

# X-ray Properties of Galaxy Clusters with *e*ROSITA

Joseph Hall and Ben Maughan

*University of Bristol*

*New Results in X-Ray Astronomy 2025*

4 September 2025

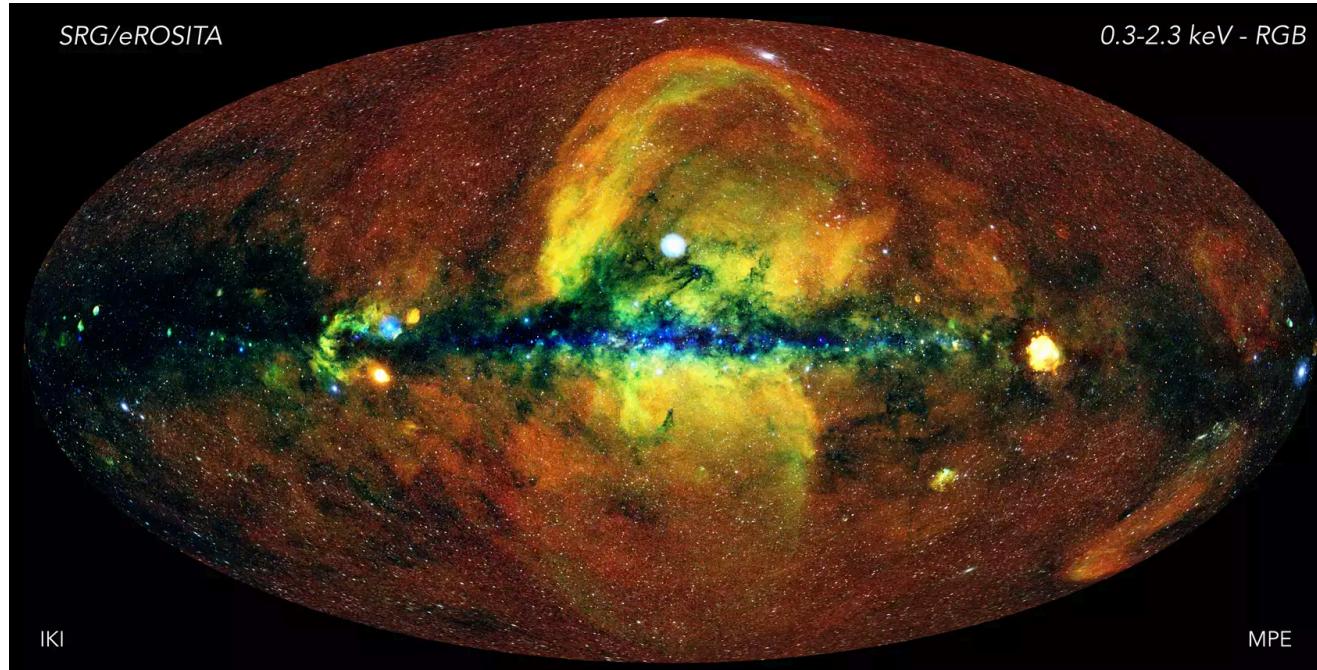
# BACKGROUND

## A New Era

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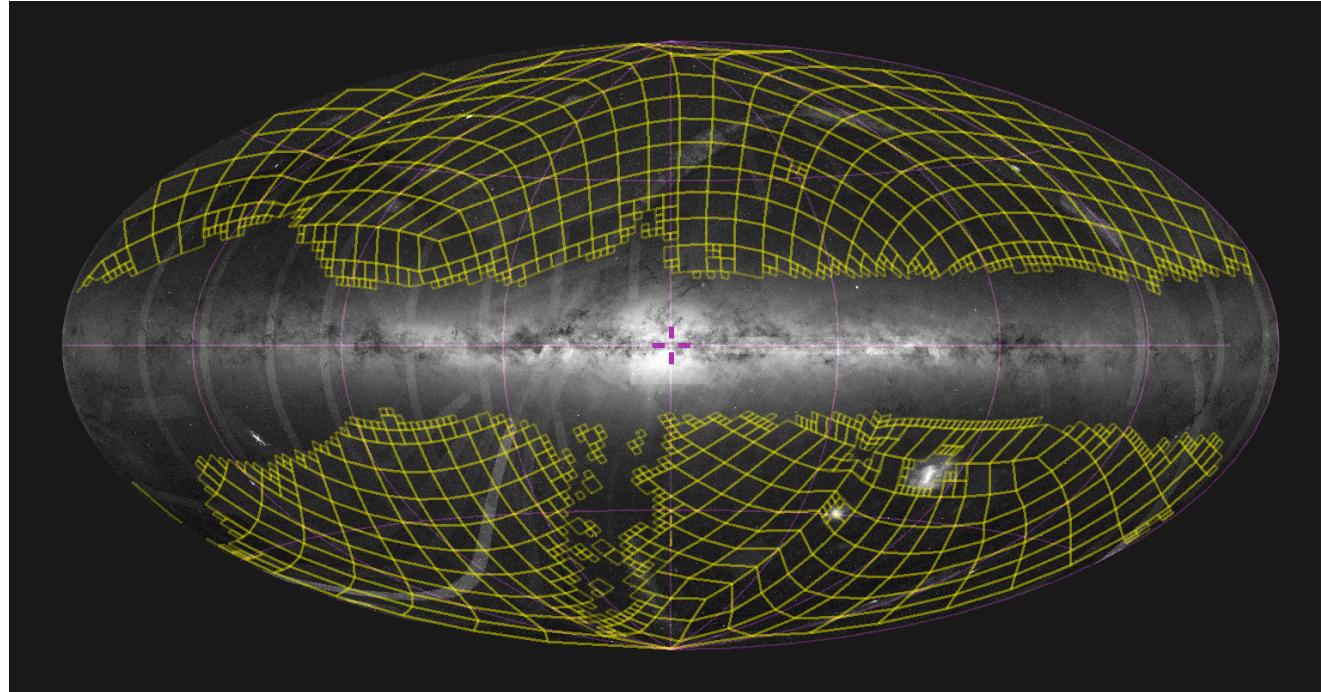
For 2.5 years from 2019 **eROSITA** mapped the X-ray sky, so far providing 2 data releases

*Brunner et al. 2022, Merloni et al. 2024*

*Image Credit: Jeremy Sanders, Hermann Brunner and the eSASS team (MPE); Eugene Churazov, Marat Gilfanov (on behalf of IKI)*

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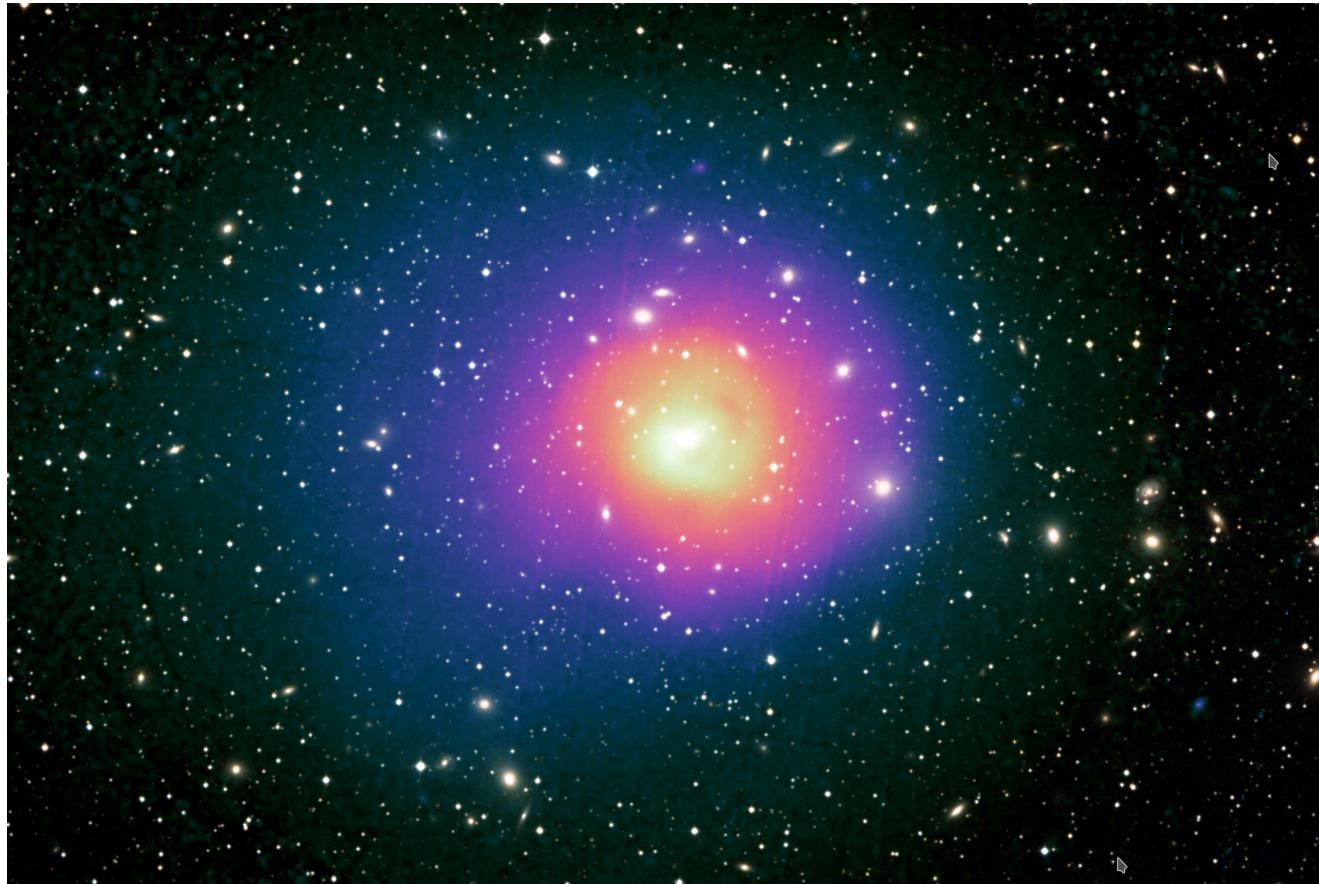
The optical sky has been well-mapped by **DES** and **DESI**, with **Euclid** Q1 data providing a preview of the full data coming next year

