THE 2009 X-RAY VIEW OF GALAXY GROUPS: MASS, ENTROPY AND AGN FEEDBACK IN GALAXY GROUPS

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OUTLINE

3. MASS PROFILES FOR A SAMPLE OF X-RAY BRIGHT AND RELAXED GROUPS
4. ENTROPY PROFILES FOR THE SAME SAMPLE. RELEVANT SCALE FOR BREAKDOWN OF SELF-SIMILARITY
5. AGN FEEDBACK IN TWO INTERESTING OBJECTS

A SPECIAL ERA IN X-RAY ASTRONOMY

Chandra

•1 arcsec resolution

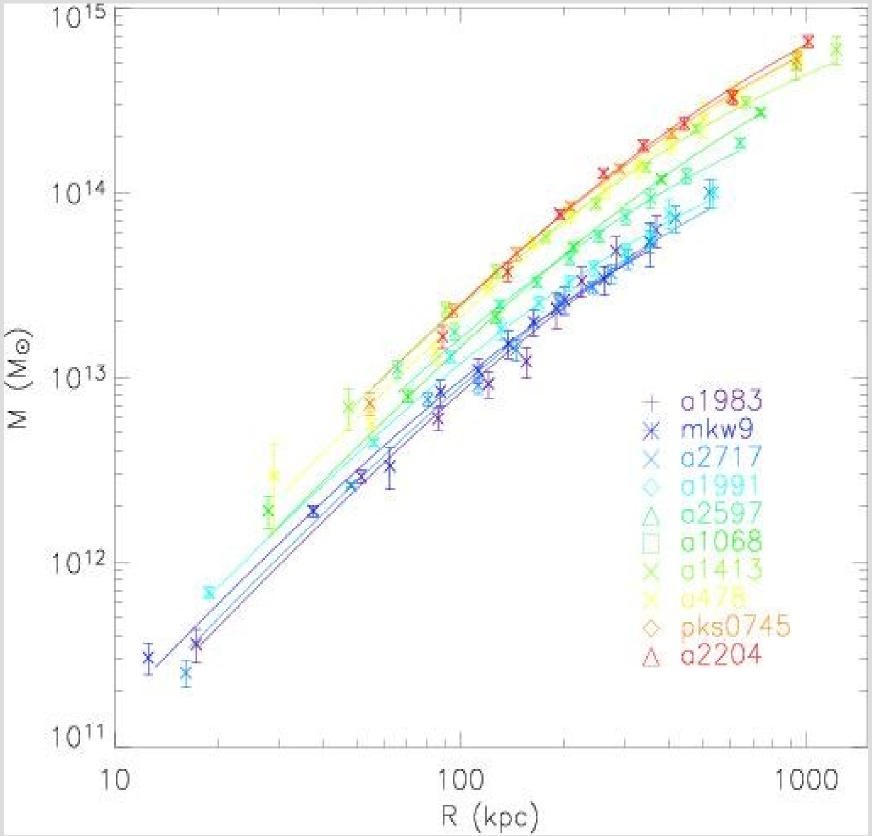
XMM-Newton

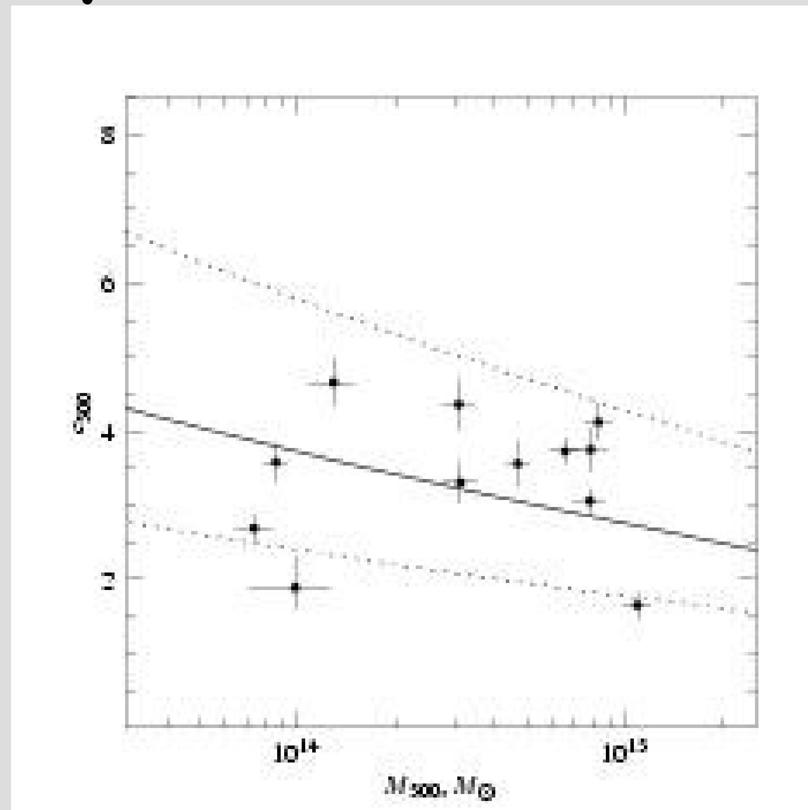
•High sensitivity due to high effective area, i.e. more photons

