University of BRISTOL

1 June 2023

The X-ray Properties of Optically Selected Galaxy Groups

C. Wood[1], B. Maughan[1], J. Crossett[2], D. Eckert[3], M. Pierre[4], and A. S. G. Robotham[5]

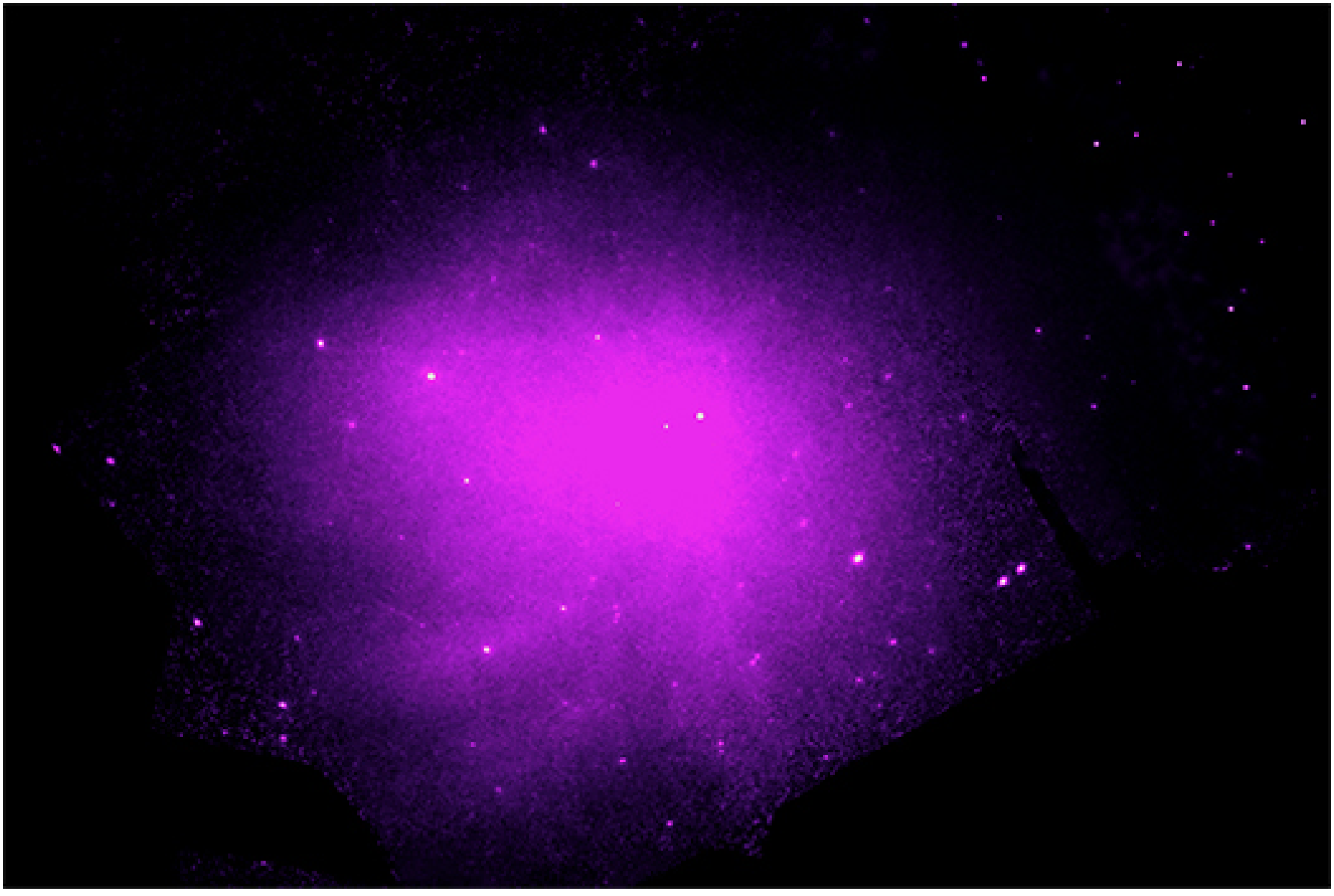
[1]University of Bristol, [2]Universidad de Valparaiso, [3]University of Geneva, [4]Université Paris-Saclay, [5]ICRAR

cai.wood@bristol.ac.uk

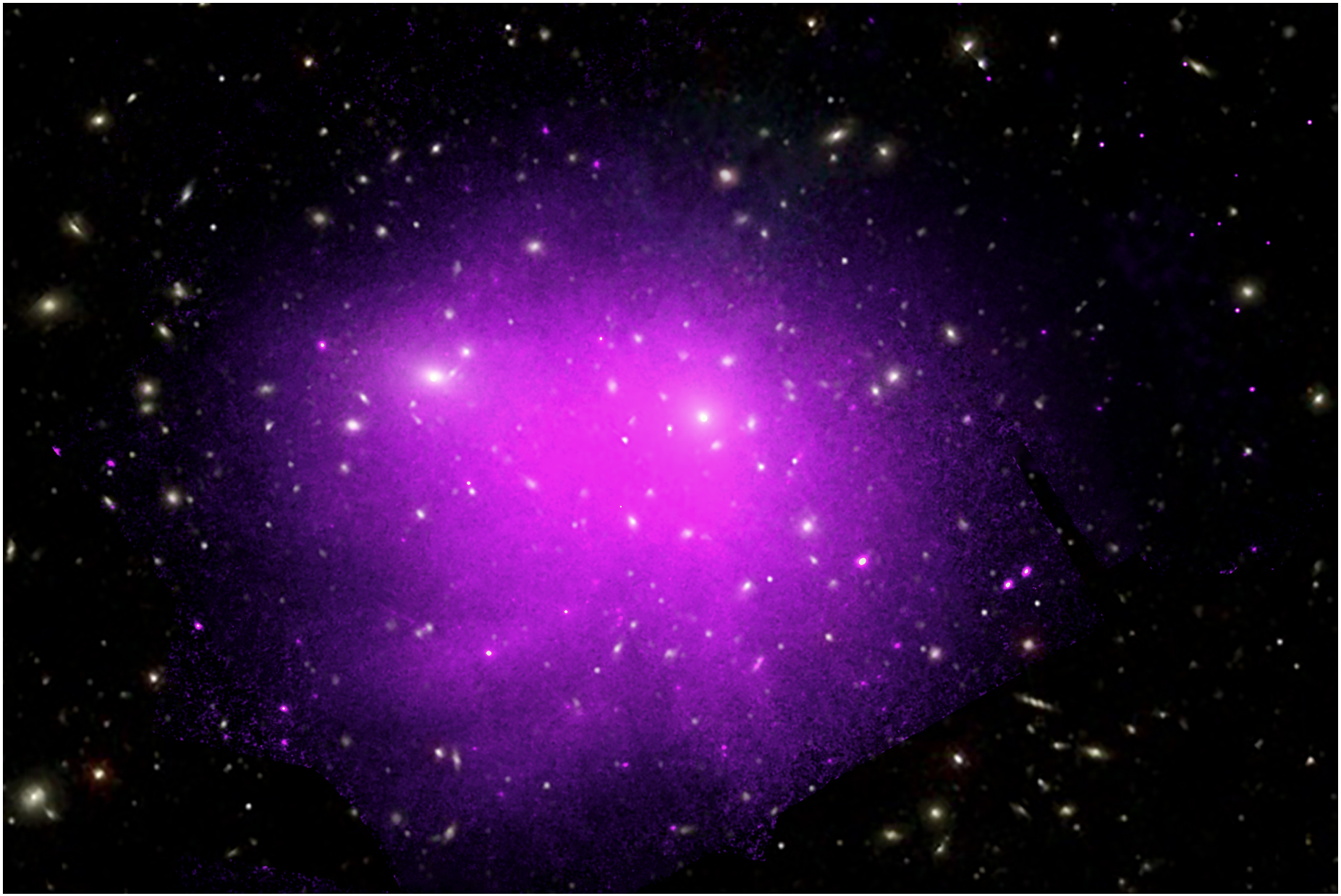
Introduction

- What are Galaxy Groups?
- Self-similarity
- GAMA & XXL surveys
- Measure X-ray Luminosity of Optically Selected Galaxy Groups
- X-Ray Luminosity Function
- Luminosity - Mass Relation