*DES Collaboration 2021, Dey et al. 2022, Euclid Collaboration 2025  
Image credit: Wen & Han 2024 via VizieR*

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*Image Credit: ESA/XMM-Newton/DSS-II/J. Sanders et al. 2019*

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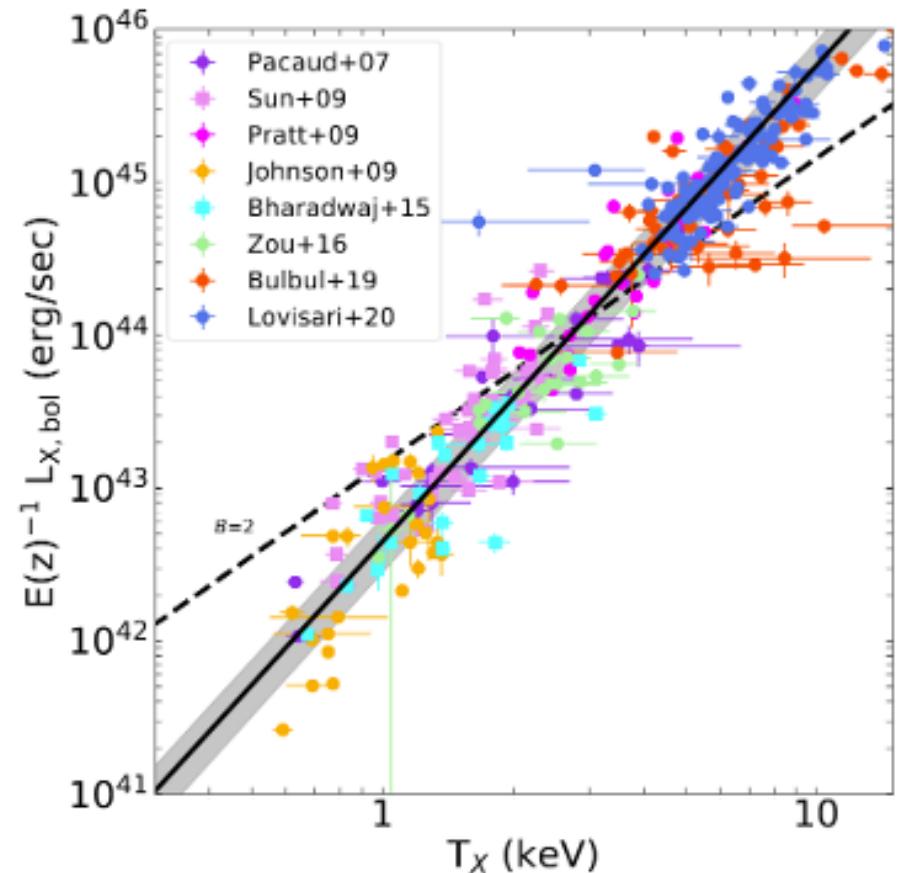
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*Image Credit: Lovisari & Maughan 2022*

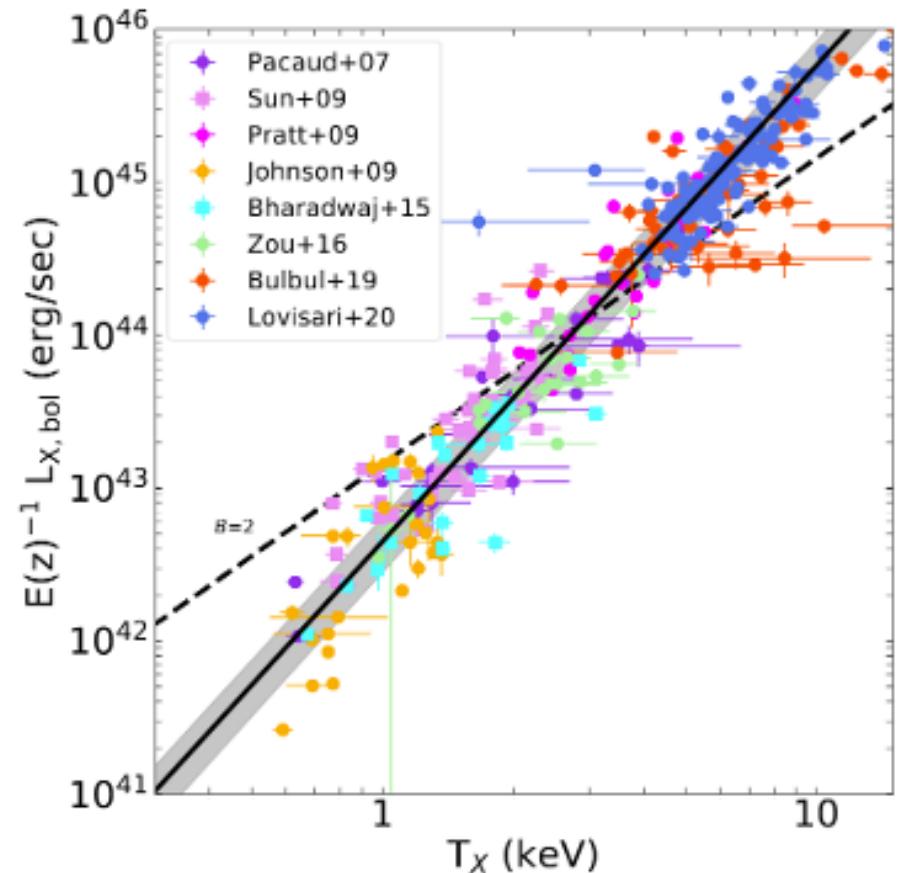
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Assuming that only gravity dictates these properties, the scaling relations can be fit by the **self-similar model**.

Deviations from the model are the result of extra astrophysics.