SUZAKU

•Low and stable background

Clusters X-ray results





Pointecouteau et al. 2005

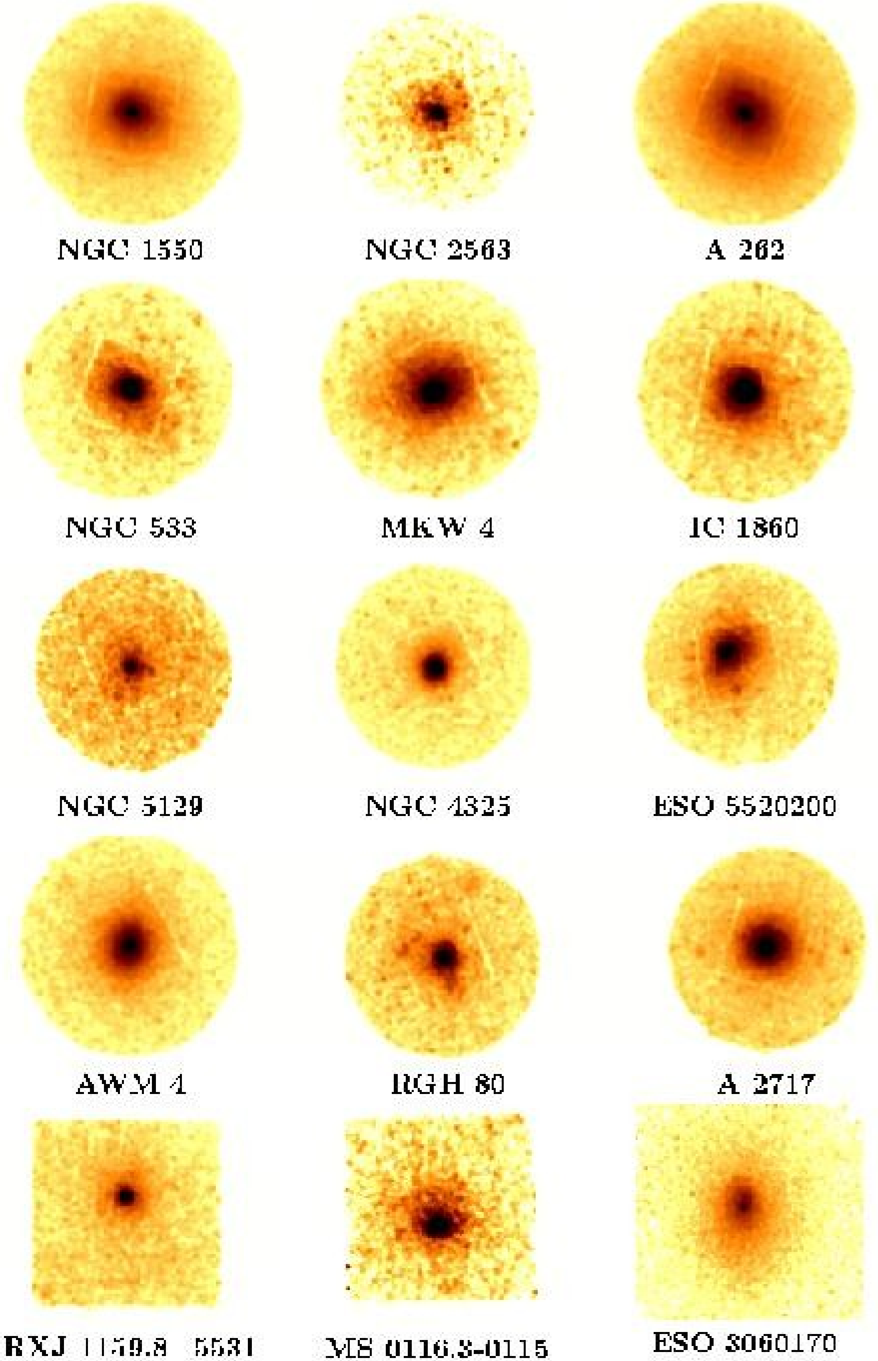
Vikhlinin et al. 2006

• NFW a good fit to the mass profile

•c-M relation is consistent with no variation in c and with the gentle decline with increasing M expected from CDM (α = -0.04±0.03, P05).

