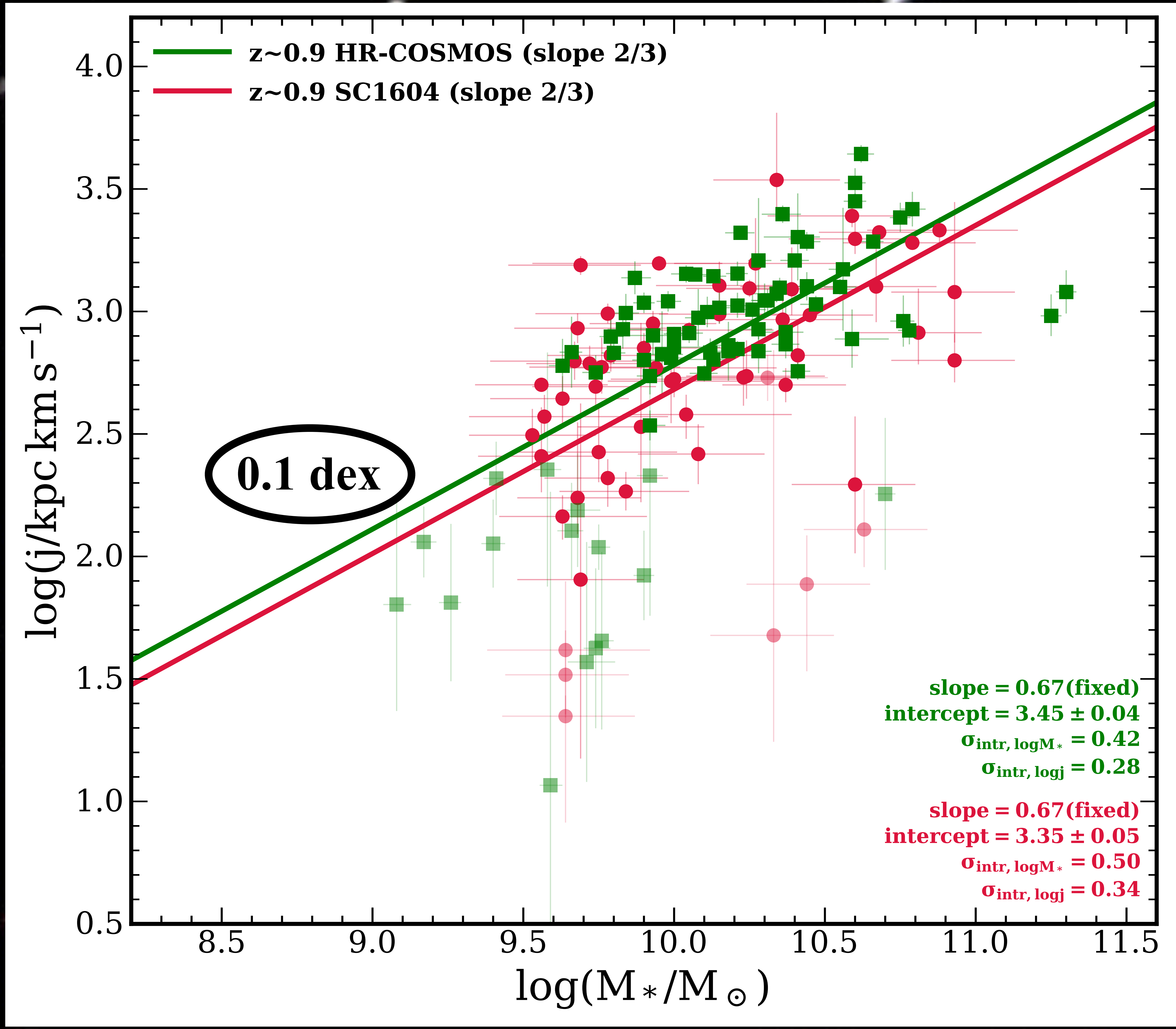

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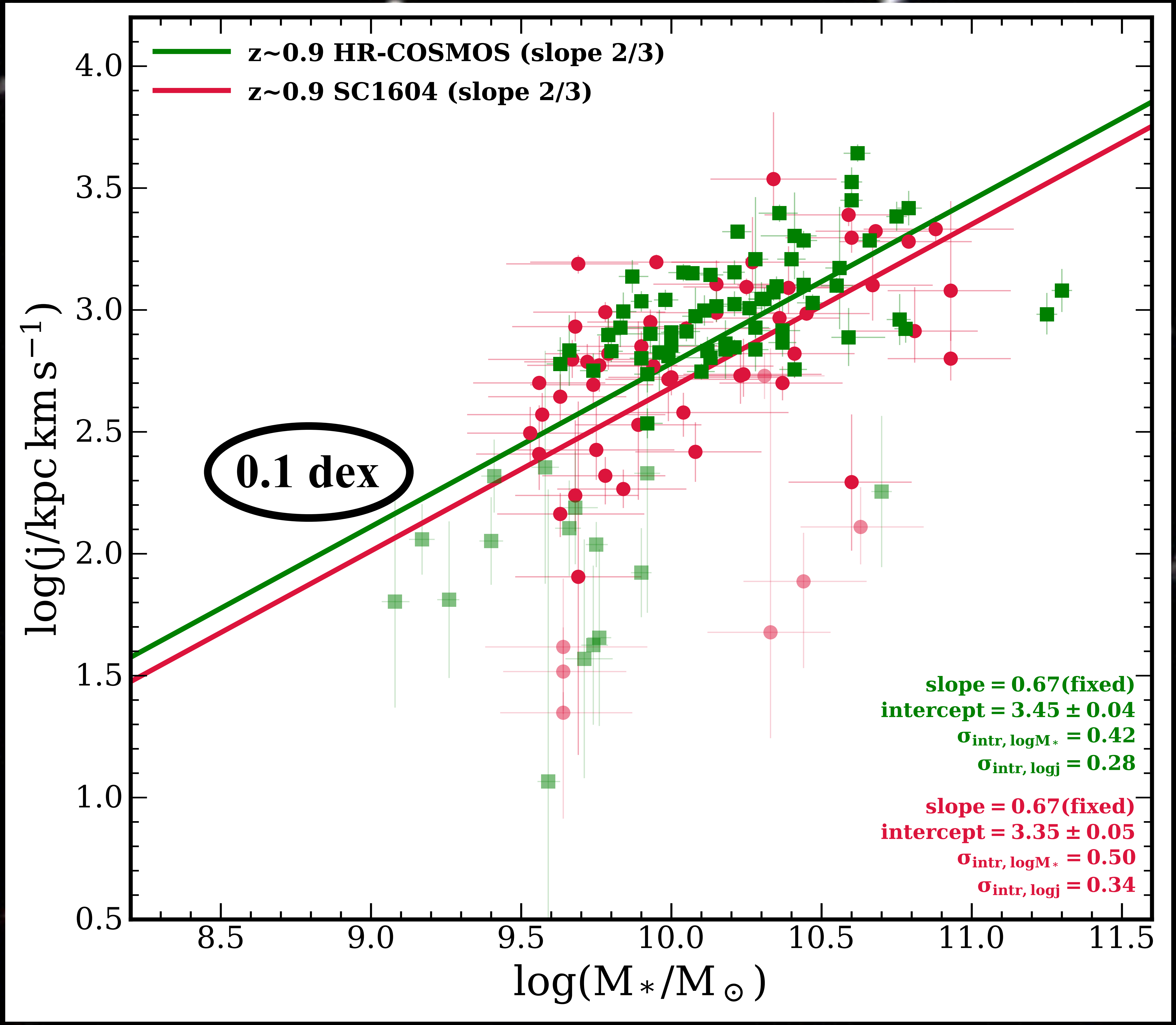