Credit: SDSS

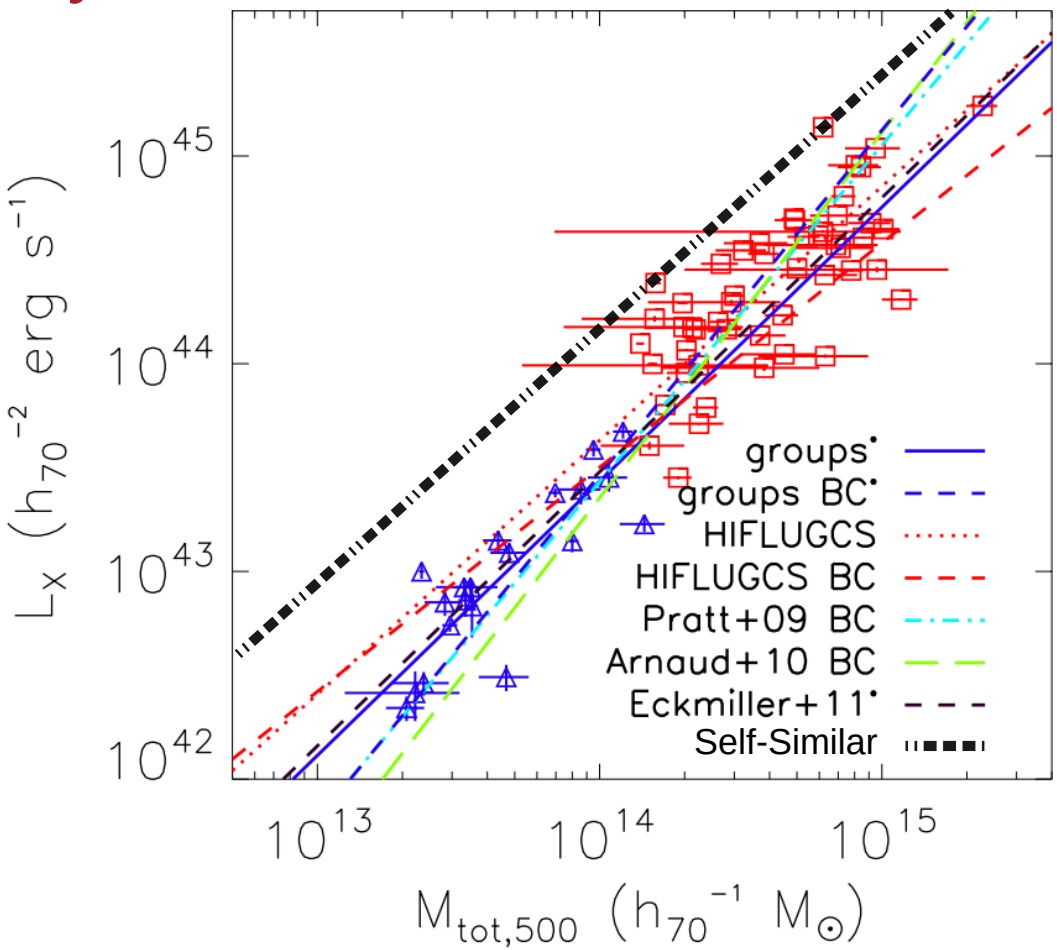


Credit: NASA/CXC/Univ. of Chicago, I. Zhuravleva et al



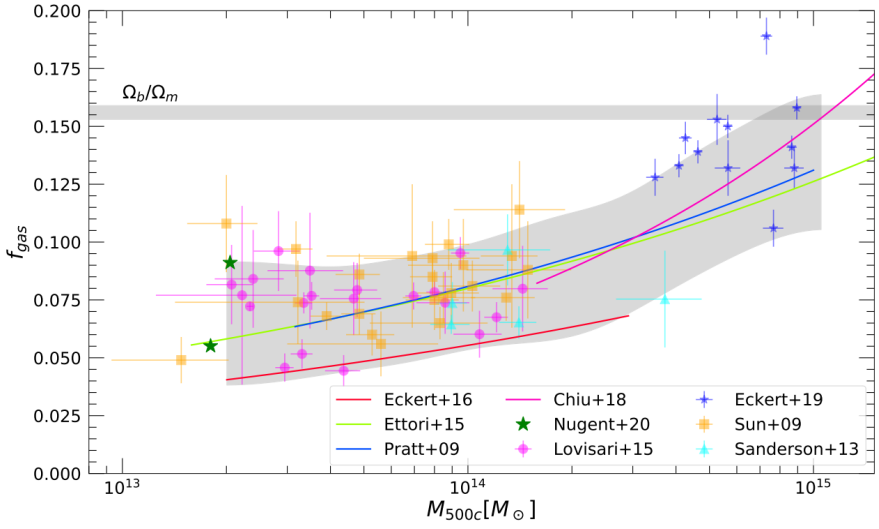
Credit: X-ray: NASA/CXC/Univ. of Chicago, I. Zhuravleva et al, Optical: SDSS

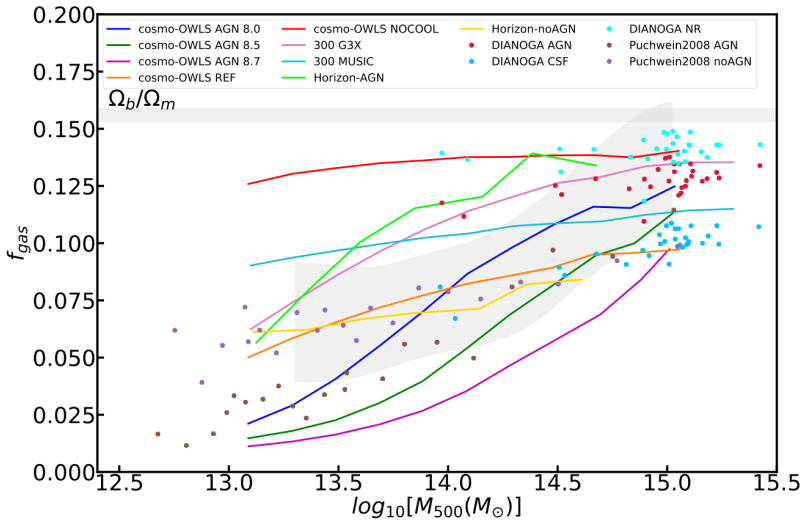
Self-Similarity



From: Lovisari et al. (2015)

Feedback

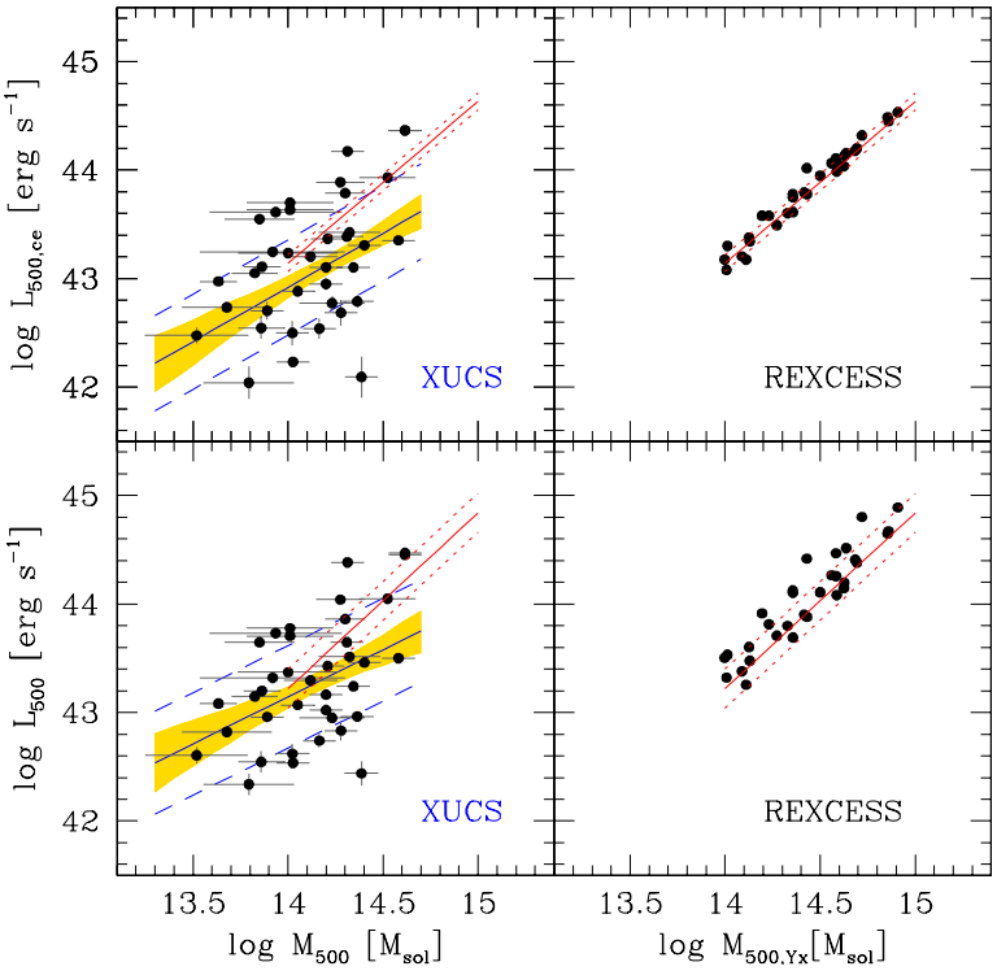




Selection effects...

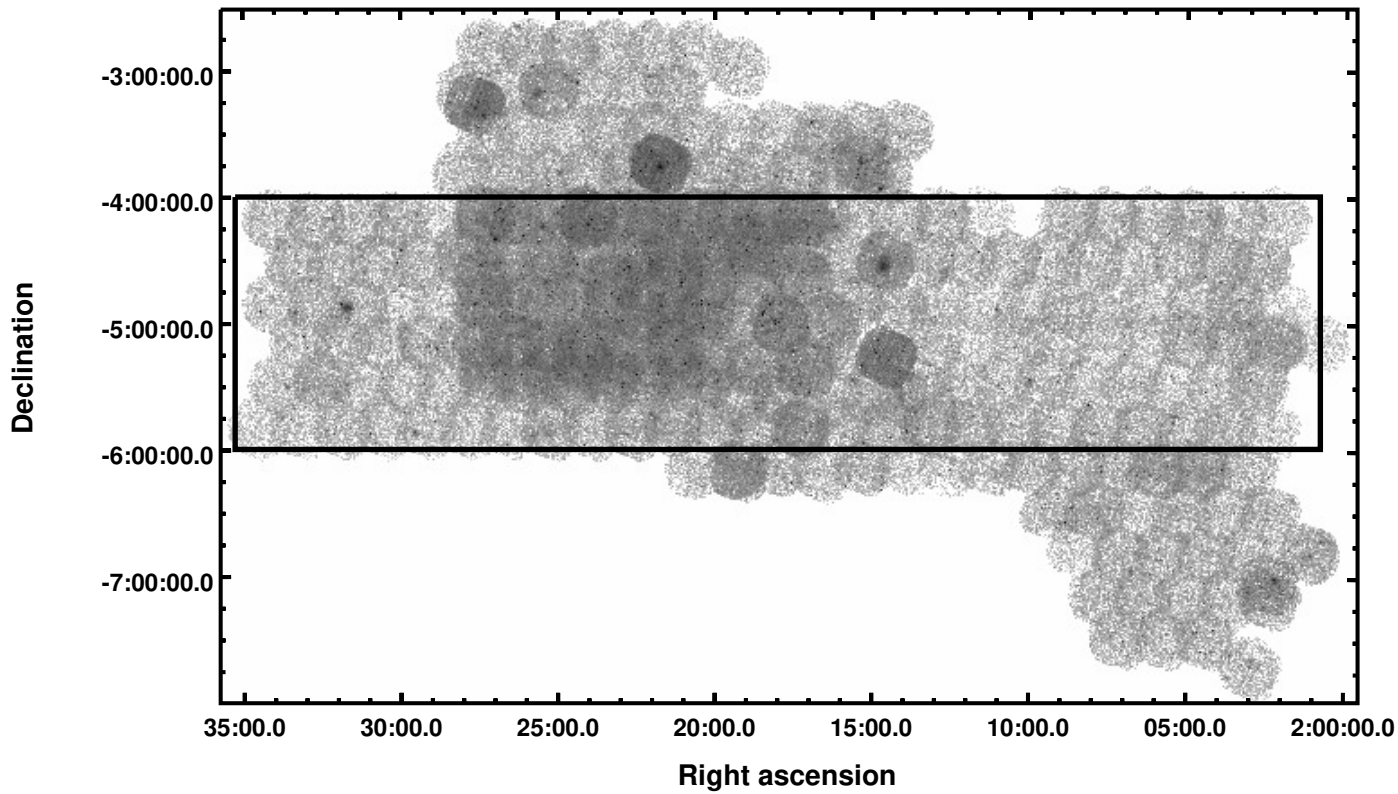
From: Eckert et al. (2021)

