A closer look at galaxy groups with X-GAP*

*XMM GROUP AGN PROJECT

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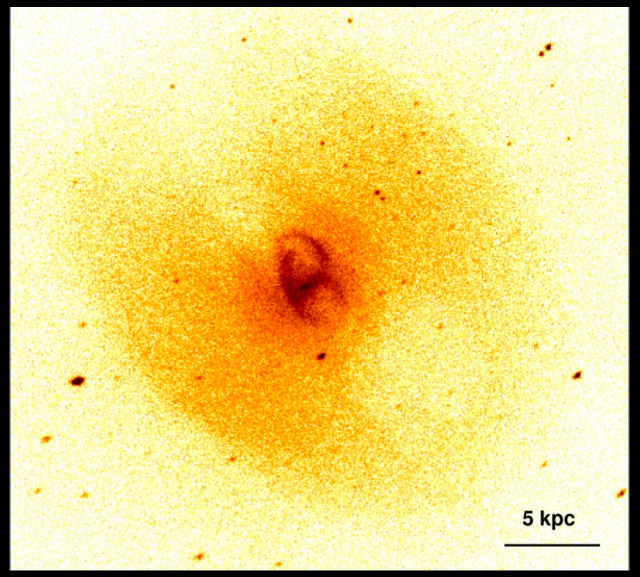
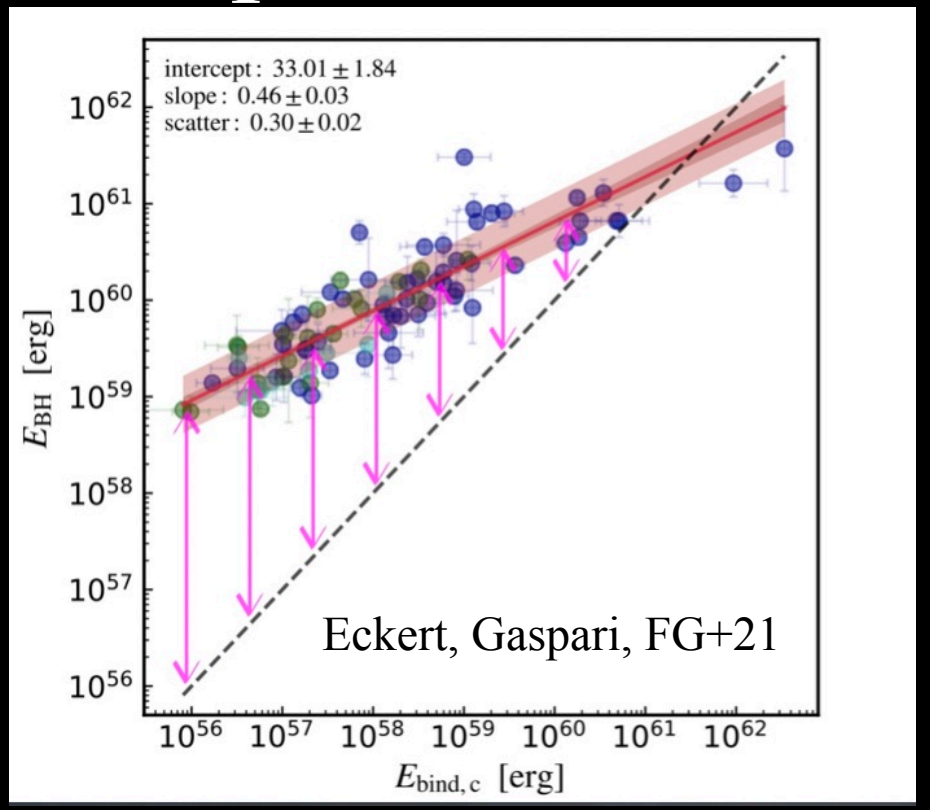


