The Hot Circumgalactic Medium in the eROSITA All-Sky Survey

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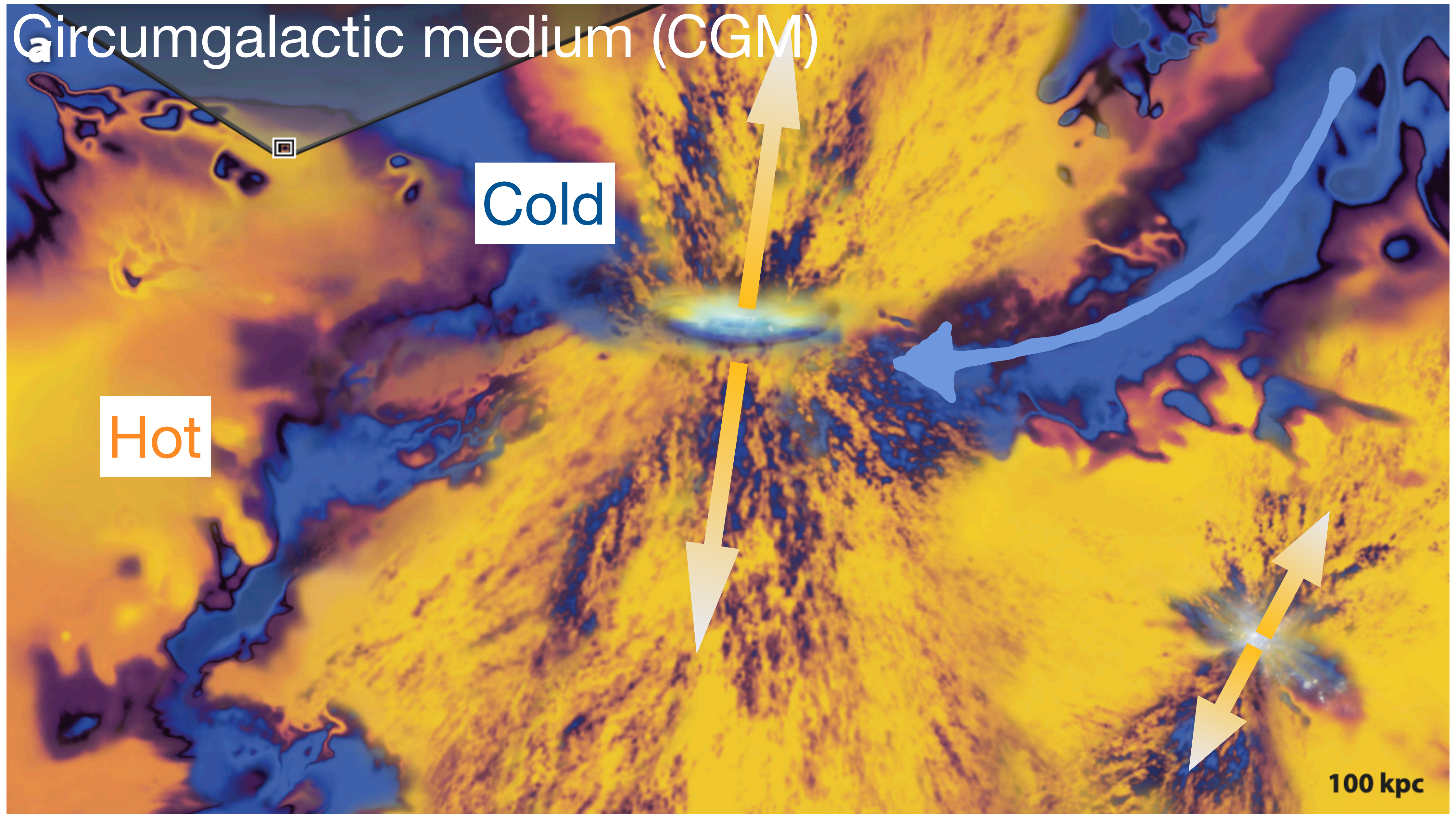
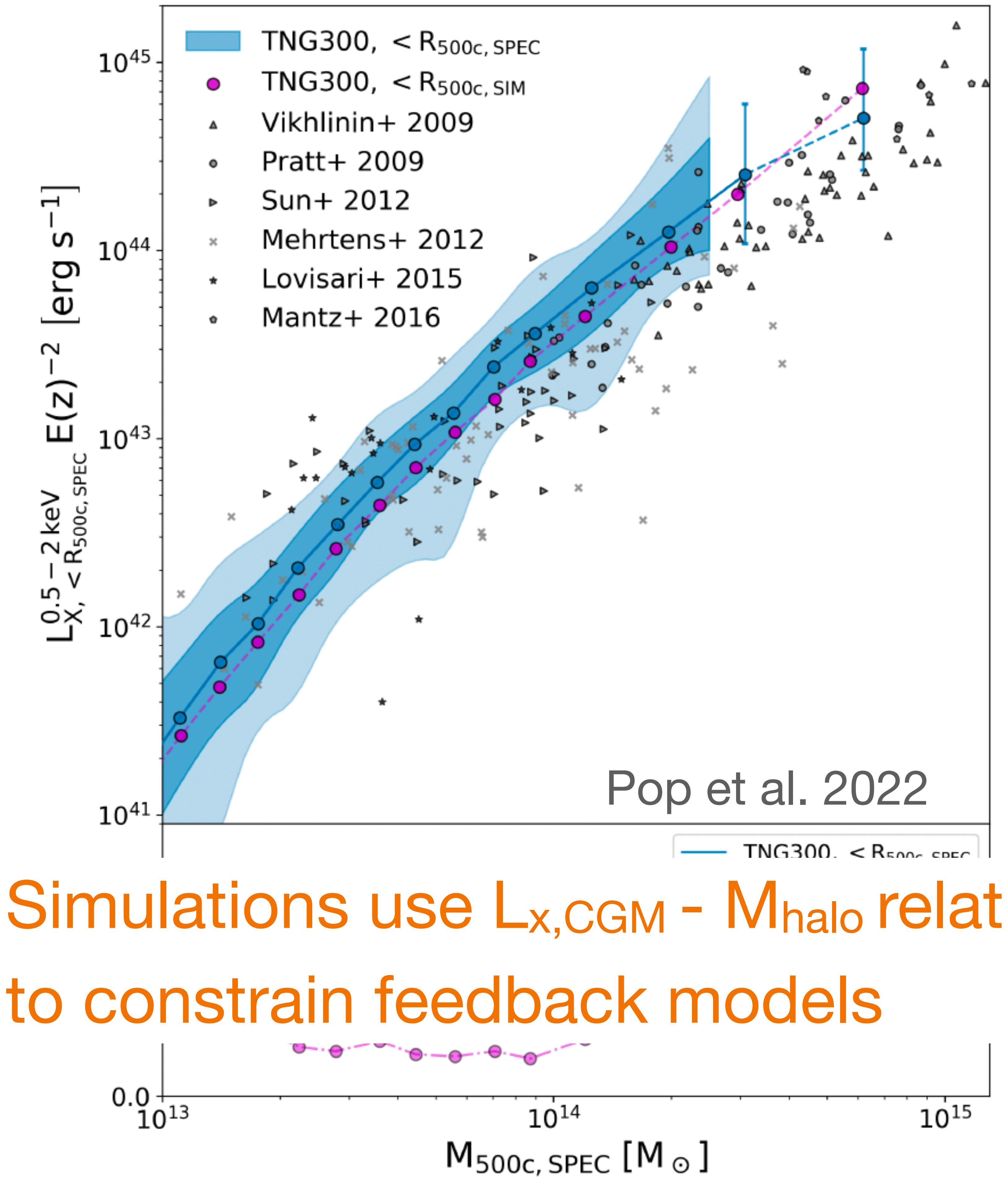
Based on arXiv:2401.17308, arXiv:2401.17309, and work soon submitted

Hot CGM and galaxy evolution

- Hot circumgalactic medium (CGM)
  - **Gravitational heat of accreted gas (~M_{halo})**
  - **AGN or stellar feedbacks (~SFR, M_{*})**



Faucher-Giguere & Oh. 2023



Simulations use $L_{x,CGM}$ - M_{halo} relation to constrain feedback models

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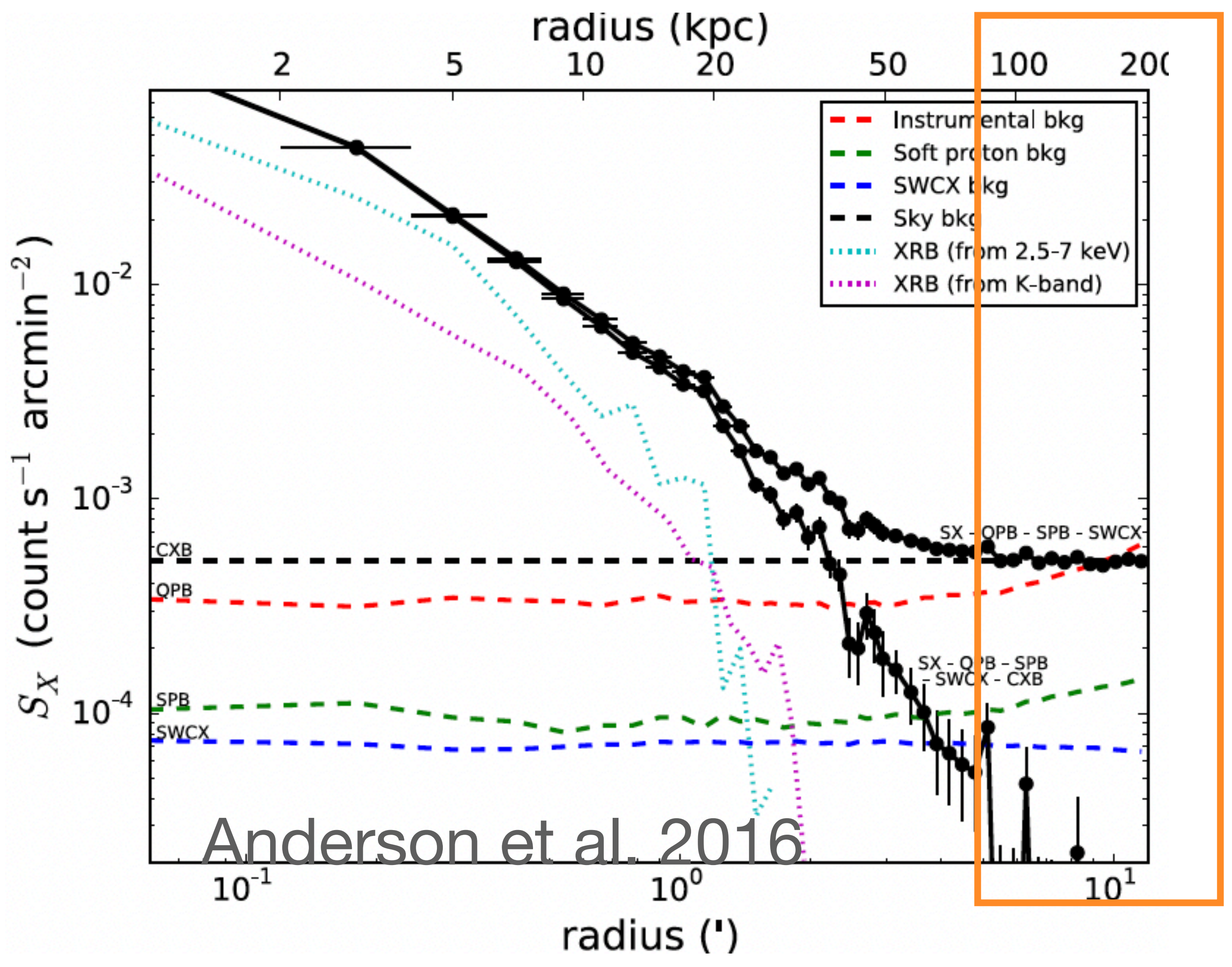
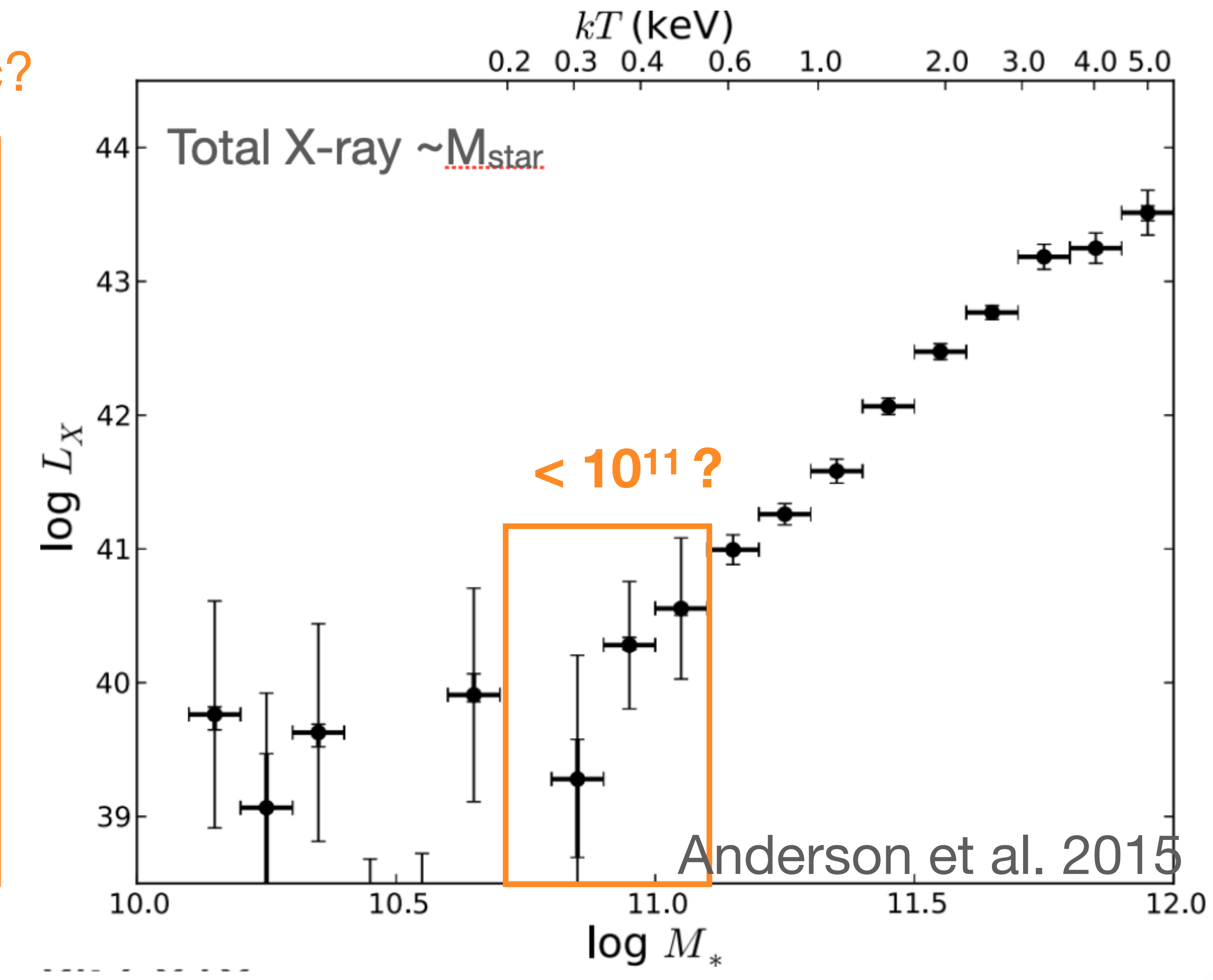
Detect hot CGM