*Image Credit: Lovisari & Maughan 2022*

# Cluster Cosmology

Counting the number of clusters in the universe can help to constrain cosmological parameters, particularly  $\sigma_8$  and  $\Omega_M$

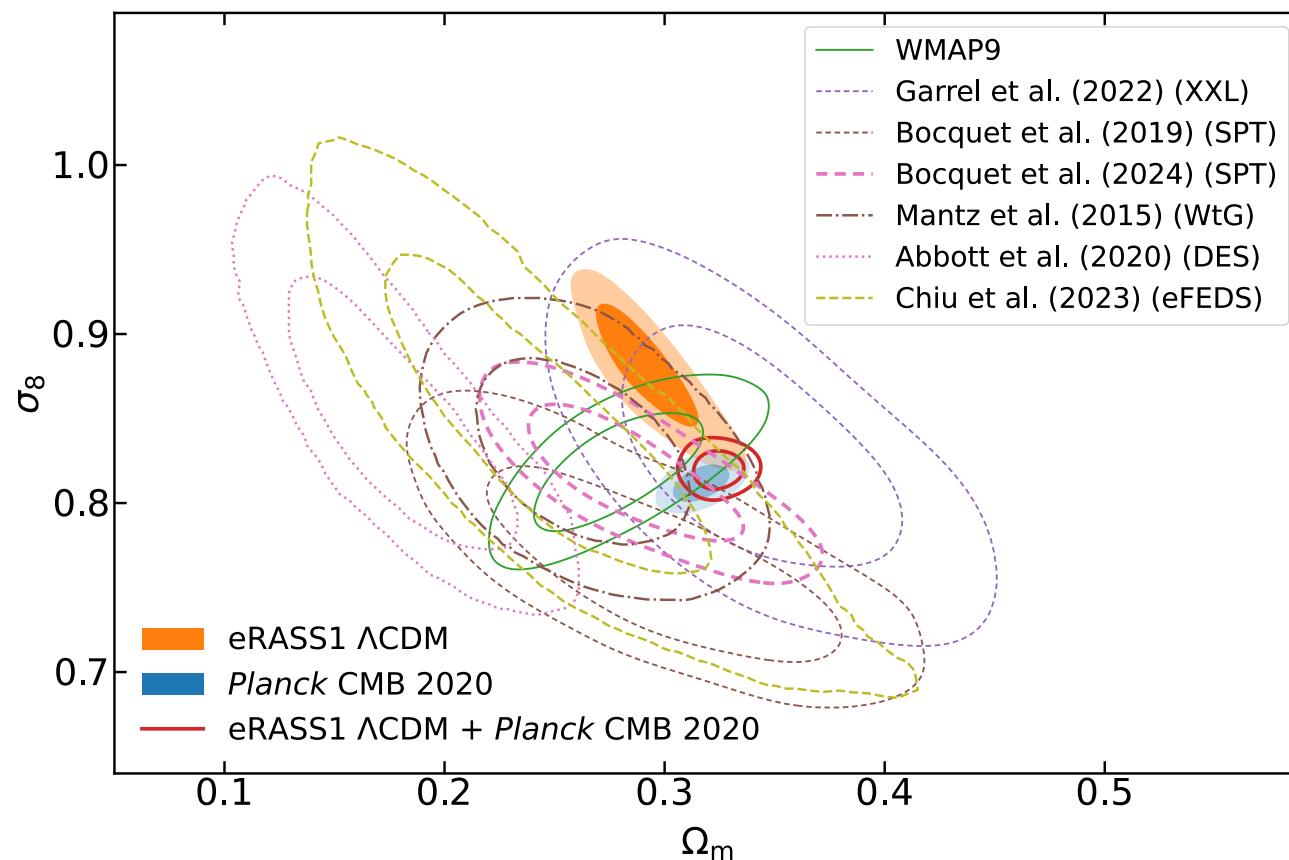
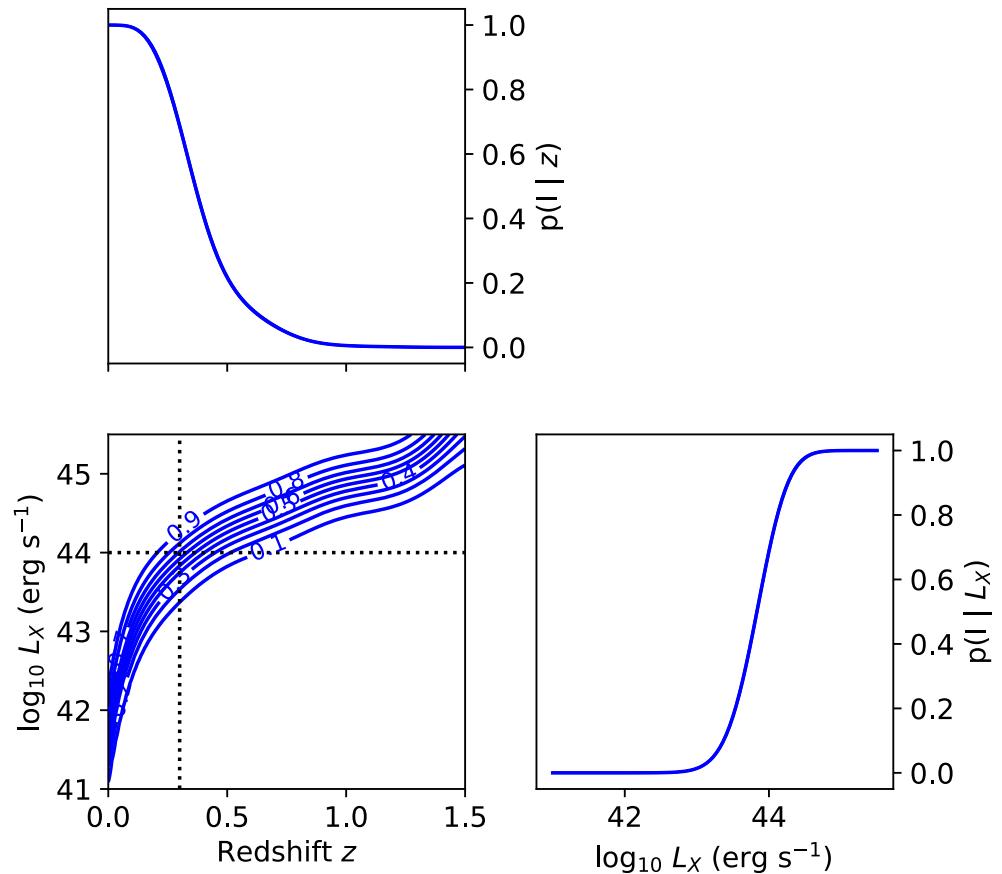


Image Credit: Ghirardini et al. 2024

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*Image Credit: Clerc et al. 2024*

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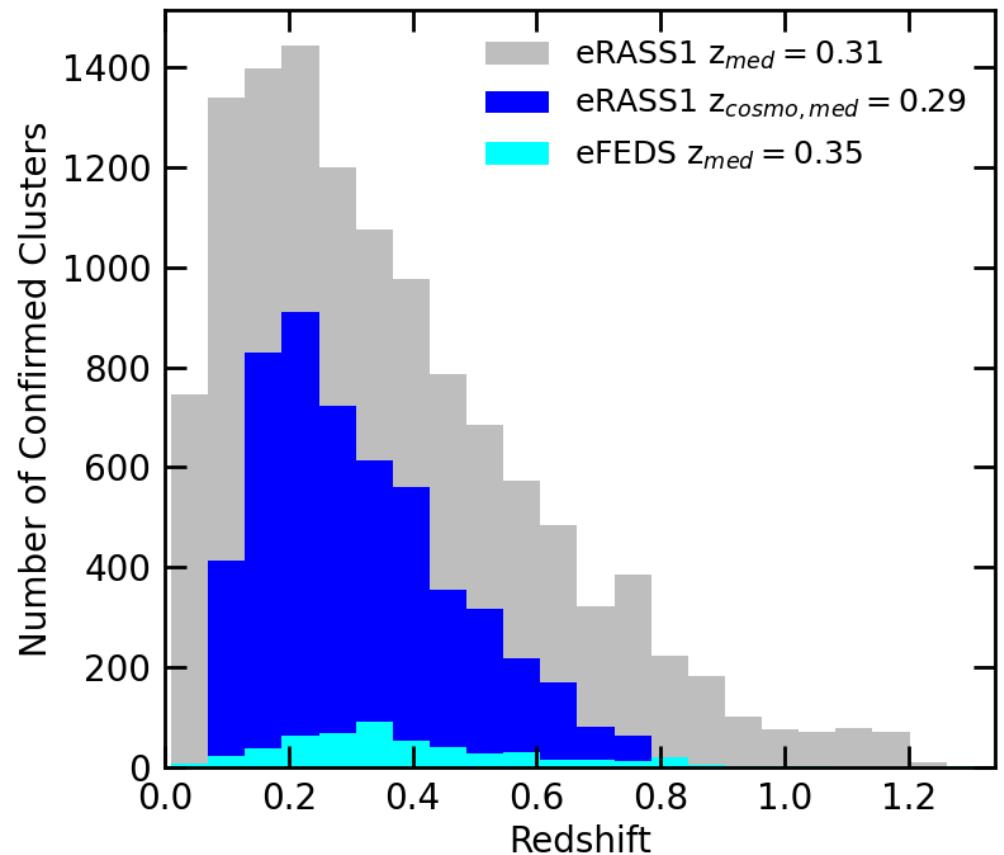


