### Testing the Low-Mass End of X-Ray Scaling Relations with Galaxy Groups



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# Motivation

- Galaxy clusters are important cosmological tools
- Scaling relations necessary for large samples
- Groups are expected to be more strongly influenced by non-gravitational effects
- Relations need to be tested for the low-mass range

## **Groups vs. Clusters**

	Groups	Clusters
Member count	< 50	50 - 10,000
Temperature	$\approx 1 \text{ keV}$	3 – 10 keV
Extent	0.1 – 1 Mpc	several Mpc
Luminosity $L_x$	$10^{42} - 10^{43} \mathrm{erg} \mathrm{s}^{-1}$	$10^{43} - 10^{45} \mathrm{erg} \mathrm{s}^{-1}$
Mass	$10^{13}M_\odot$	$10^{14} - 10^{15}  M_{\odot}$
Mass Fraction (Galaxies)	up to 20 %	< 5 %

In groups the mass of the galaxies is comparable to the ICM

#### Context

Some evidence for a systematic "break"

(e.g. Xue & Wu 2000, Helsdon & Ponman 2000, Finoguenov et al. 2001, Sanderson et al. 2003, Gastaldello et al. 2007, Davé et al. 2008)

 Some investigations show group relations consistent with clusters, but larger scatter

(e.g. Mulchaey & Zabludoff 1998, Osmond & Ponman 2004, Sun et al. 2009)

# **Sample Selection**

- statist. complete parent samples
- L<sub>x</sub> < 2.55·10<sup>43</sup> erg/s
- z > 0.01
- 26 groups with Chandra data





- Annular regions with same number of source counts
- CXB modeled with blank-sky background files



#### **Radial Profiles**



## **Luminosity-Temperature Relation**



HIFLUGCS: Reiprich & Böhringer (2002), Mittal et al. (2009), Hudson et al. (2010)

### **L-T with Temperature Cut**



### **Mass-Temperature Relation**



### **Luminosity-Mass Relation**



LoCuSS: Zhang et al. (2008)





### **Gas Mass and Gas Fraction**



• : Sun et al. 2009 ---- : Cosmic f<sub>g</sub> from WMAP5 (Dunkley et al. 2009)

## r<sub>500</sub>vs. r<sub>2500</sub>



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# Summary

- Study of scaling relations for group sample
- Universal shape of T profiles for r > 0.05 r<sub>500</sub>
- L<sub>x</sub>-T cut at 3 keV steepens for groups
- Overall: Larger scatter, but similar slope
- Lower f<sub>g</sub> in groups
- Paper submitted to A&A