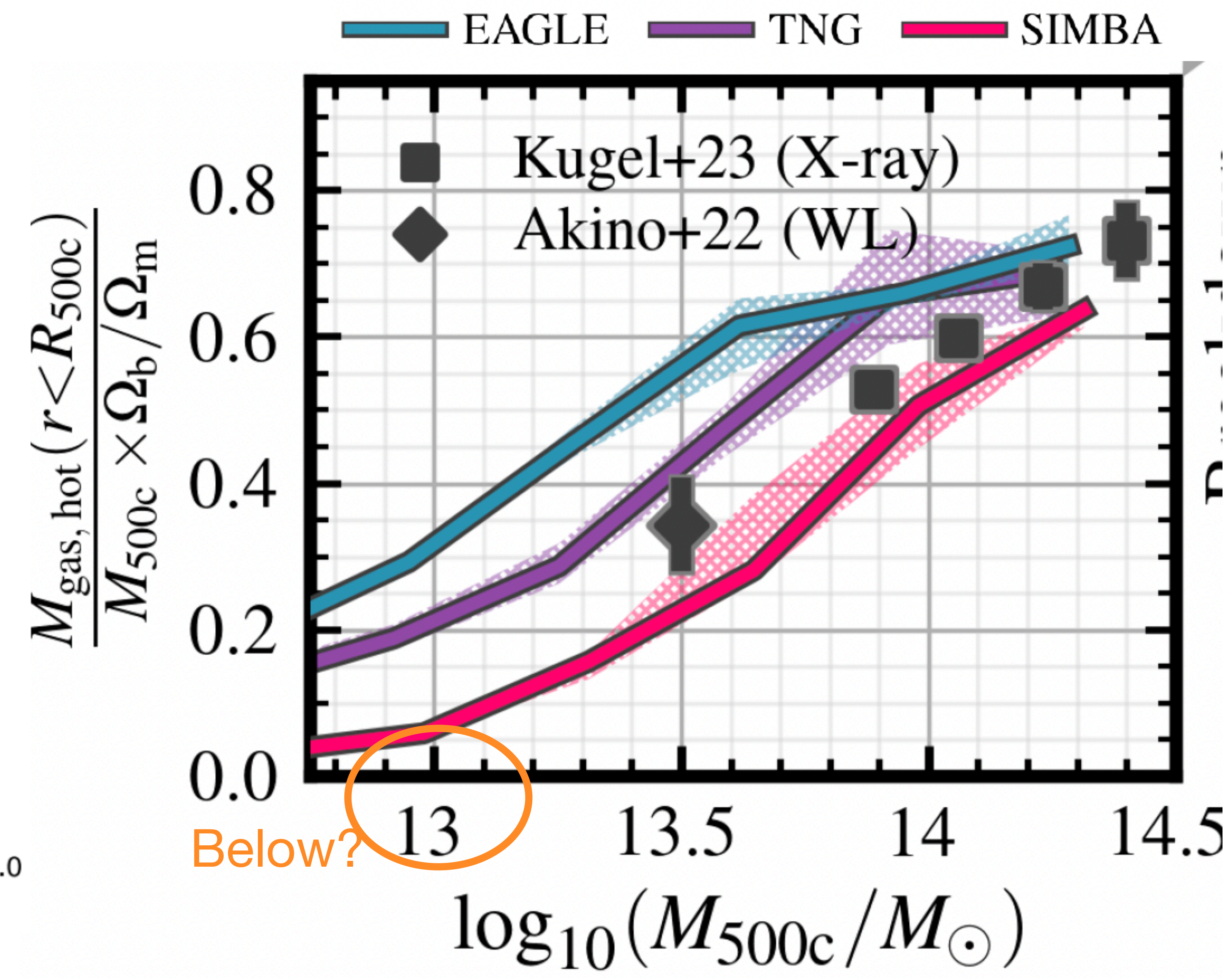
Questions:

- How bright and extended is the CGM around $M_{star}=10^{11}$ galaxies?
- How hot CGM relate to galaxy properties (M_{halo}, M_*, SFR)?
- Constraint on the galaxy evolution models?

Emission beyond 100kpc?







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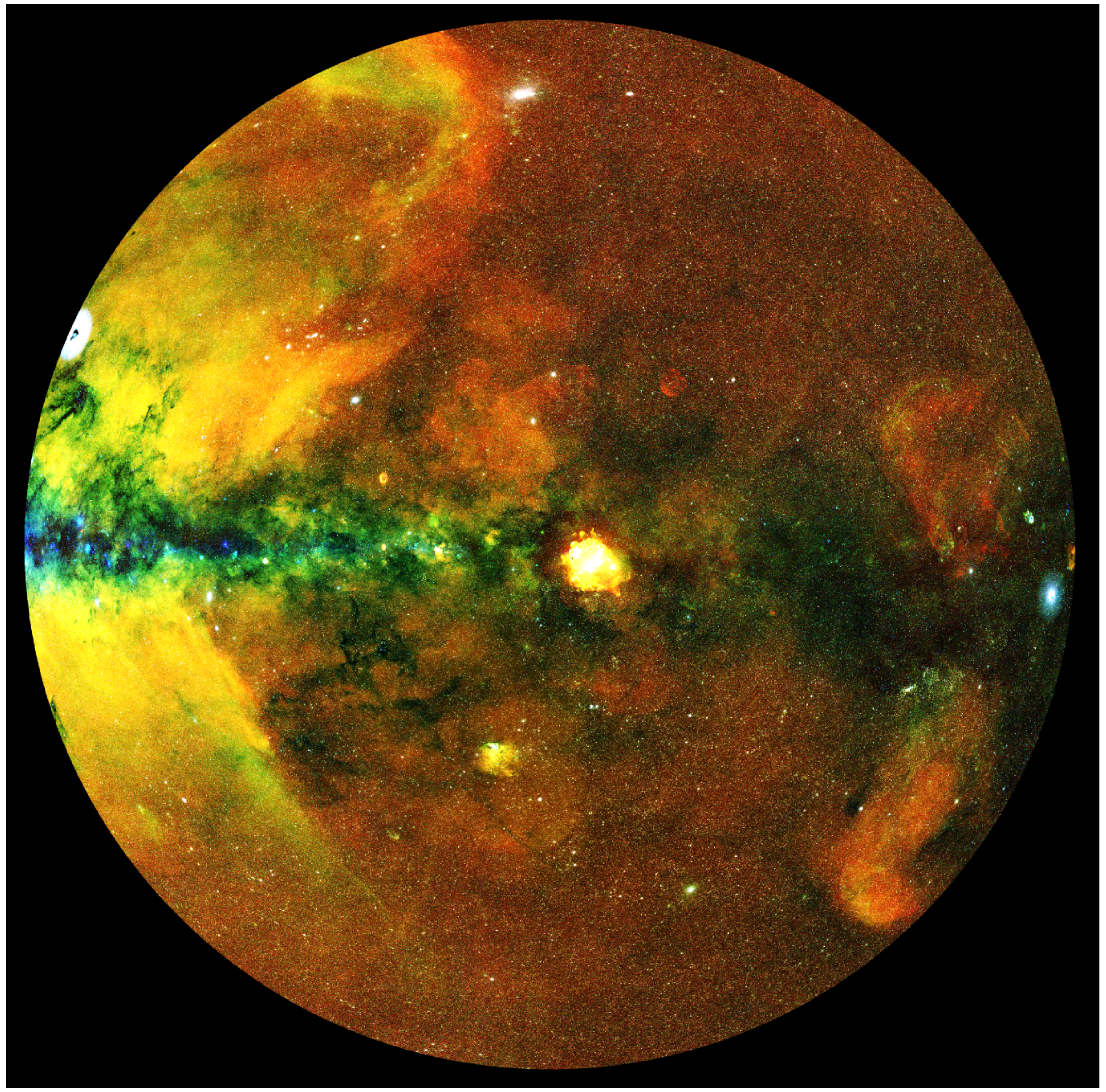
eROSITA and galaxy surveys