Image Credit: Bulbul et al. 2024

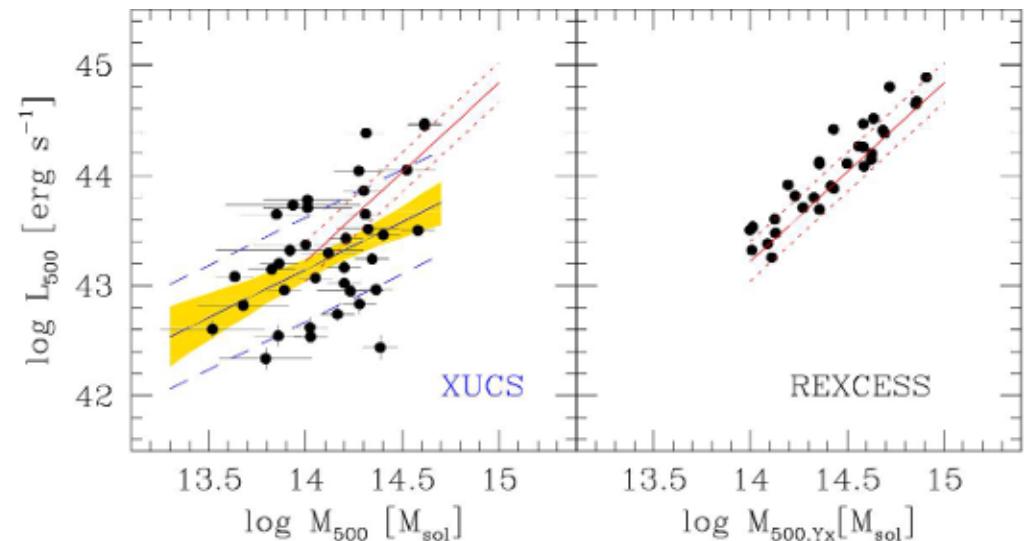
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Andreon et al. (2016) found diff's in scaling rels for **optical and X-ray clusters**



*Image Credit: Andreon et al. 2016*

**Combining eROSITA data with  
clusters found in wide optical  
surveys gives the ideal platform to  
test these biases**

# SAMPLE SELECTION

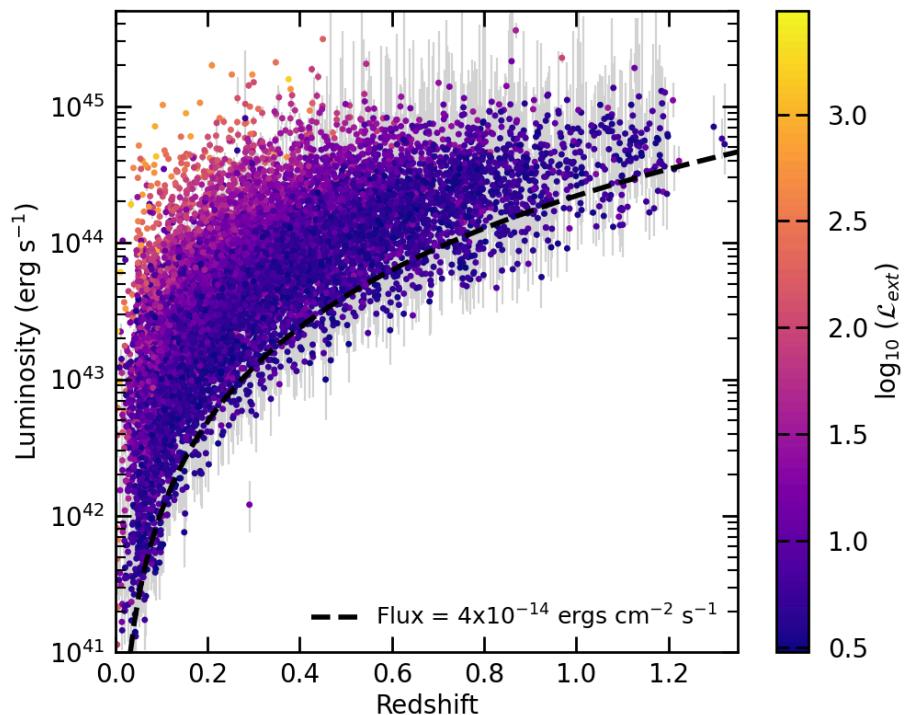
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For the **X-ray selected** sample, I used the primary eRASS1 cluster catalogue of >12,000 clusters.



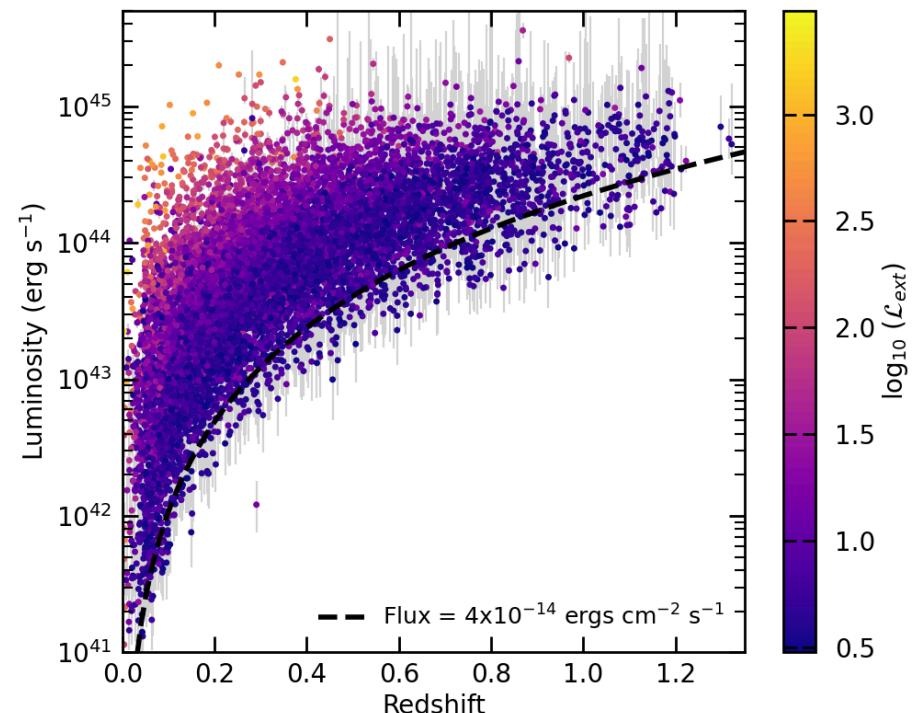
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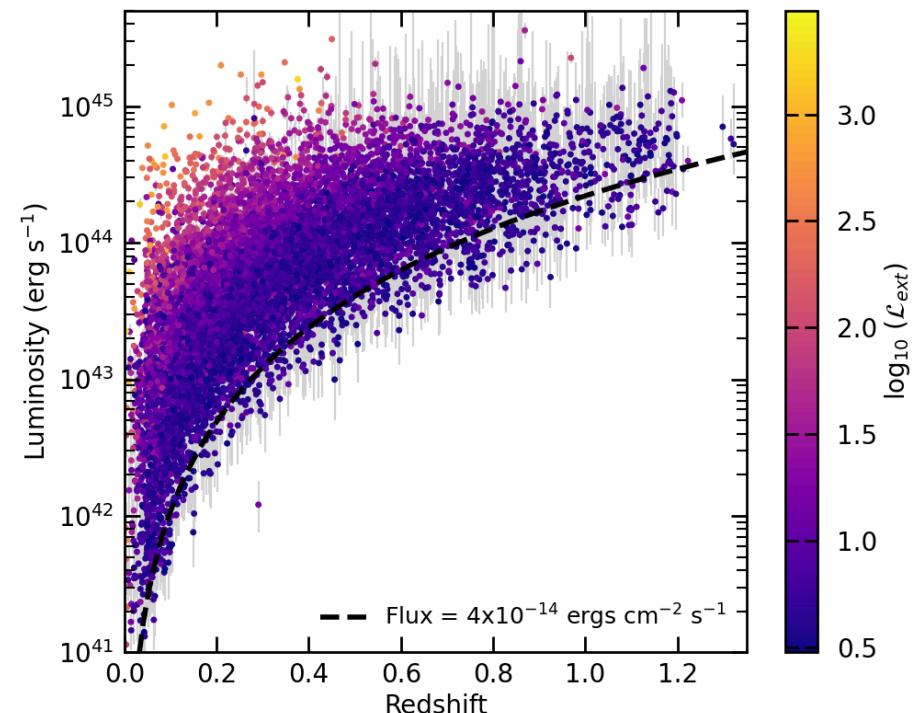
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Recent work in Balzer et al. (2025) has identified **1,000s** more clusters in the eRASS1 data