Selection bias



From: Andreon et al. (2016)

- XXL X-ray survey
- GAMA spectroscopic survey
- 235 GAMA groups (with 5+ members) in overlapping region

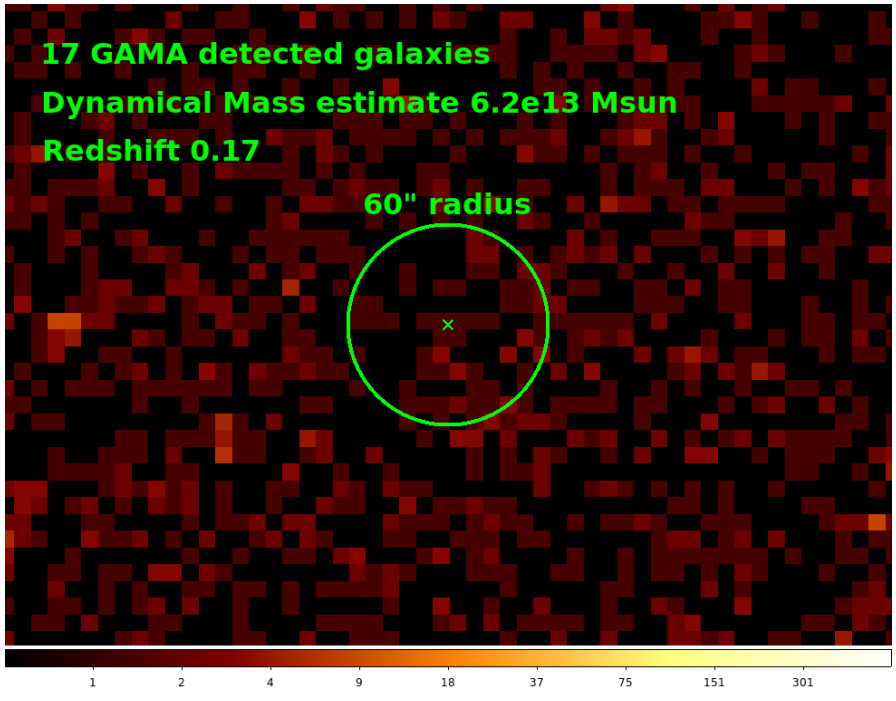


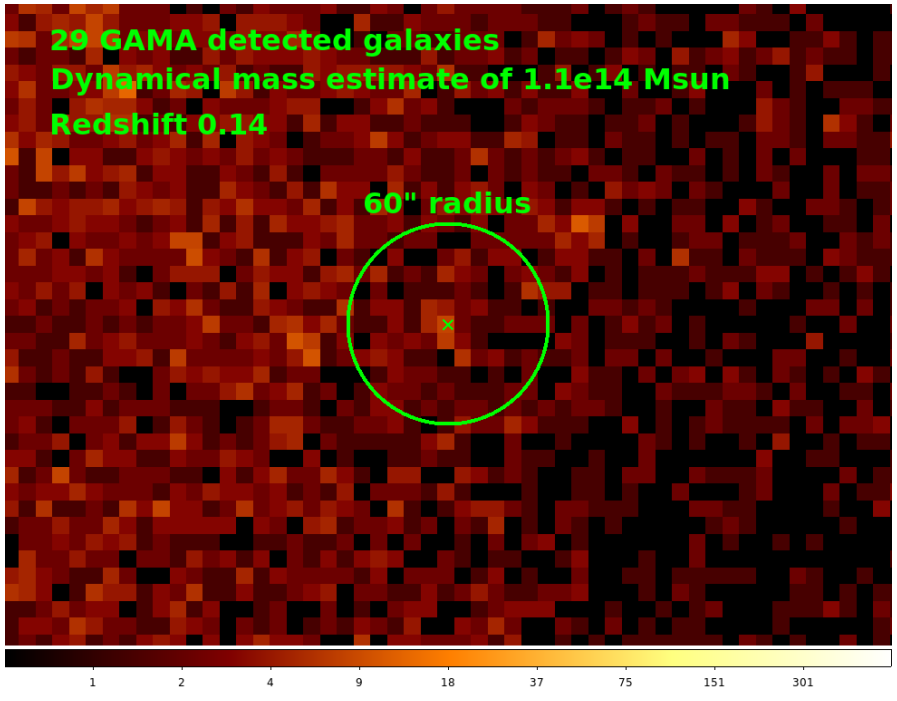
GAMA: Driver et. al (2011), XXL: Pierre et al. (2016)

FoF Algorithm: Robotham et al. (2011)