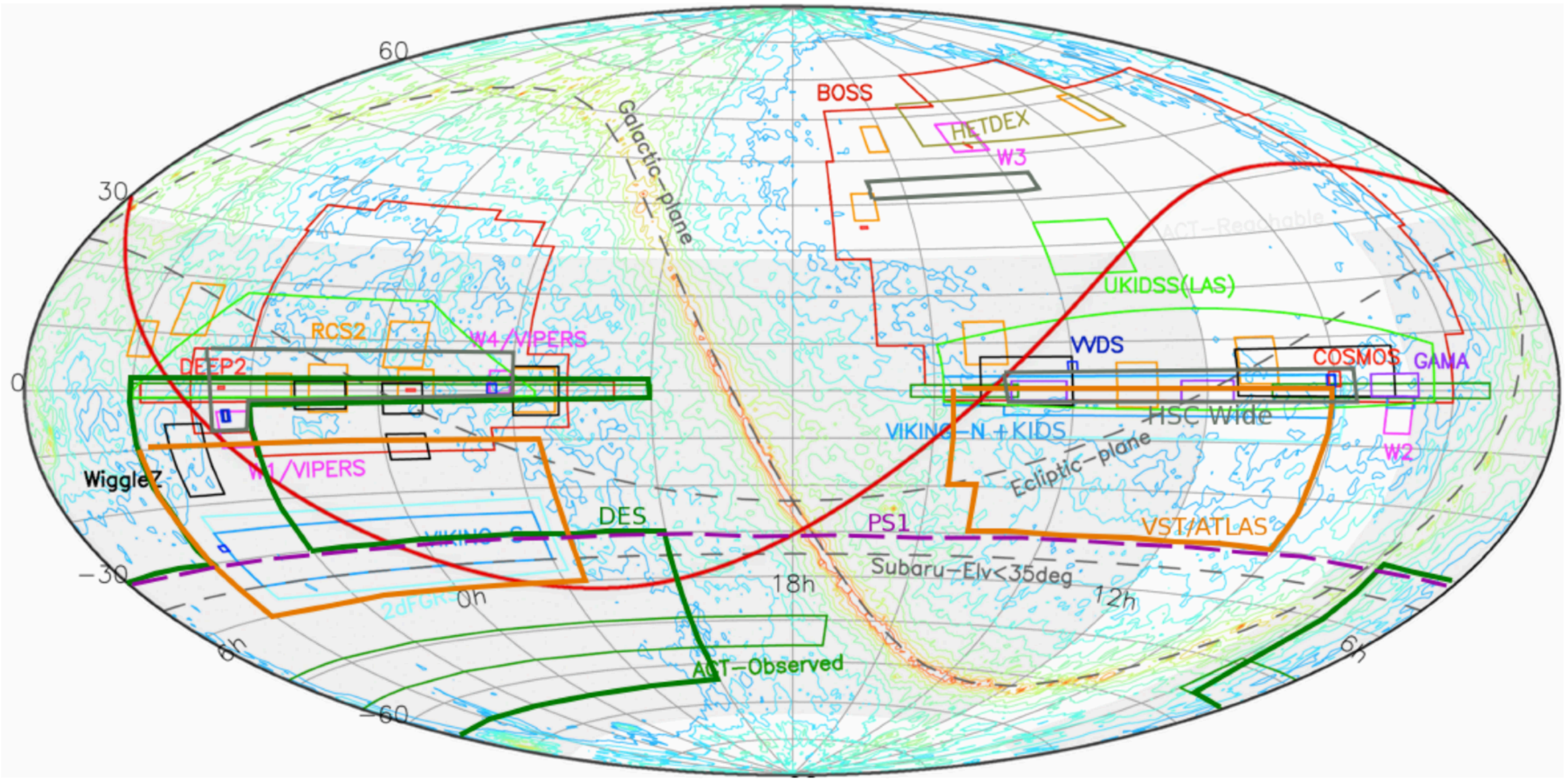
4 rounds of all-sky (eRASS:4), median t_{exp}=550s.



Merloni et al. 2024

Stack galaxies to increase statistics

- Take galaxy catalog from surveys at other bands (optical, IR)
- Select interested galaxy sample (redshift, M_{star}, SFR)
- Stack X-ray emission around galaxies



Merloni et al. 2012

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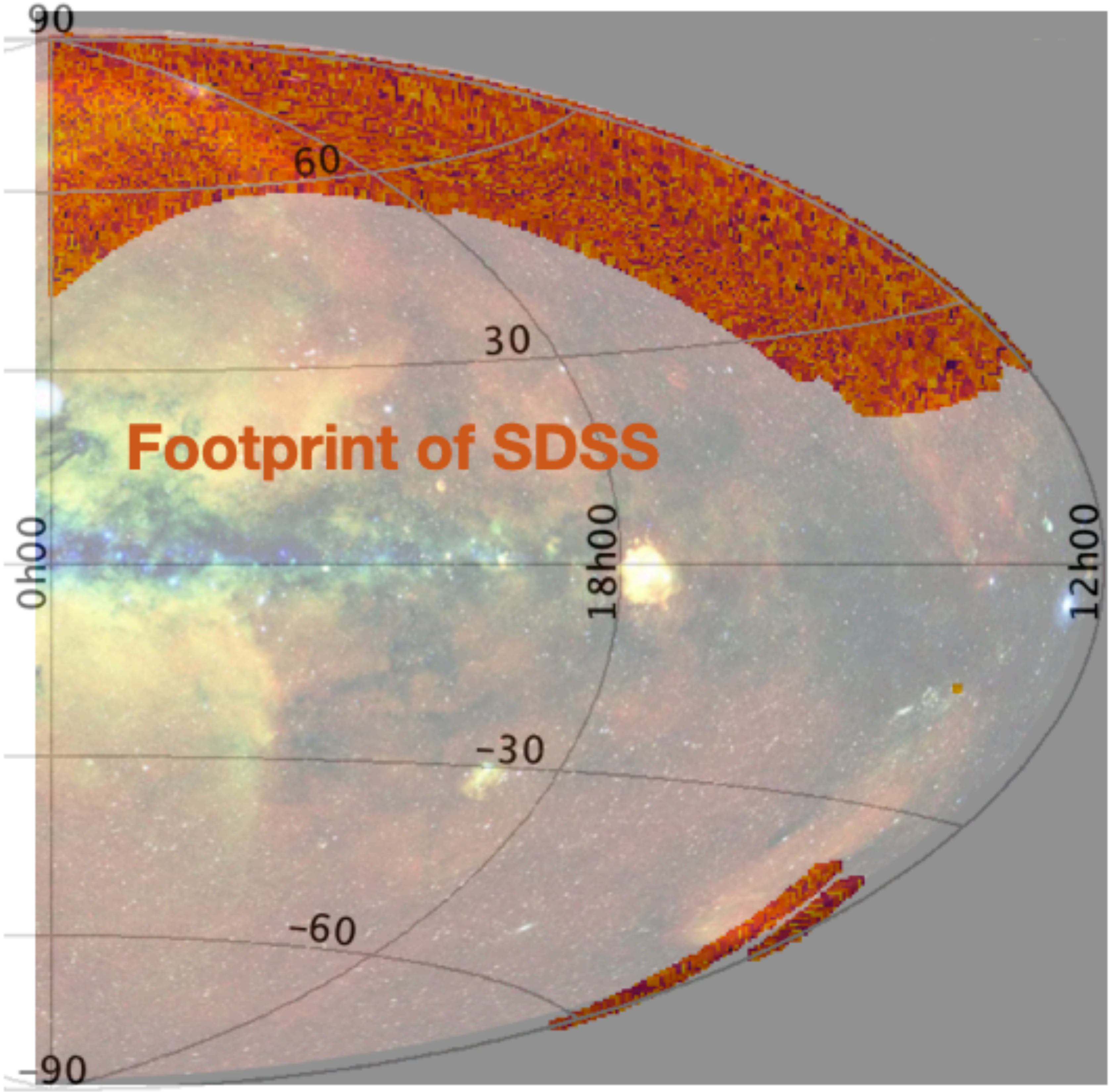
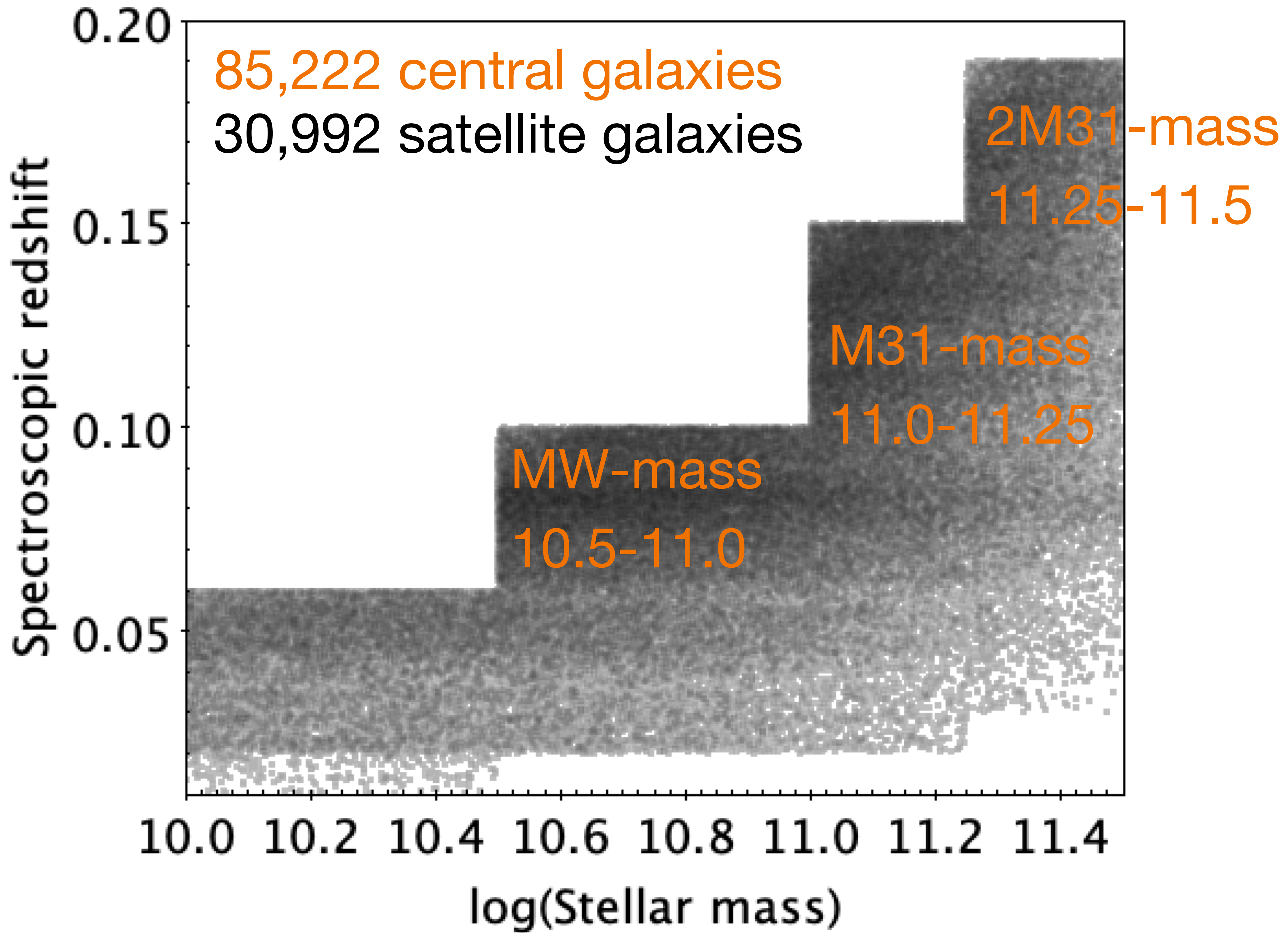
Galaxy sample

- SDSS DR7-main galaxy sample (r<17.77)
- Build approximately volume-limited galaxy samples
- Self-calibrated halo-based group finder -> central/satellite galaxy (Tinker et al. 2021)
- Define star-forming/quiescent galaxies by 4000A break





