Scaling law relations with a complete sample of galaxy groups

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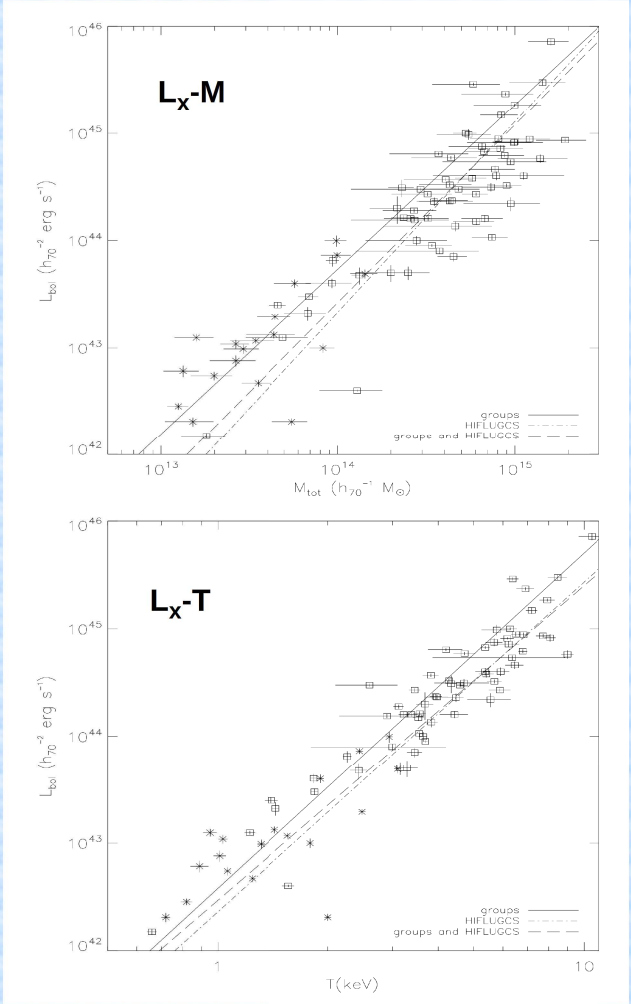
Introduction

Galaxy clusters are fundamental probes used to set tight constraints on the fundamental cosmology parameters like Ω_m and σ_8. Large well defined and statistically complete samples of galaxy clusters are obvious prerequisites for such studies. In the near future, X-ray surveys like eROSITA will increase the current statistical power by 1-2 orders of magnitude. As the first preparatory step of utilizing clusters for precision cosmology, we need to tackle systematic effects on cluster temperature and mass estimates. Most of the clusters detected with eROSITA will be in the low mass regime (i.e. groups) and there will be too few photons to measure the cluster temperature or gas mass. Basically, luminosity will have to be used as a mass proxy. We present here preliminary results of the analysis of a complete sample of galaxy groups from observations taken with XMM-Newton.