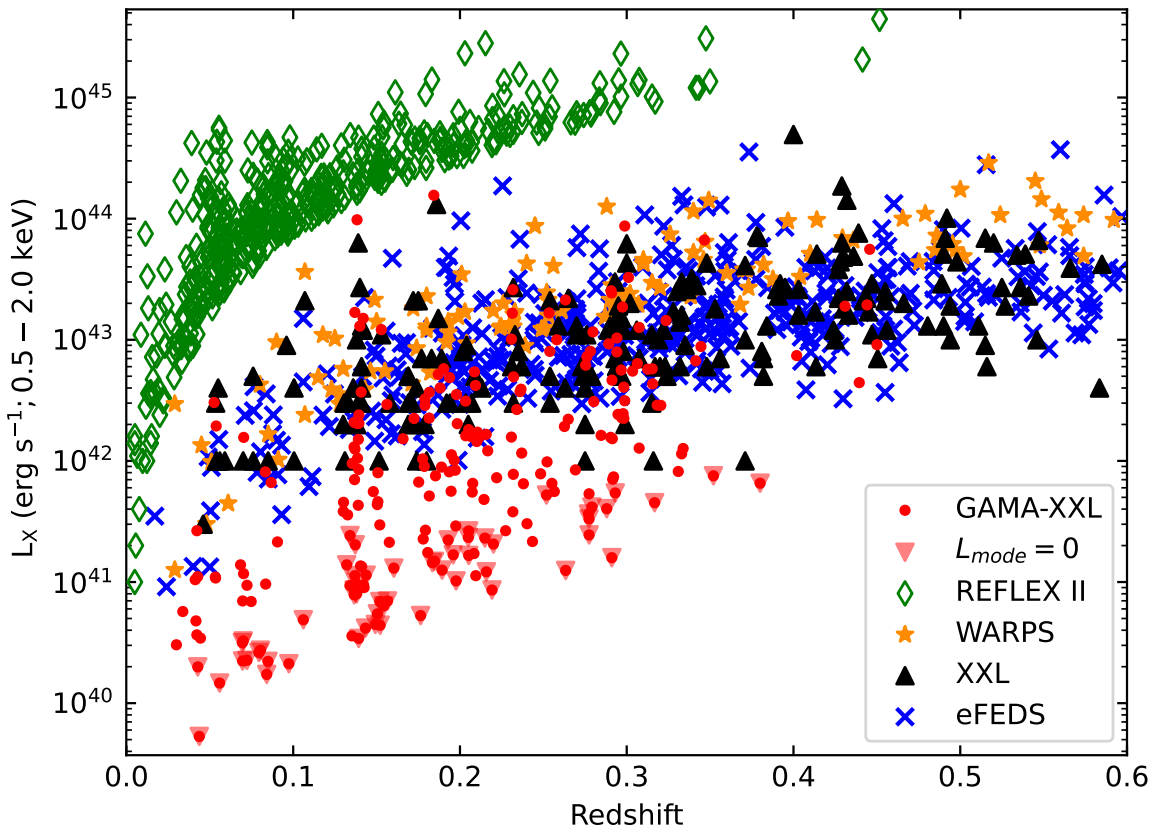
X-ray Undetected Groups

- 77% are not detected as clusters by XXL
- Use luminosity posterior



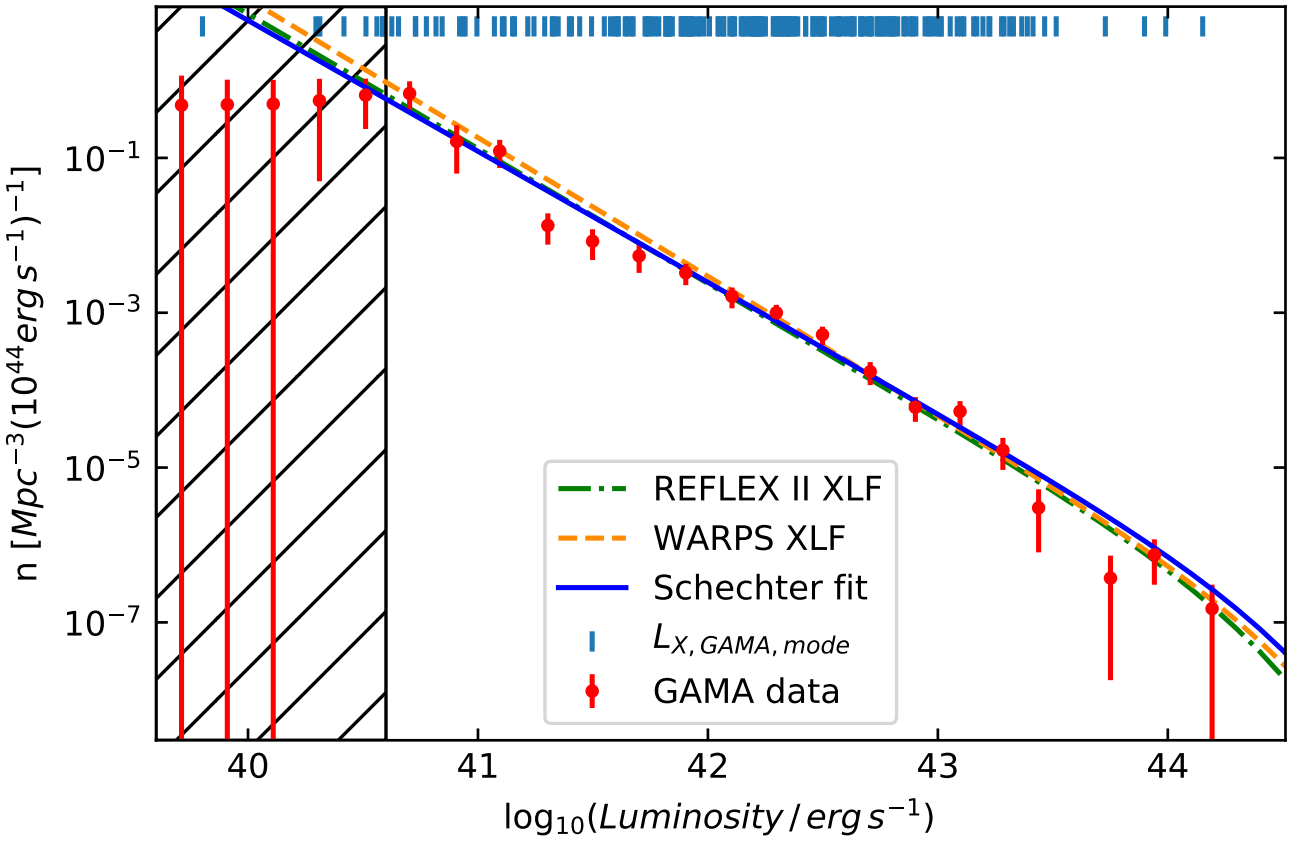


Luminosity - Redshift Space



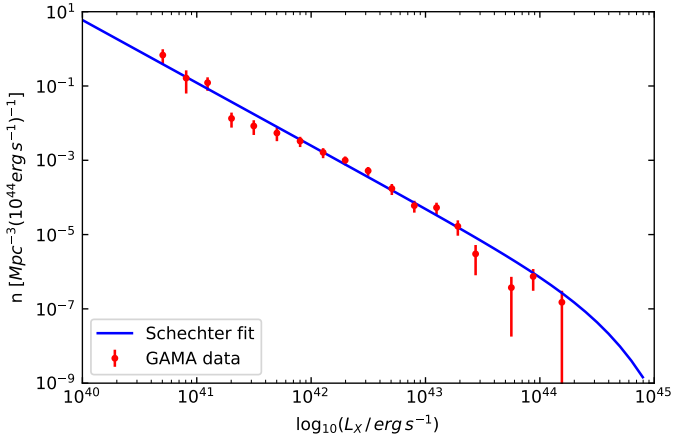
REFLEX II: Böhringer et al. (2014), WARPS: Koens et al. (2013), XXL: Pacaud et al. (2016), eFEDS: Liu et al. (2021)

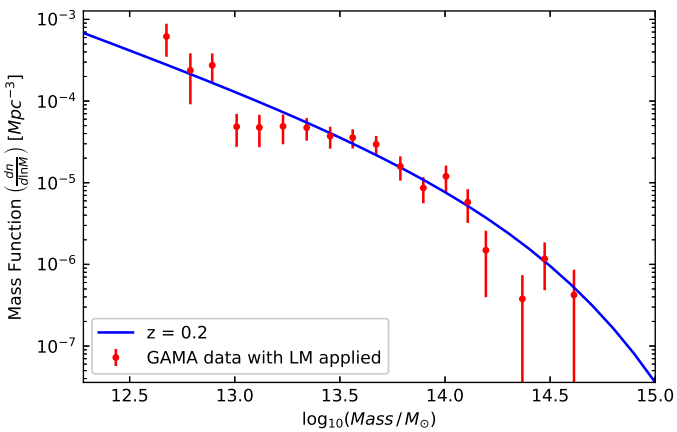
X-ray Luminosity Function

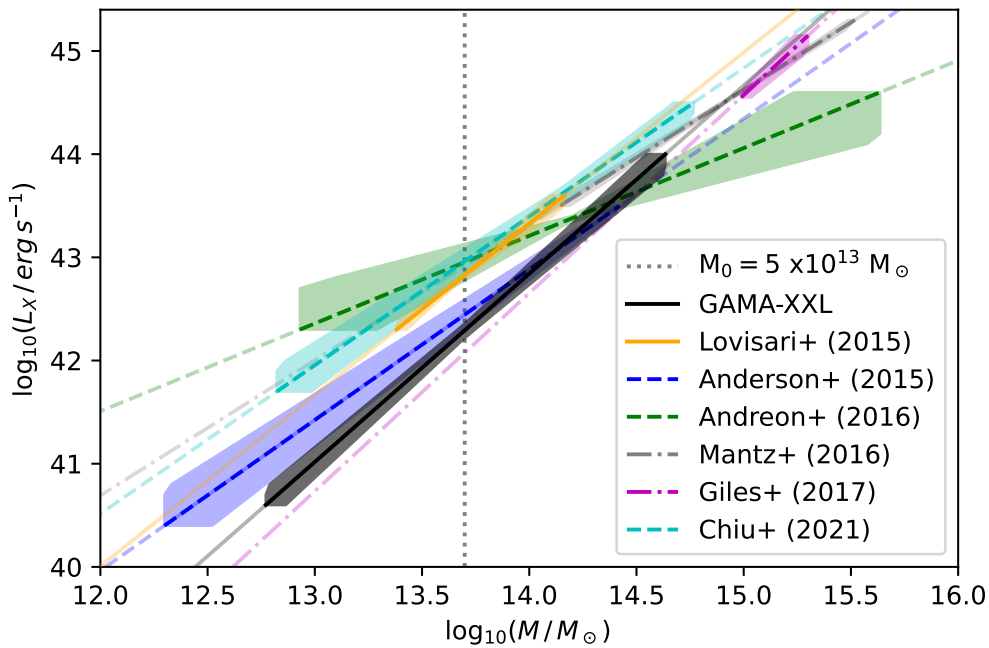


REFLEX II: Böhringer et al. (2014), WARPS: Koens et al. (2013)