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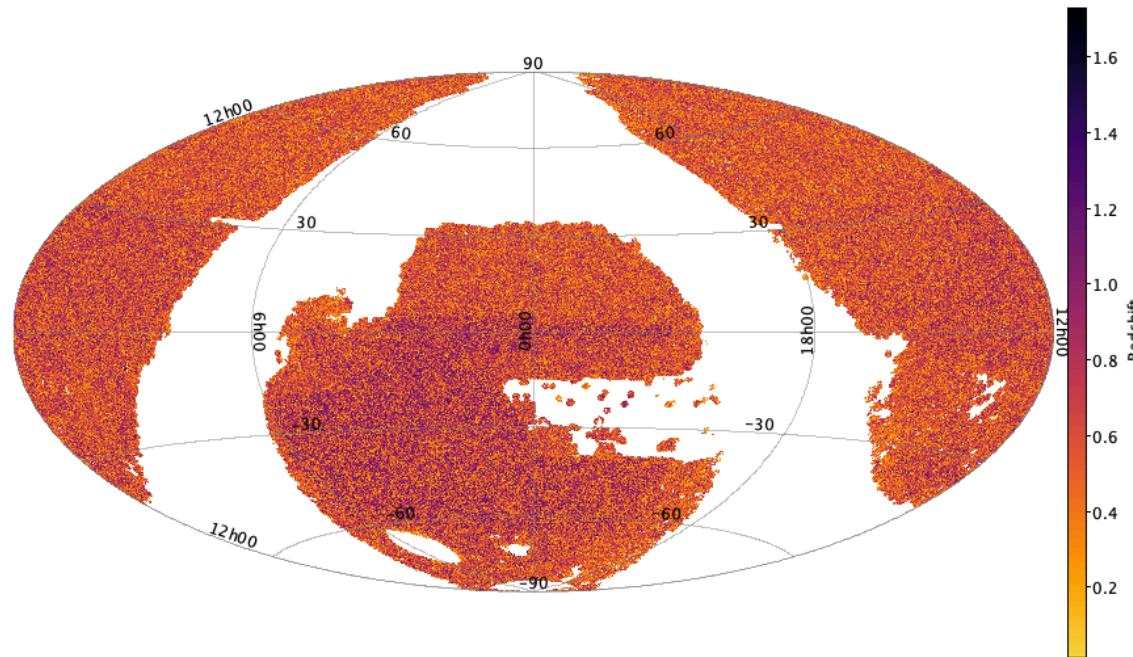
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The **DESI** legacy survey has studied large areas of the sky and several cluster catalogues have been produced.

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Of these, I used the **Wen & Han (2024)** catalogue of over 1.5 million clusters across the whole sky.



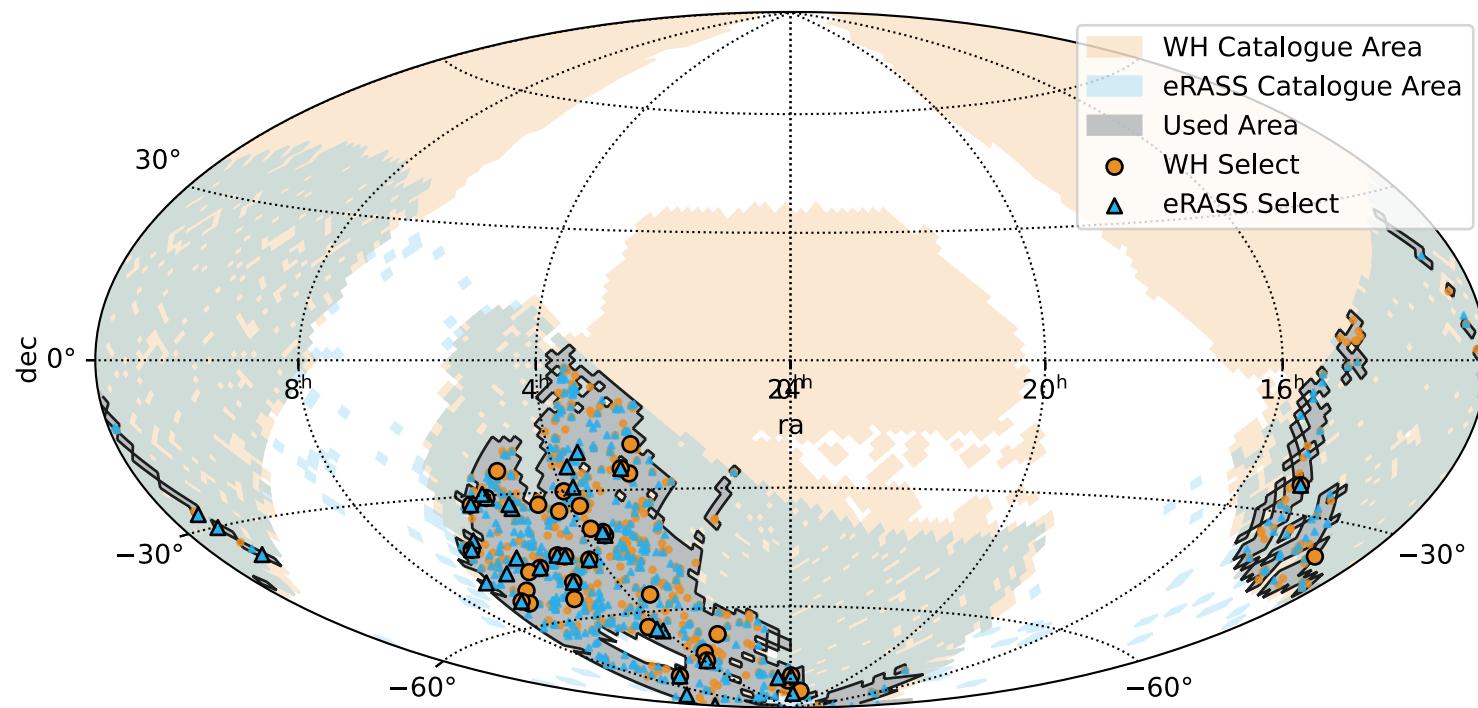
*Wen & Han (2024)*

# Sample Cross-Matching

Cross-matched the catalogues in a search area where the eRASS1 exposure > 170 s & where the **eRASS sky** intersects with the **Wen & Han field** for  $0.1 < z < 0.2$ .

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# DATA ANALYSIS

# X-rays Generate and Analyse

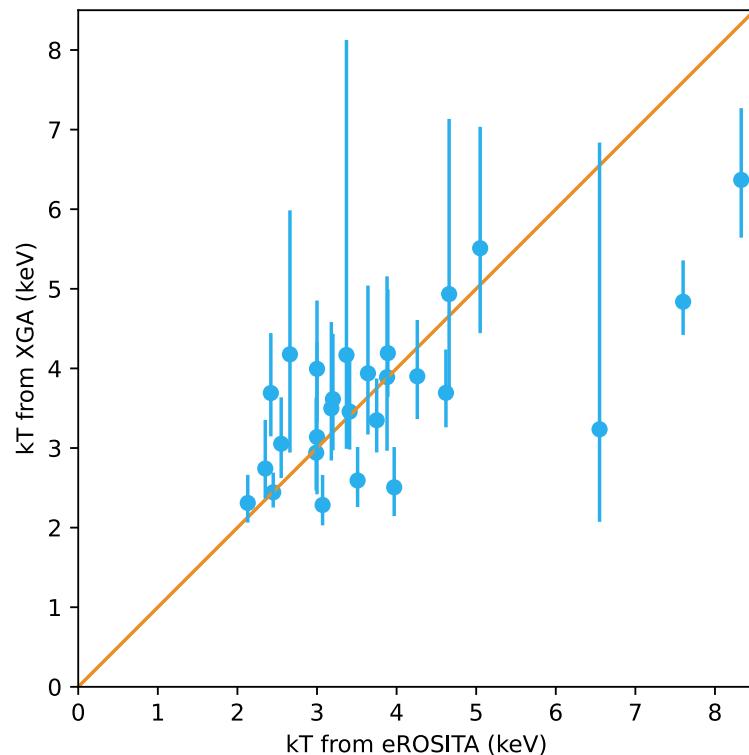
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*Turner et al. 2022, 2024a, 2024b*

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Validated XGA results by comparing its cluster temperatures with those from the eRASS catalogue.

