Probing X-ray properties of galaxy groups with optical selection

Ilaria Marini (ESO, Germany)

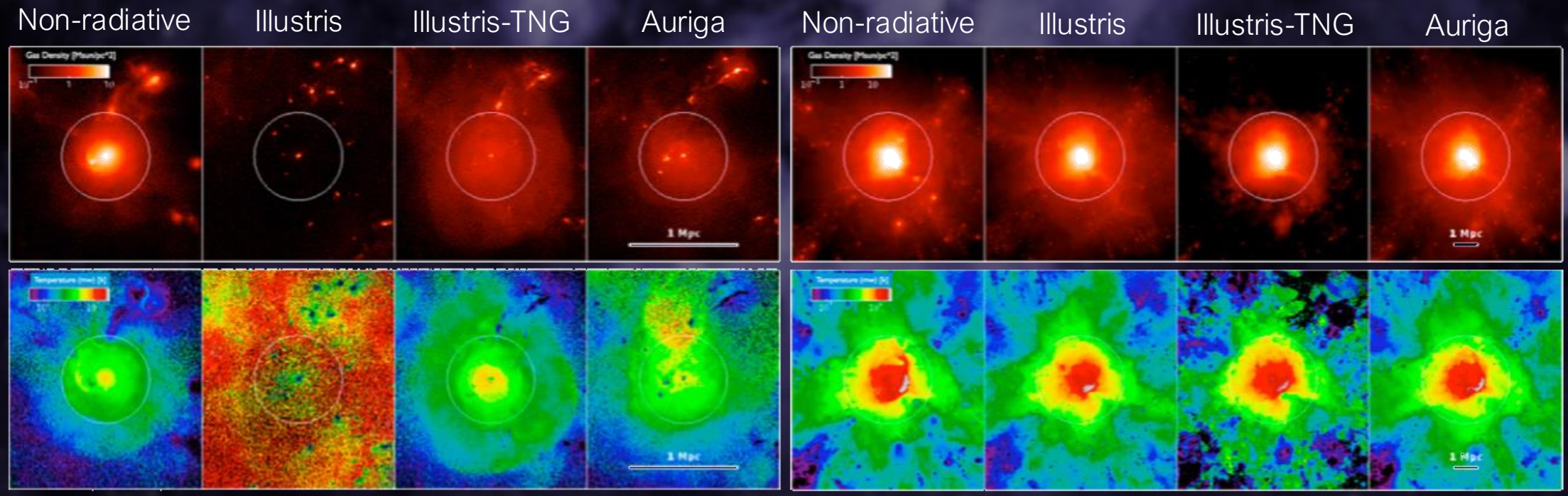
Paola Popesso (ESO), Klaus Dolag (USM/MPA), Veronica Biffi (INAF)
Stephan Vladutescu-Zopp (USM), Georg Lamer (AIP), Victoria Toptun (ESO) et al.

Mm Universe
June 23-27, 2025

GALAXY GROUPS: The ultimate testing ground for non-gravitational processes

Galaxy group: $M_h \sim 10^{13}\, M_\odot$

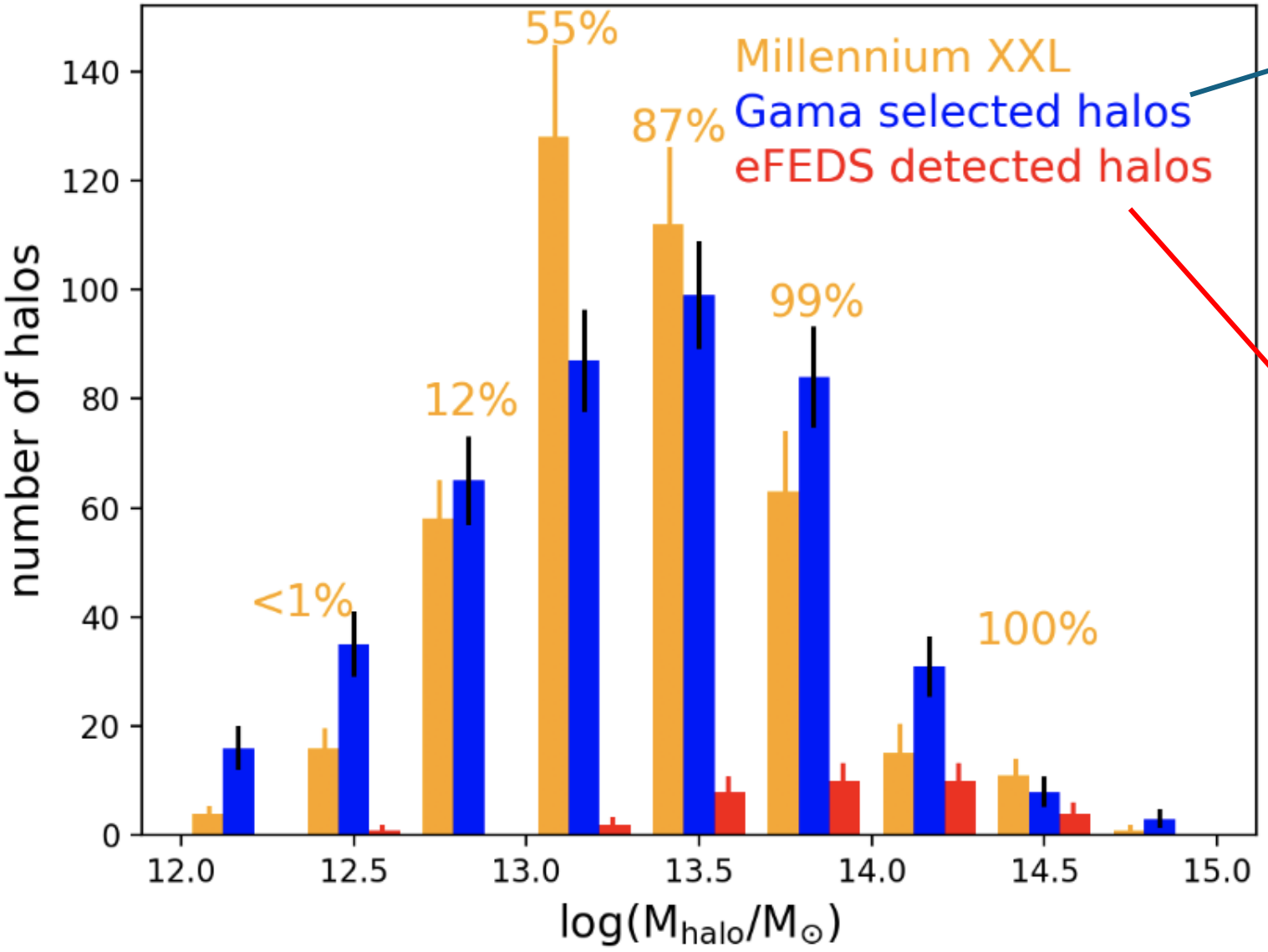
Galaxy cluster: $M_h \sim 10^{15}\, M_\odot$