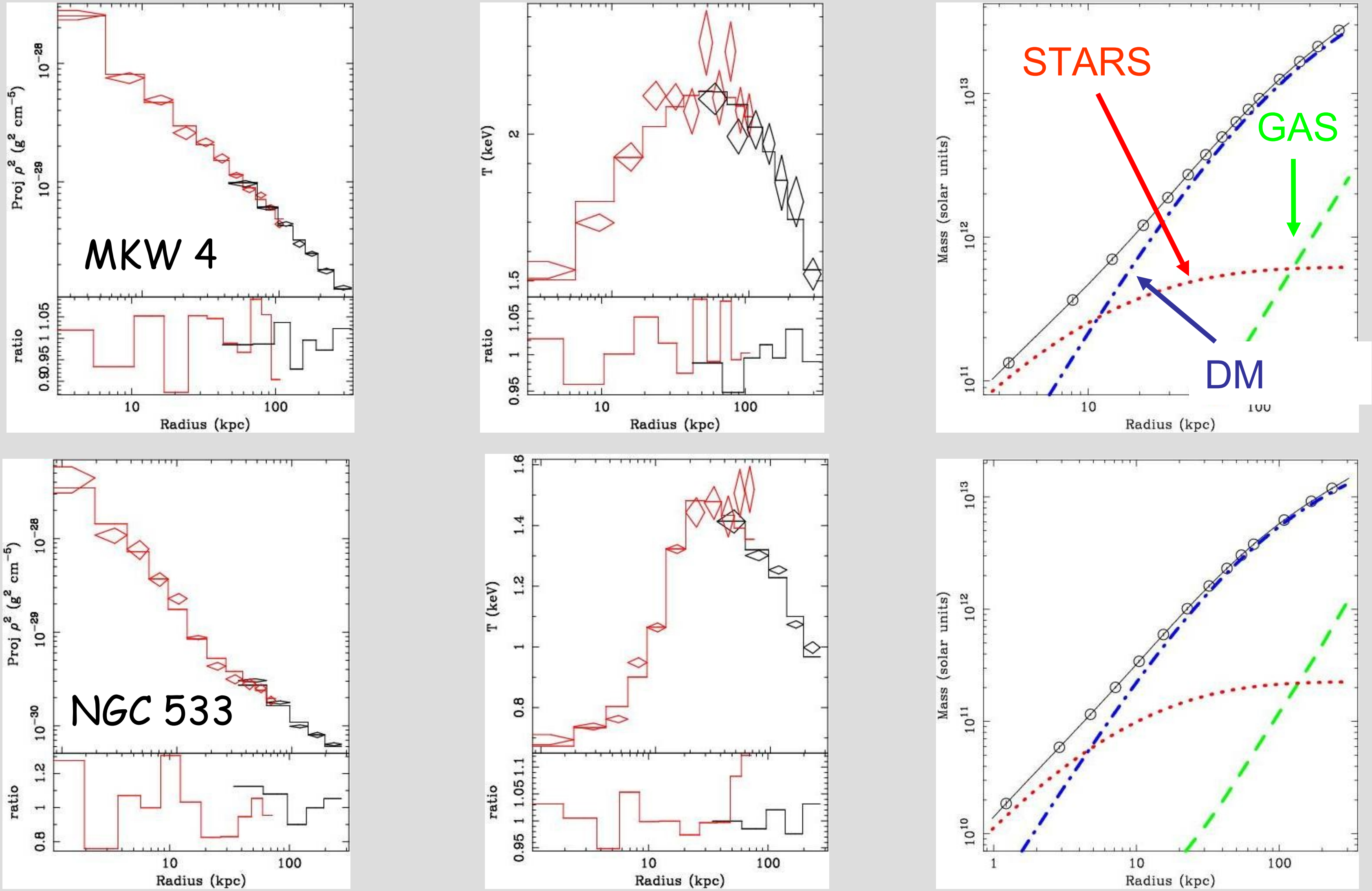
THE PROJECT

- Improve significantly the constraints on mass profiles and c-M relation by analyzing a wider mass range with many more systems, in particular obtaining accurate mass constraints on relaxed systems with $10^{12} \leq M \leq 10^{14}\ M_{sun}$
- There were very few constraints on groups scale ($10^{13} \leq M \leq 10^{14}\ M_{sun}$)
- In Gastaldello et al. 2007 we selected a sample of 16 objects in the 1-3 keV range from the XMM and Chandra archives with the best available data


NGC 1550
NGC 2563
A 262
NGC 533
MKW 4
IC 1860
NGC 5129
NGC 4325
ESO 5520200
AWM 4
RGH 80
A 2717
RXJ 1159.8 5531
MS 0116.3-0115
ESO 3060170