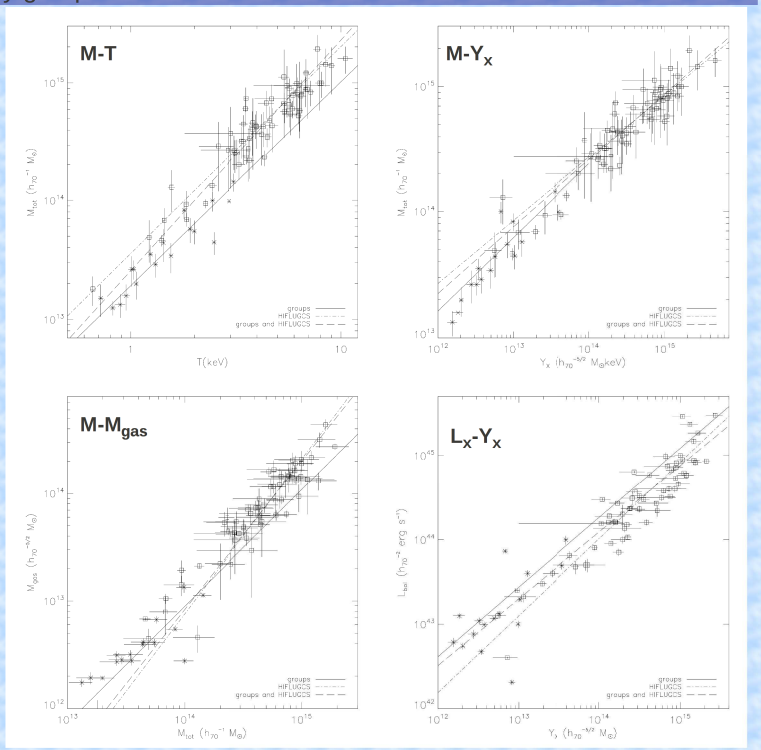
Sample and Aims

We construct a complete sample of galaxy groups by a flux limit, $f_x(0.1\text{-}2.4\ keV) \geq 5 \times 10^{-12}$ erg/s/cm^2, and two redshift cuts ($0.010<z<0.035$). This resulted in a sample of 22 groups of galaxies. By combining this sample with the HIFLUGCS creates a master sample of 86 groups and clusters ranging over more than three orders of magnitude in luminosity.
Our main goal is to improve the accuracy of the L_X-M and other relations in order to check whether or not there is a systematic difference between cluster and groups, and to thereby extend the cluster mass determination for future large sample down to the low mass regime.



L_X-T & L_X-M

Plotted above are the L_X-T and the L_X-M relations for 22 groups (asterisks) and 63 clusters (squares). Fitting groups and clusters separately gives similar slopes but a higher normalization for the groups suggesting a systematic higher luminosity at given mass and temperature.
The intrinsic scatter for groups is larger than for the cluster sample in both relations.



Y_X, M and M_{gas} relations

The M-T, M-Y_X, and L_X-Y_X relations are consistent for groups and clusters but once again the intrinsic scatter for groups is larger than for the cluster sample. Including groups into the relations does not change significantly the fits of the HIFLUGCS clusters for these three relations.
The M_{gas}-M relation for clusters is steeper than that of the groups suggesting a trend for a lower gas fraction in the low mass objects.

Relation	Sample	Slope	Normalization	$\sigma_{ln}(Y)$
M-T	groups	1.72±0.07	0.11±0.07	0.12
	HIFLUGCS	1.75±0.08	0.39±0.03	0.13
	groups & HIFLUGCS	1.95±0.06	0.34±0.02	0.16
L_X-M	groups	1.54±0.23	0.03±0.11	0.36
	HIFLUGCS	1.78±0.09	-0.37±0.06	0.39
	groups & HIFLUGCS	1.66±0.08	-0.28±0.05	0.41
L_X-T	groups	3.12±0.22	0.37±0.09	0.40
	HIFLUGCS	3.07±0.13	0.13±0.04	0.30
	groups & HIFLUGCS	2.93±0.11	0.17±0.03	0.31
M-Y_X	groups	0.59±0.07	-0.79±0.05	0.13
	HIFLUGCS	0.50±0.04	-0.57±0.08	0.13
	groups & HIFLUGCS	0.53±0.02	-0.65±0.04	0.14
M_{gas}-M	groups	1.09±0.25	0.95±0.11	0.18
	HIFLUGCS	1.44±0.13	0.88±0.10	0.20
	groups & HIFLUGCS	1.38±0.08	0.92±0.06	0.21
L_X-Y_X	groups	0.82±0.05	-1.08±0.06	0.33
	HIFLUGCS	0.91±0.04	-1.51±0.08	0.21
	groups & HIFLUGCS	0.79±0.03	-1.19±0.05	0.24

Summary

These are preliminary results which so far suggest that there is no a clear break of the powerlaw at low masses, but the scaling relations are not consistent either. Currently, we are analyzing in more details our results and investigating possible bias effects.

Note: The HIFLUGCS values are taken from
Chen Y.; Reiprich T.; Böhringer H.; Ikebe Y.; Zhang Y.-Y, 2007, A&A, 466, 805
Zhang Y.-Y, Andernach H.; Caretta C.; Reiprich T.; Boehringer H.; Puchwein E.; Sijacki D.; Girardi M.; 2011, A&A, 526, 105