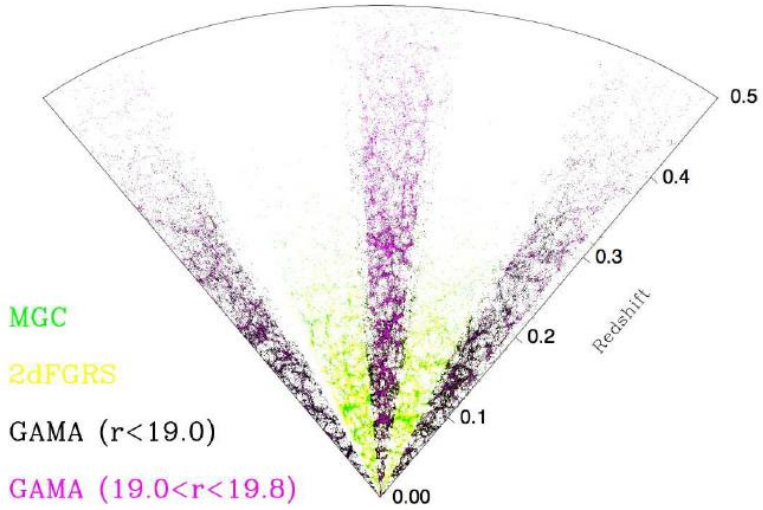


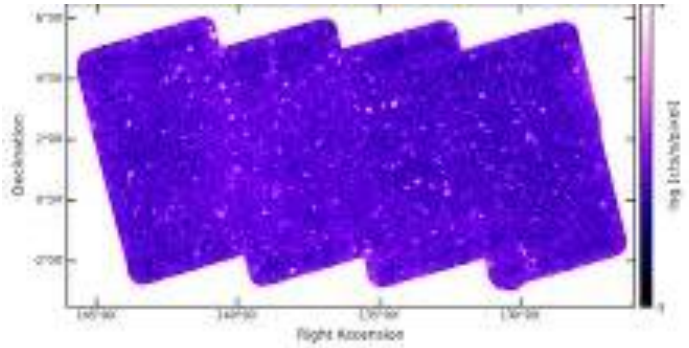
Credits: A. Pillepich

Feedback can affect strongly on the gas properties

Feedback has marginal effect on temperature and density



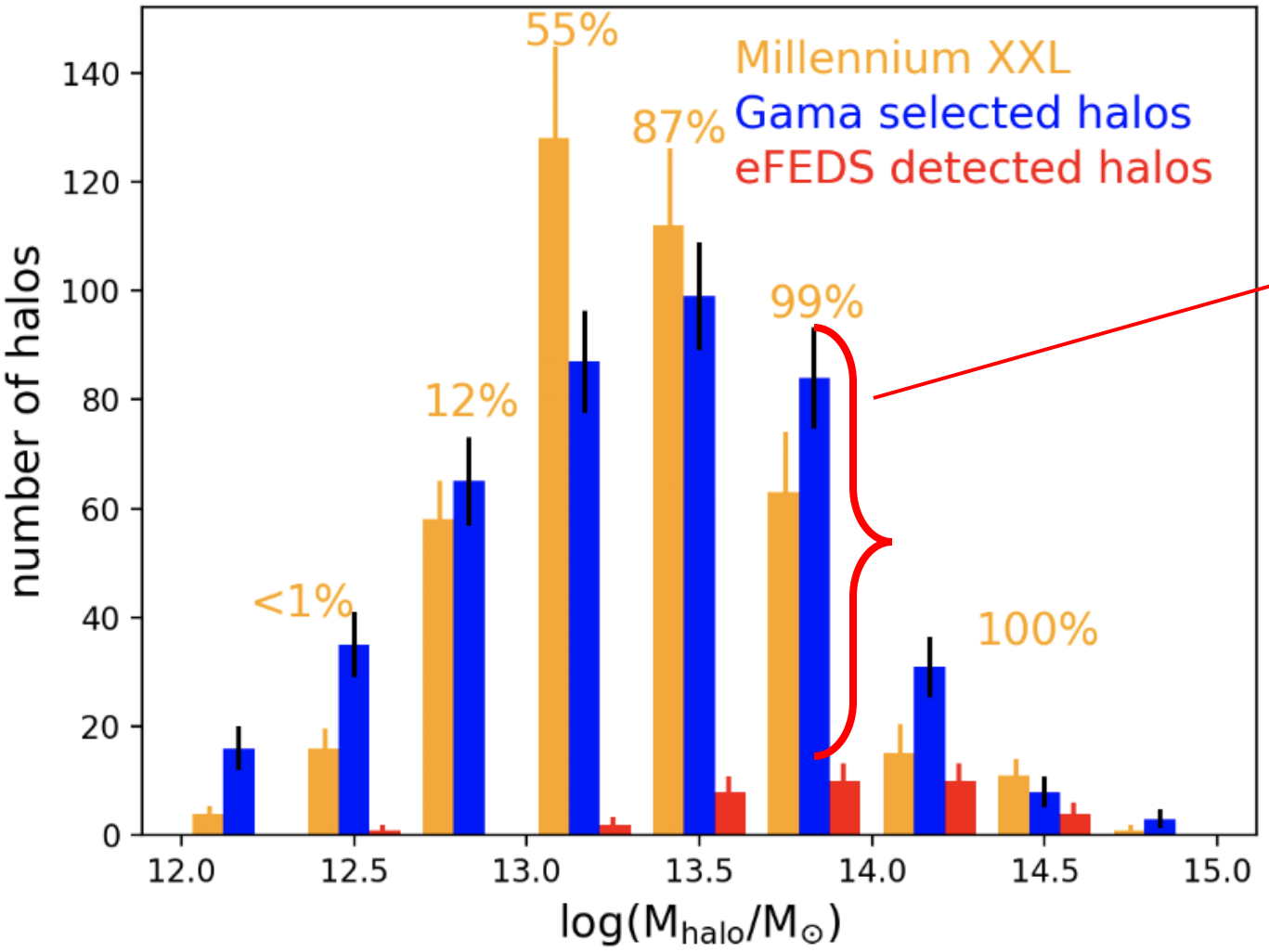




eROSITA

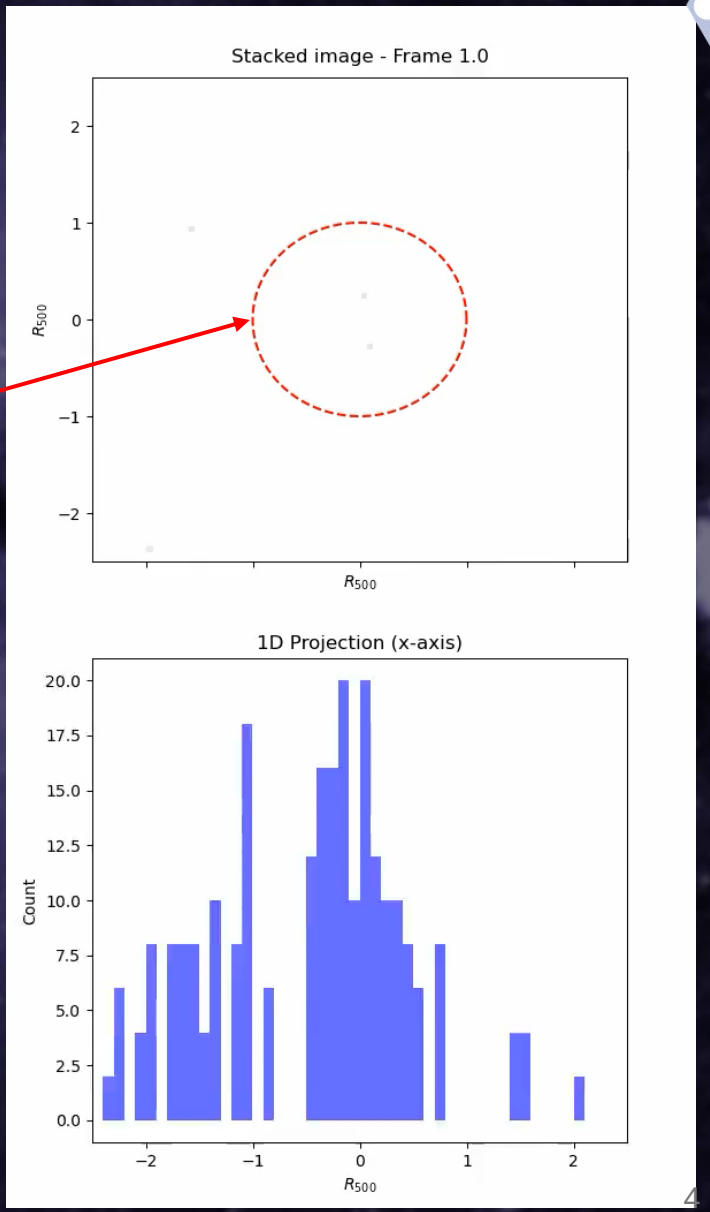
Popesso et al. 2024a

OBSERVATIONAL BIASES



Popesso et al. 2024a

STACKING

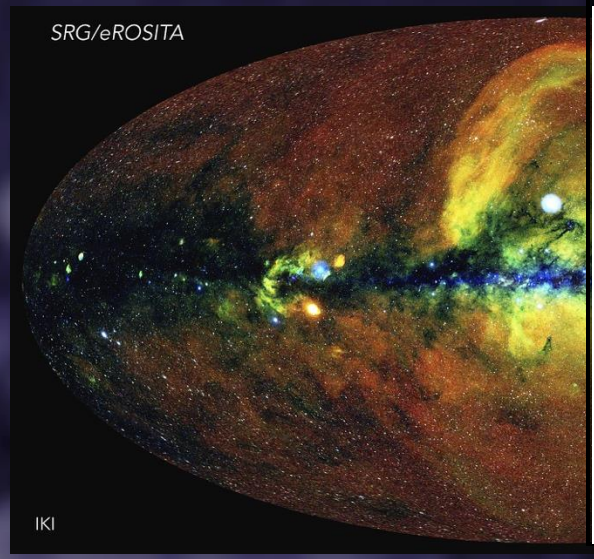


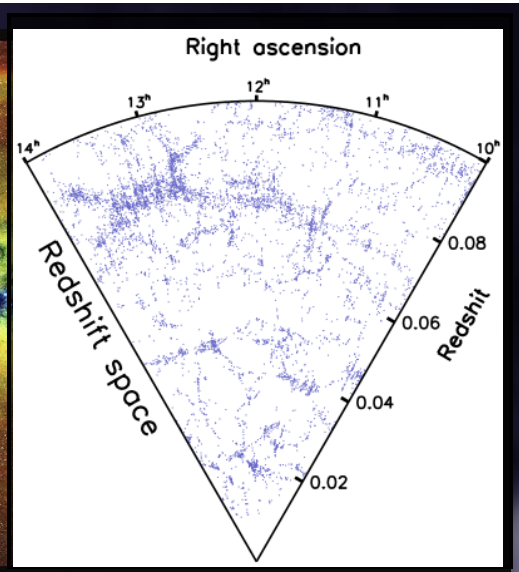
STACKING: a dual approach

Observations

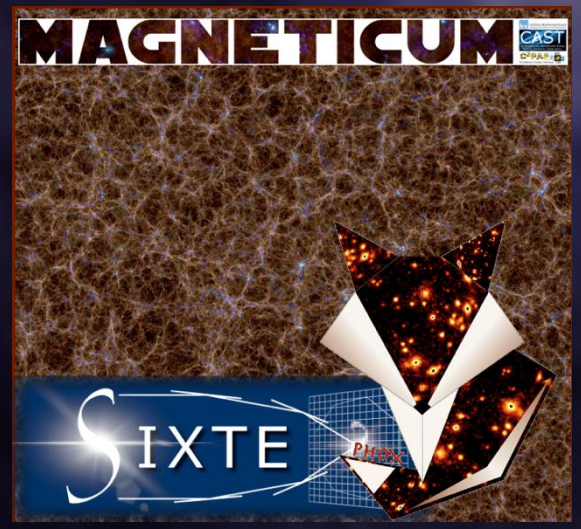
Optical selection:
SDSS DR7 (Yang+07)