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Pelliccia et al. 2019

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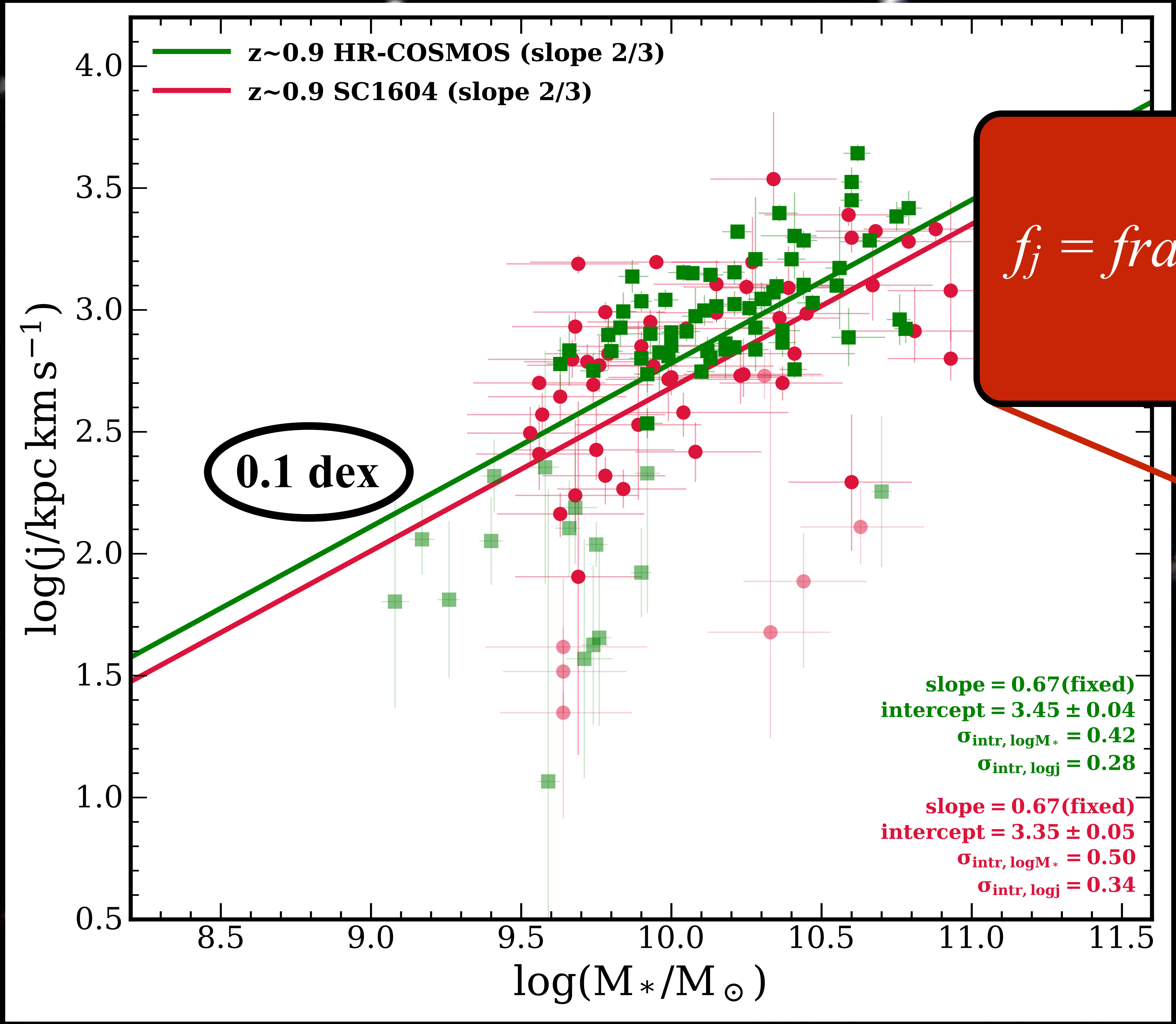

f_j = *fraction of retained* j_*

Theory

$\langle\lambda\rangle = 0.035$ (Maccio+2008)

$$j_{DM} \propto \lambda M_{DM}^{2/3} \quad (j_{DM} = J_{DM}/M_{DM})$$

$$\frac{j_*}{km\,s^{-1}kpc} \propto \lambda f_j (f_b f_*)^{-2/3} \left(\frac{H(z)}{H_0}\right)^{-1/3} \left(\frac{M_*}{10^{11}M_\odot}\right)^{2/3}$$

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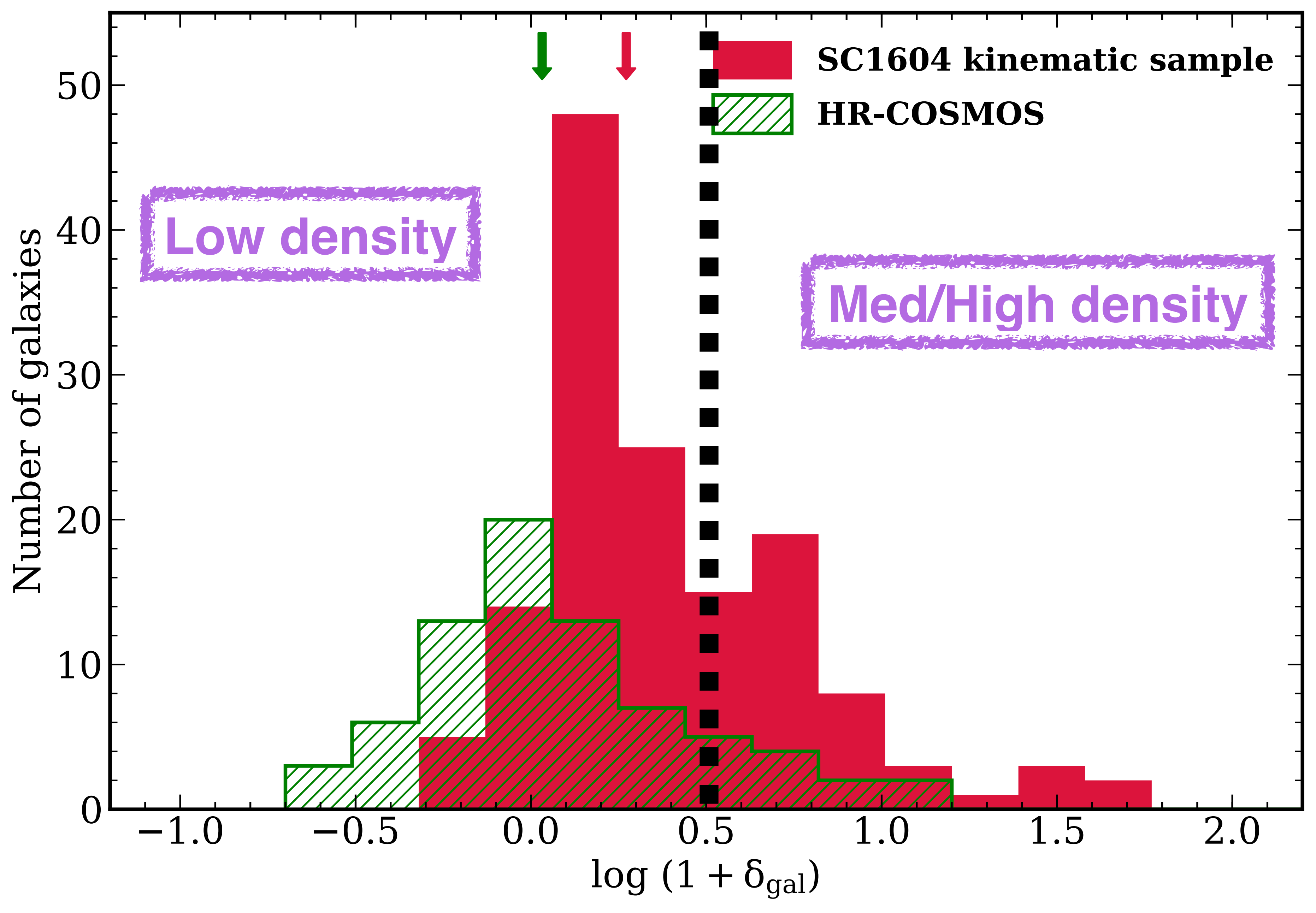