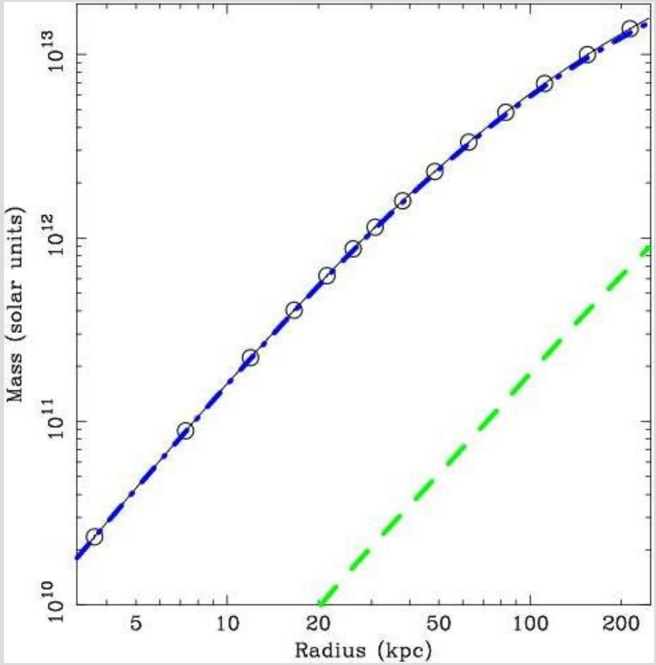
RESULTS

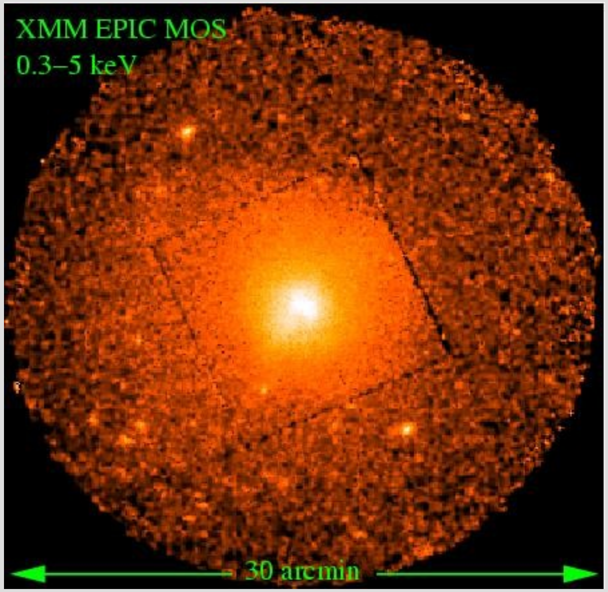
- After accounting for the mass of the hot gas, NFW + stars is the best fit model

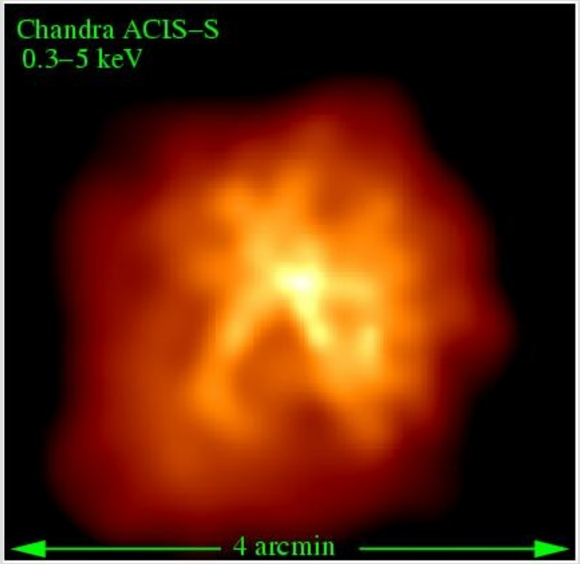


RESULTS

•No detection of stellar mass due to poor sampling in the inner 20 kpc or localized AGN disturbance