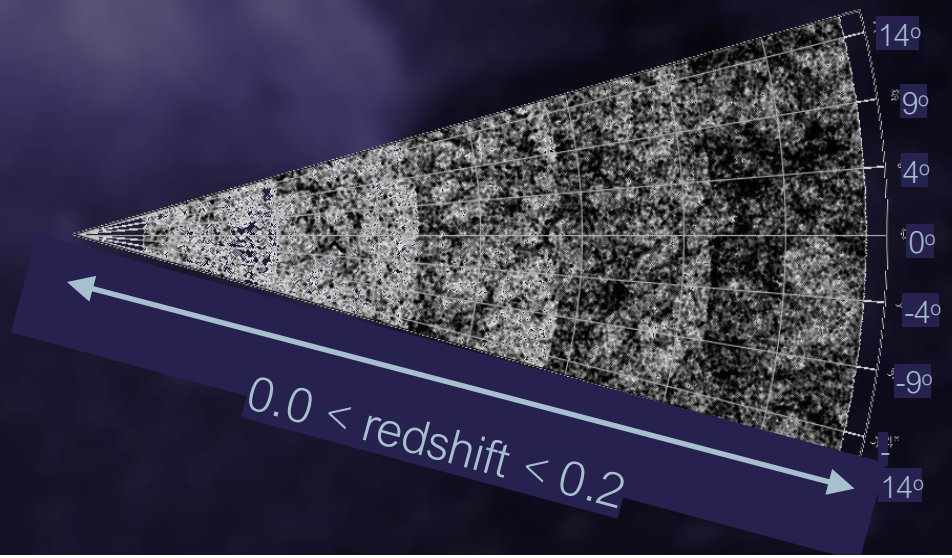
X-ray data:
eROSITA eRASS1 data
(Merloni+24)





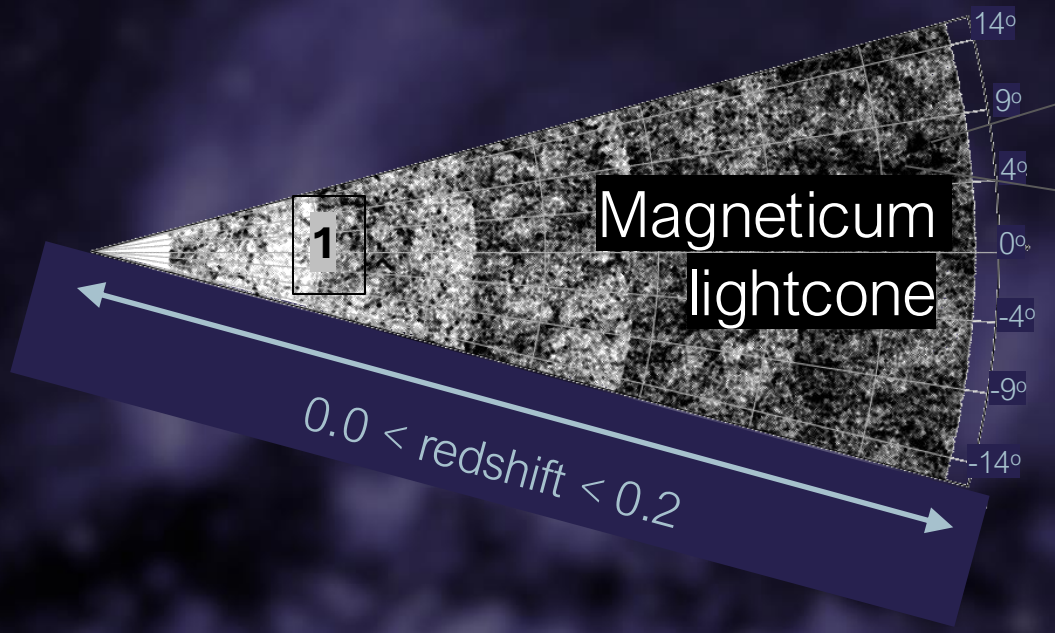
Simulations

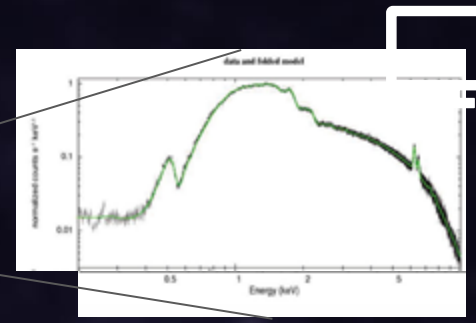




X-ray selection

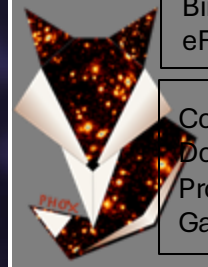
(Marini+2024)





2 ***X-ray Emission***

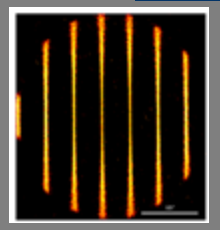
Gas Particles	(apec)
AGNs	(zpowerlaw)
Binaries	(zpowerlaw)
eFEDS background	(Liu+22)