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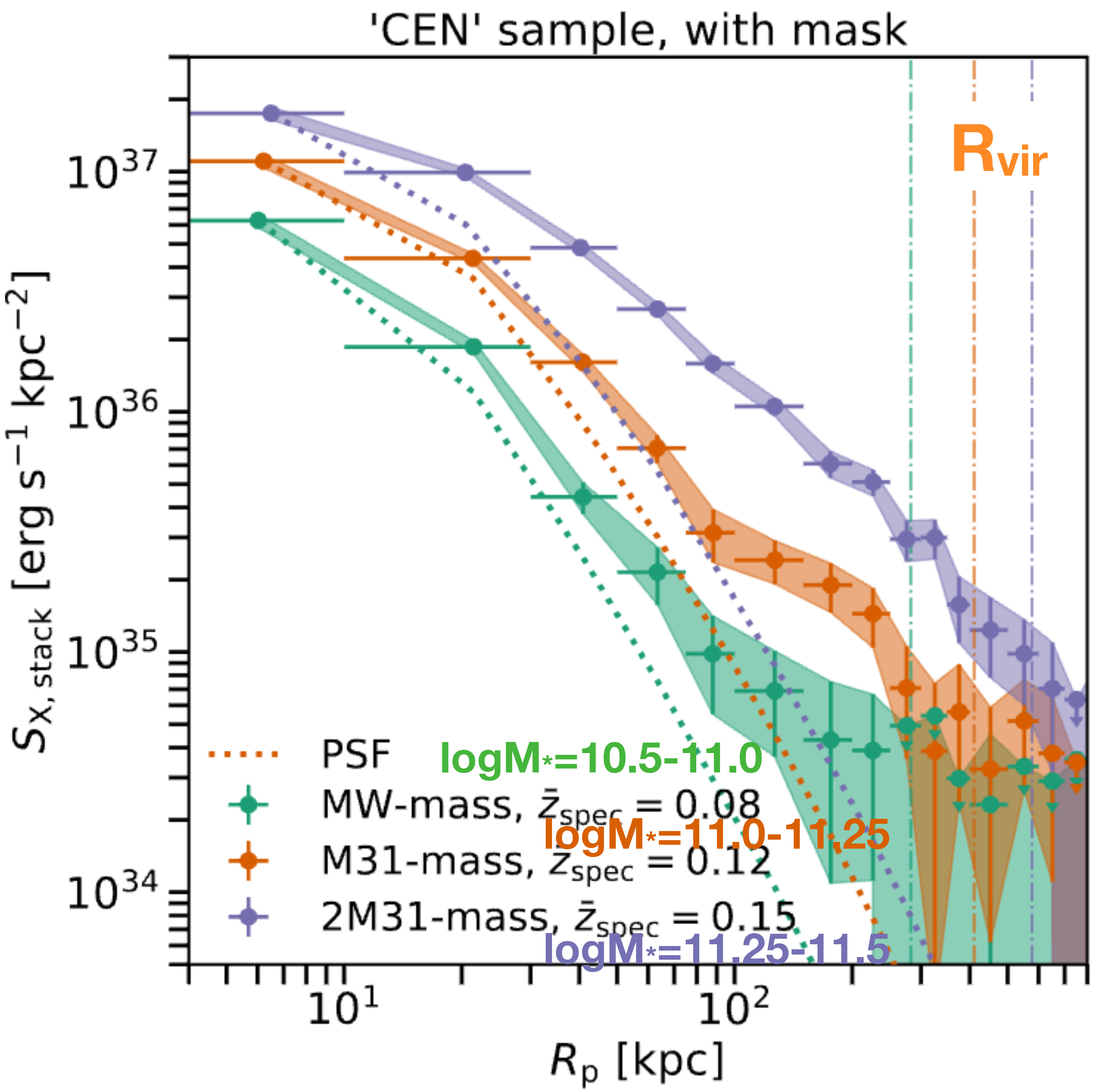
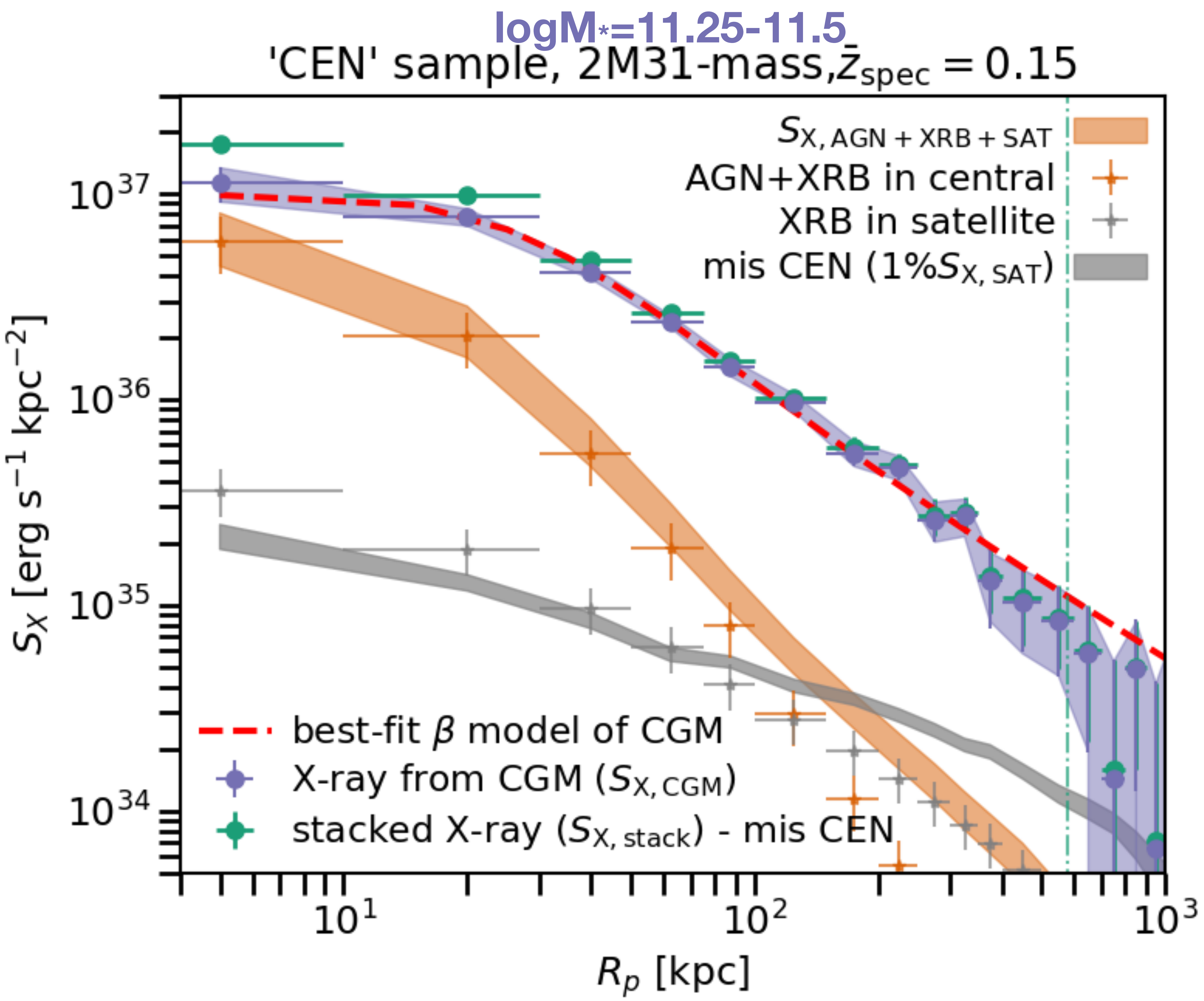
Result: extended X-ray emission from hot CGM



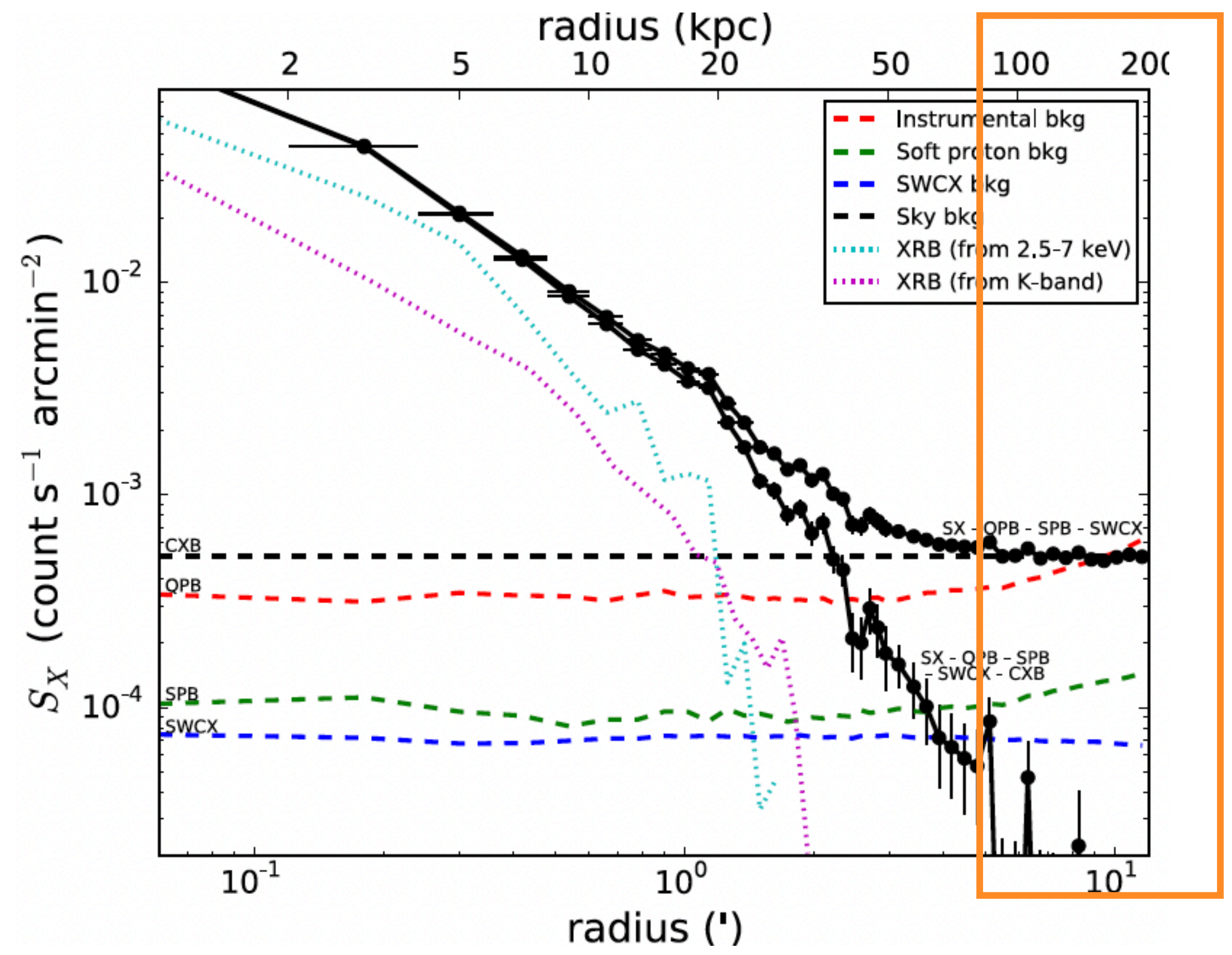
- Extended X-ray emission to **virial radius (>200kpc)** around MW-mass and more massive galaxies.