Turner et al. 2022, 2024a, 2024b

# Scaling Relations – Set-up

I measured luminosities ( $L$ ) with **XGA** and took richnesses ( $\lambda$ ) from the **Wen & Han (2024)** catalogue for all clusters in the samples.

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Account for cluster evolution by adjusting  $L$  by the standard evolution factor  $E(z)$

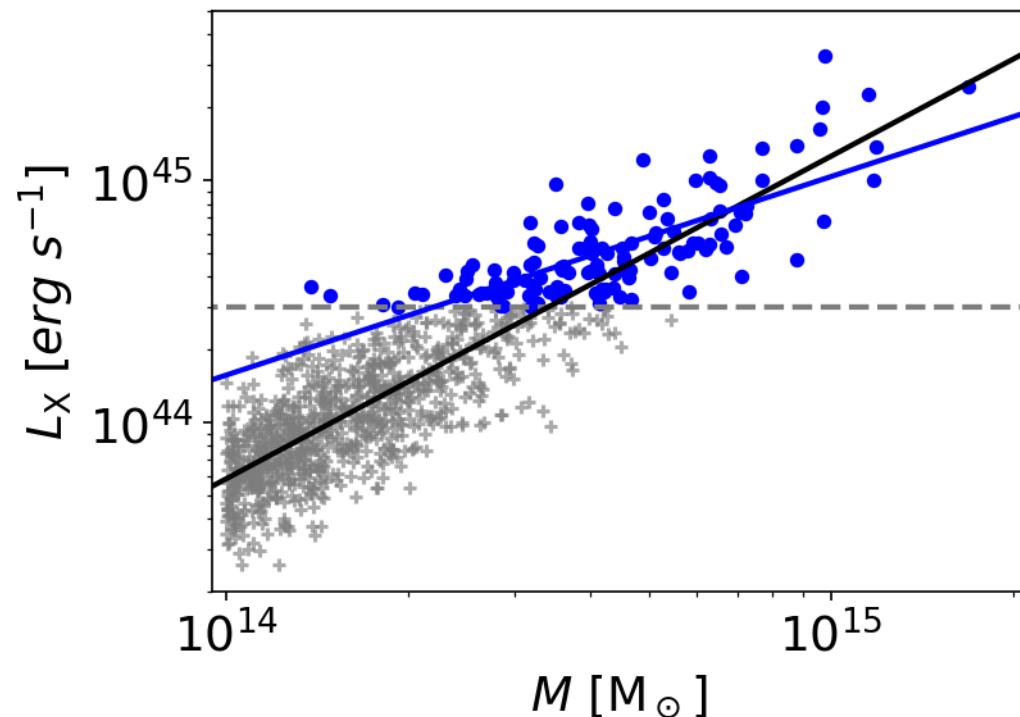
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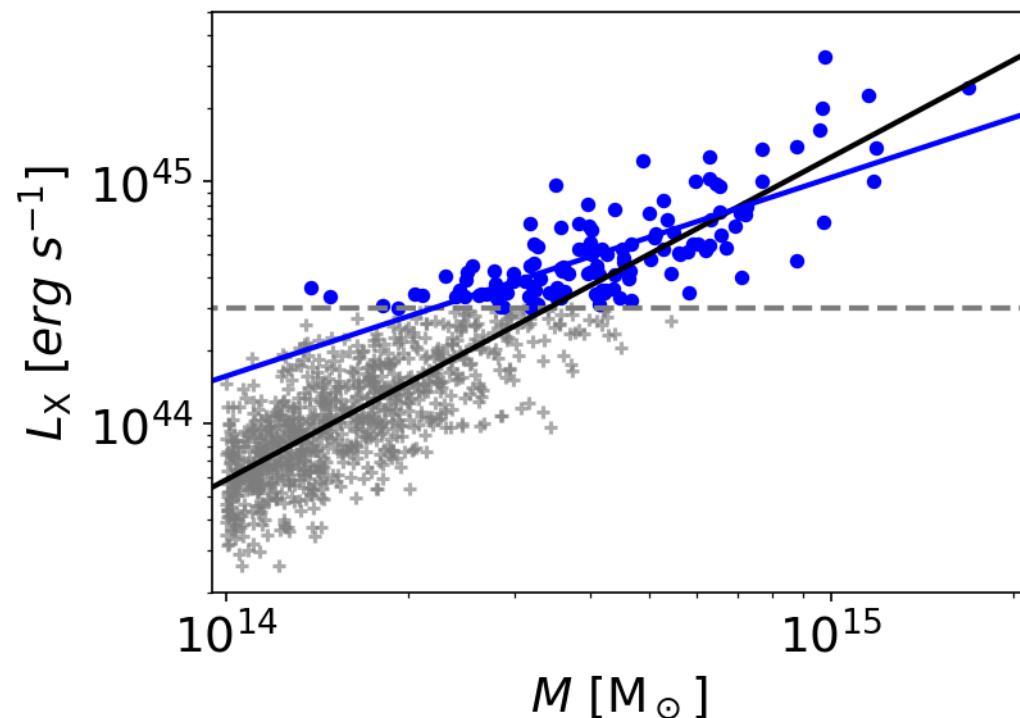
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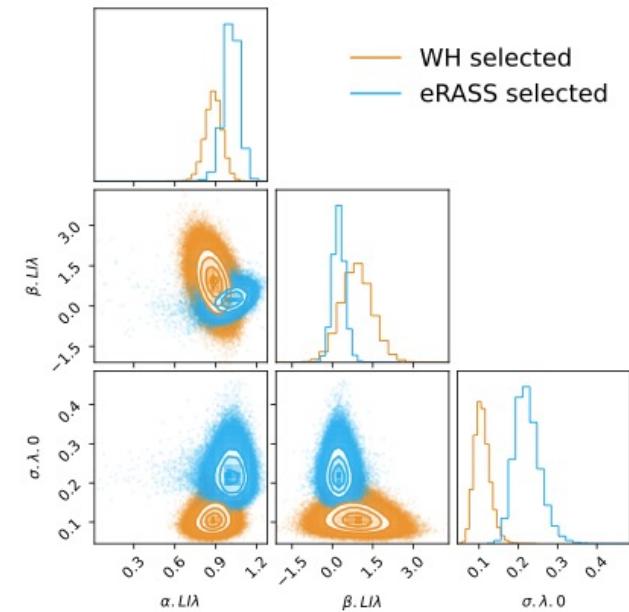
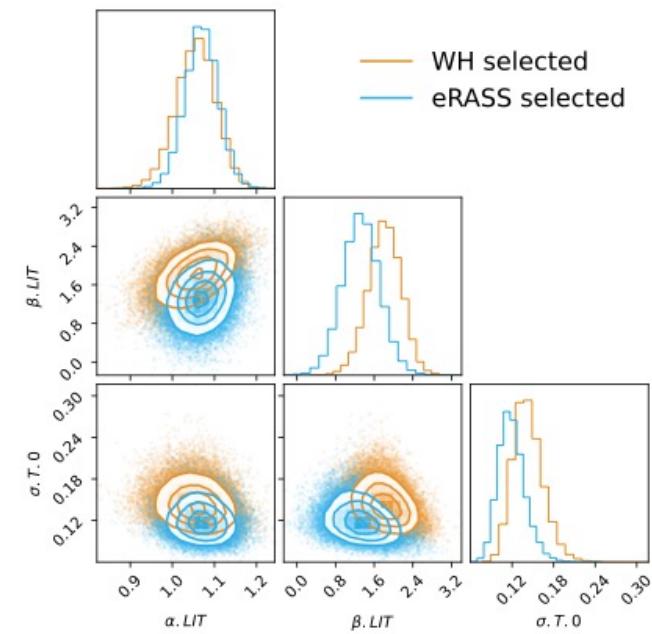
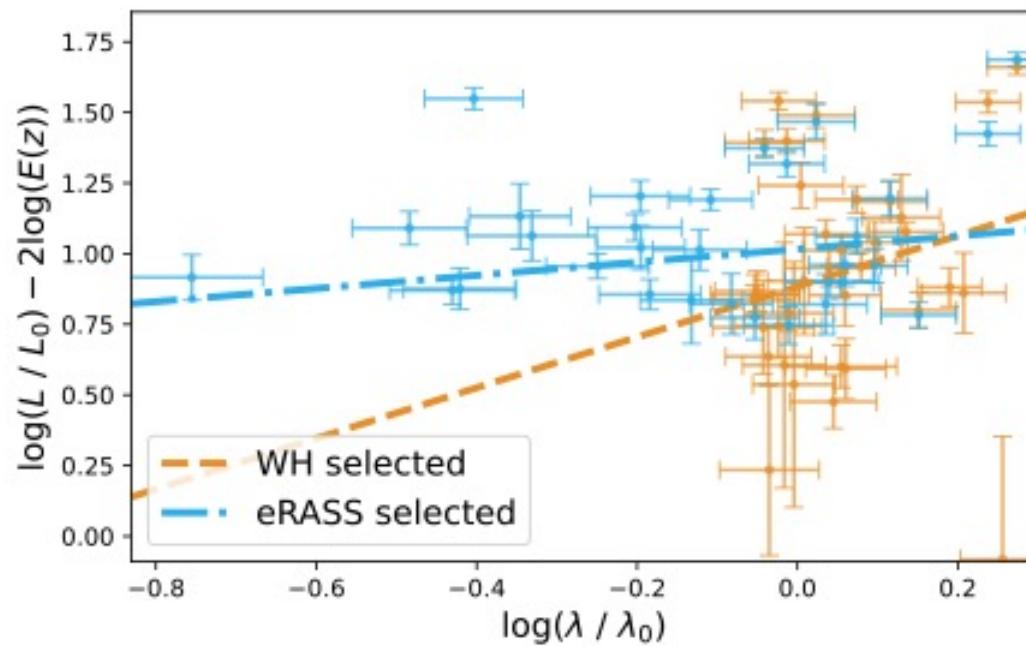
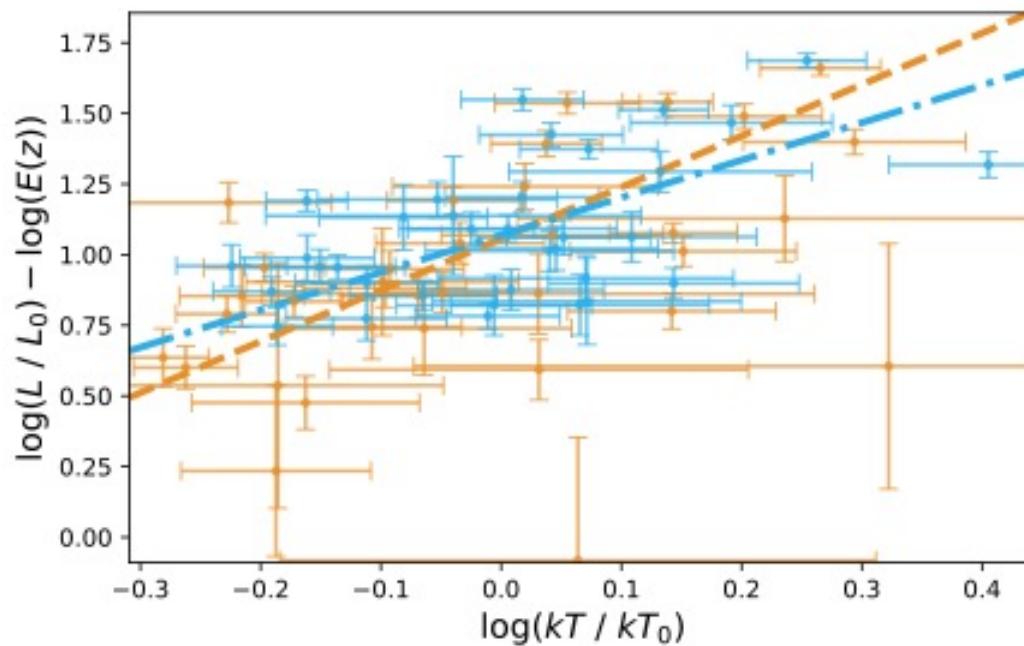
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See **Zoe Altria's** talk on her work fitting scaling relations!