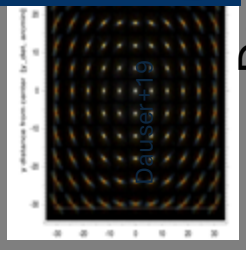


Cosmological z-distortion
Doppler Effect
Projection Effects
Galactic Absorption

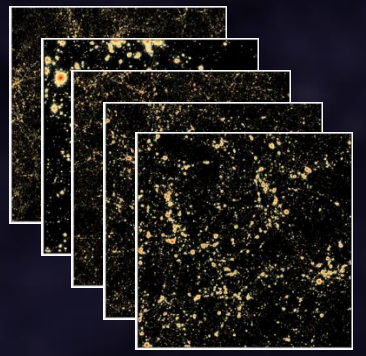
Biffi+12,13,18; Vladutescu-Zopp+23

3 ***Simulate eROSITA***



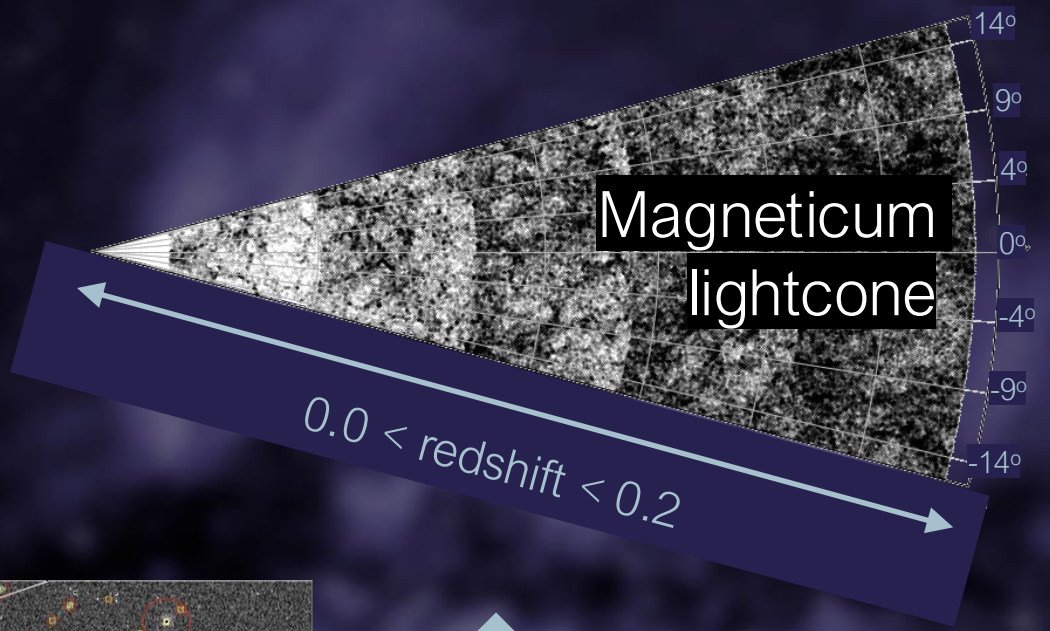


Dauser+19

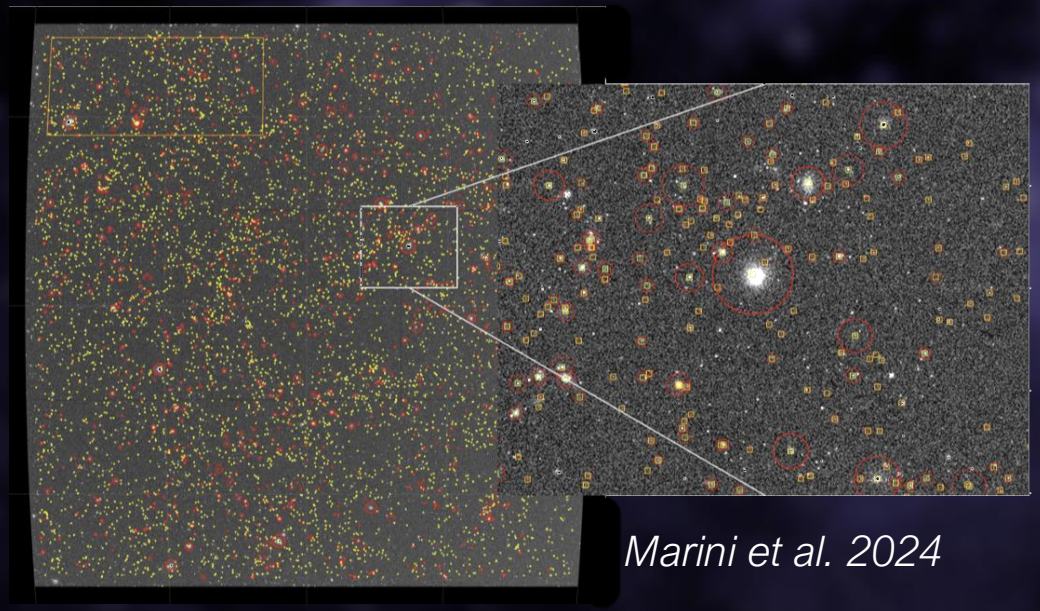


X-ray selection

(Marini+2024)



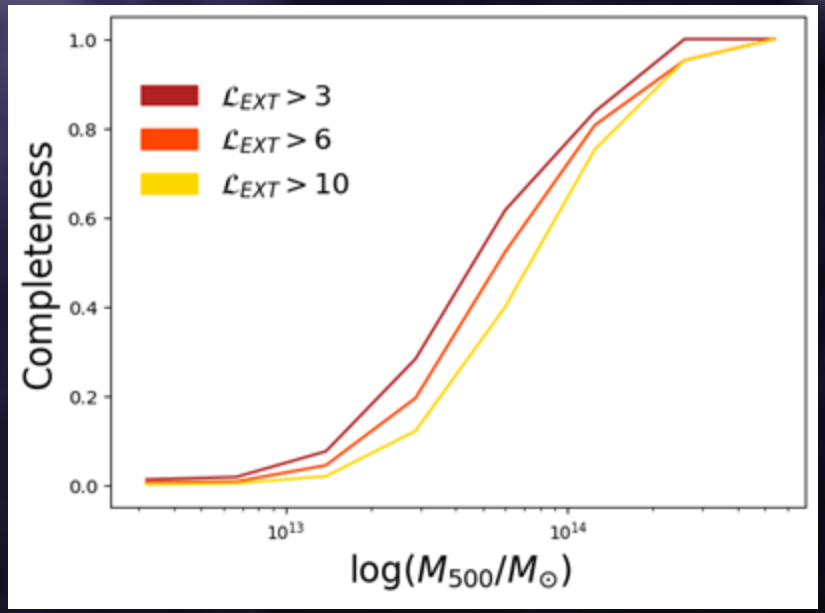
Is X-ray stacking reliable?



30 deg

Marini et al. 2024

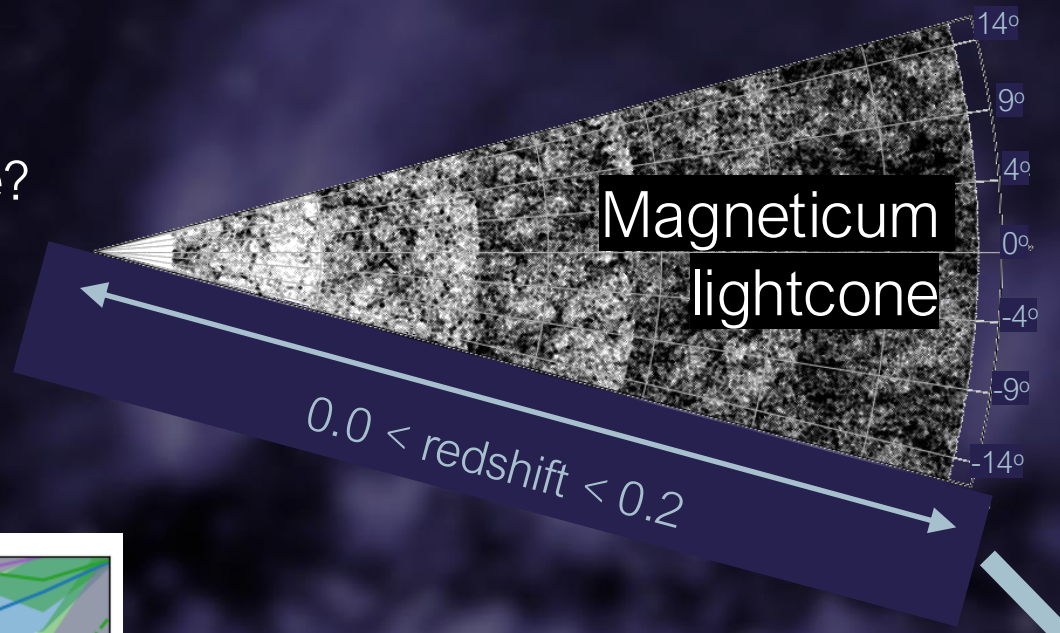
Selection Function

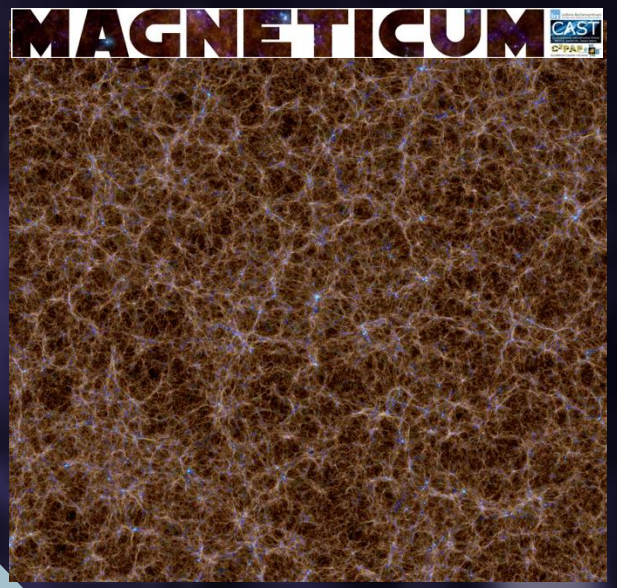


Optical selection

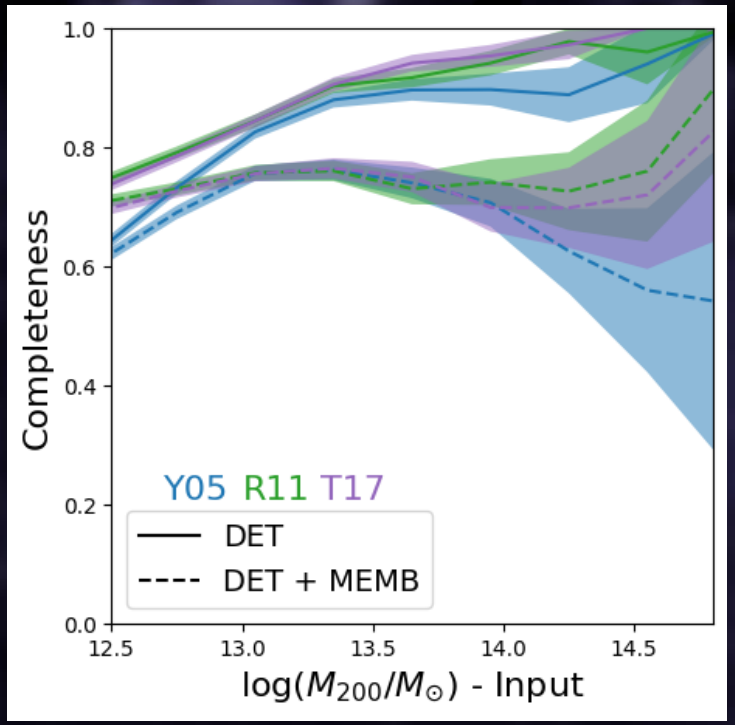
(Marini+2025)

Are optical catalogs reliable?