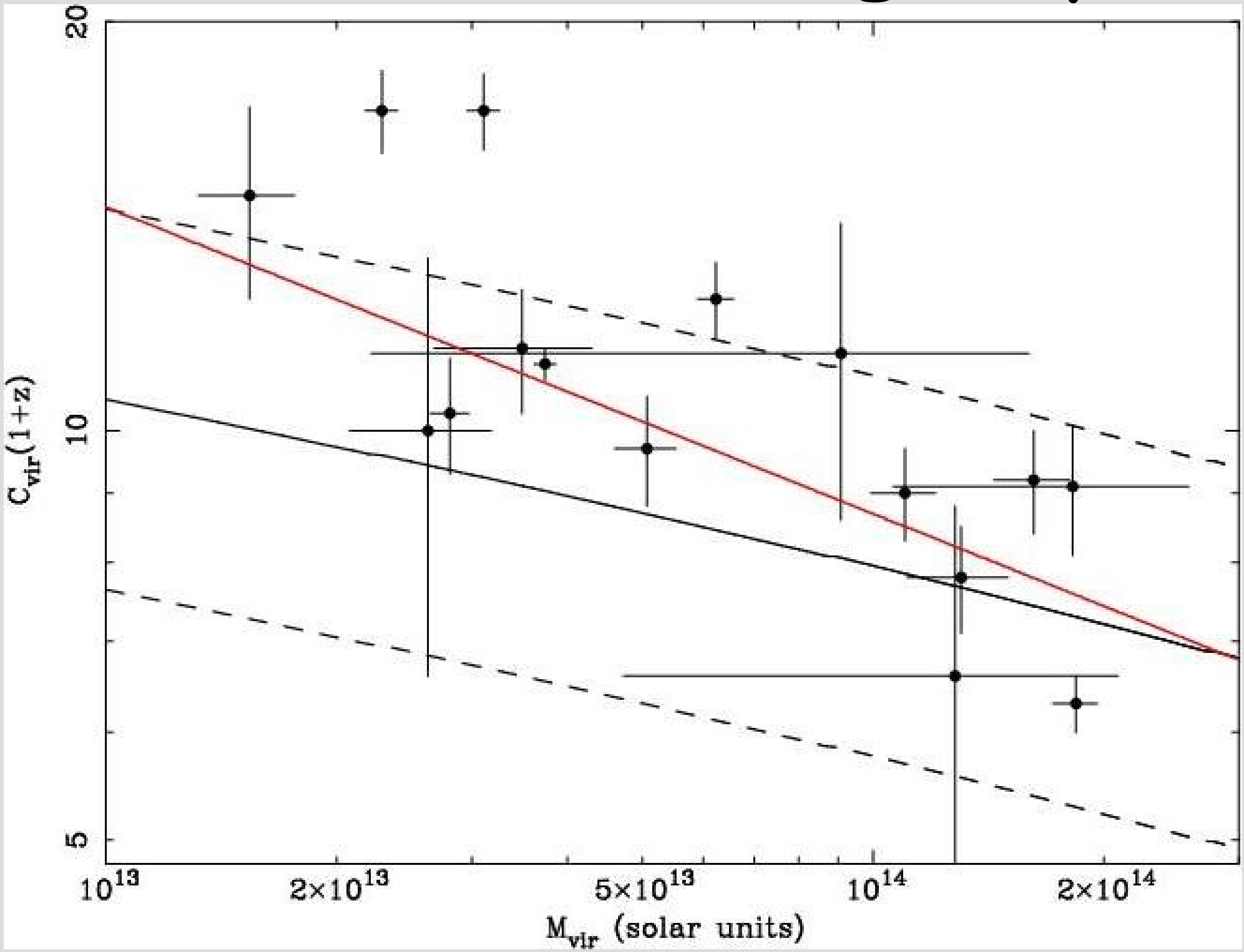




Buote et al. 2002

NGC 5044

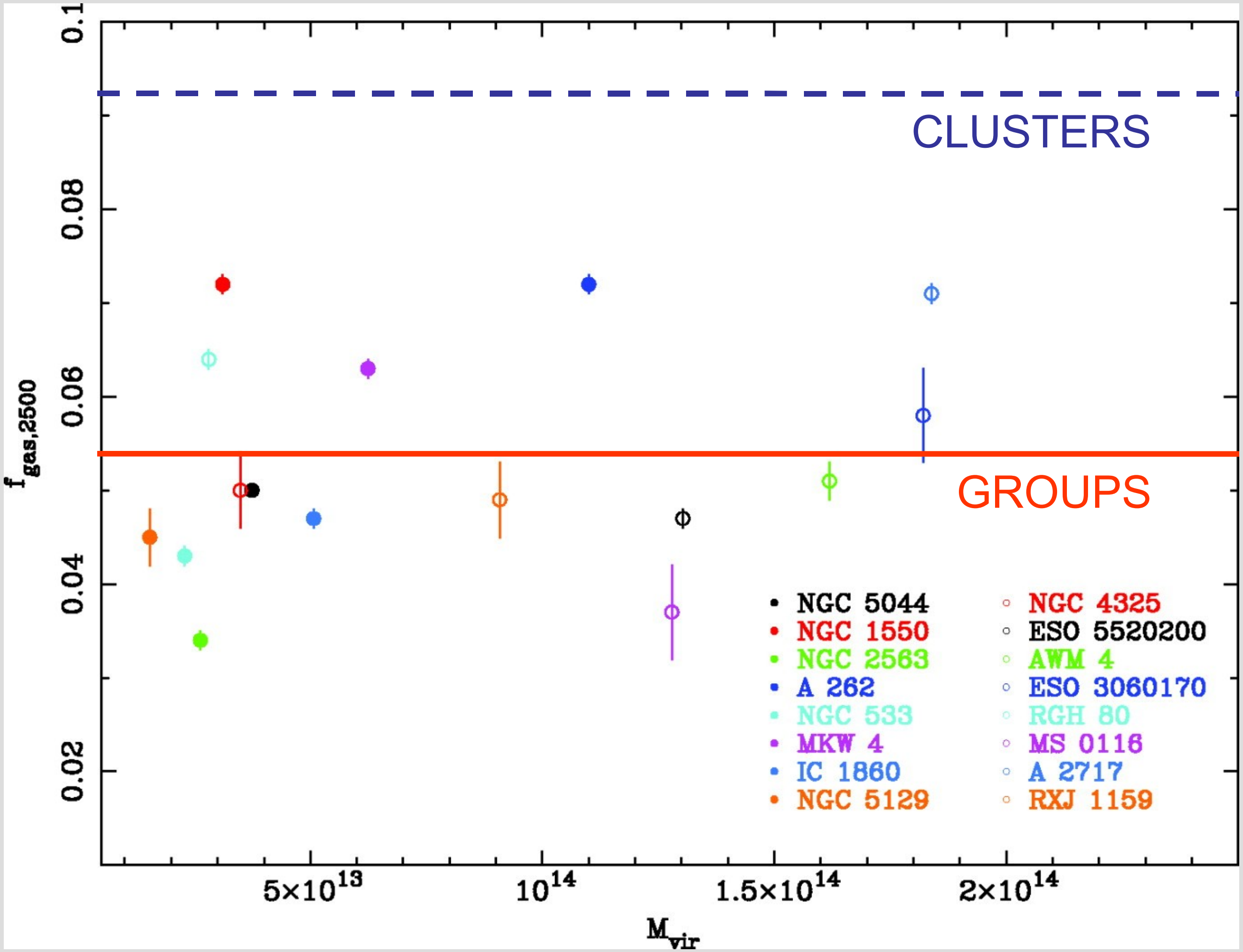
c-M relation for groups