# RESULTS

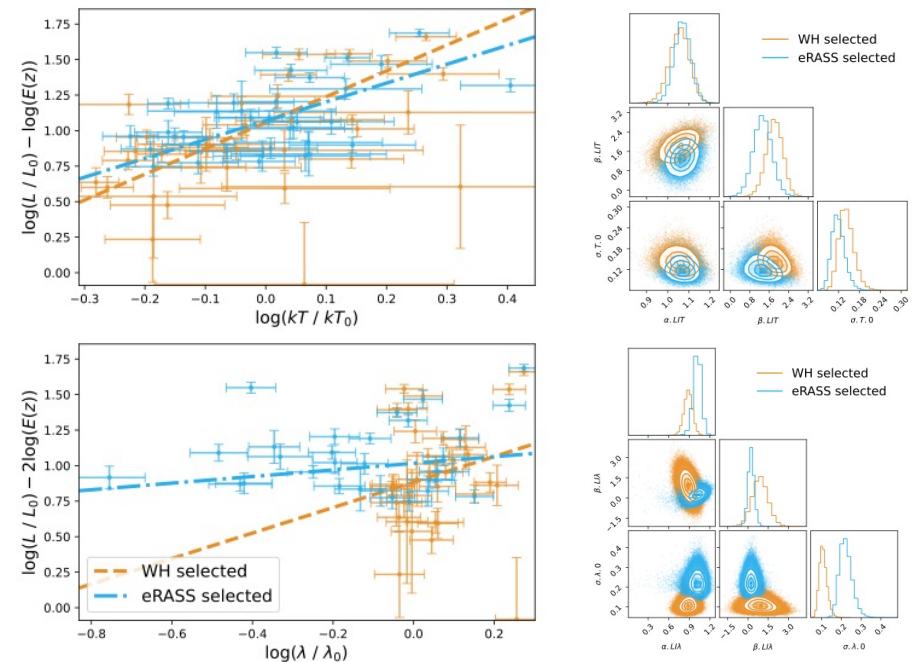
# Results



# Discussion

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Parameter	$L - T$		$L - \lambda$	
	WH	eRASS	WH	eRASS
$\alpha$	$1.06 \pm 0.05$	$1.07 \pm 0.04$	$0.88 \pm 0.06$	$1.02 \pm 0.06$
$\beta$	$1.8 \pm 0.3$	$1.3 \pm 0.4$	$0.9 \pm 0.6$	$0.2 \pm 0.2$
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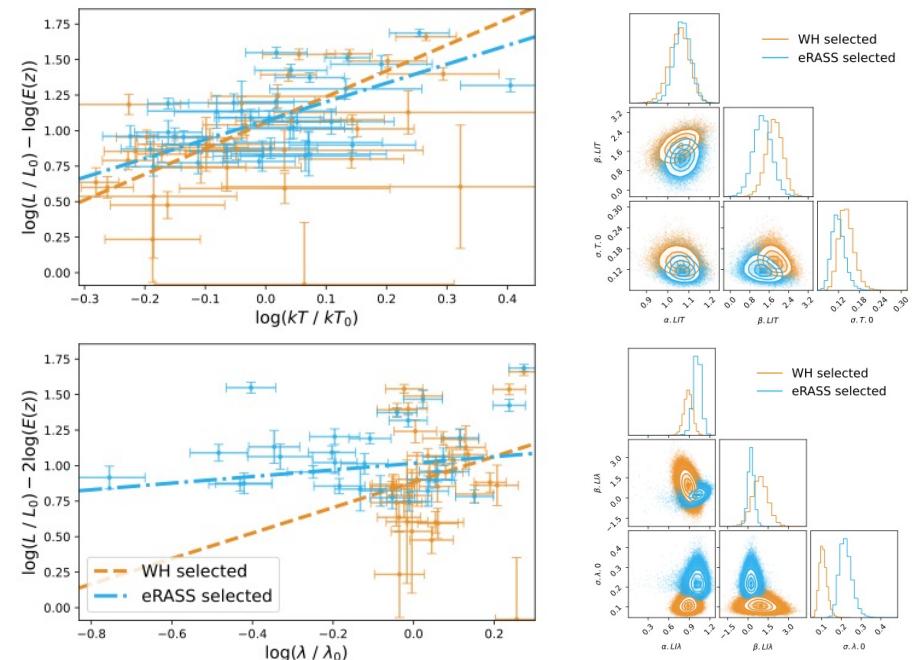