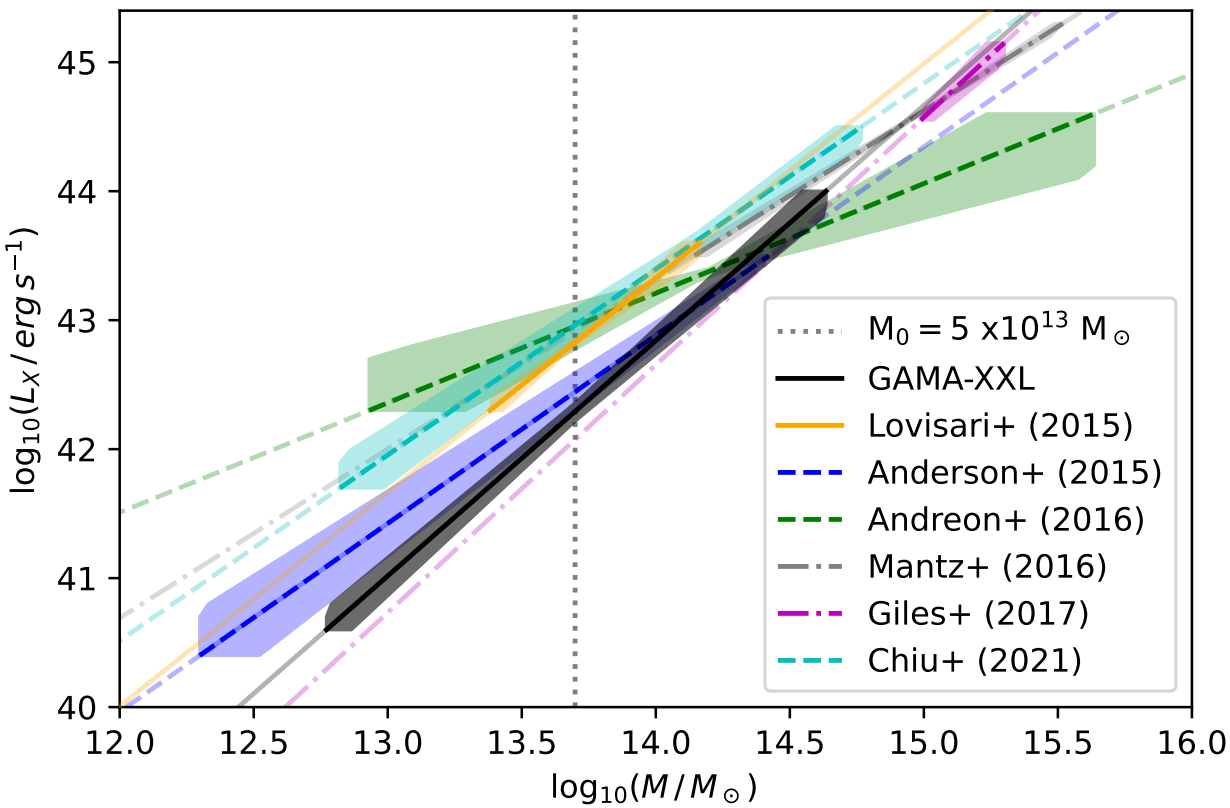
Luminosity - Mass Relation





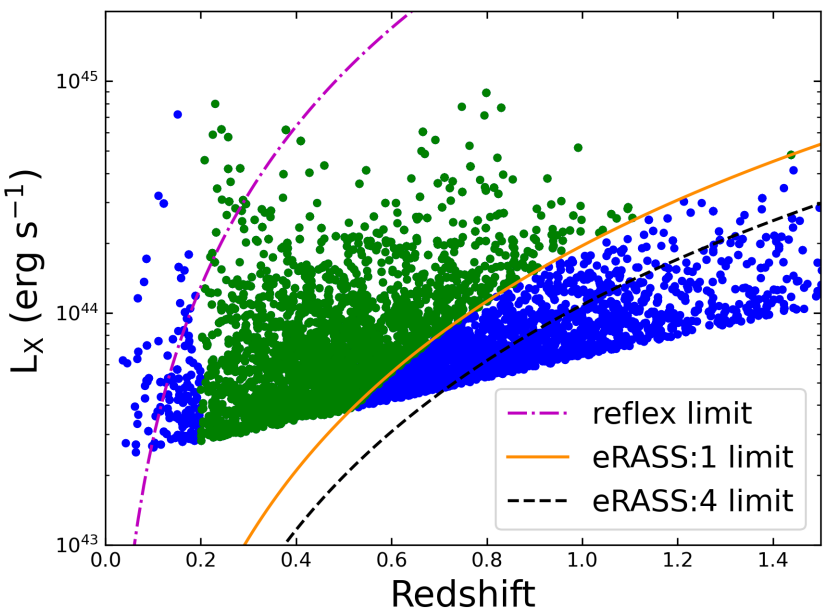


Luminosity - Mass Relation



Euclid & eROSITA

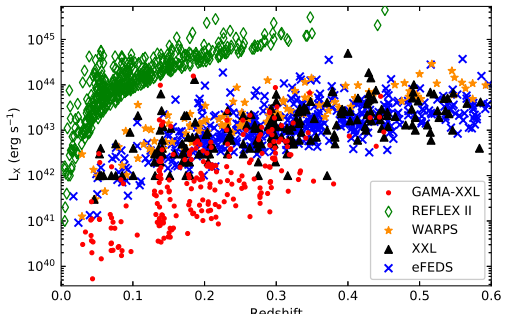
- DR1 / eRASS:1 overlap $\sim$ 1,250 deg^2
  - estimate 5,000 clusters
- DR3 / eRASS:4 overlap $\sim$ 7,500 deg^2
  - estimate 60,000 clusters

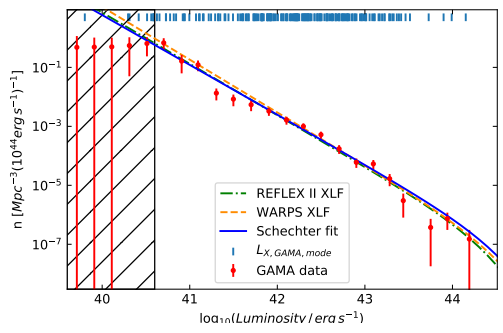


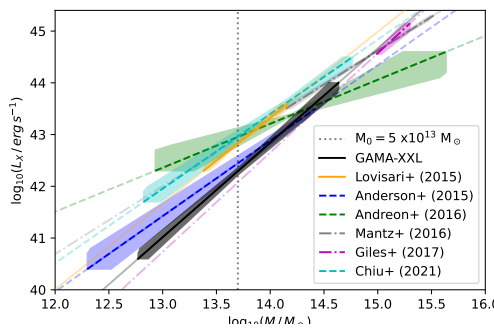
Forecast from Sartoris+ (2016)

Summary: Part 1

- Measured X-ray luminosities of optically selected galaxy group sample
- Observed X-ray luminosity function and inferred luminosity-mass relation shape
- Inclusion of non-detections allowed exploration of low luminosity regime
- Results suggest feedback and X-ray selection bias present







Euclid: Mass / Richness Covariance using ICM mass proxies

C. Wood[1], B. Maughan[1], L. Baumont[2], F. Pacaud[3], and G. Pratt[2]

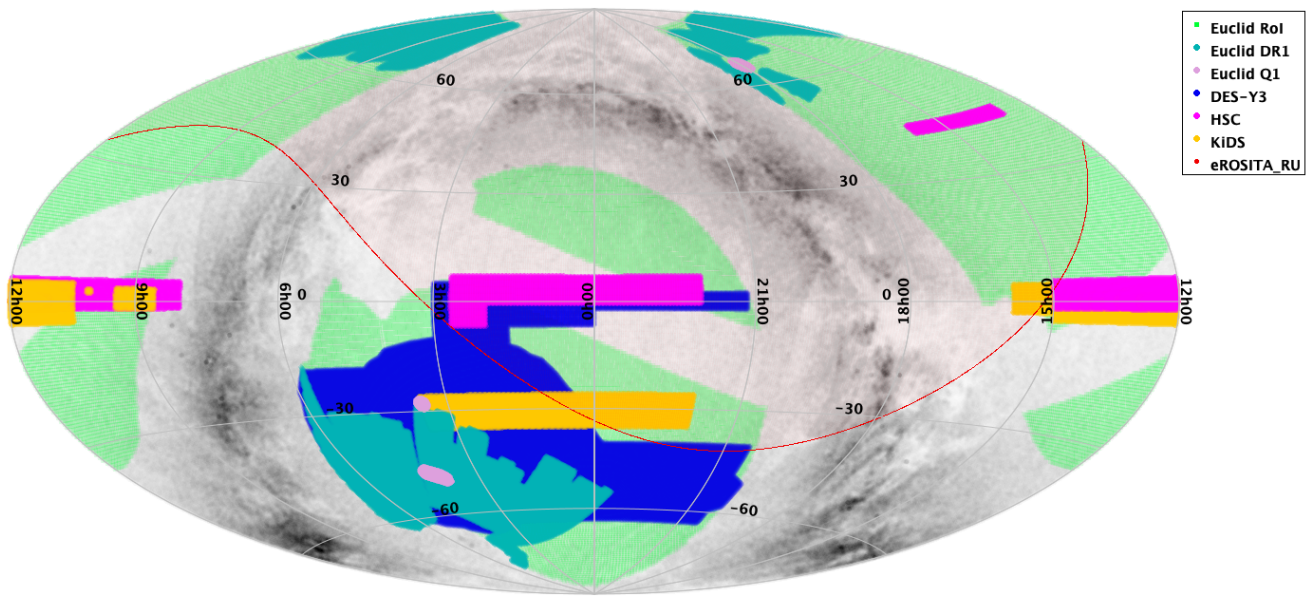
[1]University of Bristol, [2]Université Paris-Saclay, [3]University of Bonn

Introduction

- Why covariance matters to Euclid
- How we can use ICM proxies to measure covariance
- XXL, eFEDS & HSC surveys
- Work in Progress...

Euclid

- Near-infrared survey covering $\sim$ 15,000 deg^2 of extragalactic sky
- Estimate 2 $\times 10^6$ clusters with M $> 10^{14} M_\odot$ out to z ~ 2
- Selection function has weak redshift dependence
- Weak lensing mass measurements expected for clusters at z ≤ 0.6

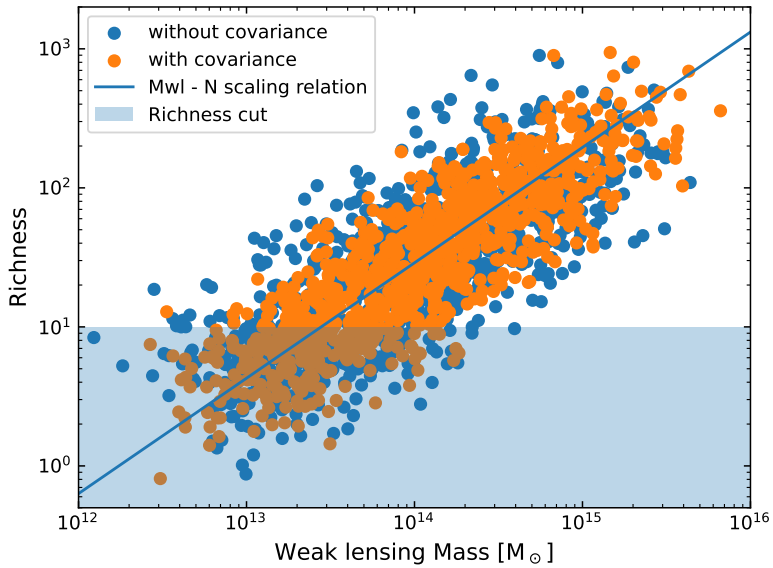


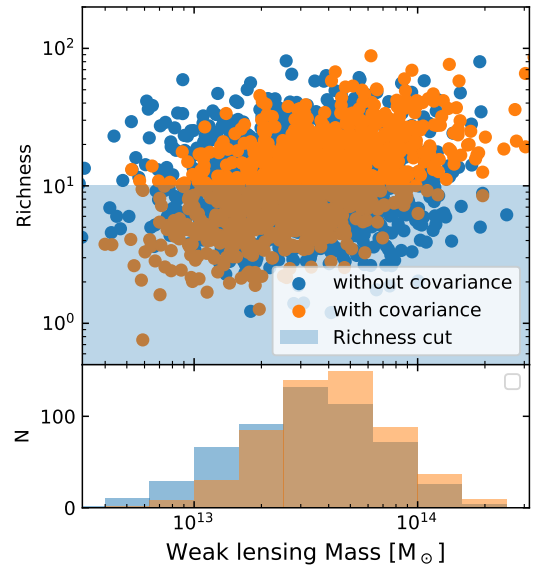
Forecast from Sartoris+ (2016)