Result: extended X-ray emission from hot CGM

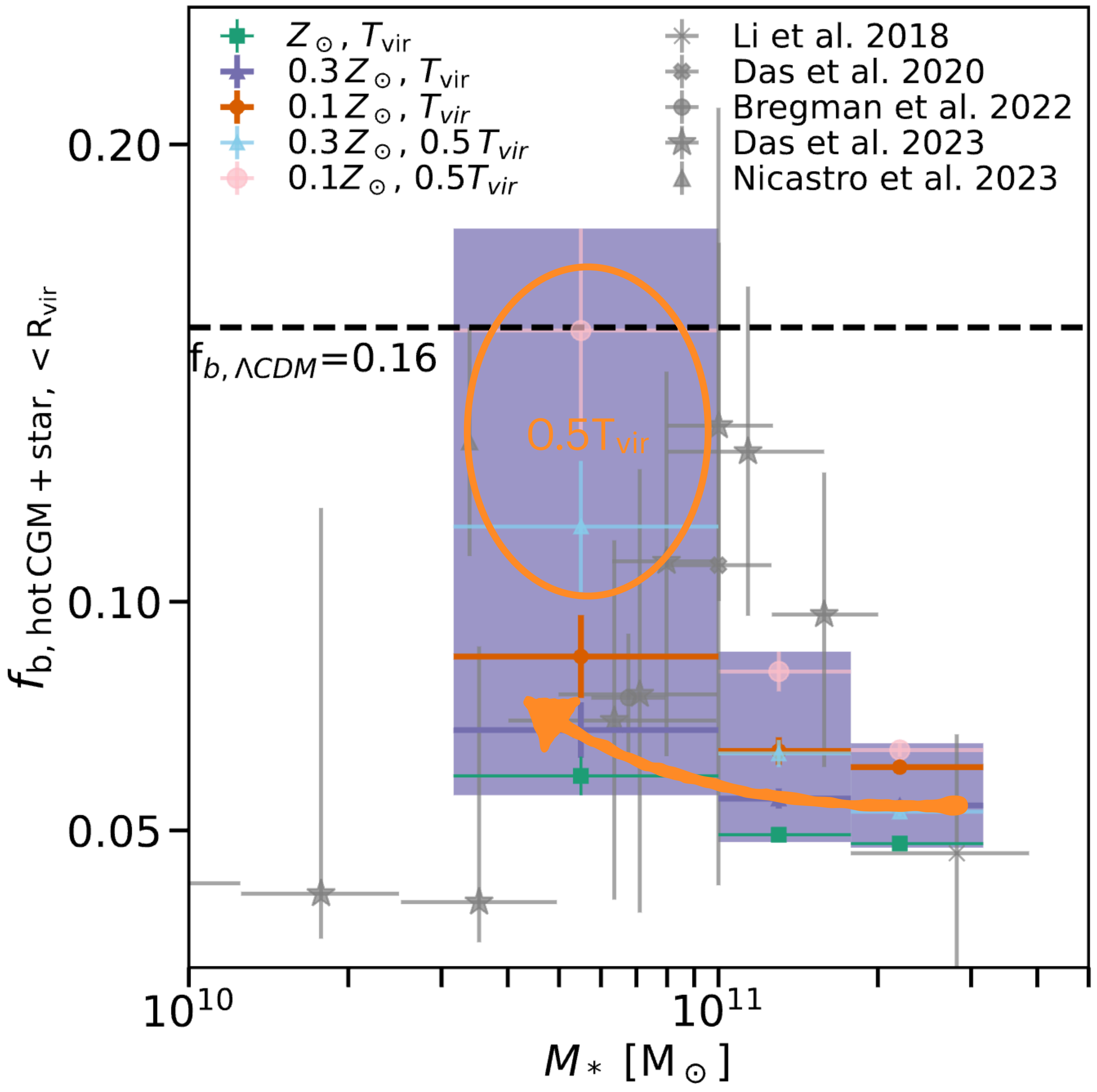


- Model and subtract the X-ray emission from: misclassified central galaxies, unresolved AGN and XRB
- Residual is the hot CGM emission extending to R_{vir}.

Q1: Emission beyond 100kpc?



Result: Baryon fraction



To derive the density from the flux, we assume the CGM has

- Virial or half virial temperature,
- 0.1, 0.3, 1.0 solar abundance,

Sign of flattening/increasing of baryon fraction with M_{star} decreasing?

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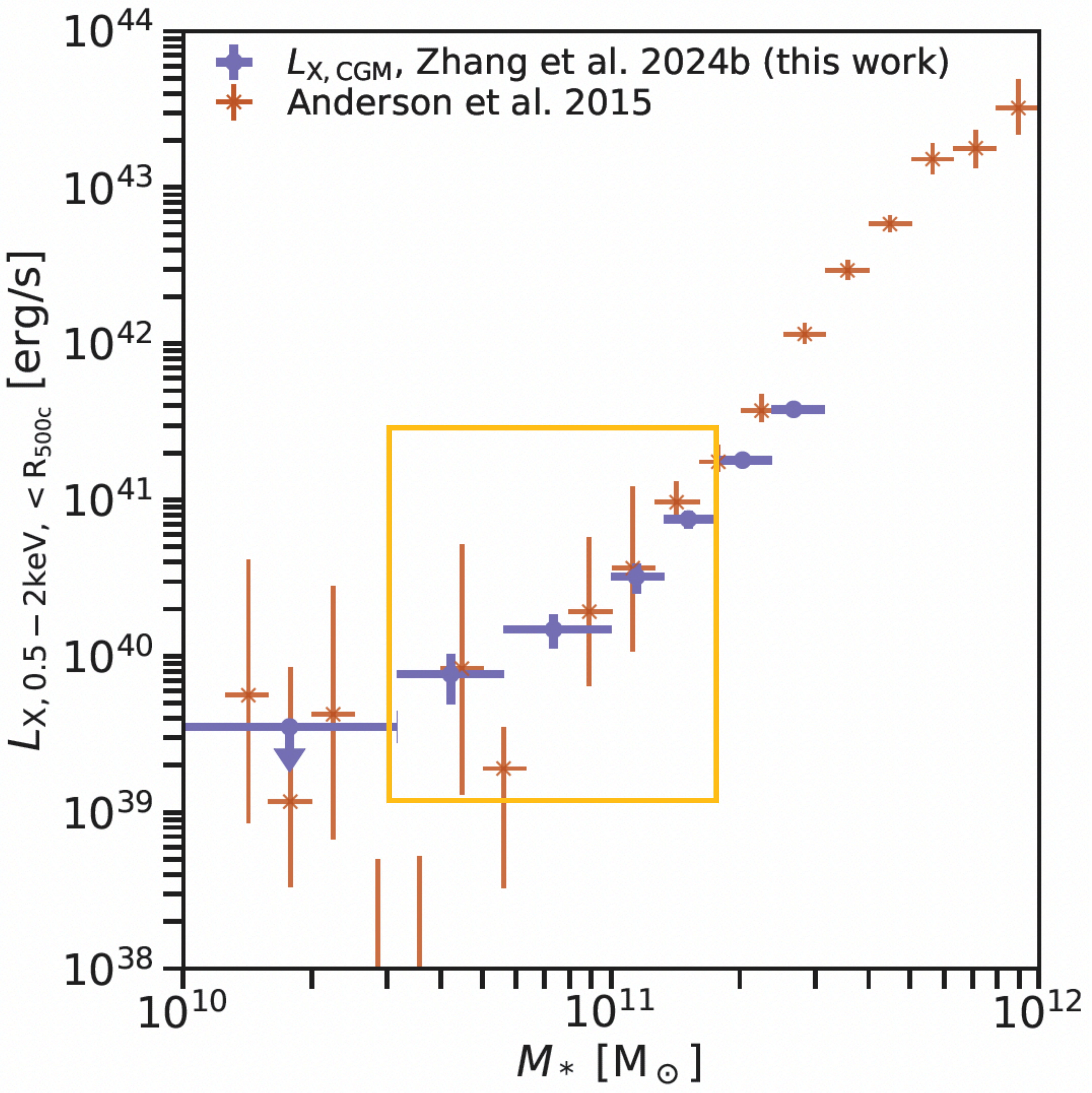
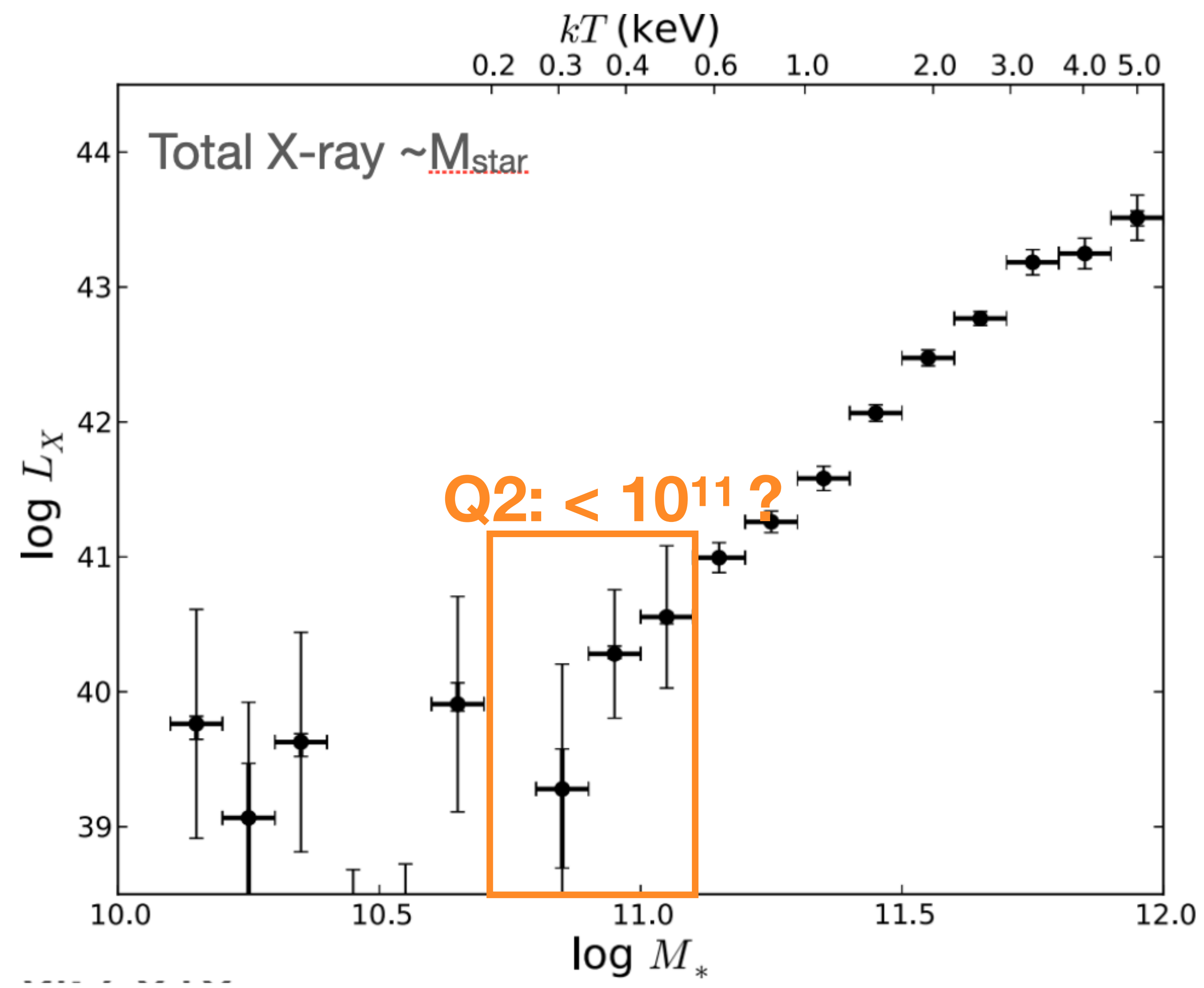
Result: L_{CGM}-M_{star} scaling relation

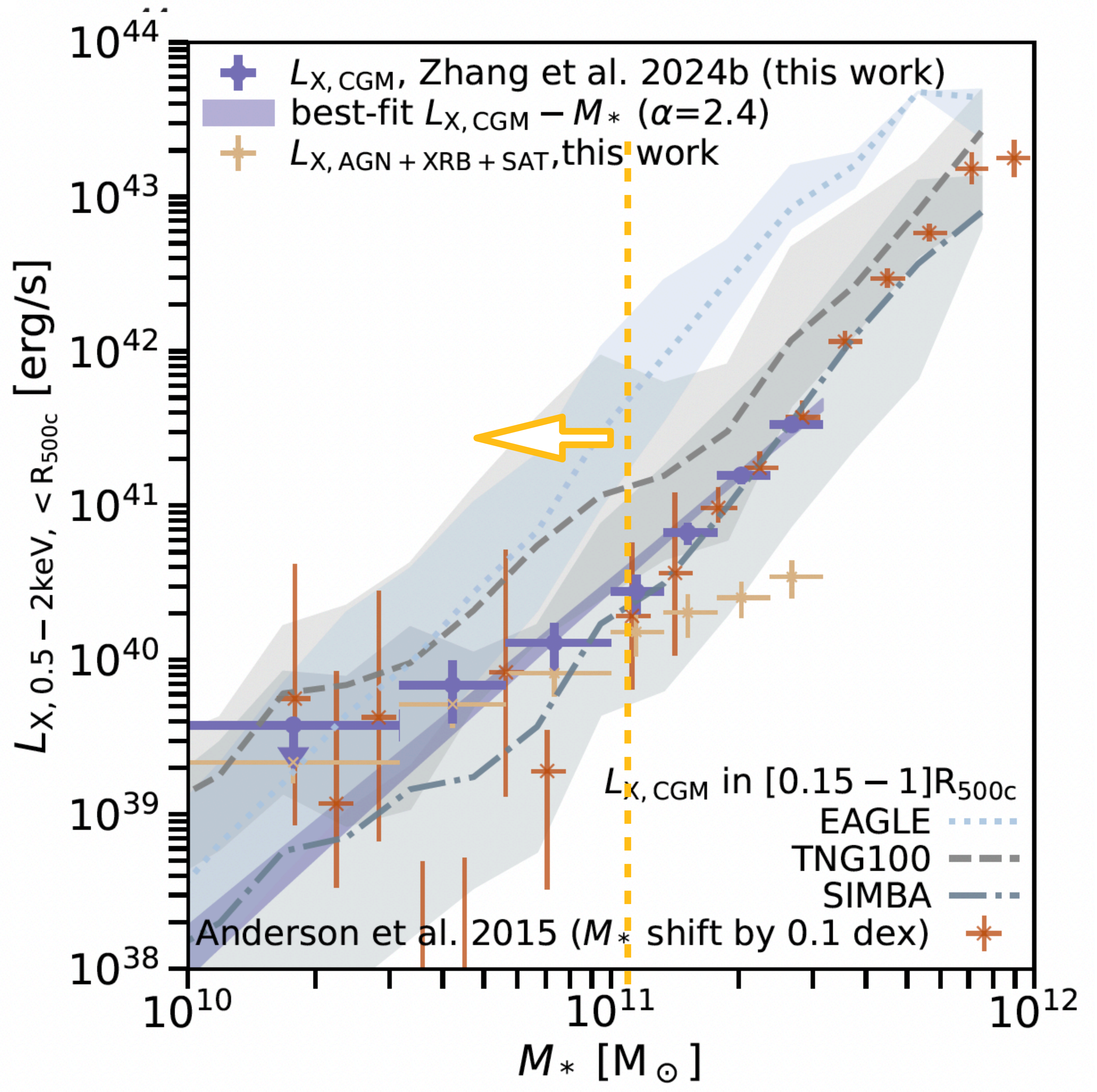


- Our X-ray luminosity of hot CGM within R_{500c}.
- Results from Anderson et al. 2015

Improvement of S/N at lower-mass galaxies.