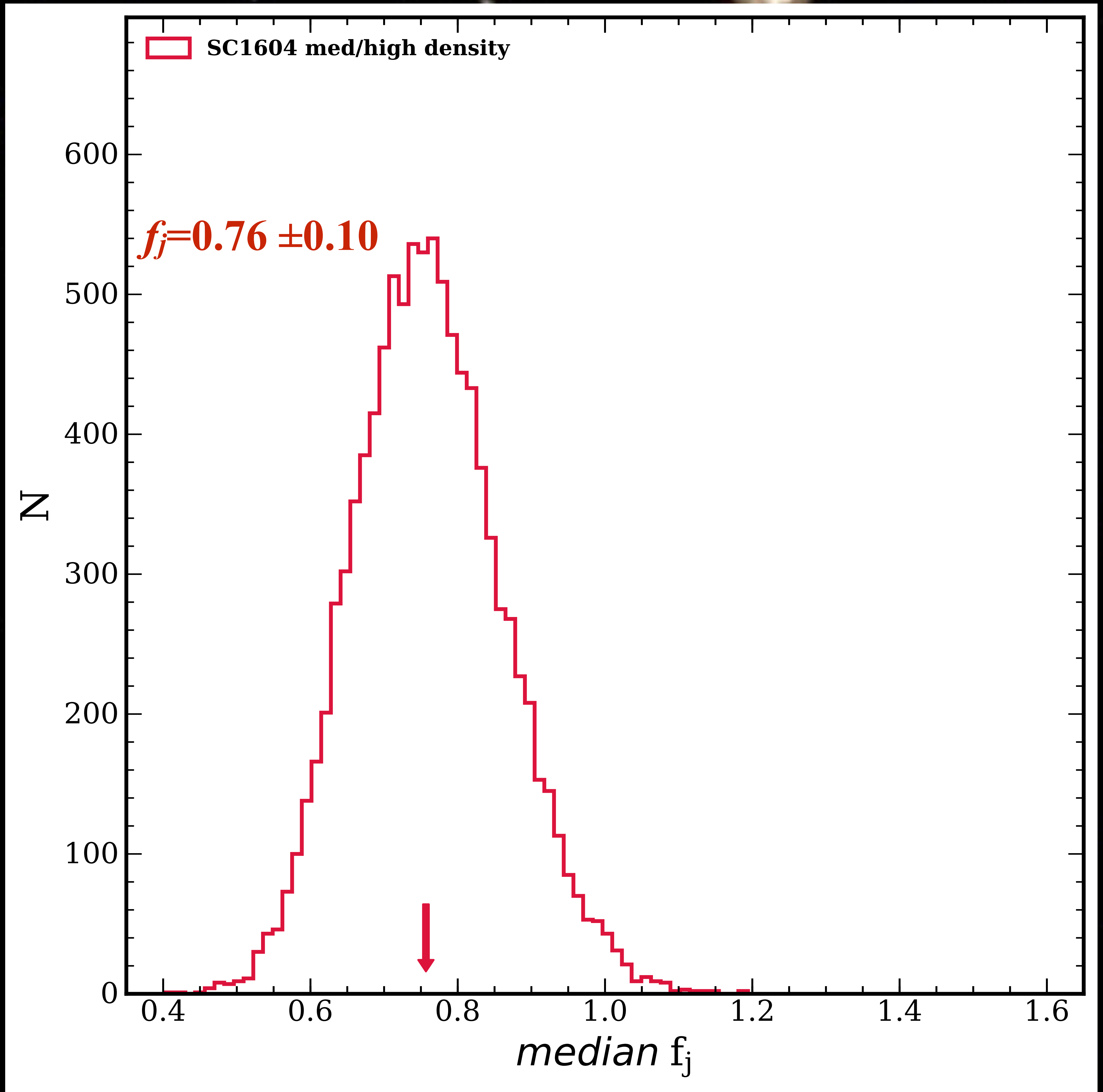

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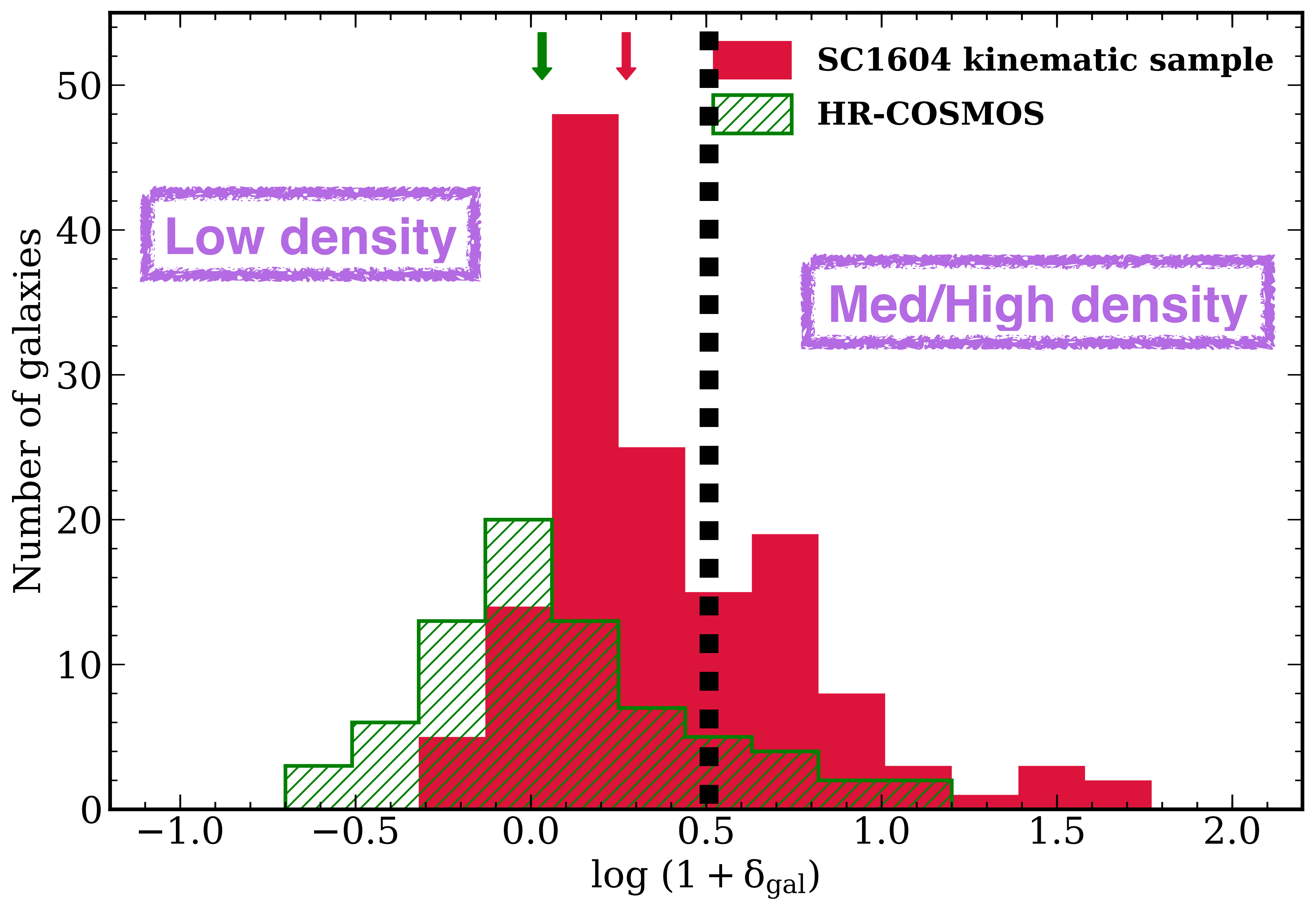