Image credit: Florian Pacaud

Euclid Mass / Richness Covariance

- Clusters selected on basis of “Euclid-richness”
- Weak-lensing masses measured for all clusters
- Covariance would lead to biased mass calibration
- Sources of covariance: LoS elongation, Miss-centring, shared photo-z

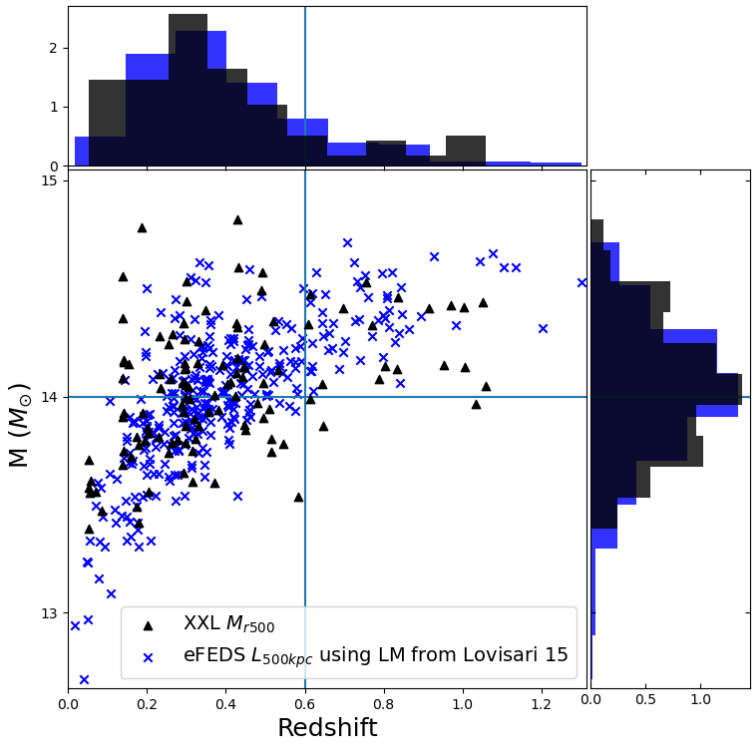




Using ICM mass proxy to measure covariance

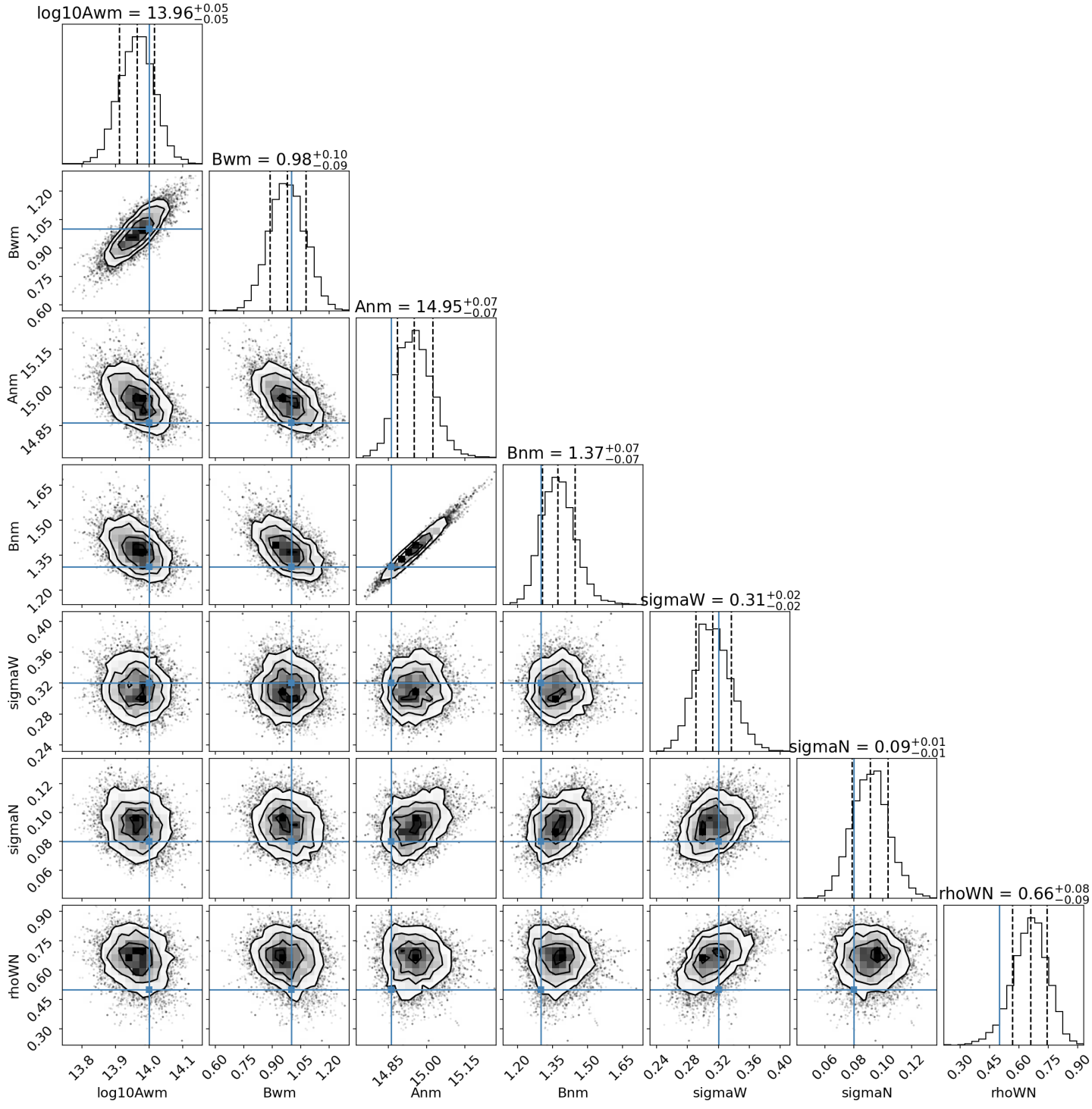
- Need completely independent selected sample
- Measure Euclidized richness and weak lensing masses
- Constrain the covariance based on ICM mass proxies
- Ideal mass proxy has low covariance with weak-lensing mass

eFEDS & XXL X-ray data



		XXL	eFEDS
Total in Overlap		197	378
M>14, z<0.6, X-Ray constraints		47	37
Matches	AMICO	44	35
	PzWav	31	25
No Matches	AMICO	3	2
	PzWav	16	12

$\sim$ 180 X-ray detected clusters

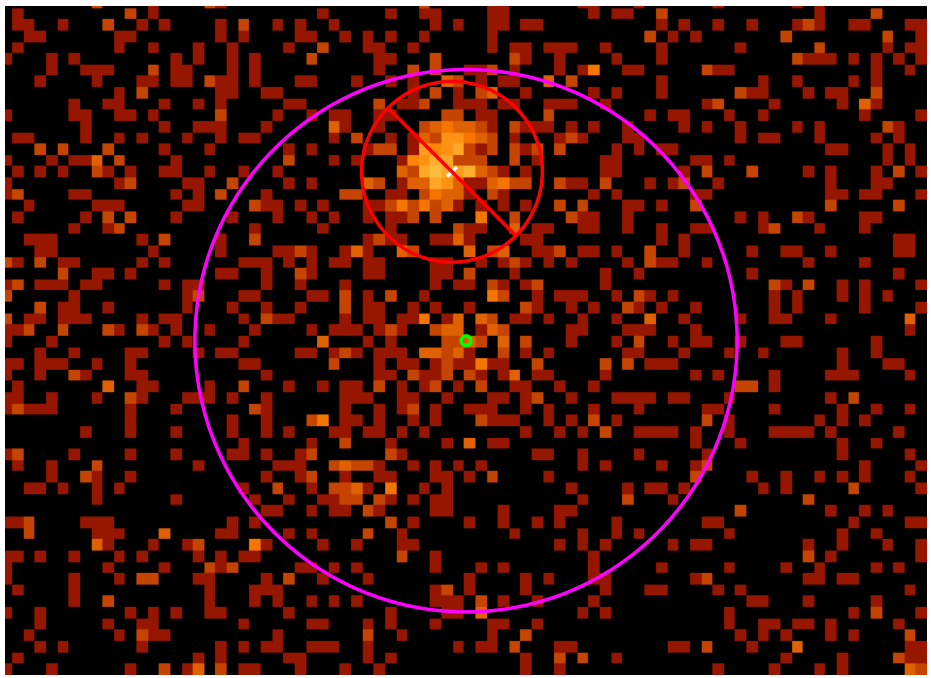

log10Awm = 13.96$^{+0.05}_{-0.05}$
Bwm = 0.98$^{+0.10}_{-0.09}$
Anm = 14.95$^{+0.07}_{-0.07}$
Bnm = 1.37$^{+0.07}_{-0.07}$
sigmaW = 0.31$^{+0.02}_{-0.02}$
sigmaN = 0.09$^{+0.01}_{-0.01}$
rhoWN = 0.66$^{+0.08}_{-0.09}$
log10Awm
Bwm
Anm
Bnm
sigmaW
sigmaN
rhoWN