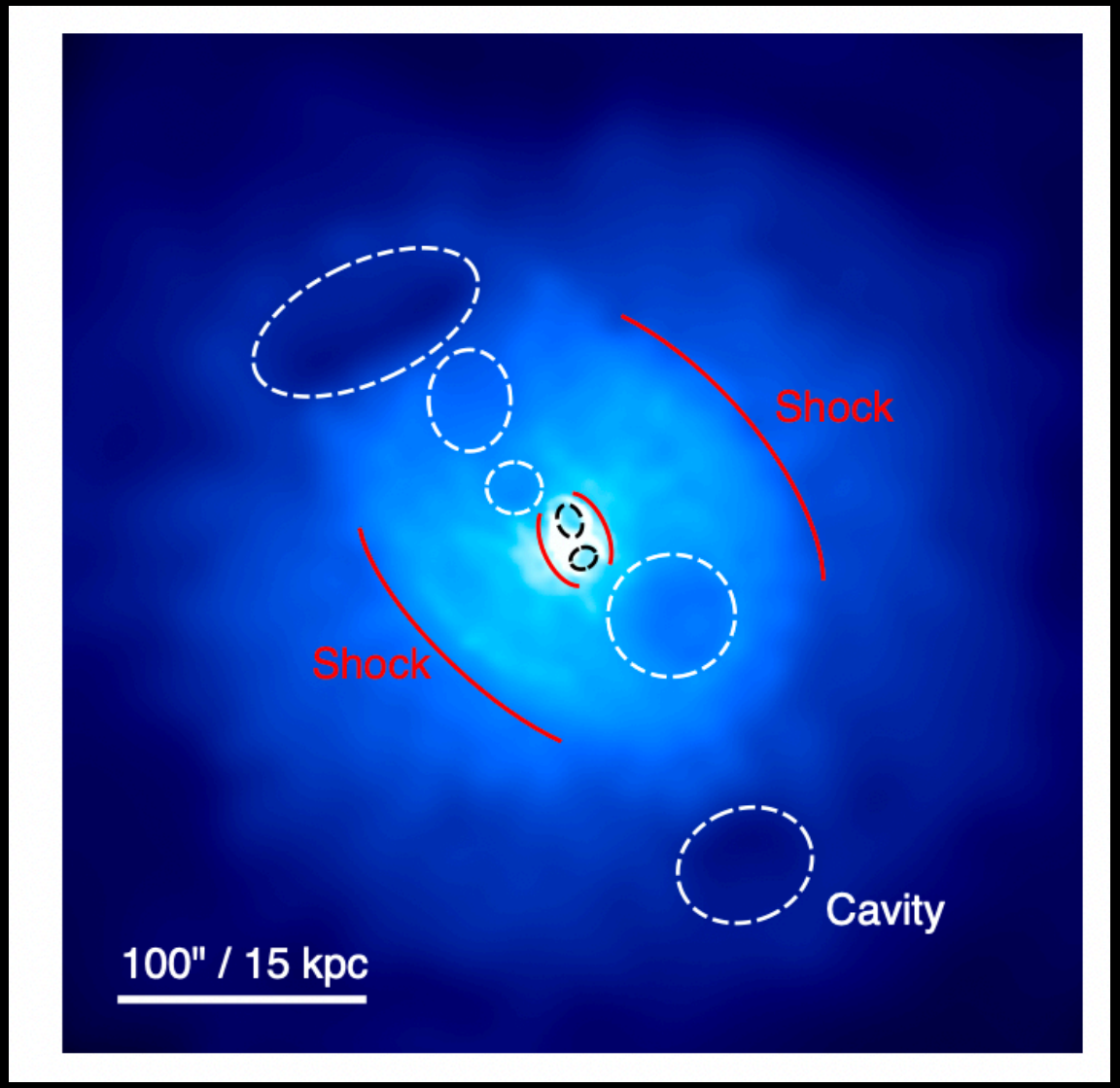
NGC 5813 Randall+15

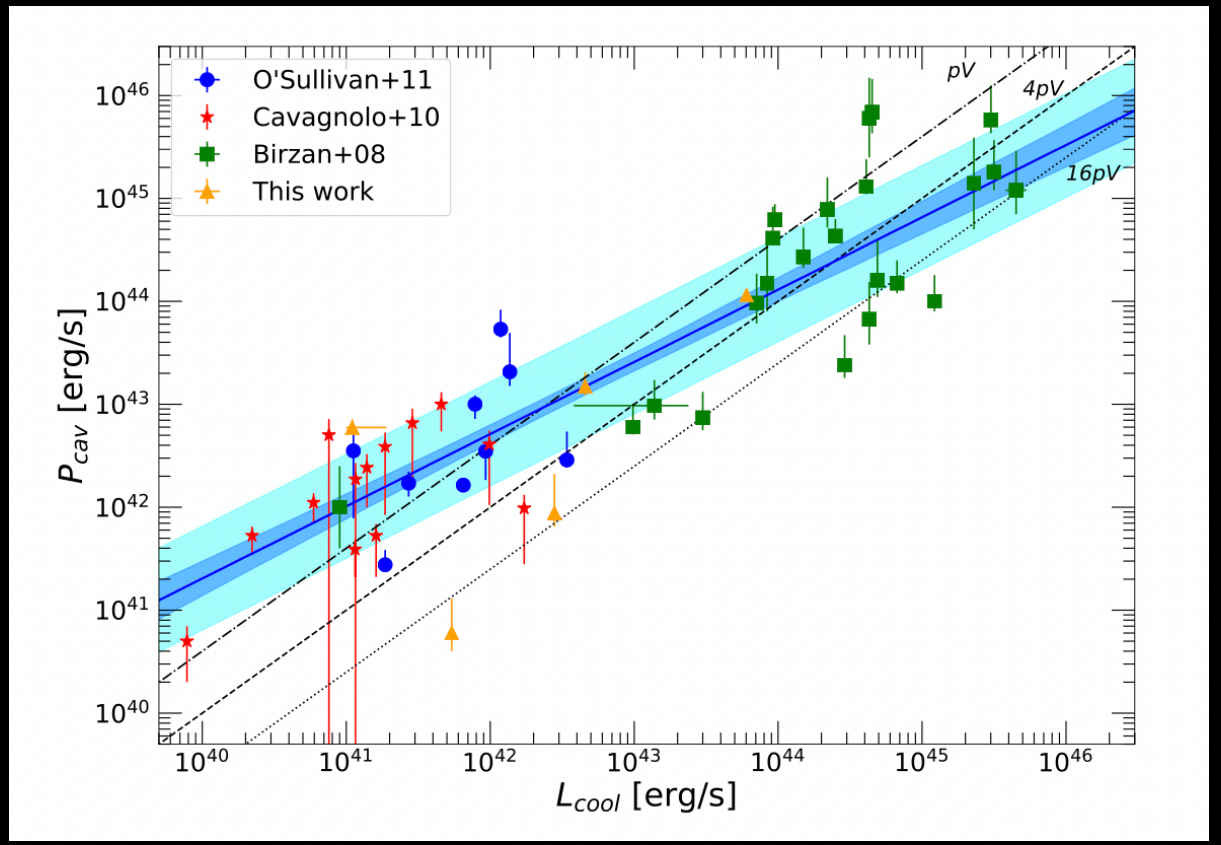
Why Groups are so important



- If only gravity works, halos of different masses are scaled version of each other and power law relations exist between observables (L, T, …) and with mass, but deviations seen due to non-gravitational energy input
- Non gravitational impact of feedback (AGN) is critical at the group scale (10e13 – 10e14 M_{sun})