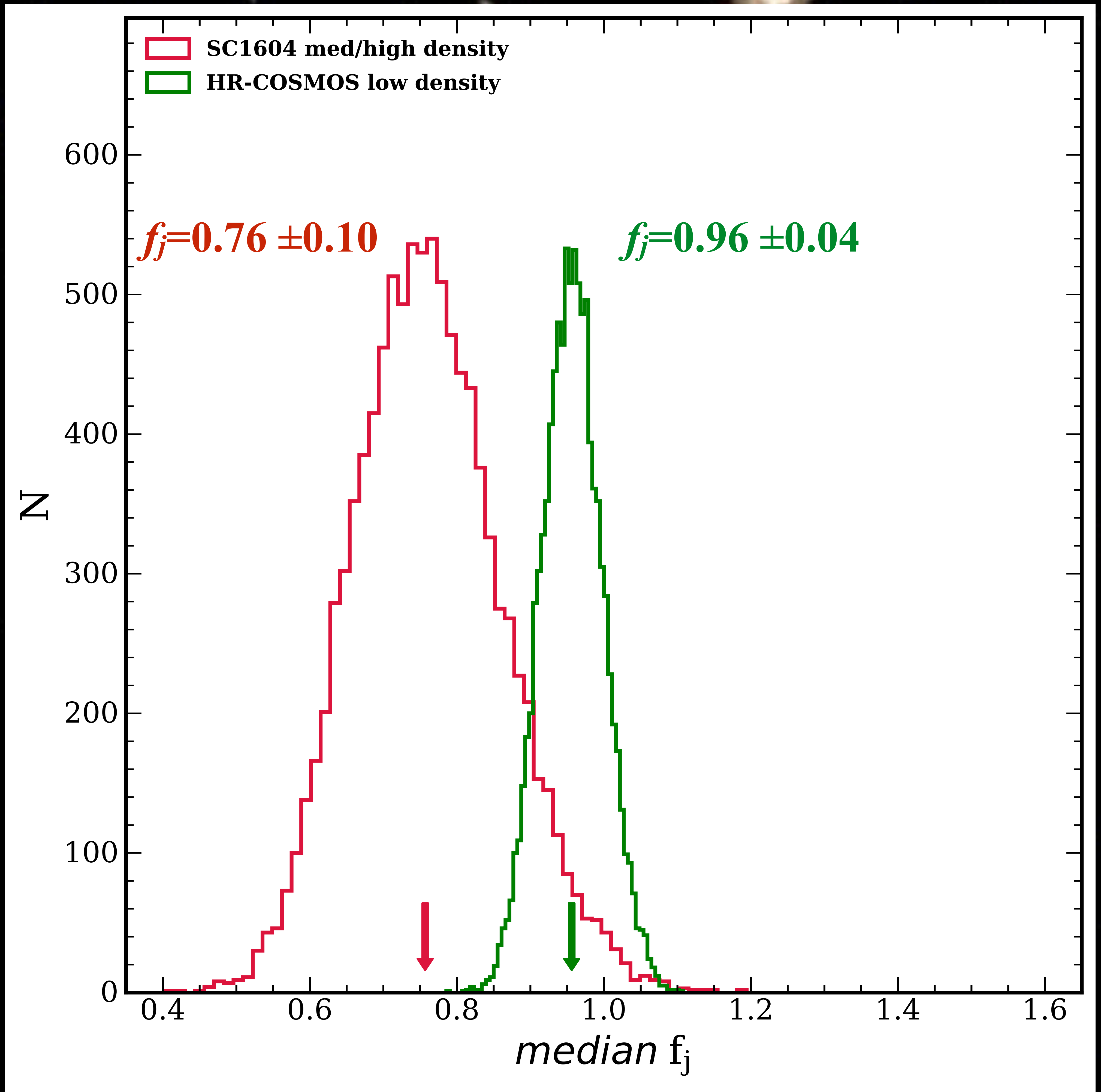

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