Summary: Part 2

- Introduced why covariance may be an issue for Euclid
- Aim to measure Mass - Richness covariance using ICM proxies
- Work in progress on obtaining Euclidized measurements of X-ray selected sample
- pre-launch project, revisit with DR1

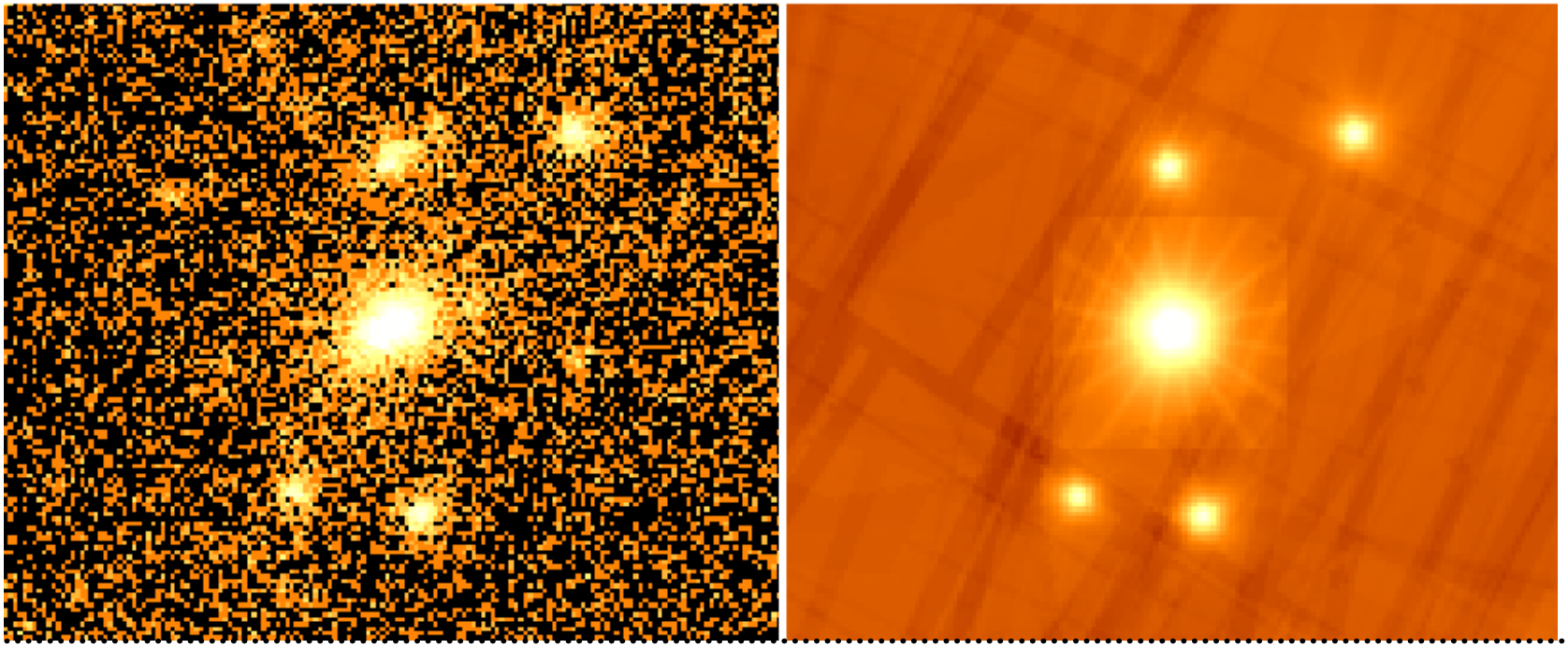
Excluding Non-Central Point Sources

For point sources located between 30” and 110” away from the group location, the point source region was masked and remaining flux in the aperture modelled and subtracted.

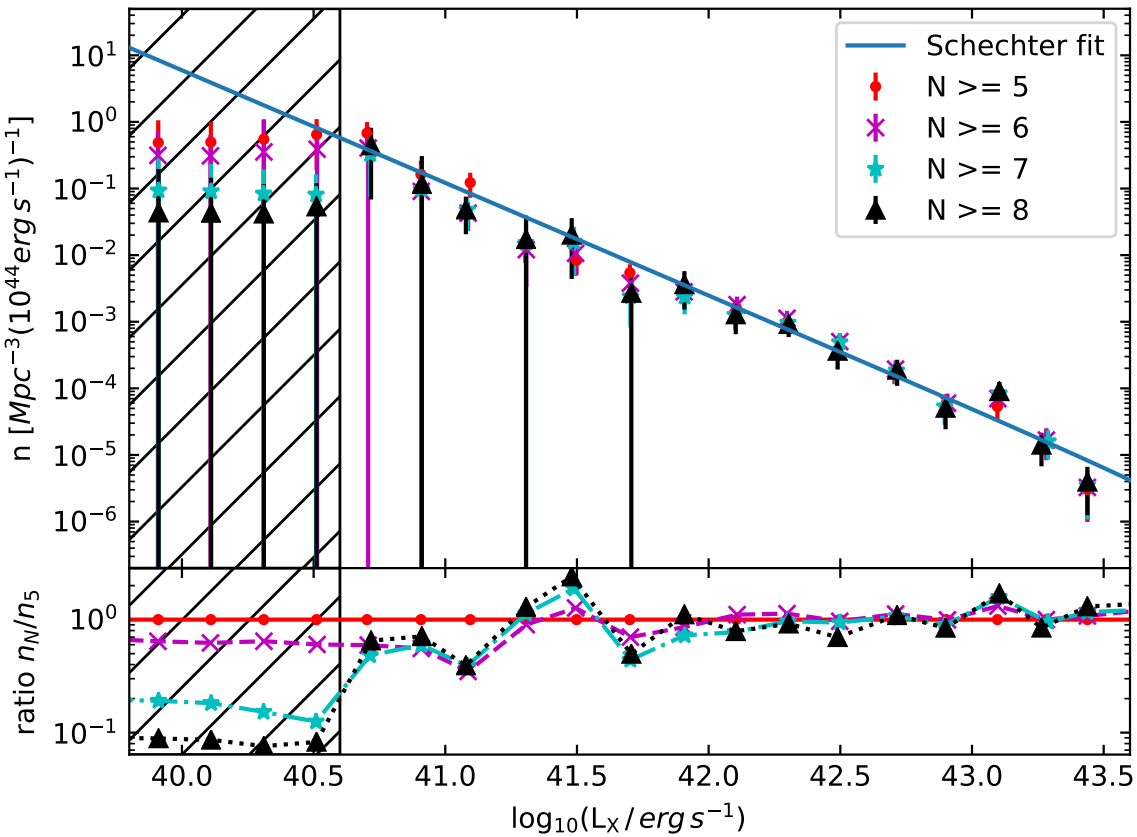


Modelling Central Point Sources

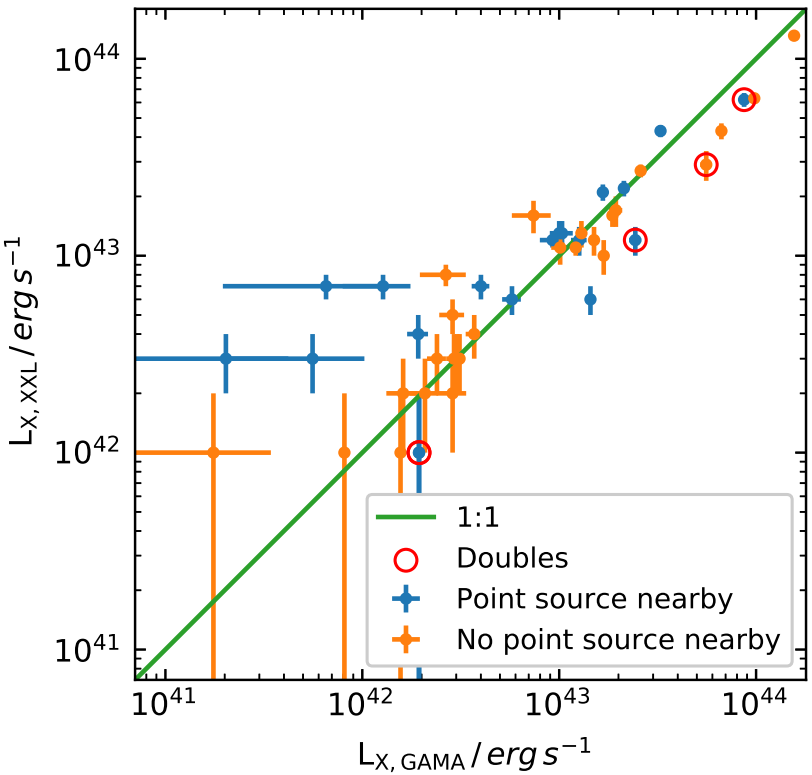
In cases where the point source was closer, the point source and group emission were modelled using the PSF and a beta model, and the proportion of emission expected from the group found.