Result: L_{CGM}-M_{star} scaling relation



- Our X-ray luminosity of hot CGM within R_{500c}.
- Results from Anderson et al. 2015

Improvement of S/N at lower-mass galaxies.

Comparison to the EAGLE, TNG100, and SIMBA simulations.

- log(M_{star})>11.0, agree well
- log(M_{star})<11.0, simulations deviate from observation.

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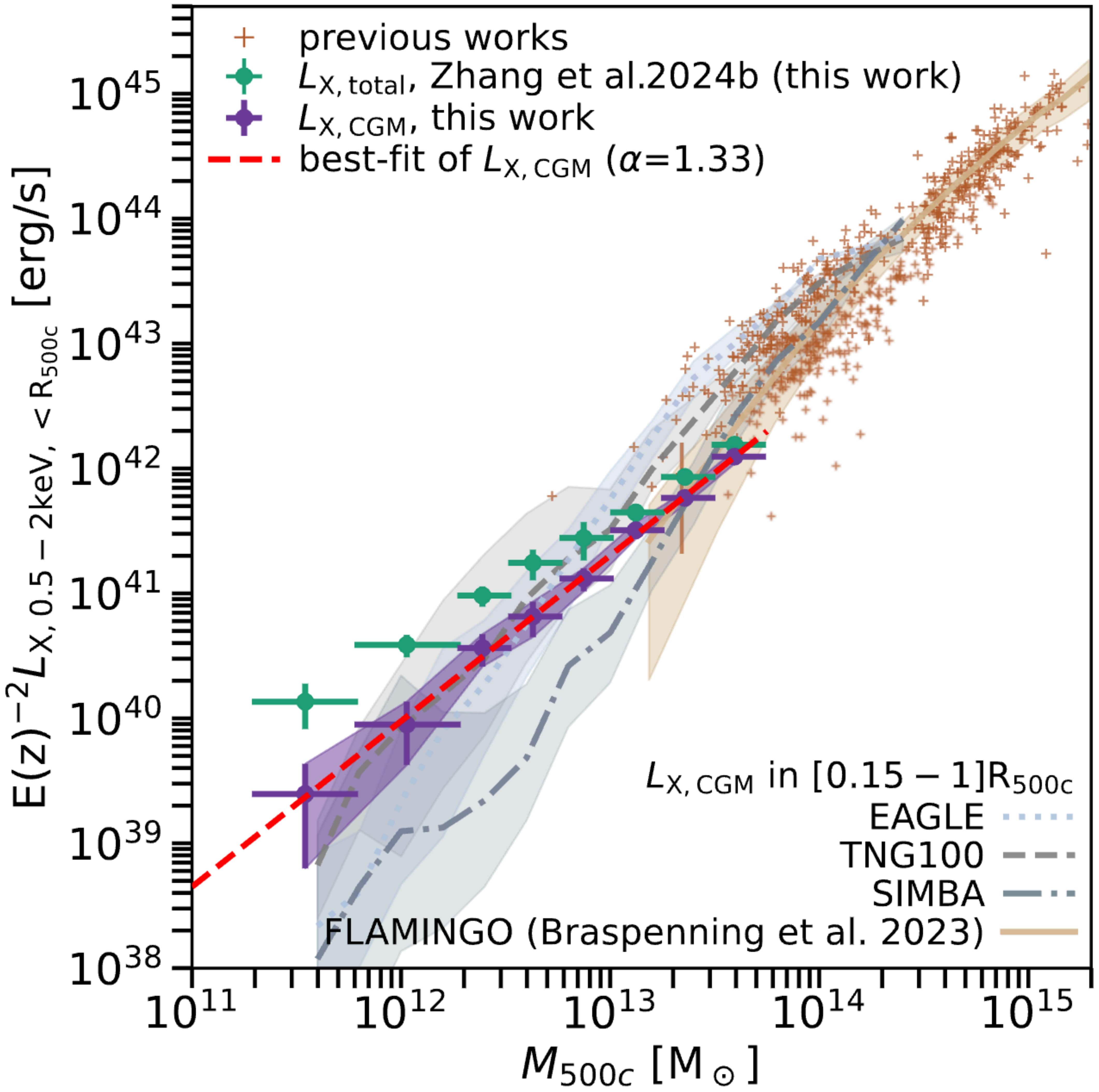
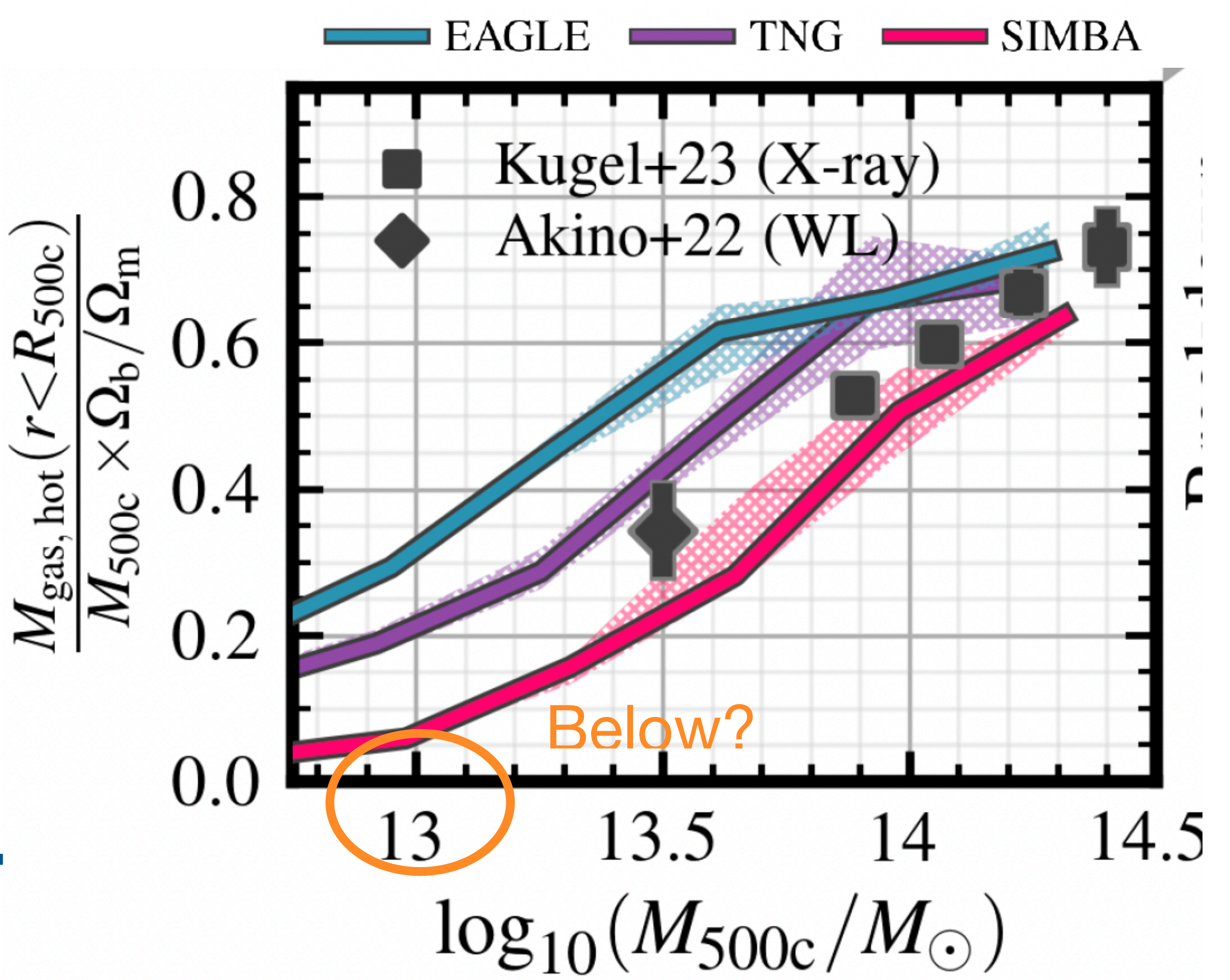
Result: L_{CGM}-M_{halo} scalng relation



- Our X-ray luminosity of hot CGM within R_{500c}.
- Previous observations of galaxy clusters and groups.

A single power law with an index≈1.3 can describe the L_{CGM}-M_{halo} relation at $\log(M_{500})<13.5$



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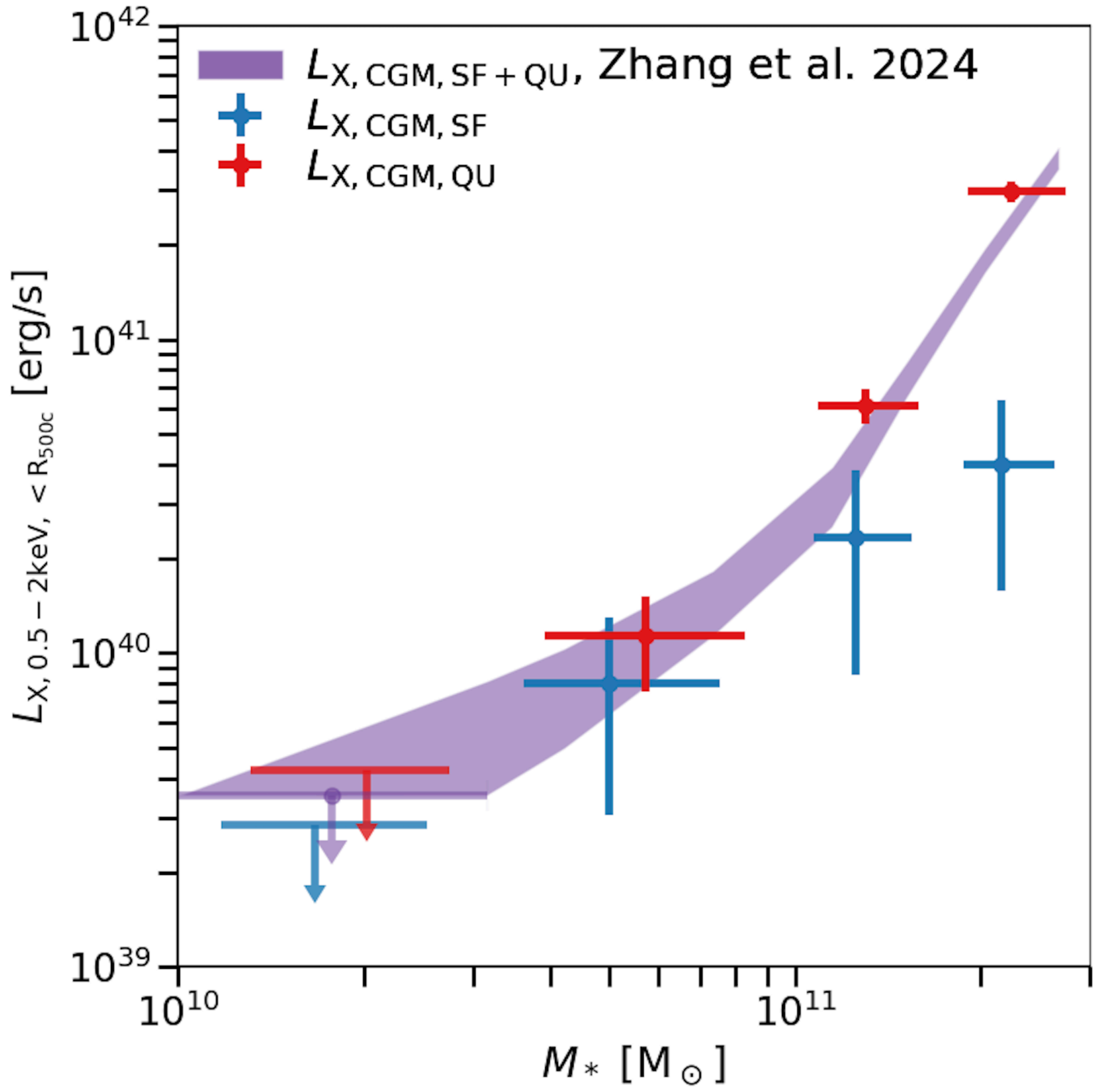
Result: Hot CGM around SF/QU