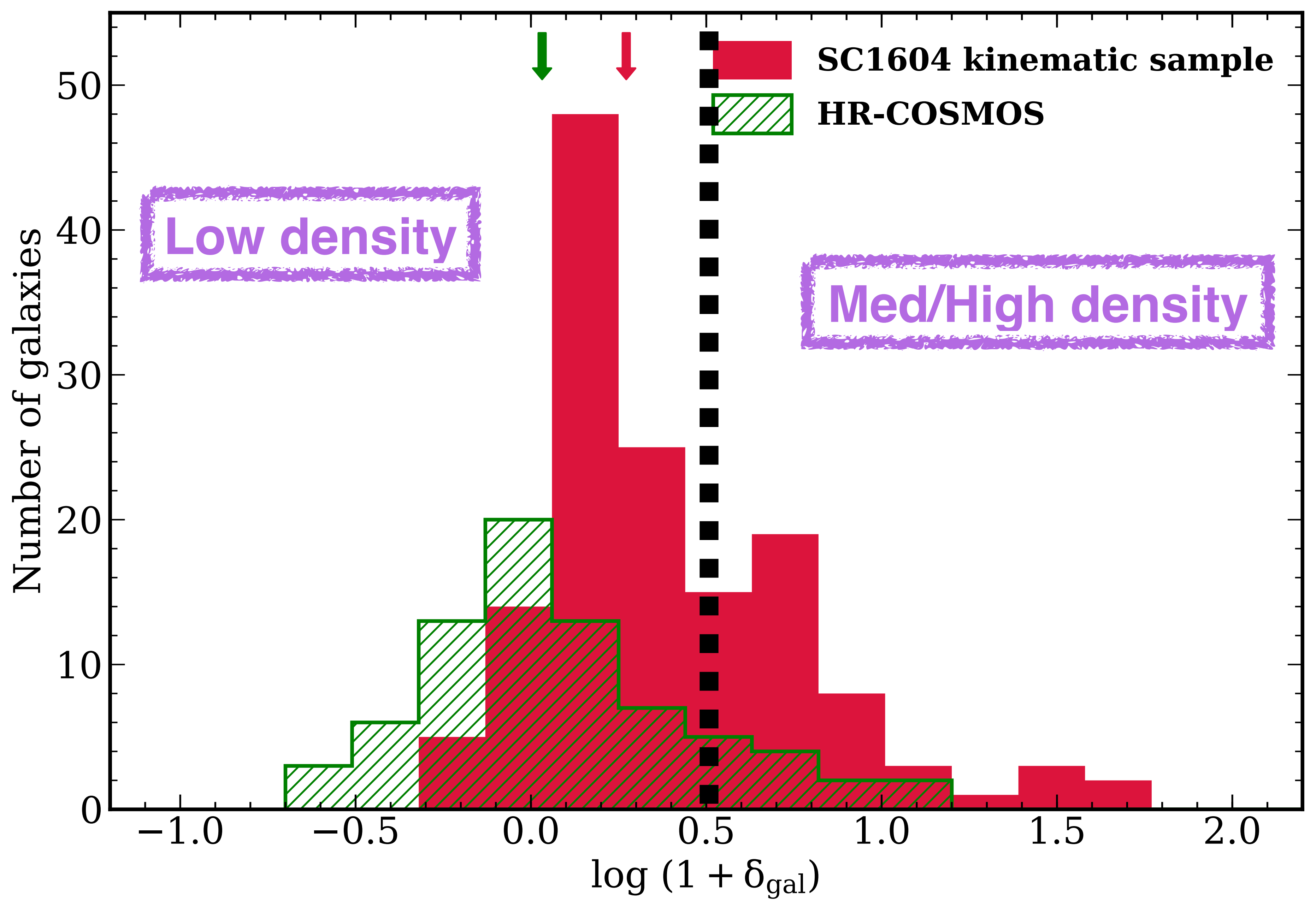
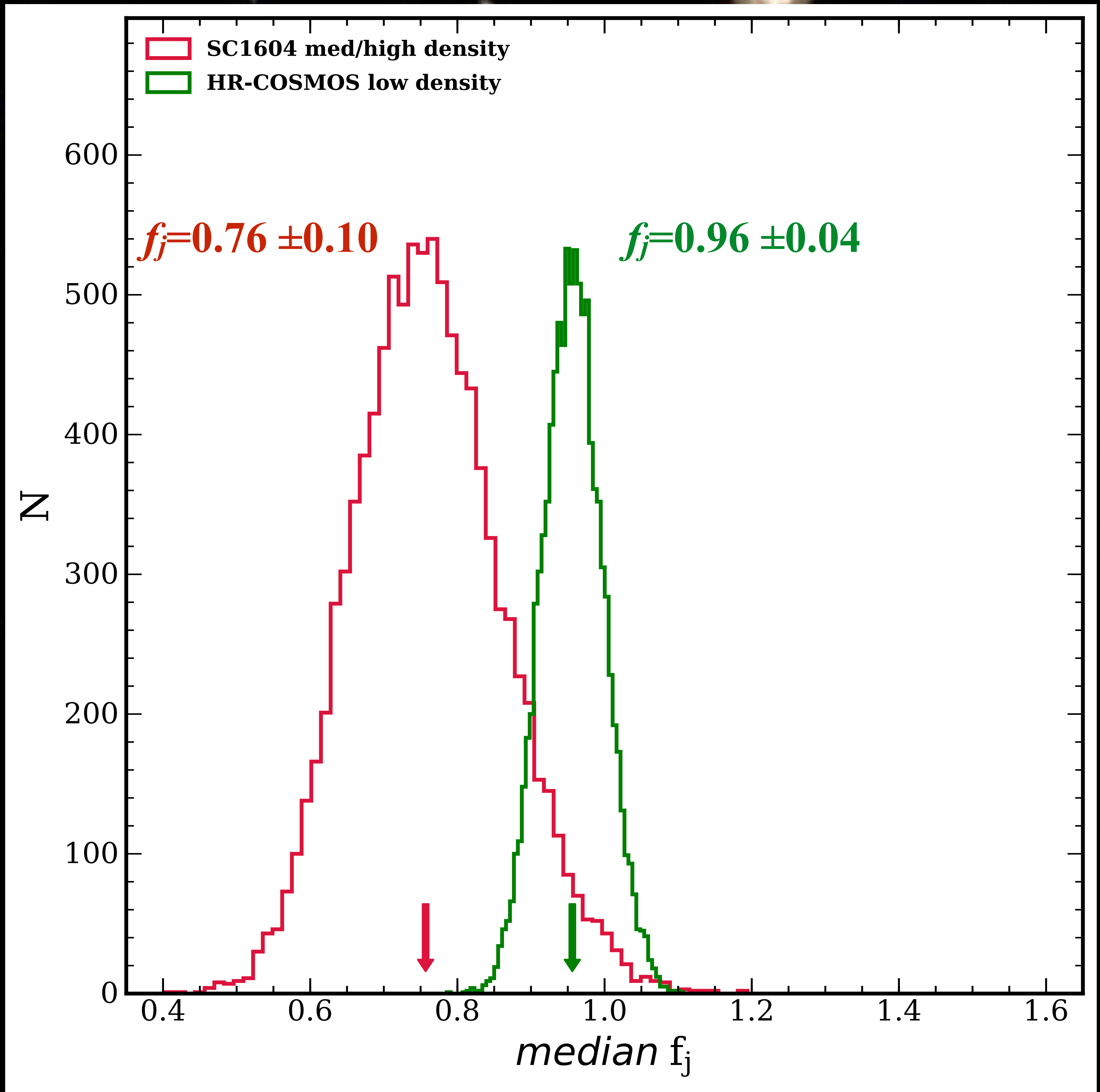


MERGERS?