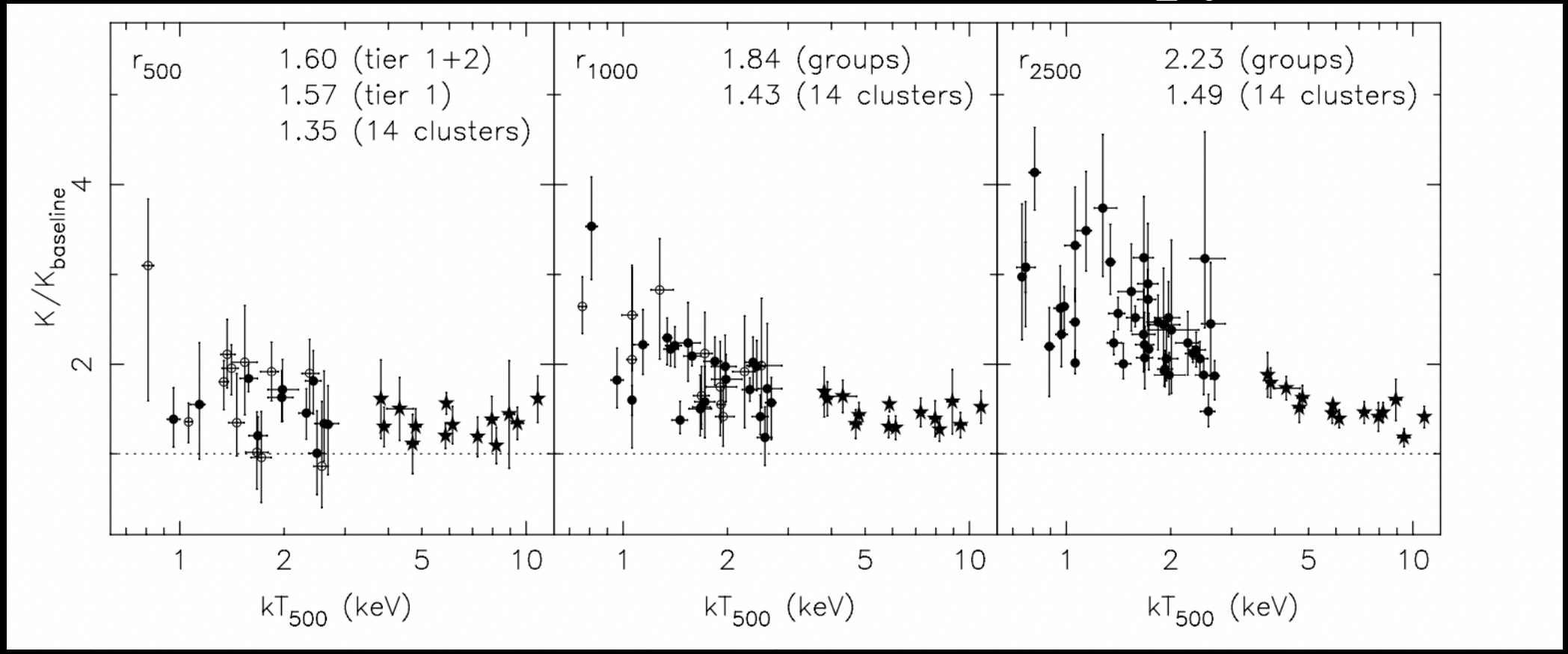
AGN Feedback in groups





Eckert, Gaspari, FG+21

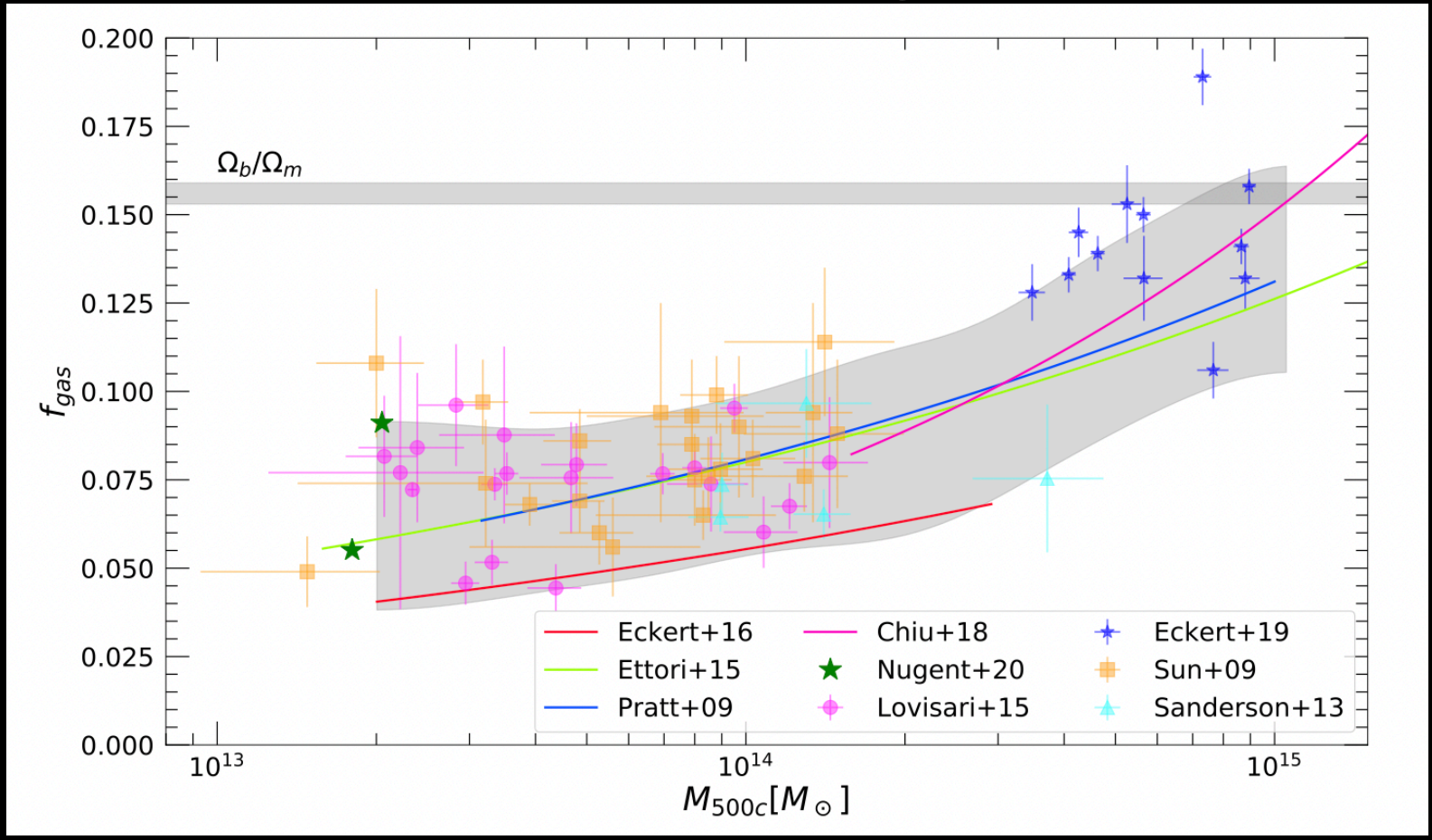
AGN Feedback: entropy



Sun+09

Since the early observations with ROSAT and ASCA (Ponman+98) galaxy groups exceeds the expectations of gravitational collapse. With the detailed Chandra and XMM observations we know that the modification to entropy is mass and scale dependent (e.g. Sun+09, Pratt+10)