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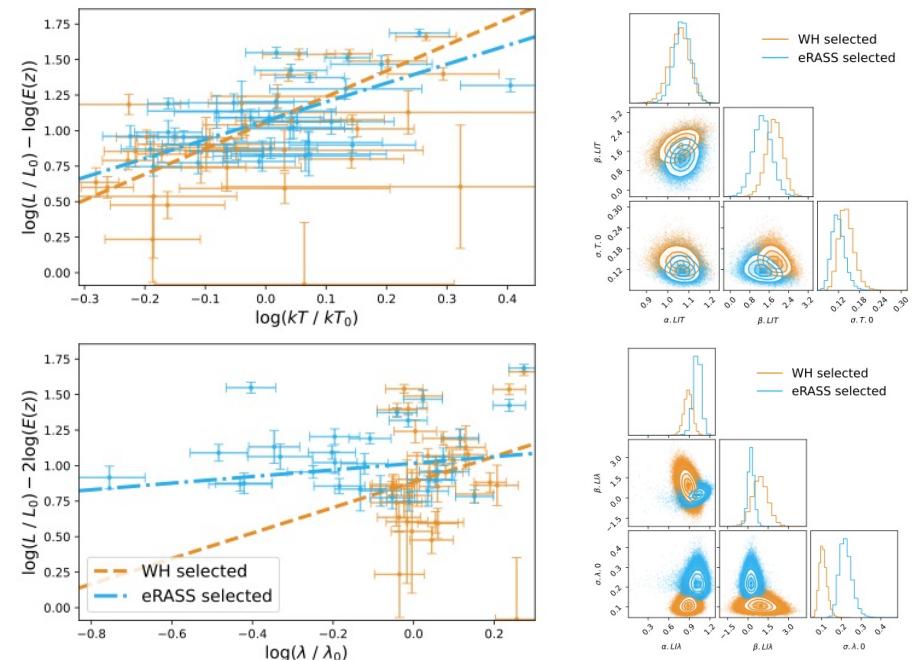
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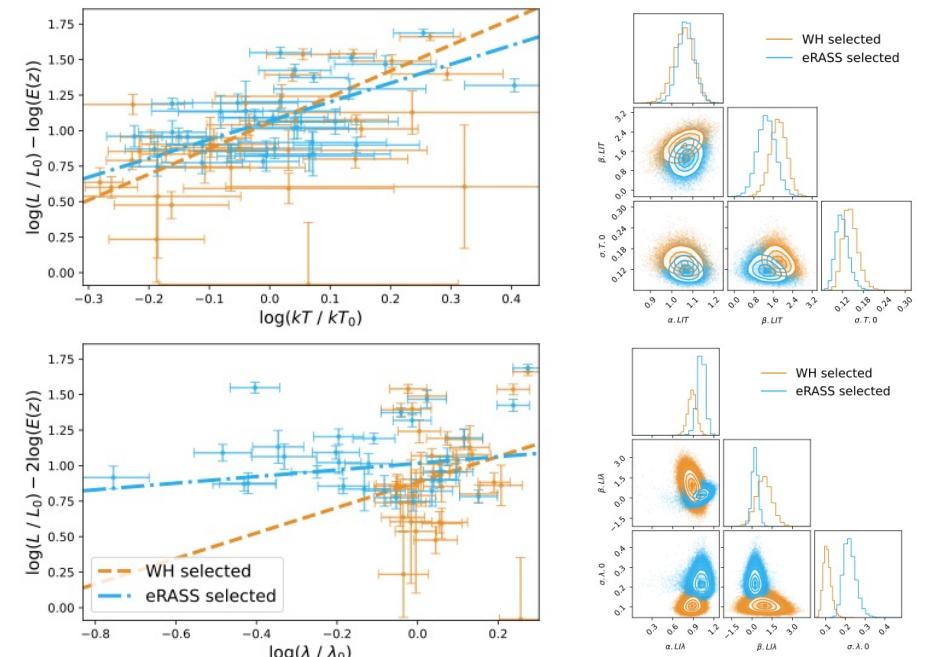
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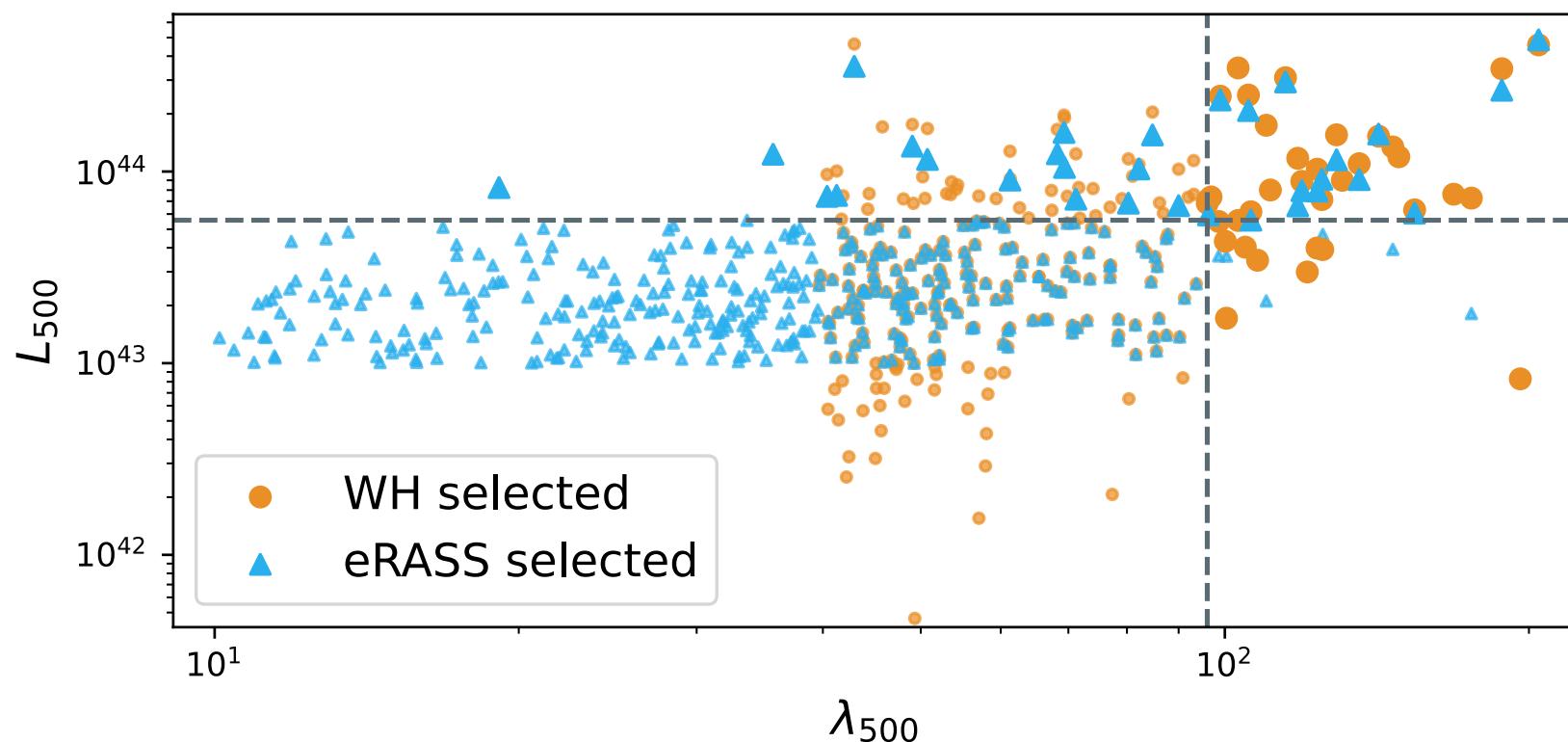
Similar to Andreon et al. (2016), we see a lot of high  $\lambda$ , low  $L$  clusters in the optical sample missed by the X-ray

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# Future Work

My samples are currently very **incomplete**. I have used only 35 from each selection method of a possible 500 that I identified during sample selection:



# SUMMARY

- ▶ Previous works have suggested that we are missing clusters, impacting cosmology
- ▶ I am trying to investigate this by comparing scaling relations of cluster properties
- ▶ Currently, the results are inconclusive but indicate that there might be something going on
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ANY QUESTIONS?