Selection Function



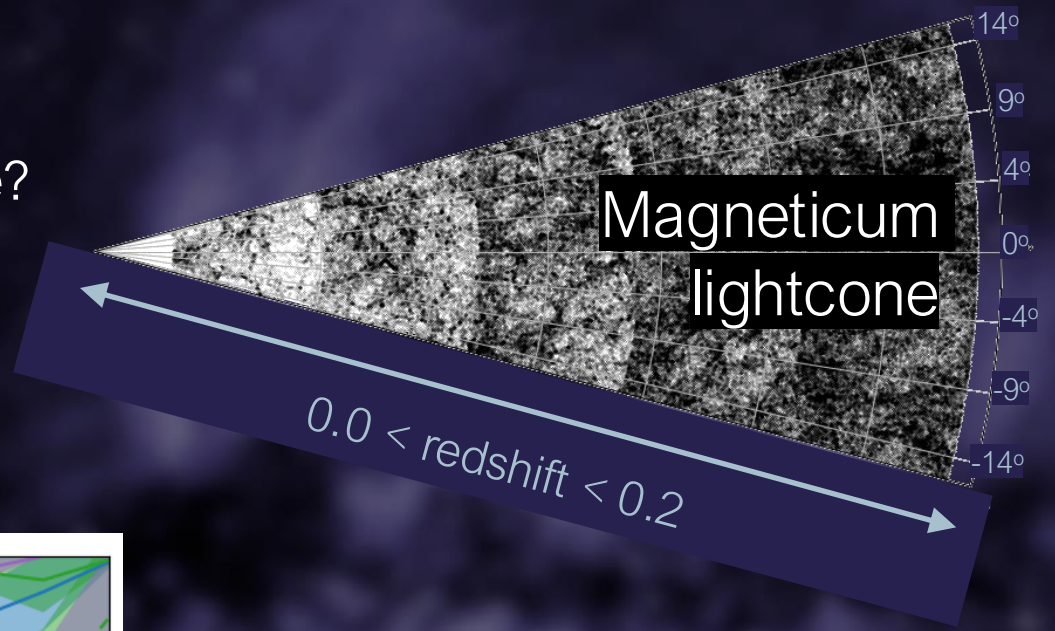
Marini et al. 2025

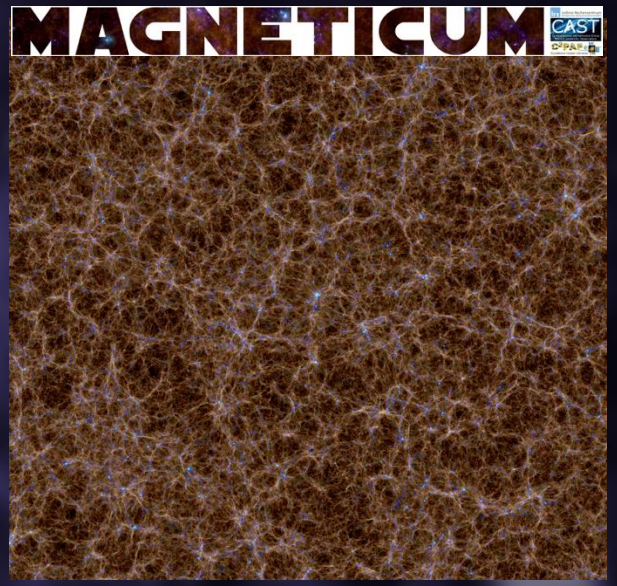
Optical mock galaxy catalog

Optical selection

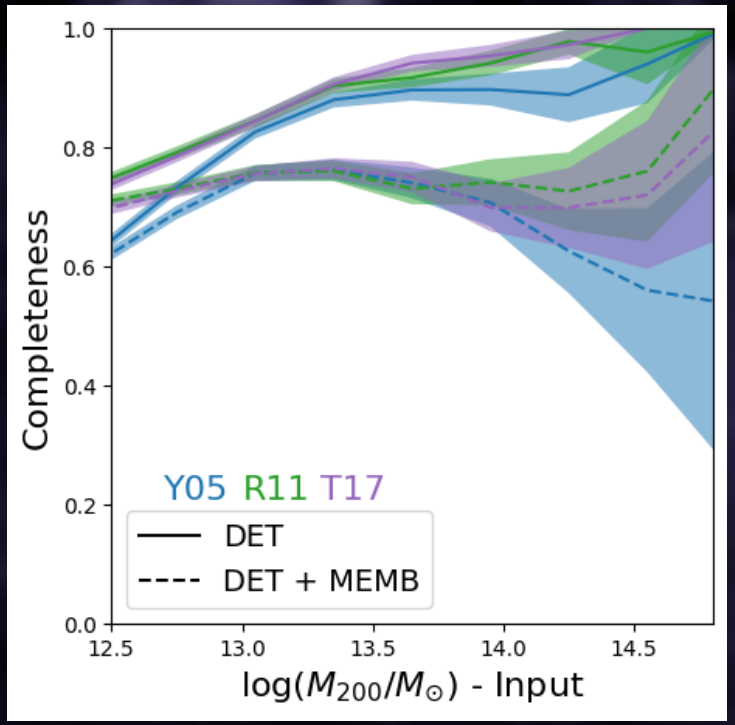
(Marini+2025)

Are optical catalogs reliable?

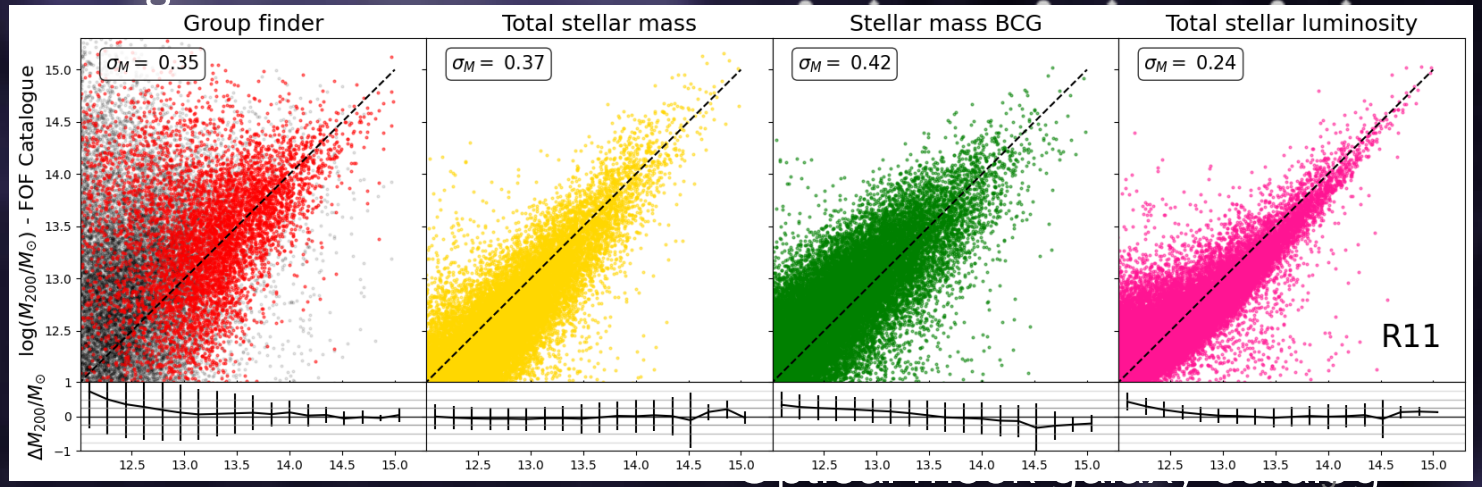




Selection Function

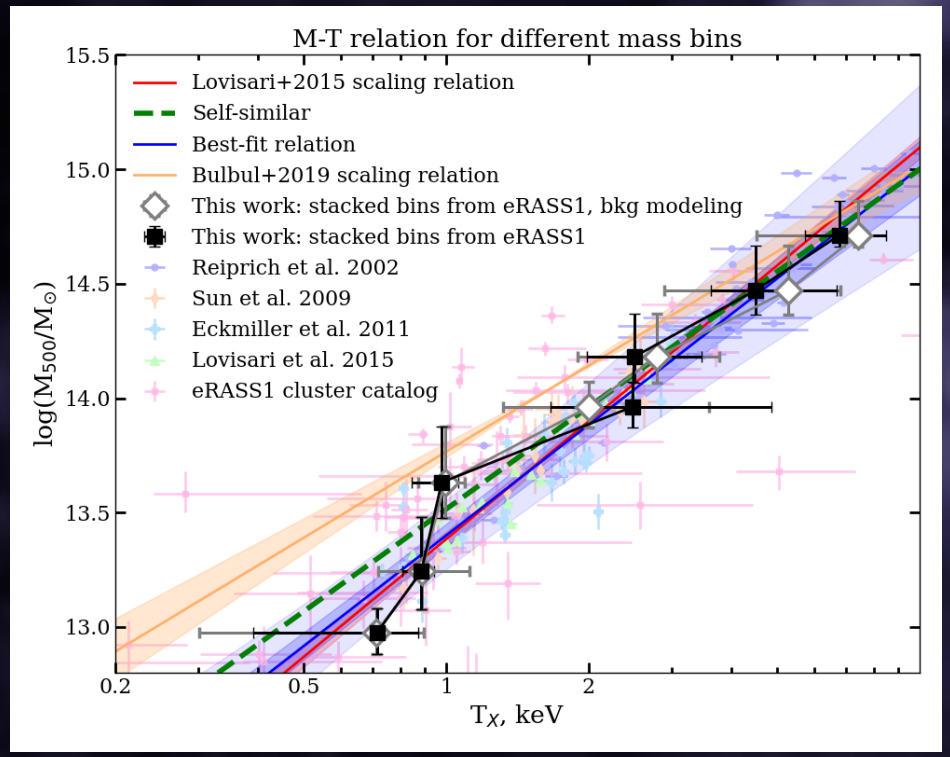


Larger uncertainties on the halo mass...