We obtain a slope α=-0.226±0.076, c decreases with M at the 3σ level

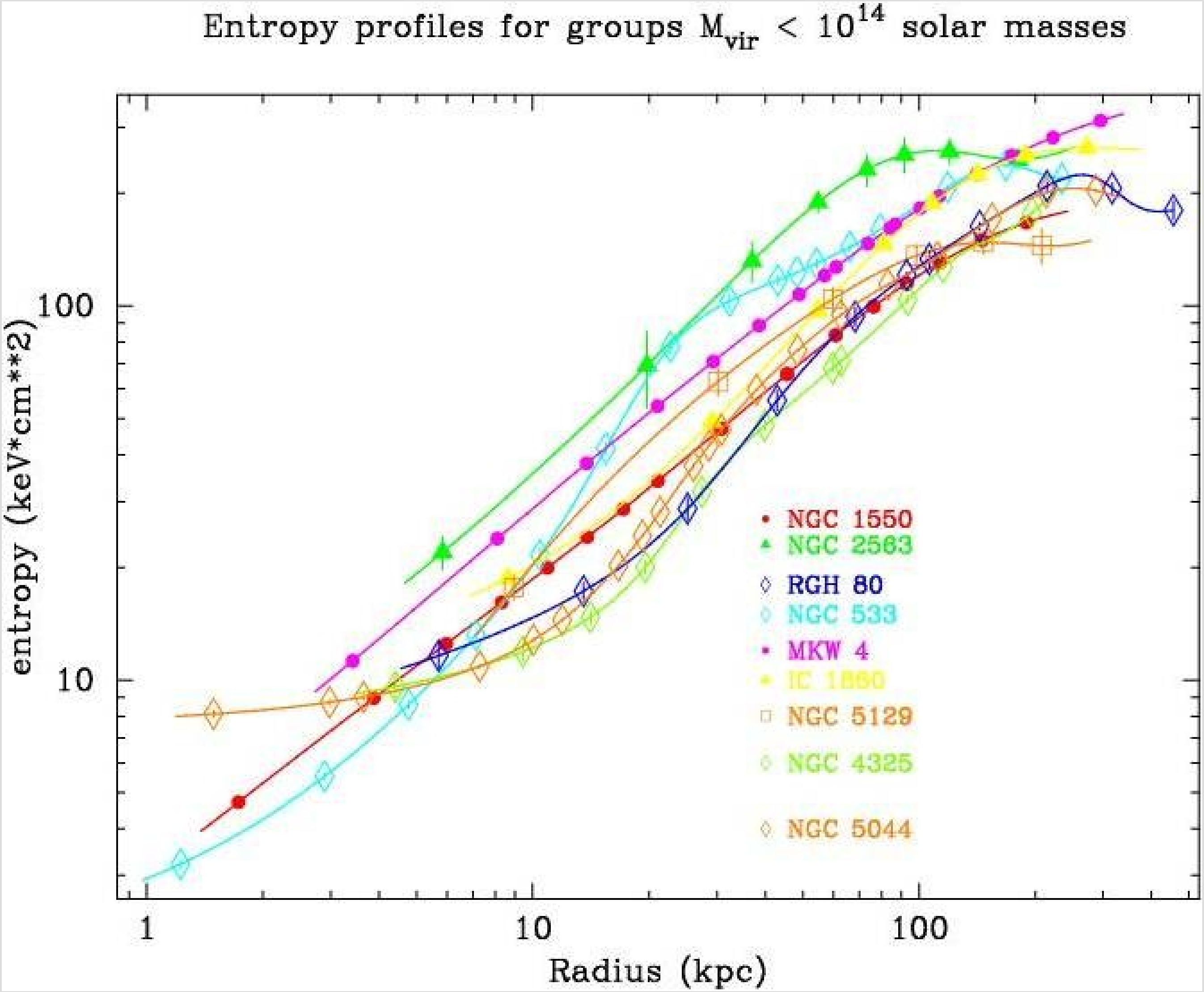
When clusters added c decreases with M at the 6.7 σ level (Buote+07)