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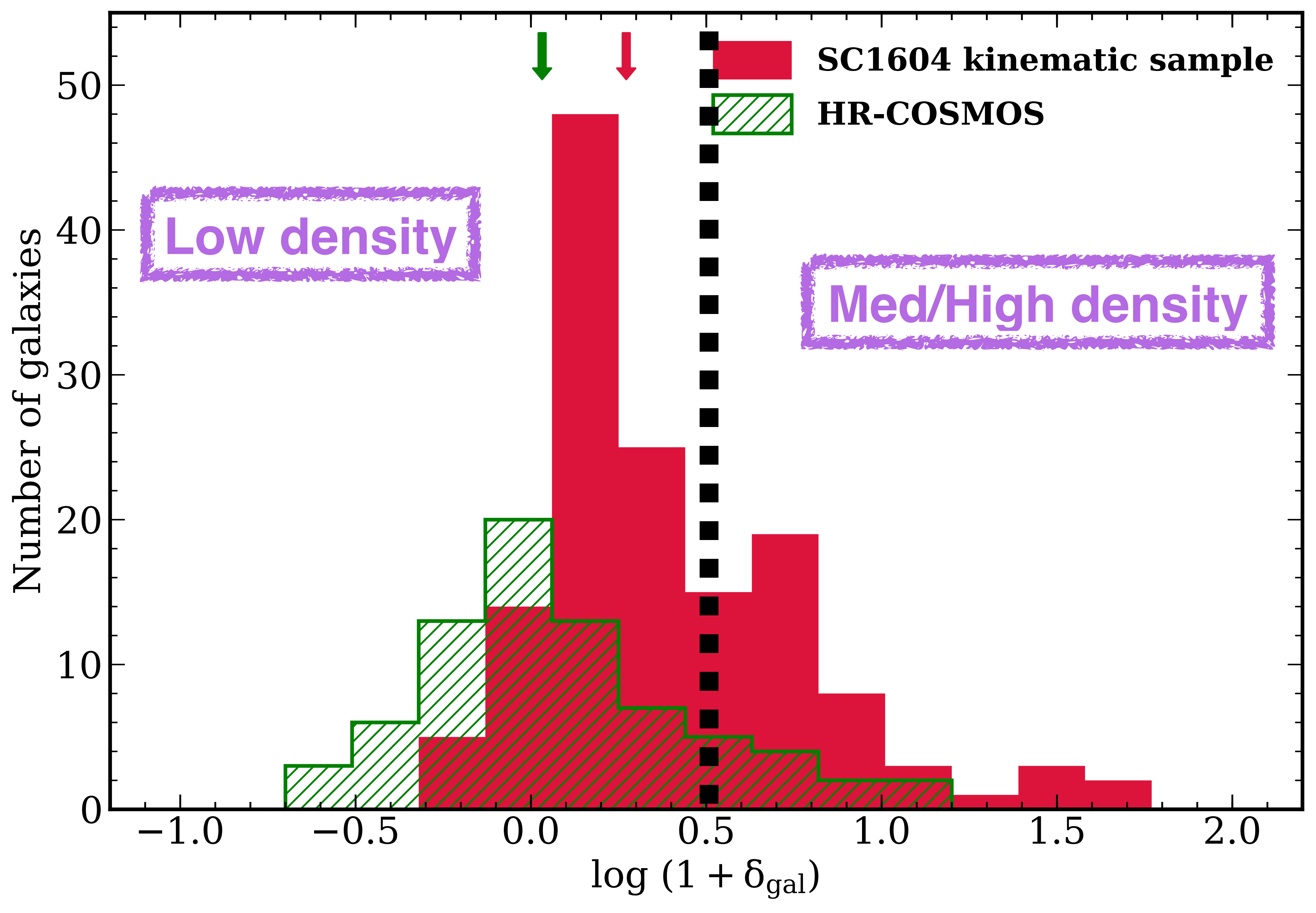

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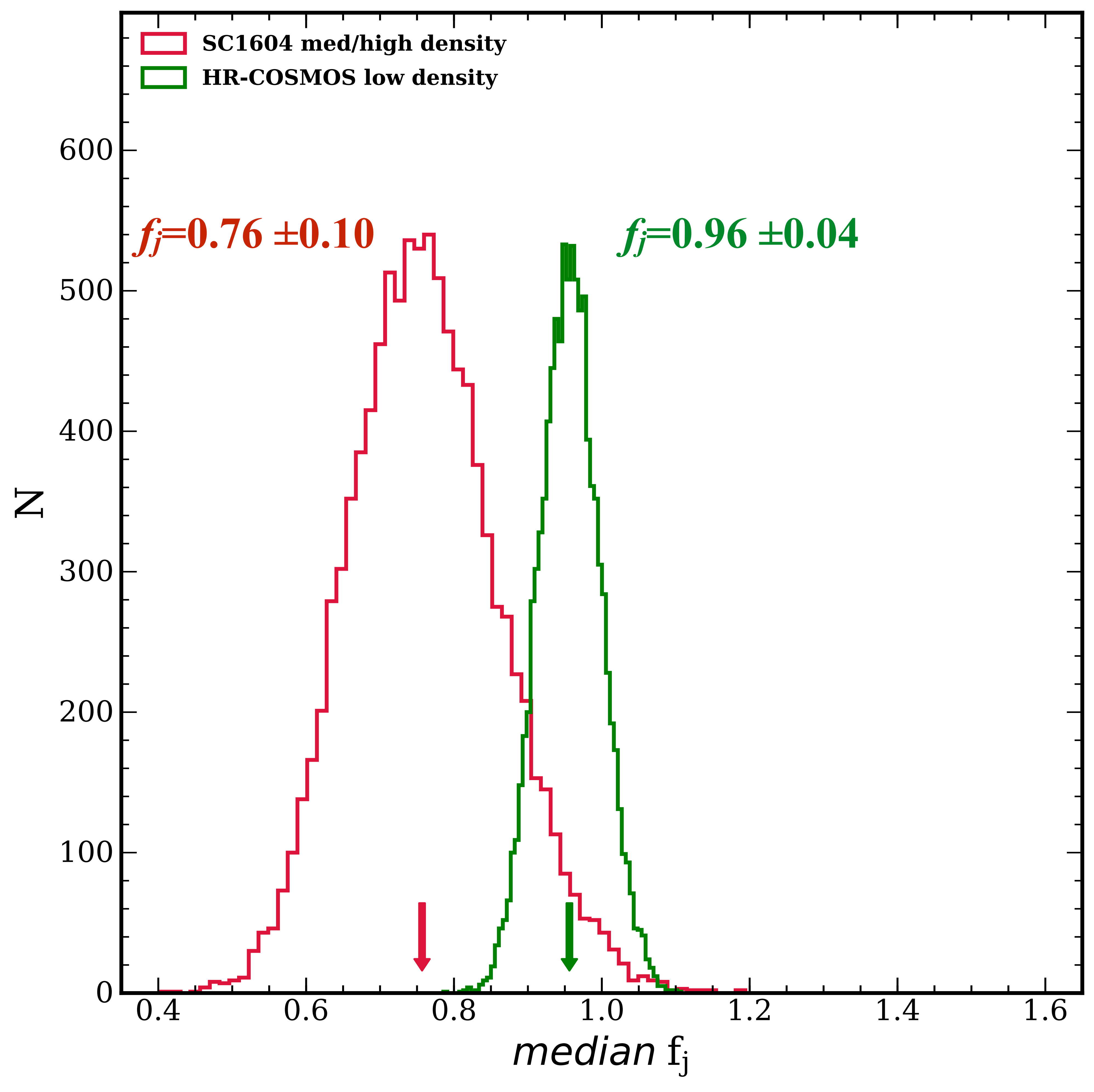

j_* loss per merger of any kind: ~20% (major), ~2% (minor)
j_* loss per GAS-POOR merger: ~40% (major), ~20% (minor)
} EAGLE simulations Lagos+218

~ 4x more major mergers in Med/High density vs low density
~ 3x more minor mergers in Med/High density vs low density
} Semi-empirical model Tomczak+2017