AGN Feedback: gas fraction

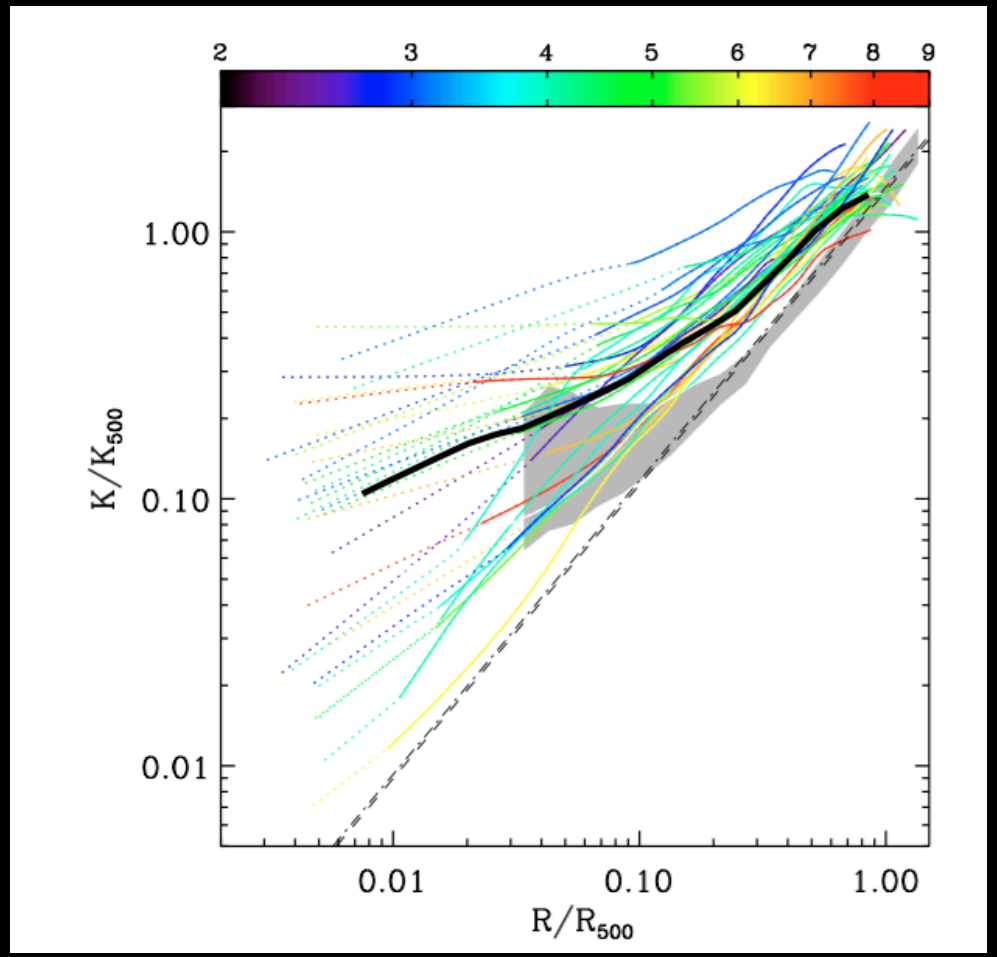


Eckert, Gaspari, FG+21

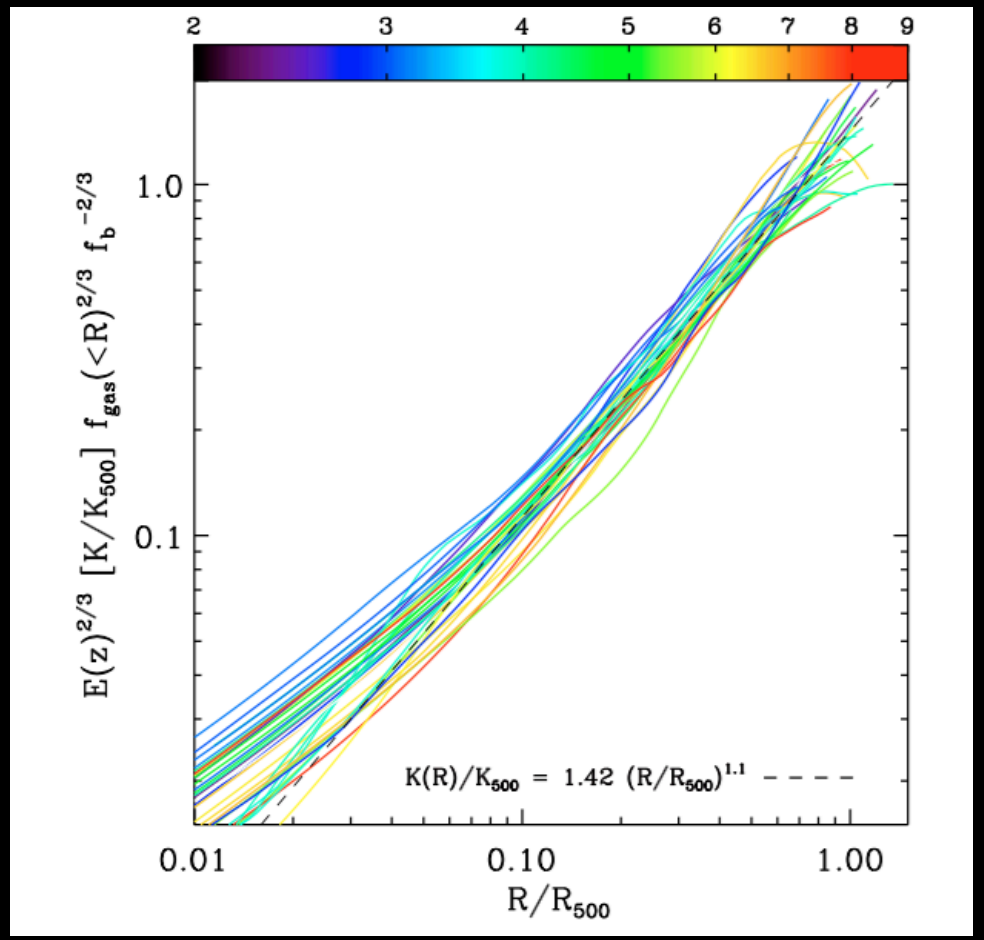
The scarse measurements of the gas fraction within R500 at the group scale shows only half the expected value. This is not compensated by the weak anti-correlation of the stellar mass fraction with halo mass