GAS FRACTIONS

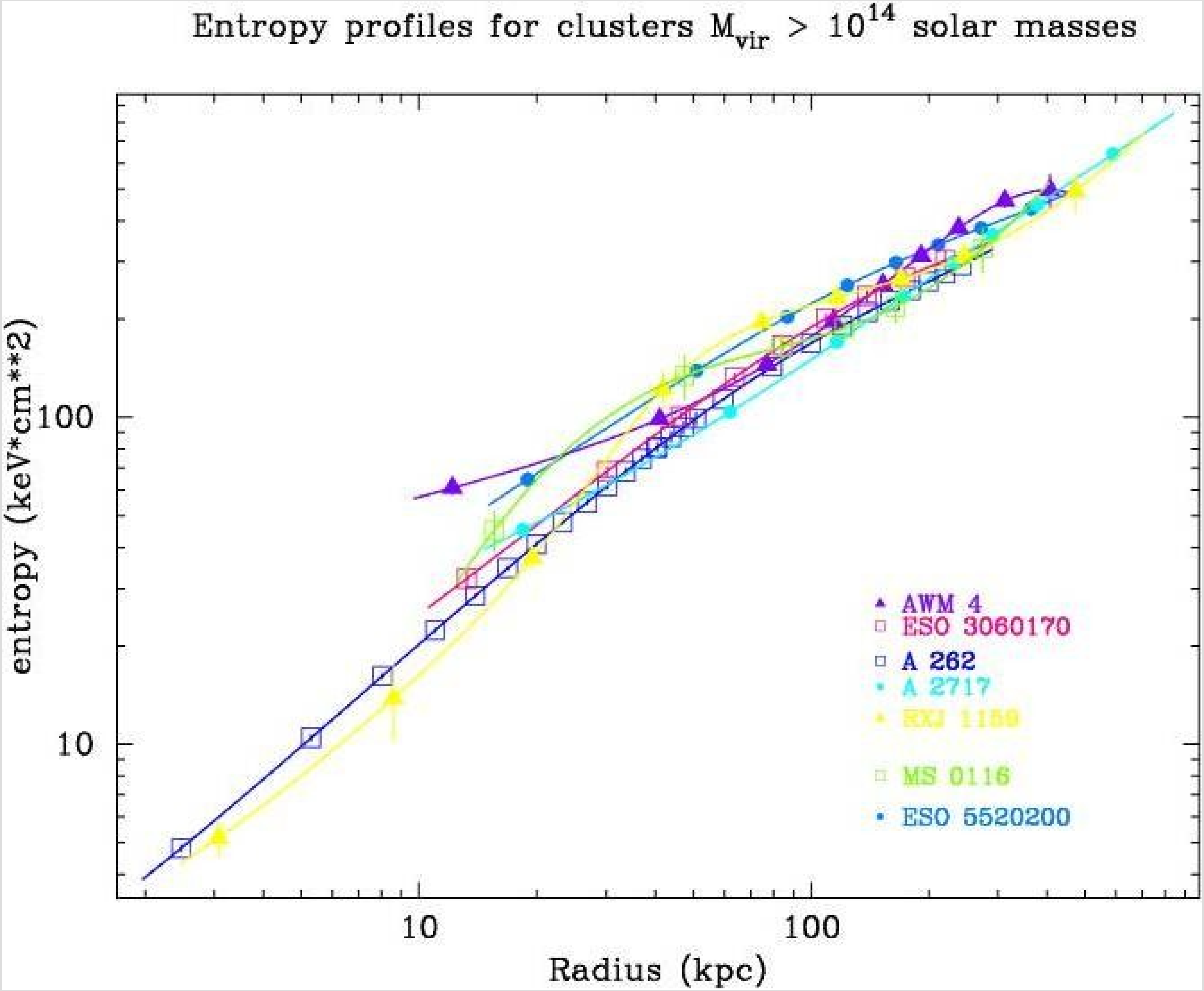


GASTALDELLO ET AL. 2007 (see also Sun+09)