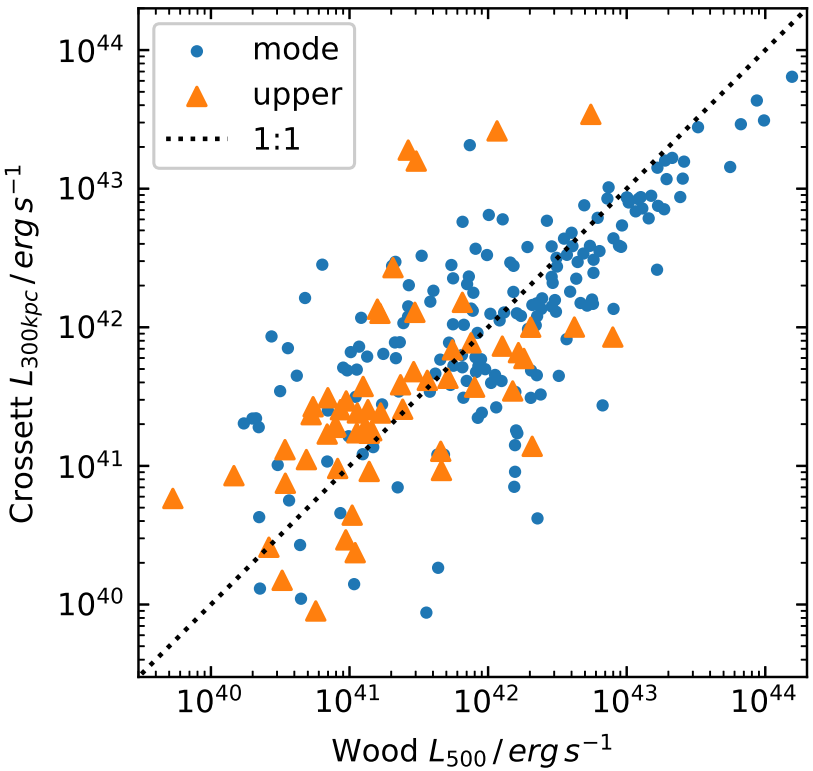


Testing N $\geq$ 5 cut-off



Comparing Luminosities

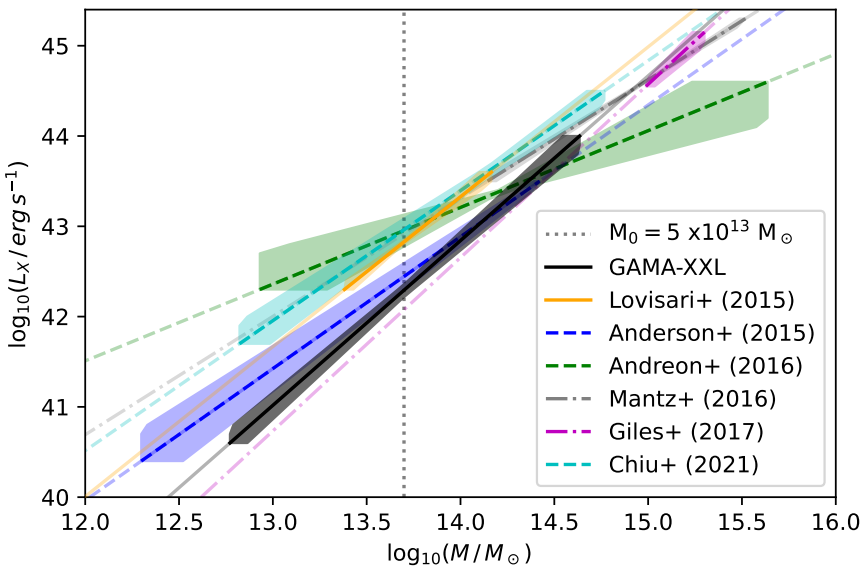


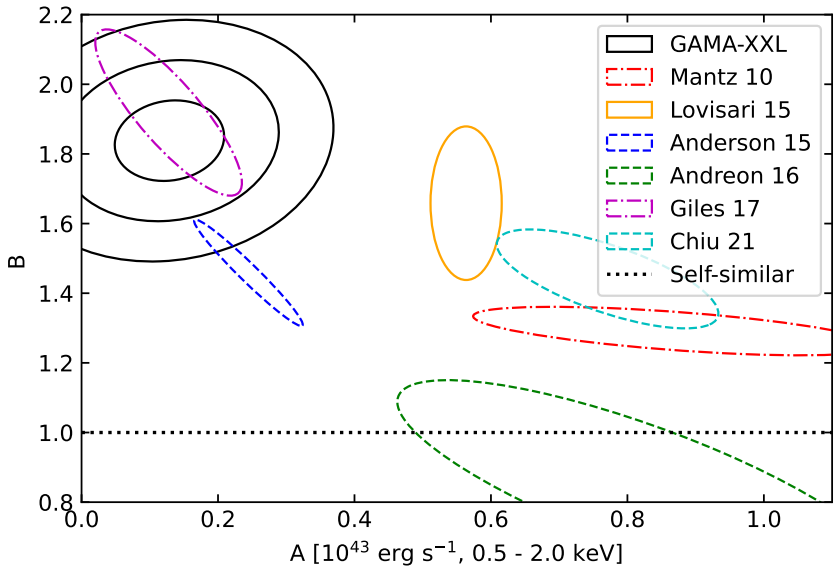


XXL: Pacaud et al. (2016)

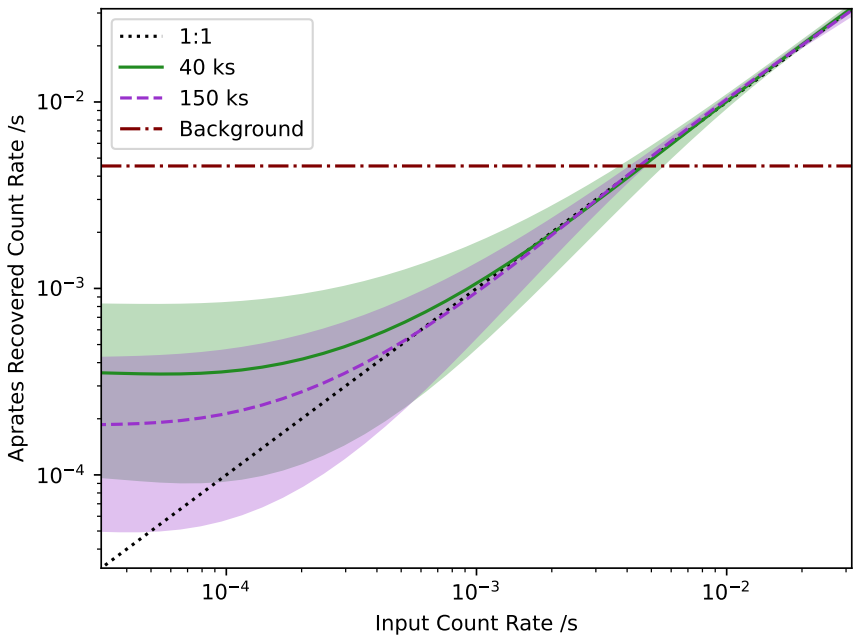
Crossett et al. (2022)

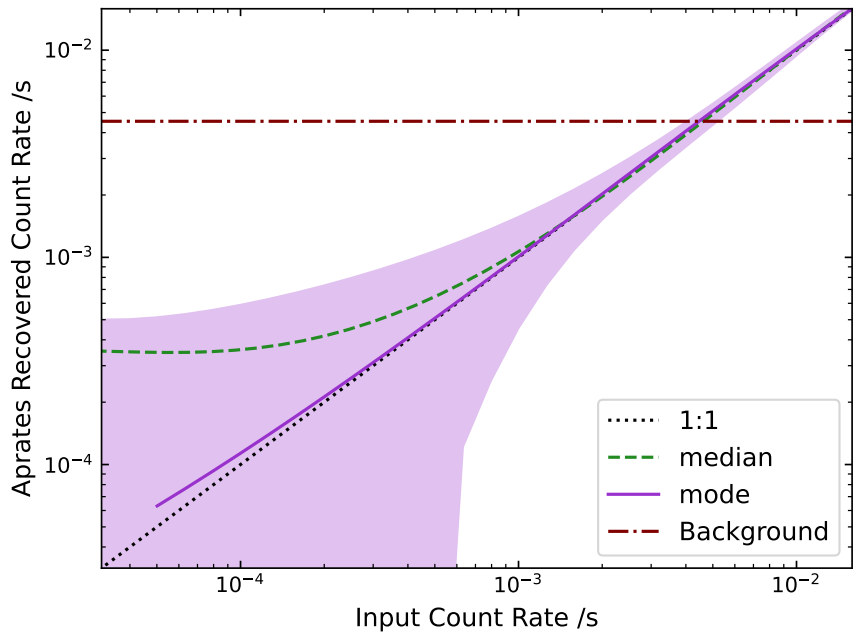
Luminosity - Mass Relation





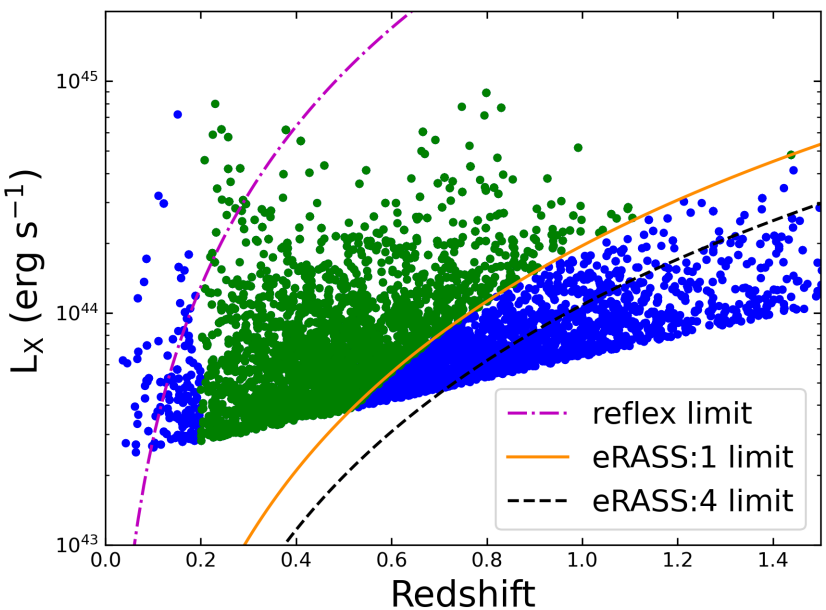
Recovering Low Count Rates





Euclid & eROSITA

- DR1 / eRASS:1 overlap $\sim$ 1,250 deg^2
  - estimate 5,000 clusters
- DR3 / eRASS:4 overlap $\sim$ 7,500 deg^2
  - estimate 60,000 clusters



Forecast from Sartoris+ (2016)