Entropy and gas fraction

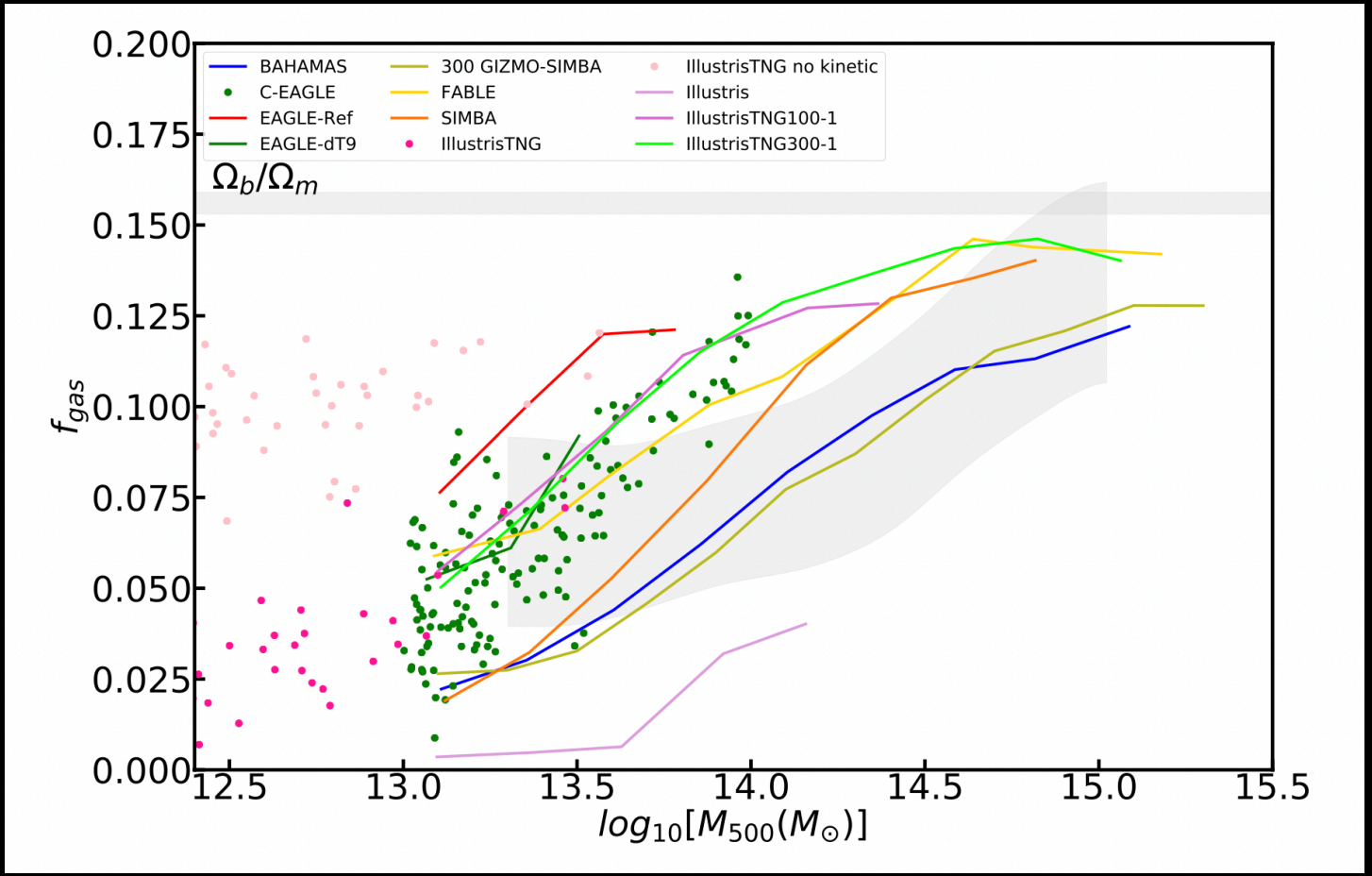
When rescaled by the f_{gas} entropy profiles have a much reduced scatter in close agreement with gravity-only prediction in the REXCESS cluster sample



