# *L*<sub>X</sub>-*M* Relations and Group Outskirts

Thomas Reiprich, Bonn http://dark-energy.net + Many Collaborators (-> See Slides)!



 Several preliminary slides/figures have been removed compared to the original version of this talk. Sorry for the inconvenience.

## HIFLUGCS $L_X$ - $M_{hyd}$ Relation

- For an overview and results of the Chandra/ HIFLUGCS cosmology work listen to Gerrit's talk (Schellenberger+TBS).
- ~60 brightest clusters in the sky.
- ~100 ks Chandra data per cluster.





HIFLUGCS  $L_X$ - $M_{hyd}$  Relation



*z*~0.05

Schellenberger+TBS

HIFLUGCS  $L_X$ - $M_{hyd}$  Relation



Schellenberger+TBS

HIFLUGCS  $L_X$ - $M_{hyd}$  Relation



Schellenberger+TBS

## Small But Well-Selected Samples With High-Quality Data



#### Mass/Redshift Distribution of Some Weak Lensing Mass Comparison Samples



Doria, Shafiee+TBS

#### Expected eROSITA Mass/Redshift Distribution.

Color code: Number of clusters in Log10



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#### HIFLUGCS L<sub>X</sub>-M<sub>dyn</sub> Relation ~200 Cluster Galaxy Velocities Per Cluster



#### From 400d Weak Lensing ( $z \sim 0.5$ ): $M_{X,Chandra}/M_{WL} \sim 1.0 (R_{500})$ $M_{X,XMM}/M_{WL} \sim 0.8 (R_{500})$ Weak Indications for Mass-Dependent Bias



 $L_X-M_{hyd}$  relation for complete local galaxy group sample, for the first time including detailed selection effect correction procedure.  $\Rightarrow$  Indications for gradual steepening of slope. Single powerlaw probably too simple.  $\Rightarrow$  Fitting functions provided. Lovisari+15



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## Outskirts

- Gaseous properties of many galaxy cluster outskirts have been explored with Suzaku (e.g., Reiprich+13 for a review).
- Galaxy group outskirts much less well studied, with partially contradicting results (e.g., Humphrey+12, Su+13).



• => More group observations required.

## Galaxy Group Outskirts



Suzaku Thoelken+16

#### Chandra Snapshots to Remove AGN



#### **Temperature and Metallicity Profiles**



Thoelken+16

## Gas Mass Fraction @ $R_{200}$ < Universal



## No Entropy Drop @ R<sub>200</sub>



#### Similar For Another Group (Wong+16)



250e-07 257e-07 271e-07 3.00e-07 3.57e-07 4.73e-07 7.01e-07 1.15e-06 2.07e-06 3.88e-06 7.49e-06

## No Entropy Drop @ R<sub>200</sub>



Wong+16

## The Future: Systematically Discover the Unexpected



### *eHIFLUGCS*



From G. Schellenberger



Hydro-simulations Roediger+15

Schellenberger & Reiprich (2016) (adapted image from Chandra Press Office)

## Summary

- $L_{\rm X}$ - $M_{\rm hyd}$ ,  $L_{\rm X}$ - $M_{\rm dyn}$ ,  $L_{\rm X}$ - $M_{\rm WL}$
- $M_{\rm hyd}/M_{\rm WL}$  (M)
- Group Outskirts
- Complete Stripping