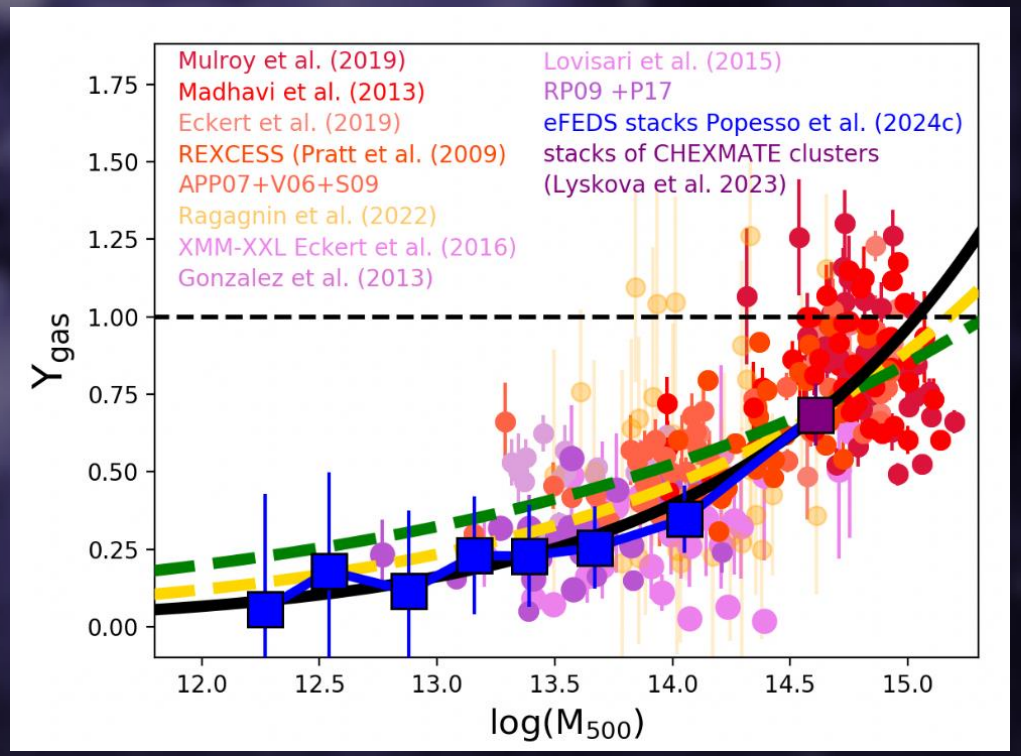
Optical selection

eRASS1+SDSS



Toptun+ accepted

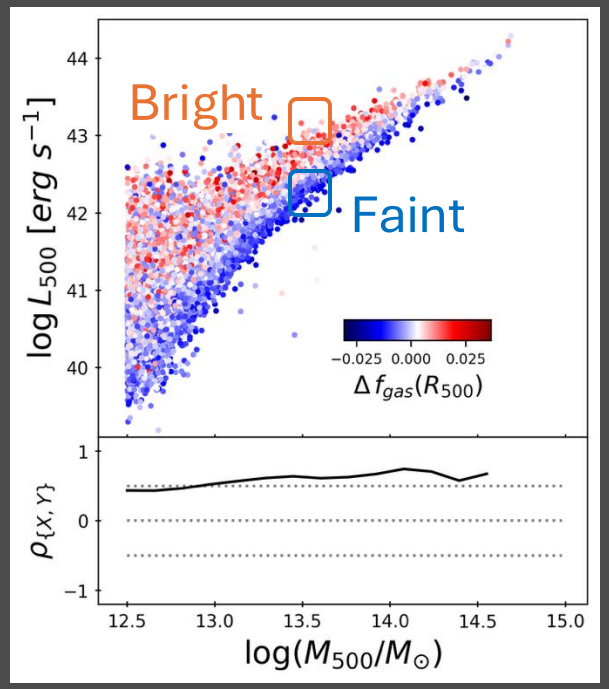
eFEDS+GAMA



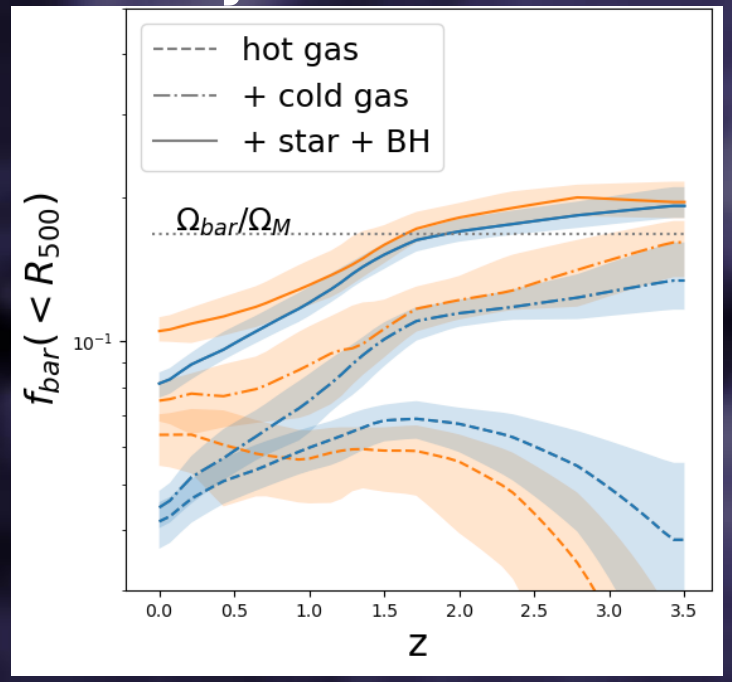
Popesso+submitted

X-ray selection and causes

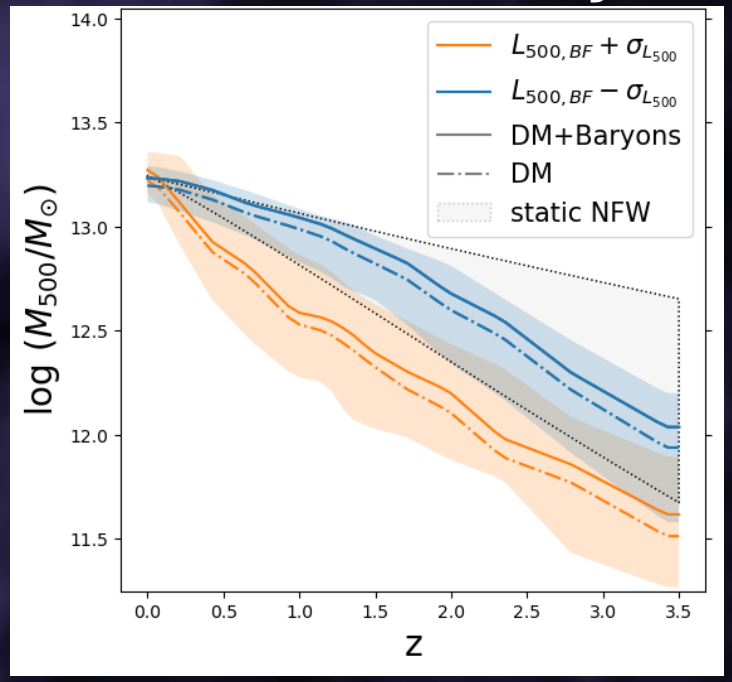
(Marini+, accepted)