Pratt+10



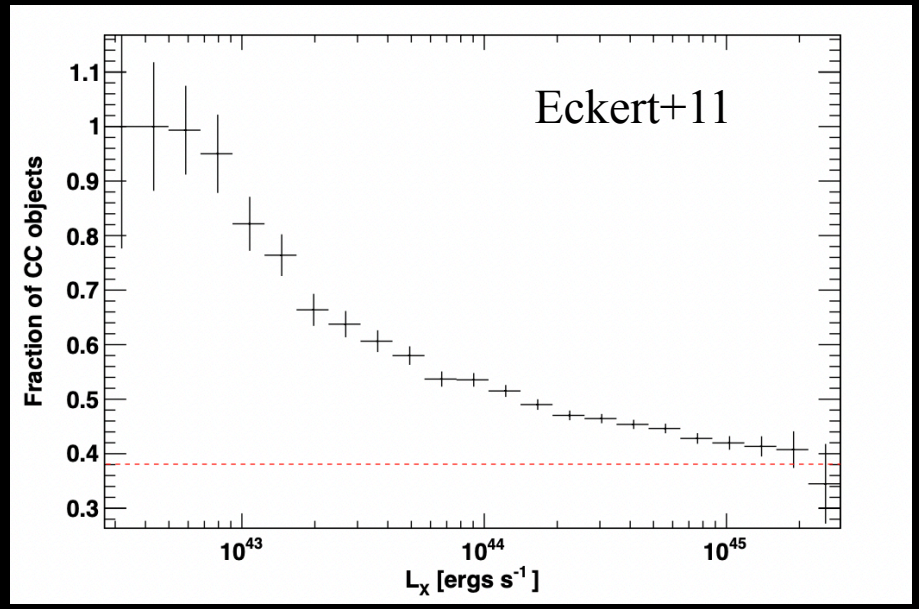
Gas fractions in simulations



Eckert, Gaspari, FG+21

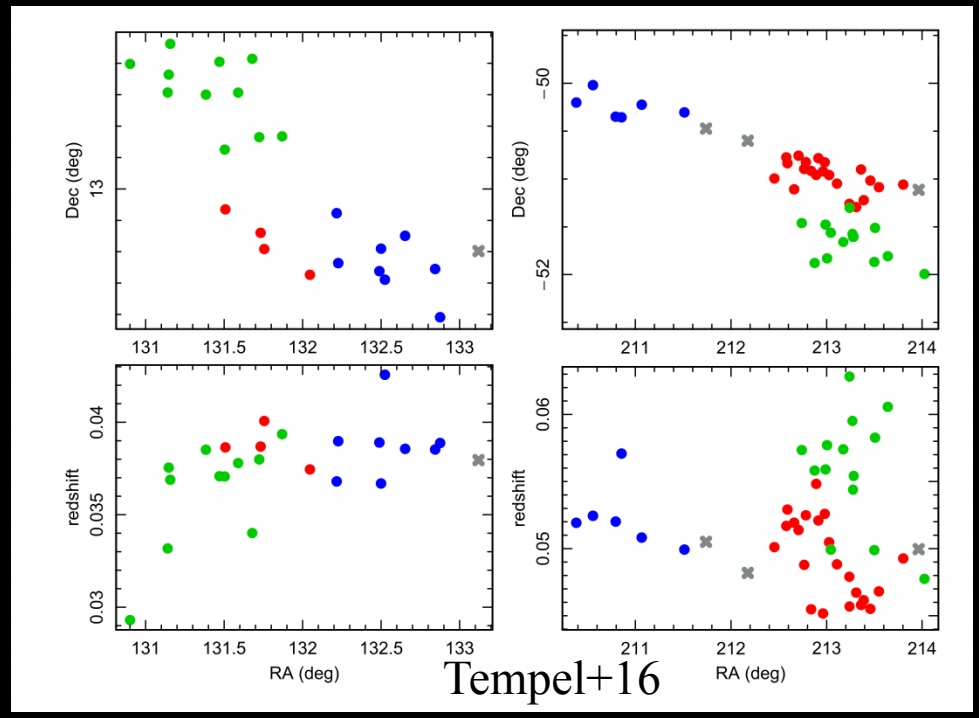
The AGN feedback scheme has a huge impact on the gas fraction of groups even in modern hydro simulations tailored to reproduce the galaxy properties at z=0. Measuring it will provide a crucial input to constrain which type of feedback is needed.

The challenge of sample selection

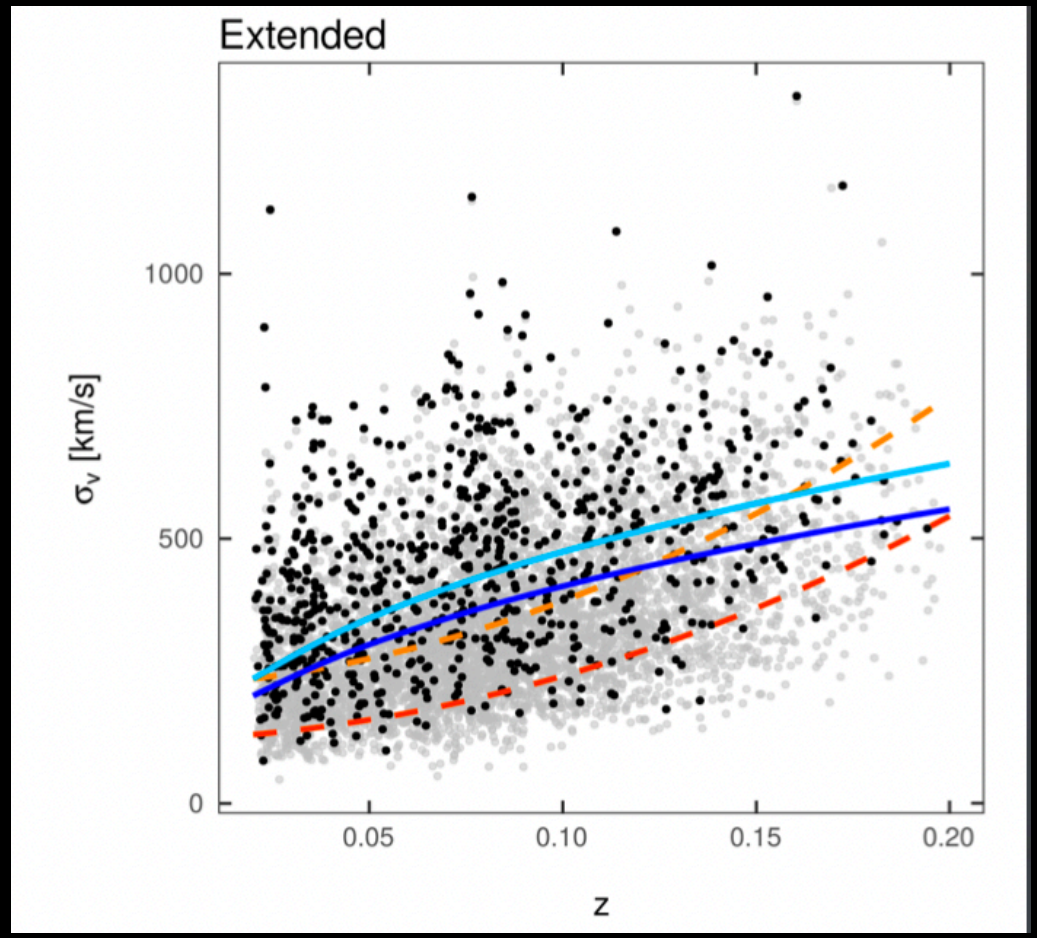


X-ray selection tends to prefer X-.ray peaked objects, undersampling low, very extented surface brightness objects (e.g. Xu+18)