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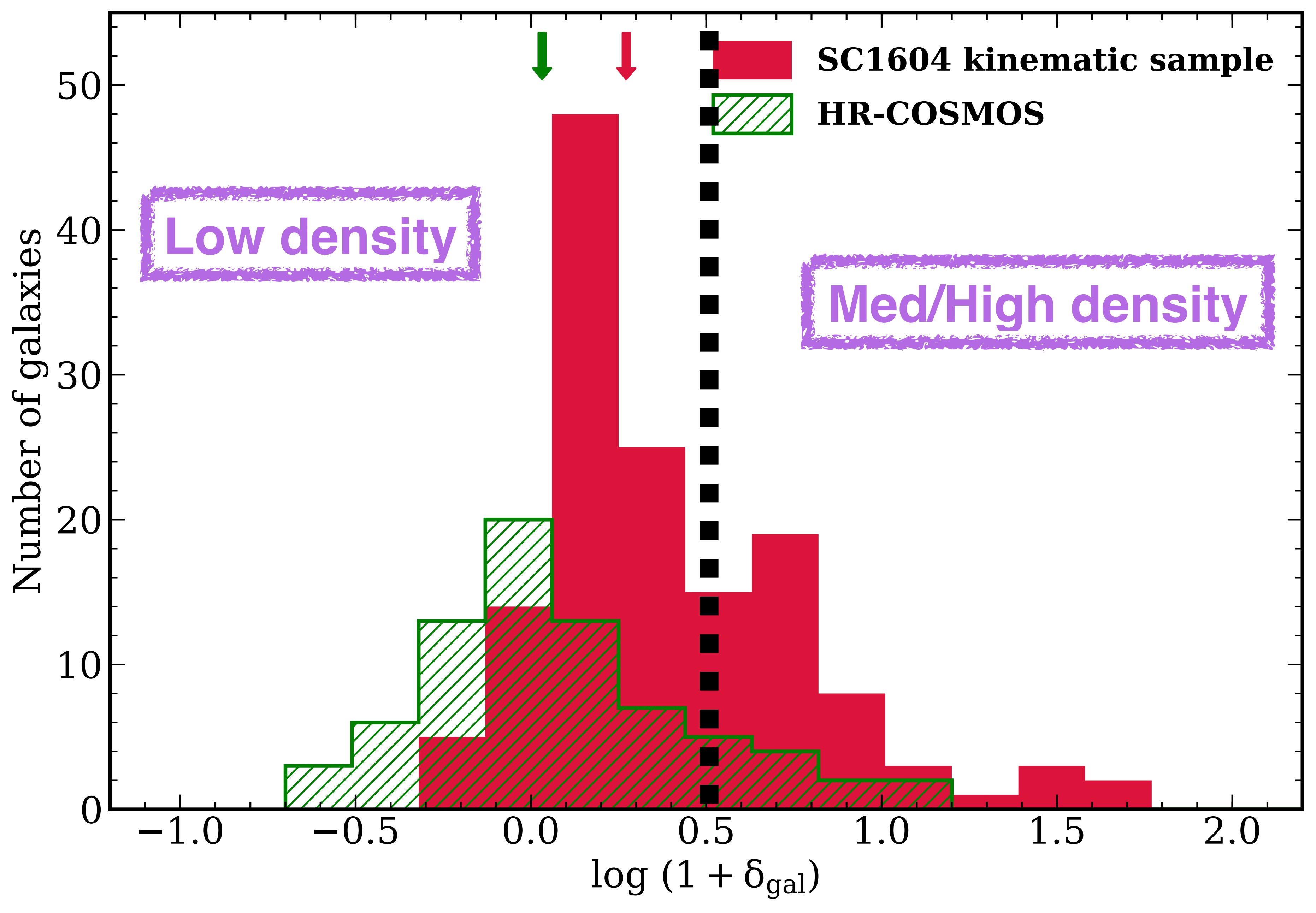

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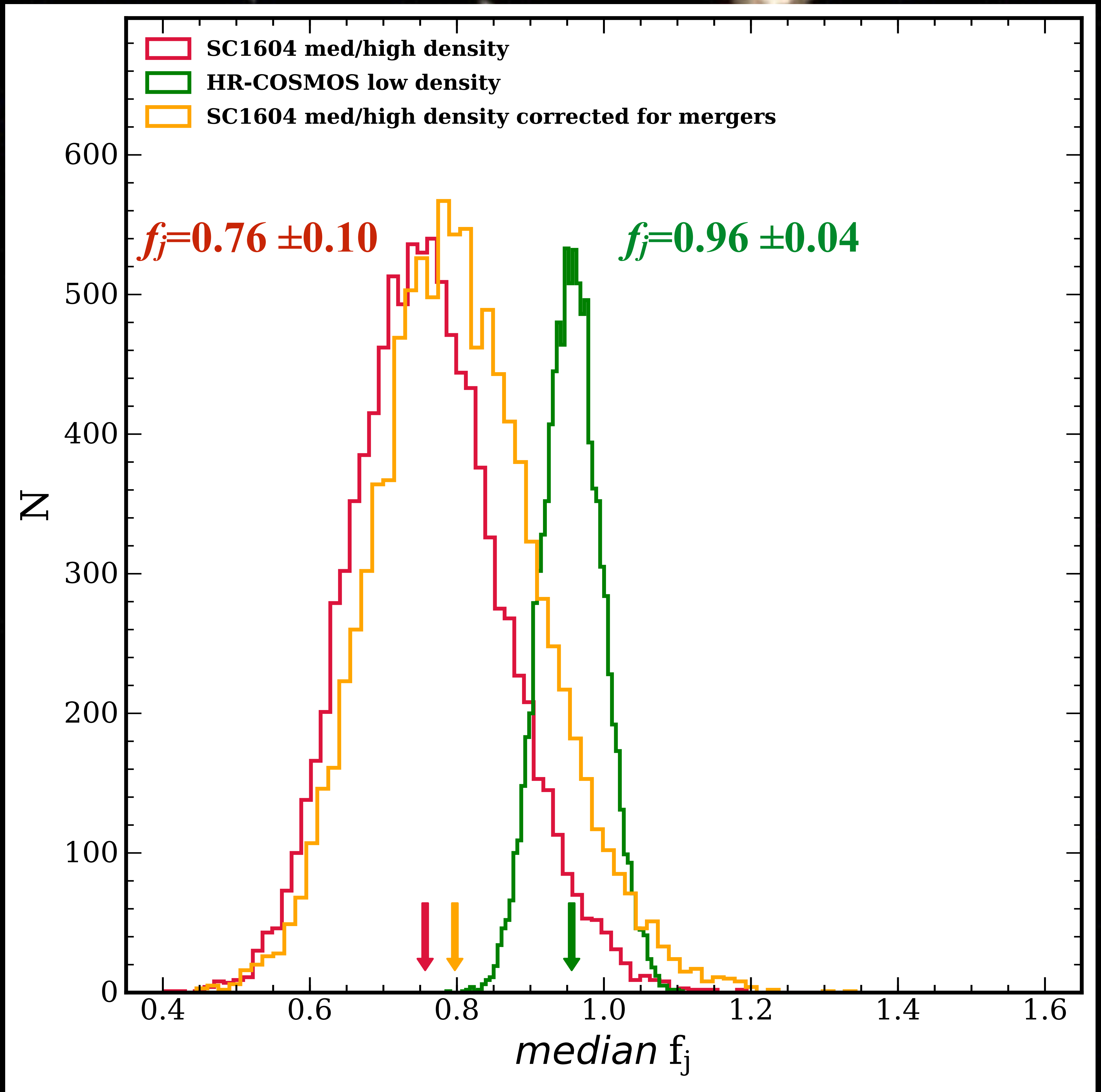