Baryonic Fraction



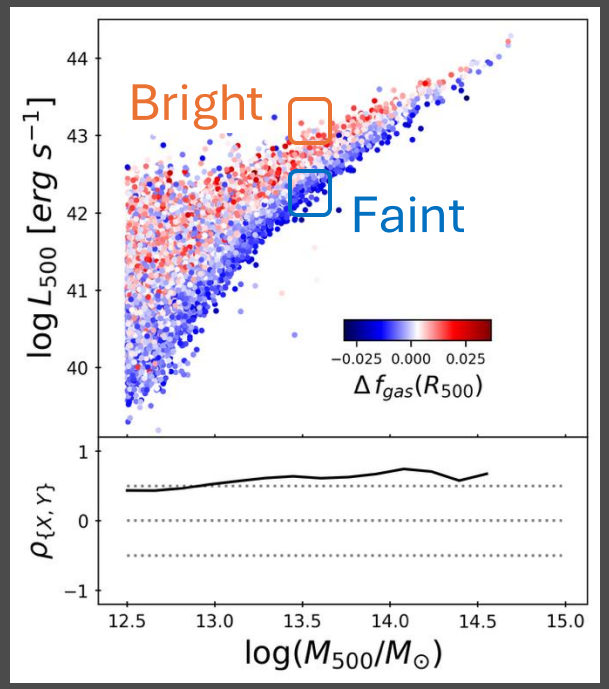
Mass Assembly

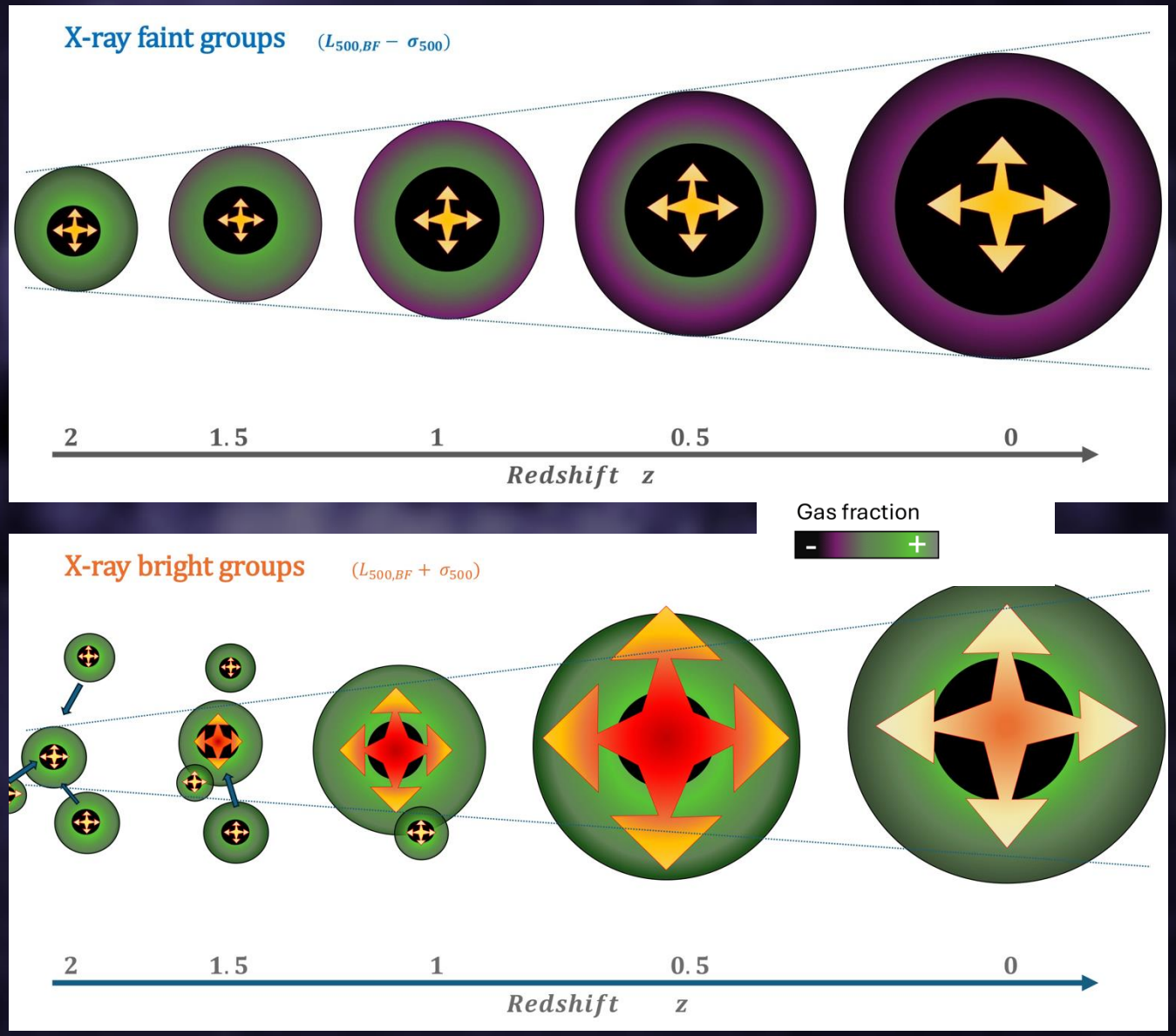


Gas content, and thus X-ray detectability, is impacted by the assembly history of the halo.

X-ray selection and causes

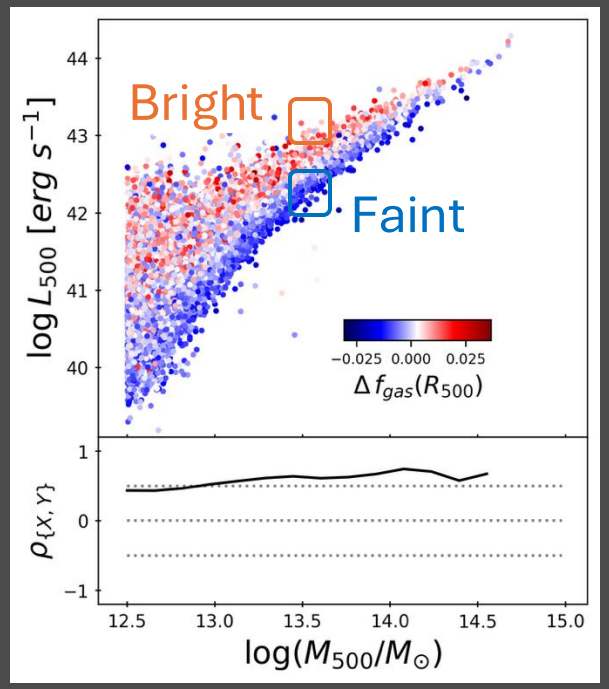
(Marini+, accepted)



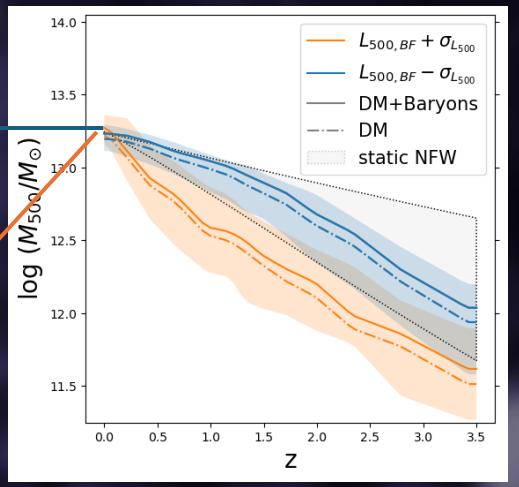


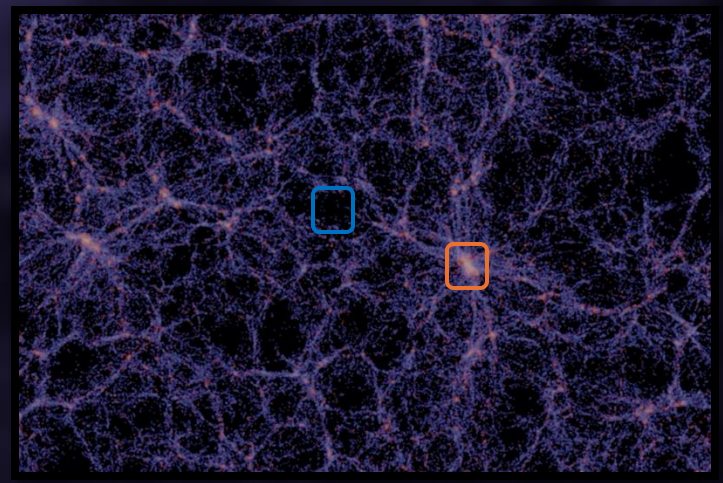
X-ray selection and causes

(Marini+, accepted)



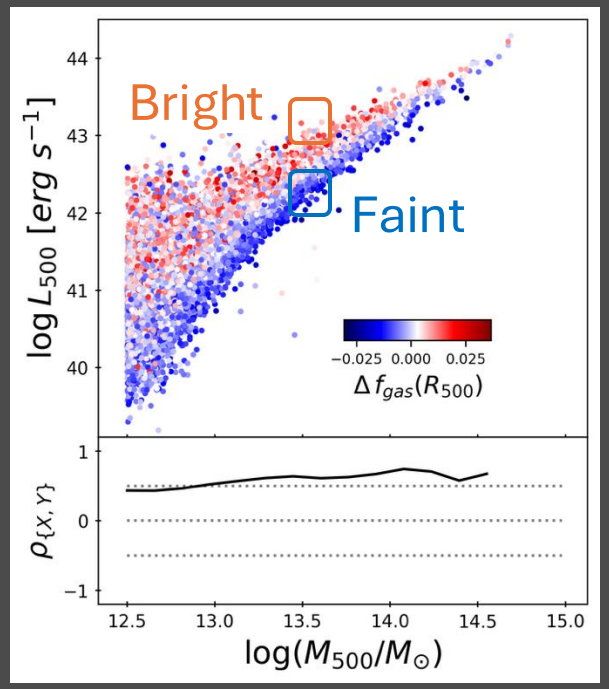
Assembly history is consistent with local environment