Optical selection based on FoF algorithms has notorious problems due to the choice of linking length, available number of ojects (e.g. Ramella+89, Duarte & Mamon 14, Tempel+16)



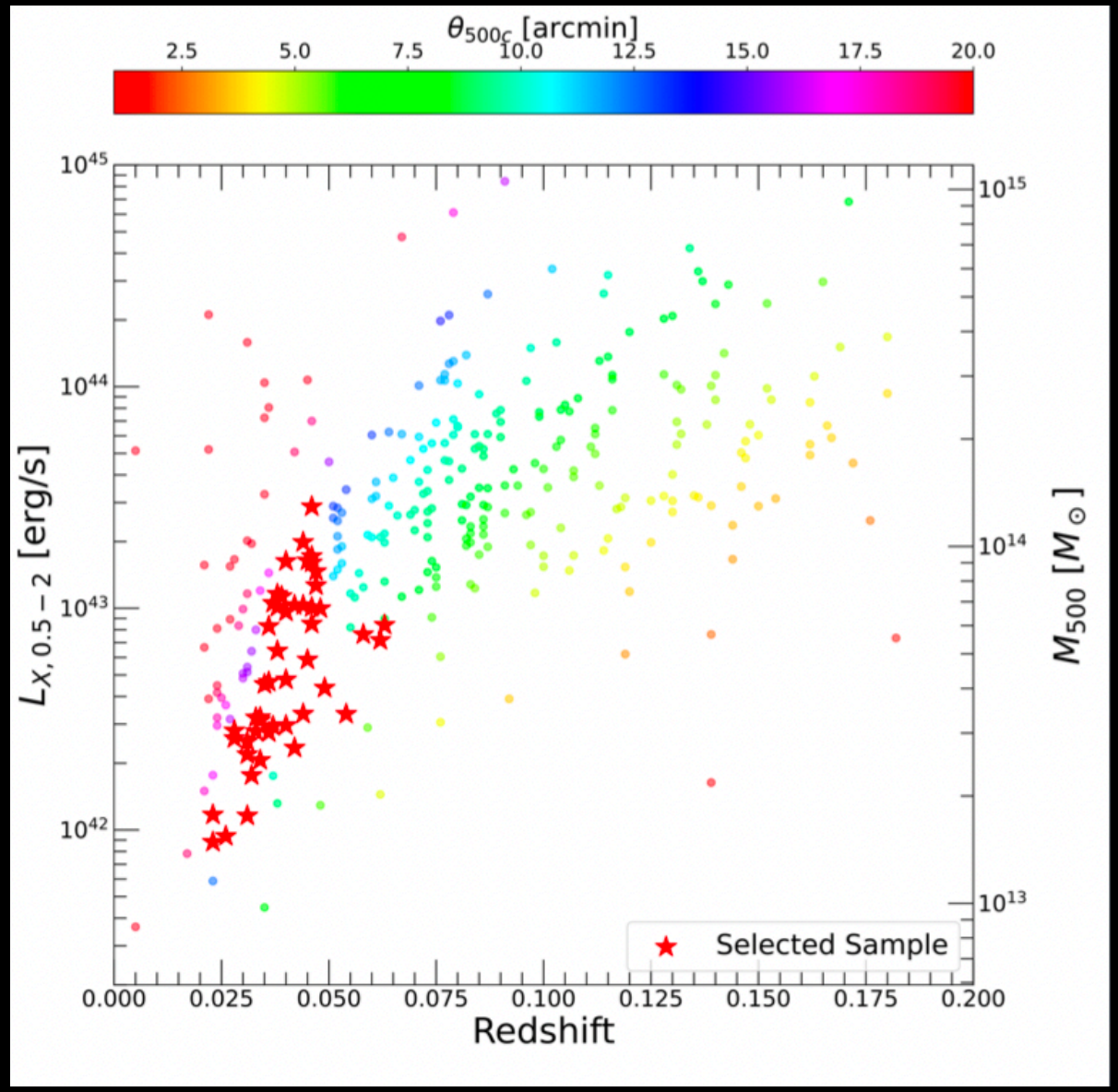
X-GAP sample selection



Finoguenov+ submitted

We cross-correlated SDSS FoF group sample (Tempel+17) with core-excised RASS extended sources (Finoguenov et al. subm.)

X-GAP sample selection



We applied the selection criteria:

- $\theta_{500} < 15'$ to fit the XMM FoV
- $z < 0.05$ to select the group regime
- $N_{gal} > 8$ to have a robust velocity dispersion

Final sample: **49** groups with uniform XMM follow-up (AO21 LP, 859 ks)

11 archive observations, until now 23 observations performed

Quality of the XGAP data

ID 3460

ID 16393

ID 6159

Our combined opical and improved RASS X-ray extended source detection allows us to detect groups in a broad range of dynamical states

Quality of the XGAP data

The relatively flat surface brightness objects show an excess entropy and low gas fraction out to R500 that we are able to recover with no need of extrapolation