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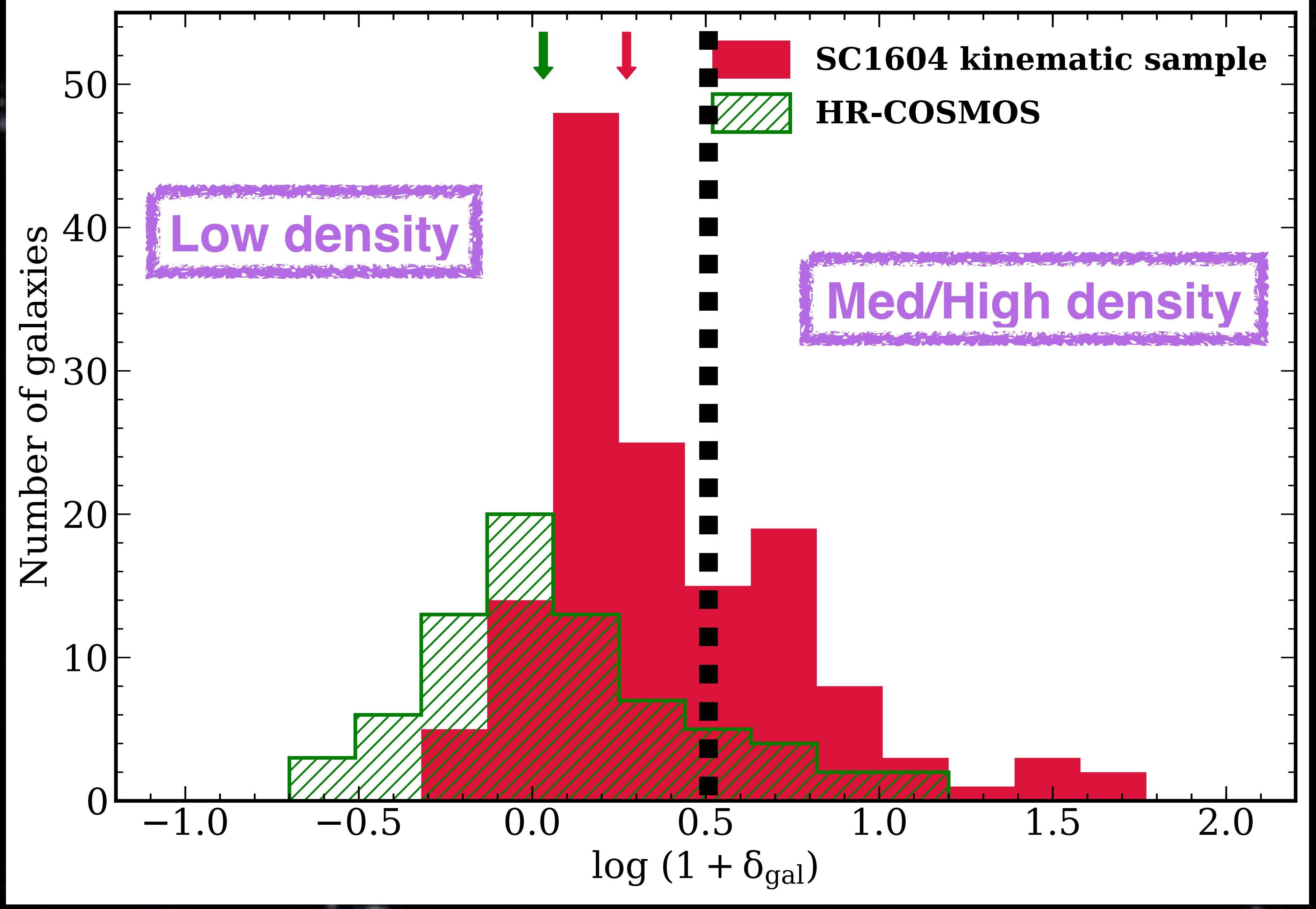

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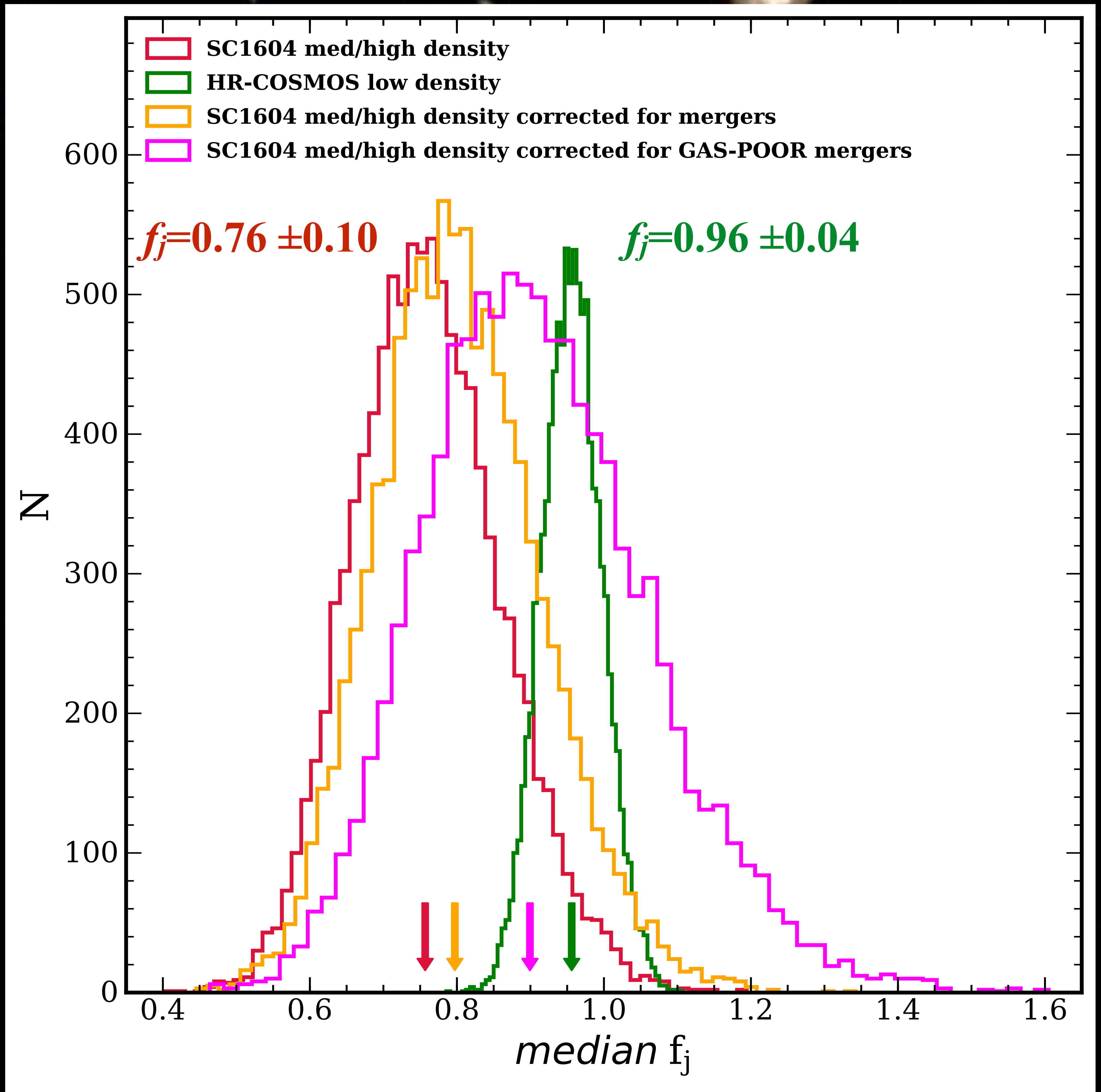

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SUMMARY

✓ No clear sign of environmental effect on the Stellar-Mass/B-Band Tully-Fisher relation.

✓ Galaxies in higher density local environments have larger stellar-to-dynamical mass ratio.

✓ Galaxies in higher density local environments have lost ~20% of their original specific angular momentum. Mergers may explain this loss, but more data are needed to better investigate it.


THANKS!