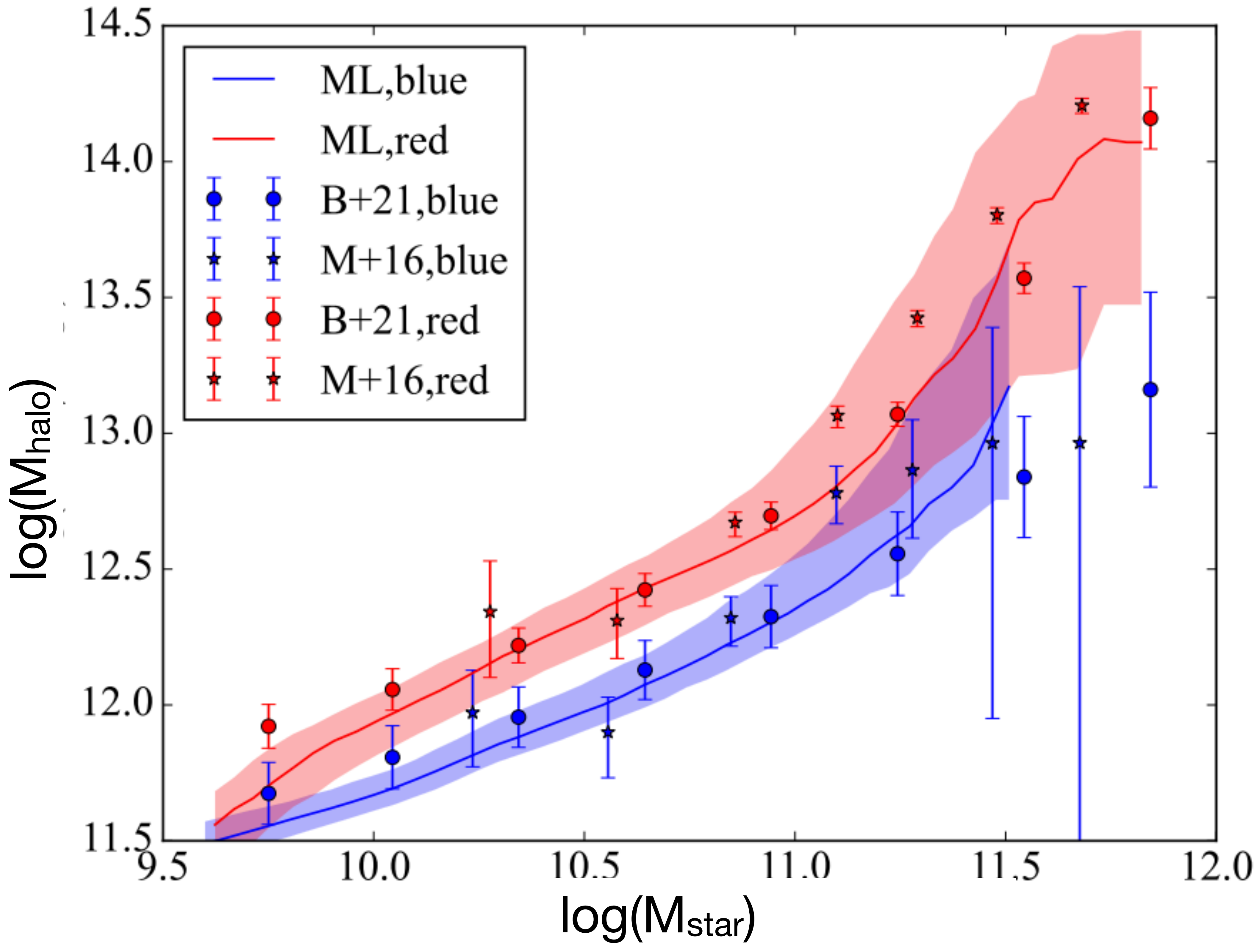


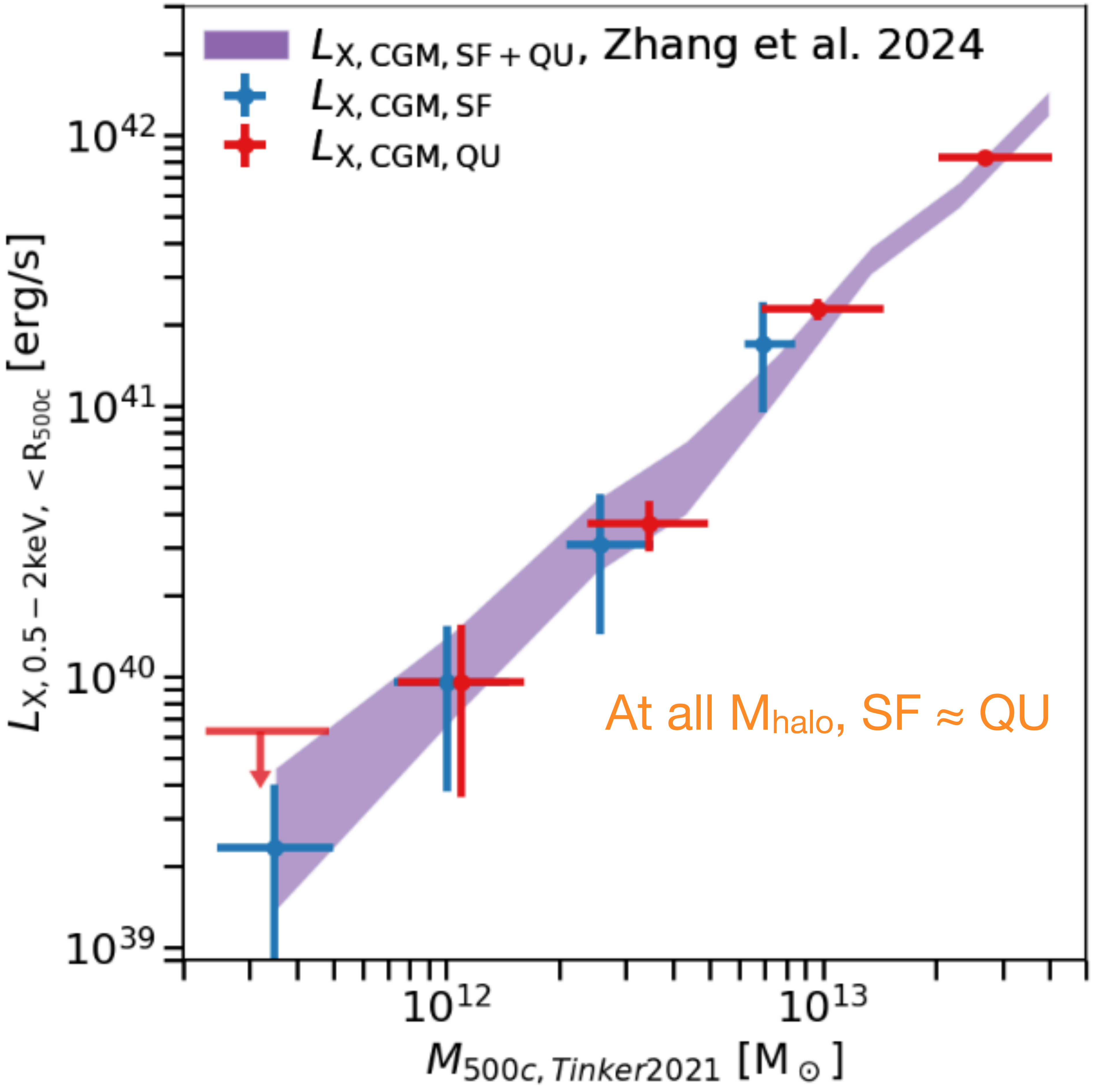
L_{CGM}-M_{star} scaling relations of star-forming and quiescent galaxies

- $\log(M_{star})<11.0$, SF ≈ QU
- $\log(M_{star})>11.0$, SF < QU

Result: Hot CGM around SF/QU

Star-forming galaxies locate in lower-mass dark matter halo than quiescent galaxies.





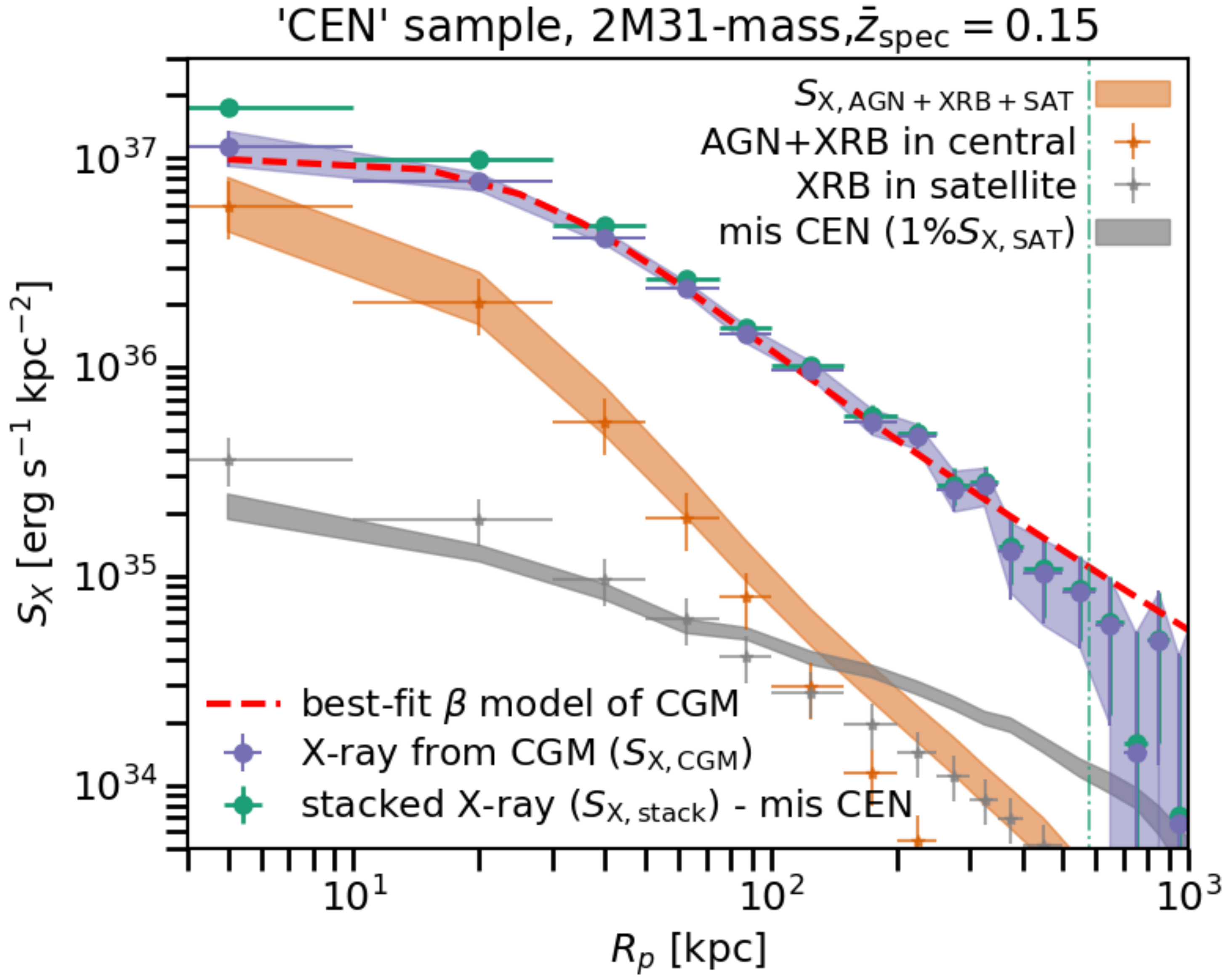
Summary

We answered: • How bright and extended is the CGM around MW-mass galaxies.