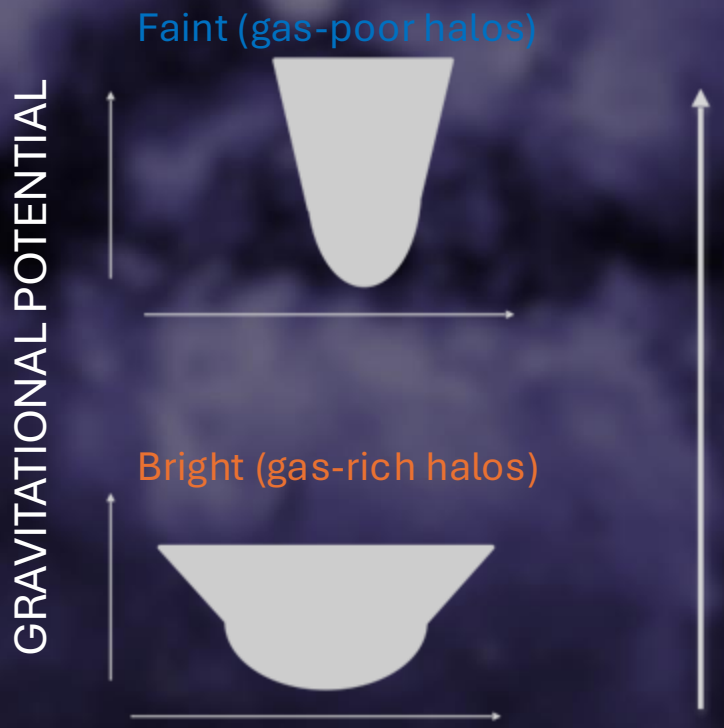


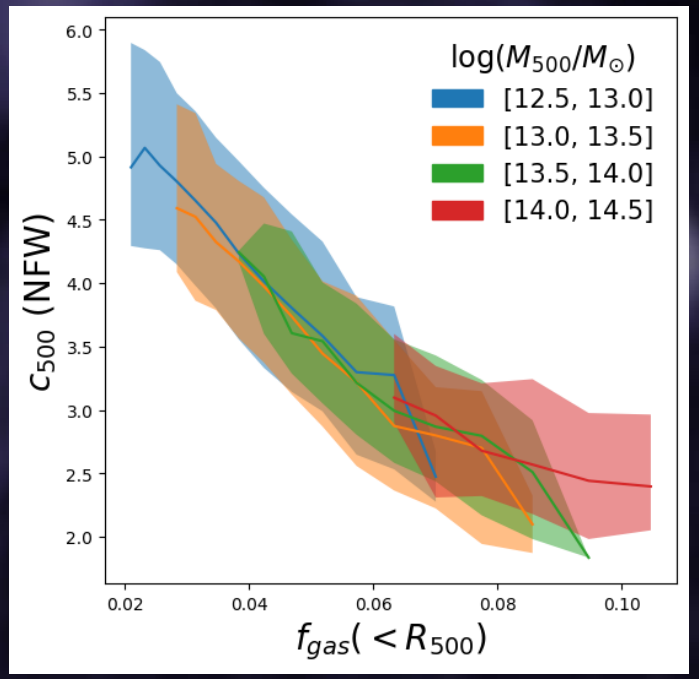


X-ray selection and causes

(Marini+, accepted)

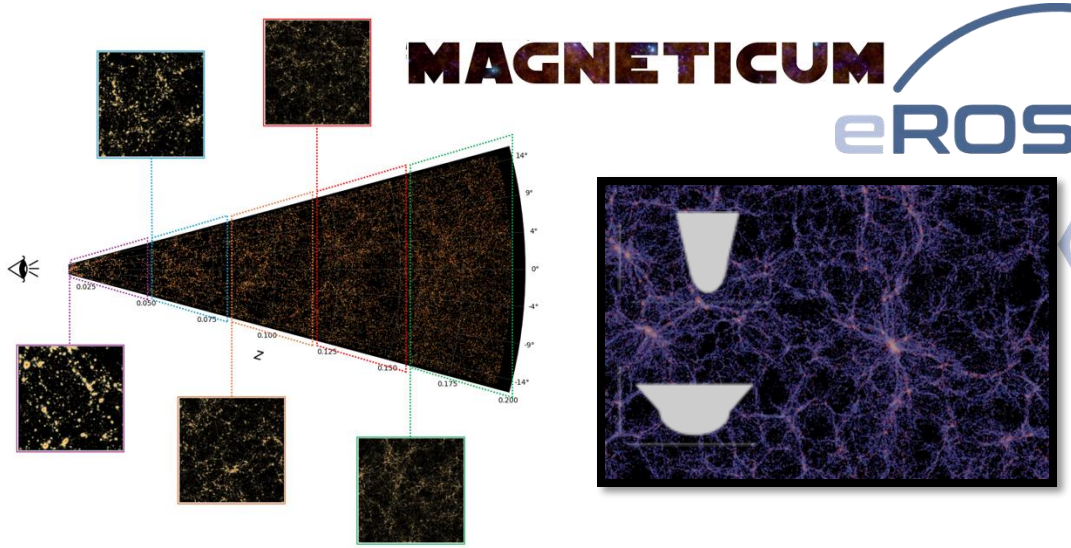


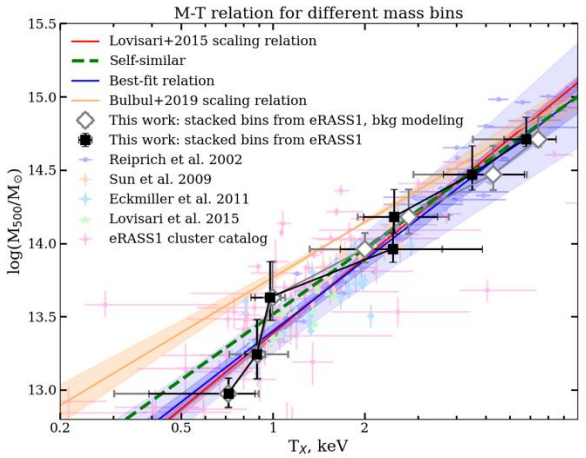




RESULTS & TAKE-HOME MESSAGES

- Optical selection + stacking allows us to infer average properties of the hot gas in galaxy groups.
- Assembly history is equally important as AGN feedback with hot gas content for X-ray detectability.
- Unbiased (or differently biased) scaling relations can be reconstructed and help constrain baryonic effects.



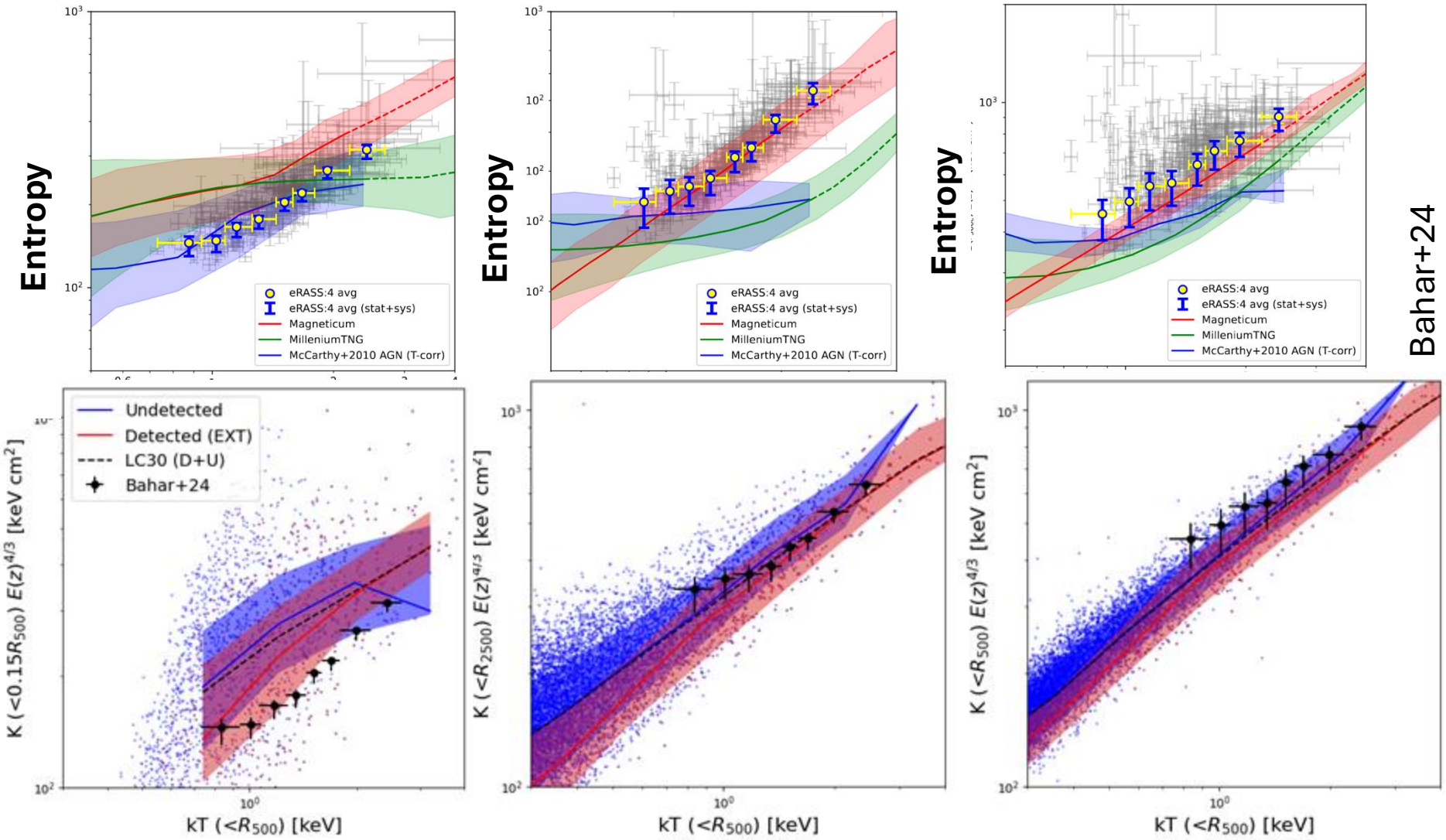


Ilaria Marini, ESO post-doc
Ilaria.Marini@eso.org

X-ray selection and causes

(Marini+2024)

Entropy: $K = T / n_e^{2/3}$



Bahar+24