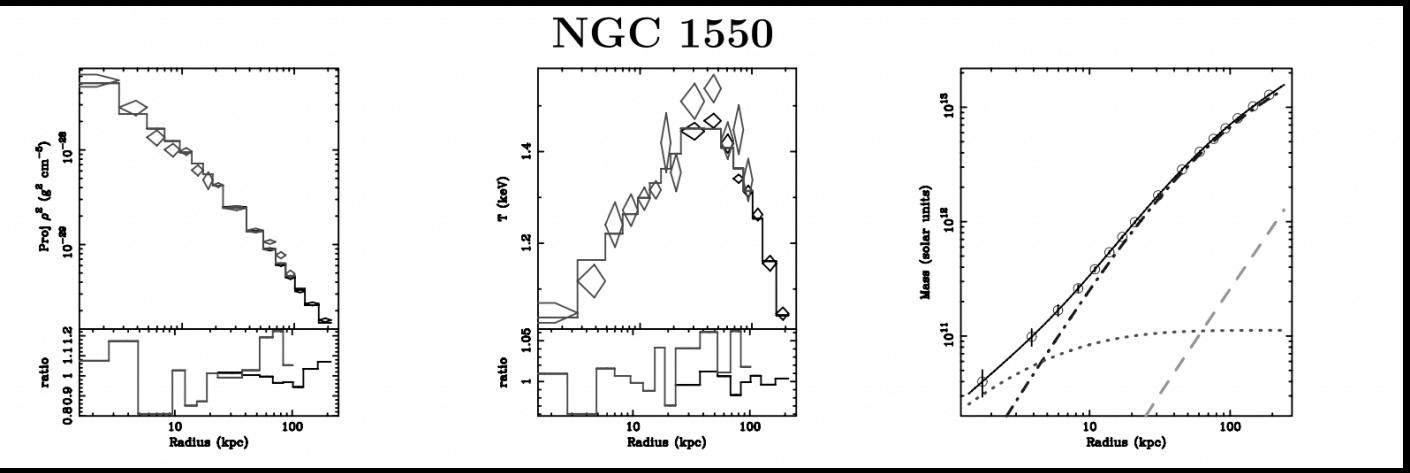
The objectives of XGAP

Sub-projects

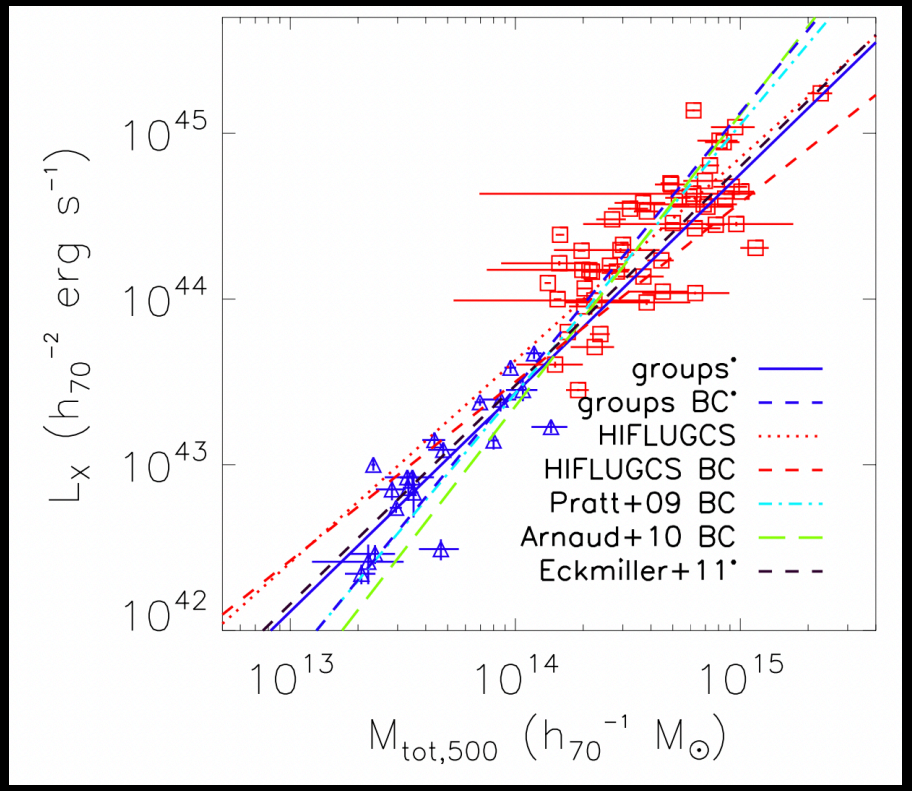
This page contains the list of sub-projects and their associated pages

- Gas fraction at R_{500} and its dependence on mass (Lead: D. Eckert)
- Thermodynamic profiles (density, temperature, entropy) out to R_{500} (Leads: D. Eckert, F. Gastaldello)
- Hydrostatic mass profiles, comparison with velocity dispersion, c-M relation (Lead: F. Gastaldello)
- Hydrodynamical simulations and mock observations (Lead: B. Oppenheimer)
- 2D spectral mapping and hydrodynamic features (cavities, shocks) (Lead: E. O'Sullivan)
- Scaling relations: Lx, T, σ_v, T, Y_x (Lead: L. Lovisari)
- Radio properties and statistics (Leads: M. Brienza, F. De Gasperin, R. Kale)
- X-ray vs optical selection: gas properties, galaxy populations (Lead: A. Finoguenov)
- Sample selection function (Lead: A. Le Brun)
- Metallicity, Fe-mass-to-light ratio (Leads: F. Mernier, A. Simionescu)
- Dynamical state measurements, cool core fraction (Lead: G. Schellenberger)
- Sunyaev-Zel'dovich properties (Lead: E. Pointecouteau)
- Velocity dispersions and dynamical mass measurements (Lead: G. Mamon)
- Galaxy populations, stellar masses and spectroscopy (Lead: C. Haines)
- H-alpha filaments (Lead: M. Sun)
- Molecular gas (Lead: E. O'Sullivan)

The objectives of XGAP



FG+07



Lovisari+15

Brienza, LOFAR HBA analysis

Summary

- XGAP is a dedicated program to determine the properties of the IGrM in a carefully selected sample to answer the still open question of the gas fraction below 10^{14} M_{sun}
- This will provide a crucial input for the implementation of the AGN feedback into modern hydrodynamical simulations (and a calibration dataset to model baryonic effects for eROSITA, Euclid, LSST)
- INAF is playing a key role in this new attention paid to the scale of galaxy groups: XGAP has its origin in the series of review promoted by Lovisari-Ettori, see also the recent workshop organized in Bertinoro