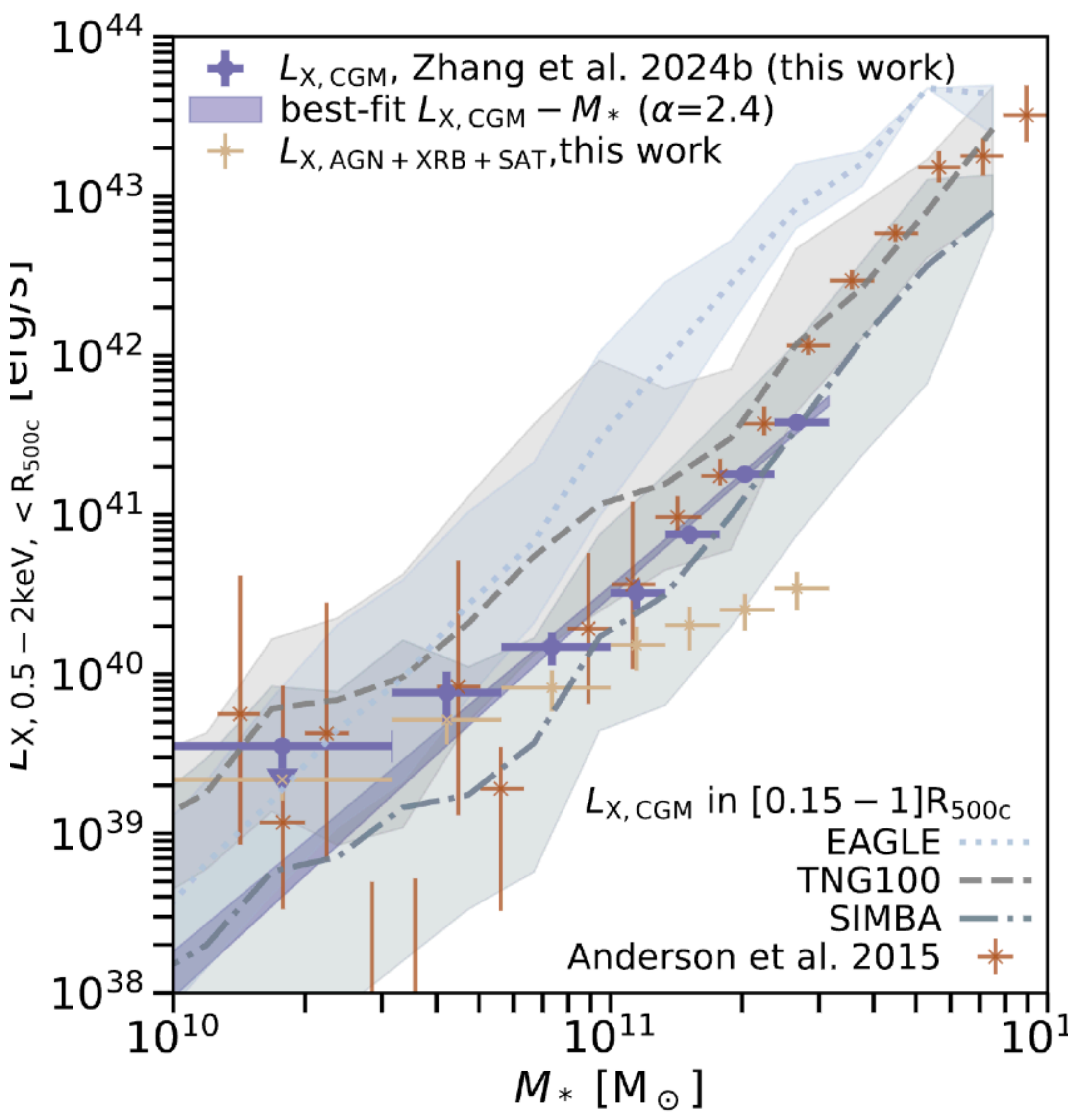
• How hot CGM relate to galaxy properties (M_{halo}, M_*, SF/QU).

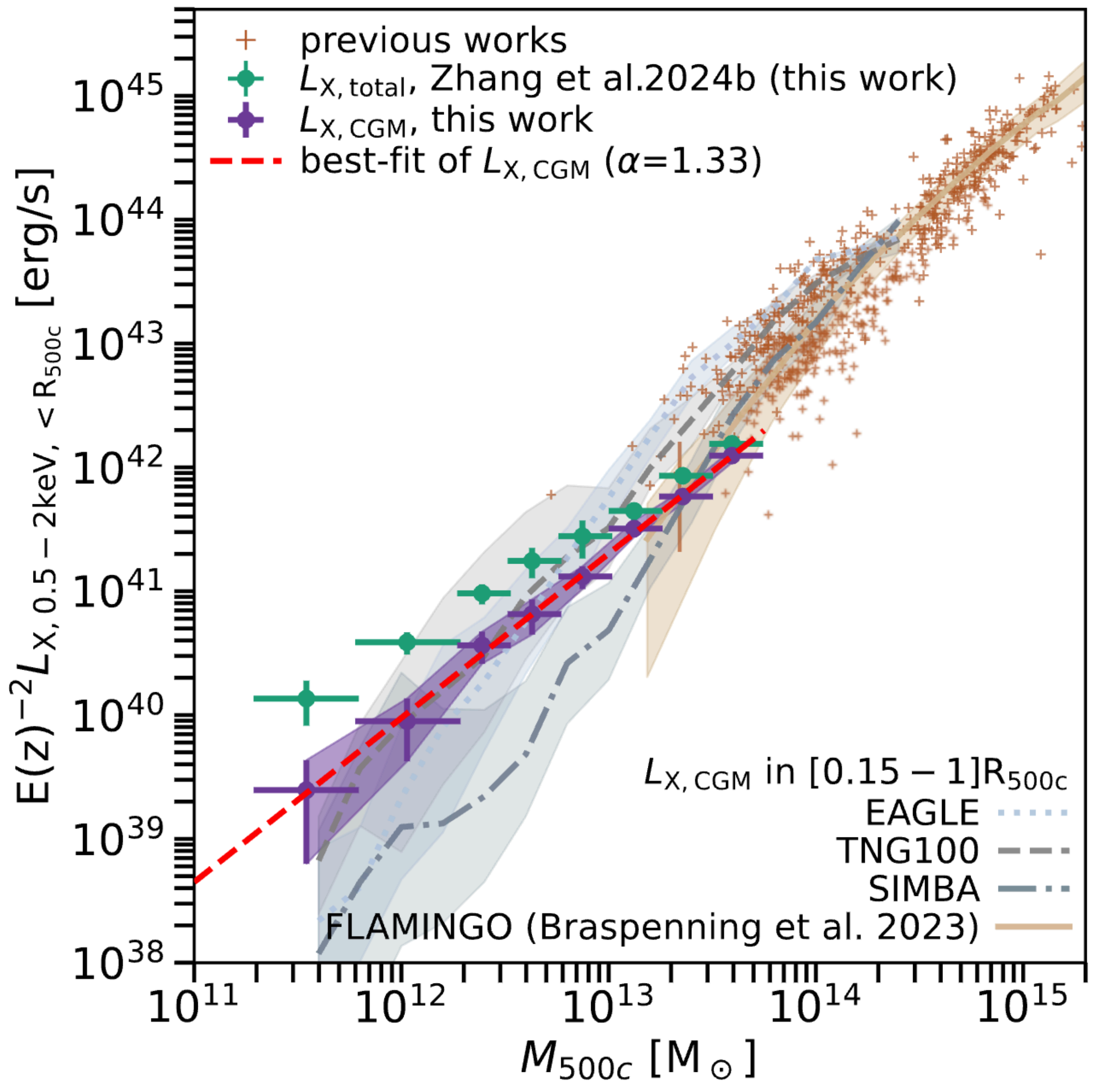
To explore: • Constraints on the galaxy evolution models?

• Surface brightness profiles

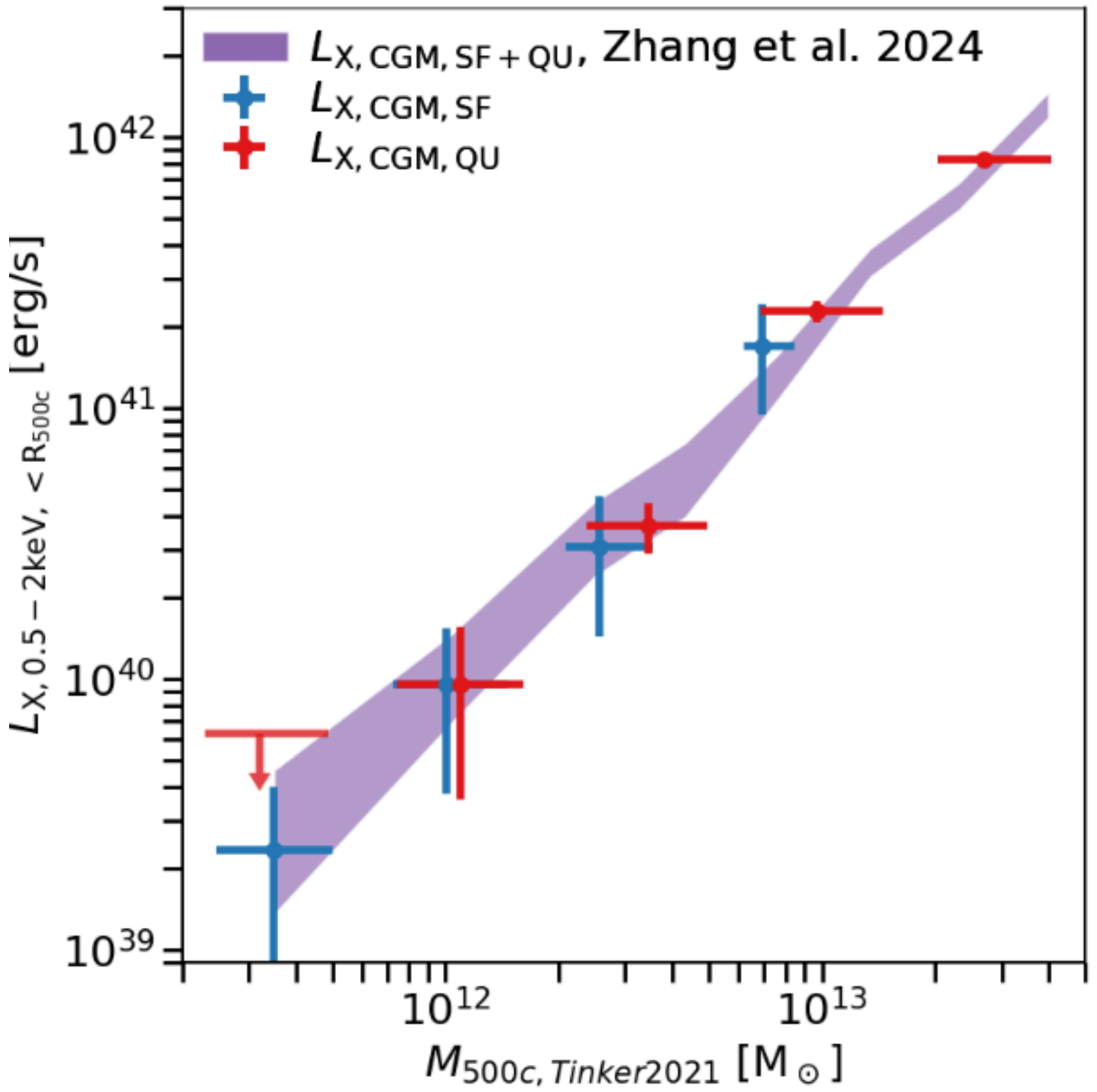


• Scaling relations





• SF/QU comparison



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