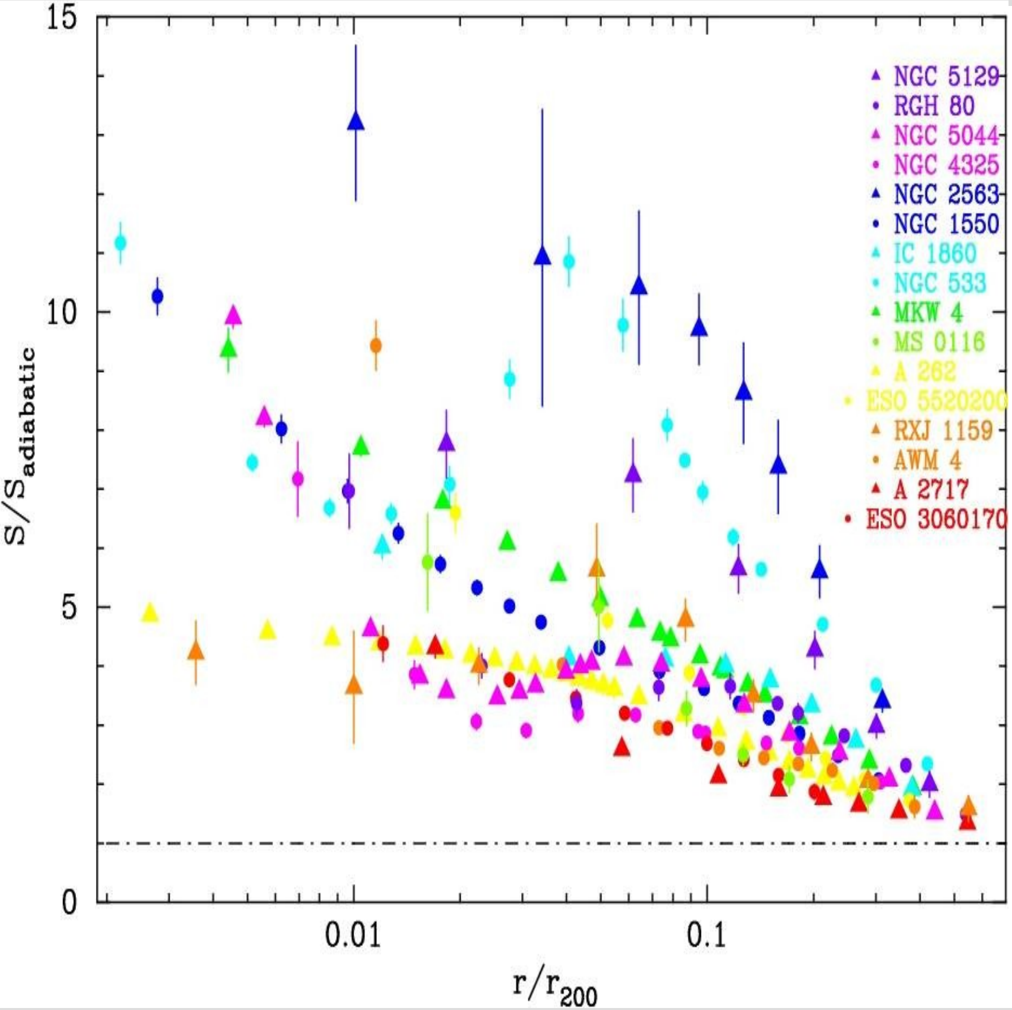
ENTROPY PROFILES

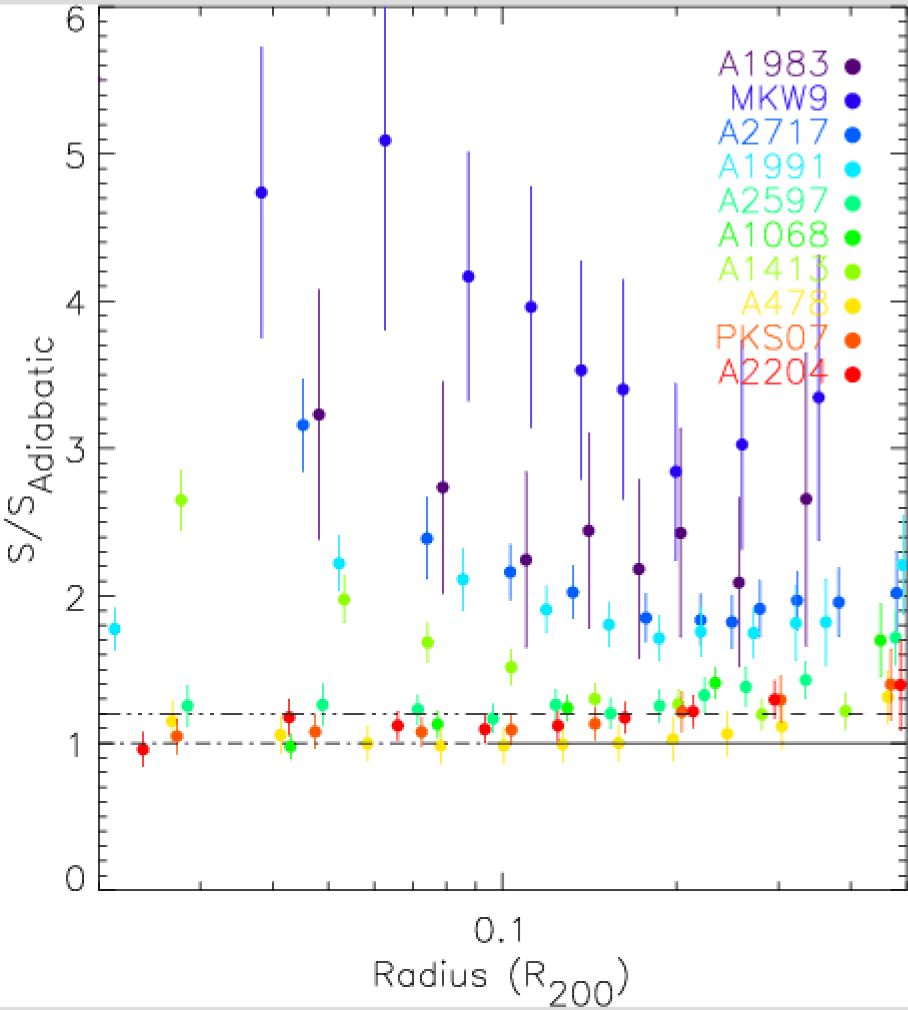


ENTROPY PROFILES



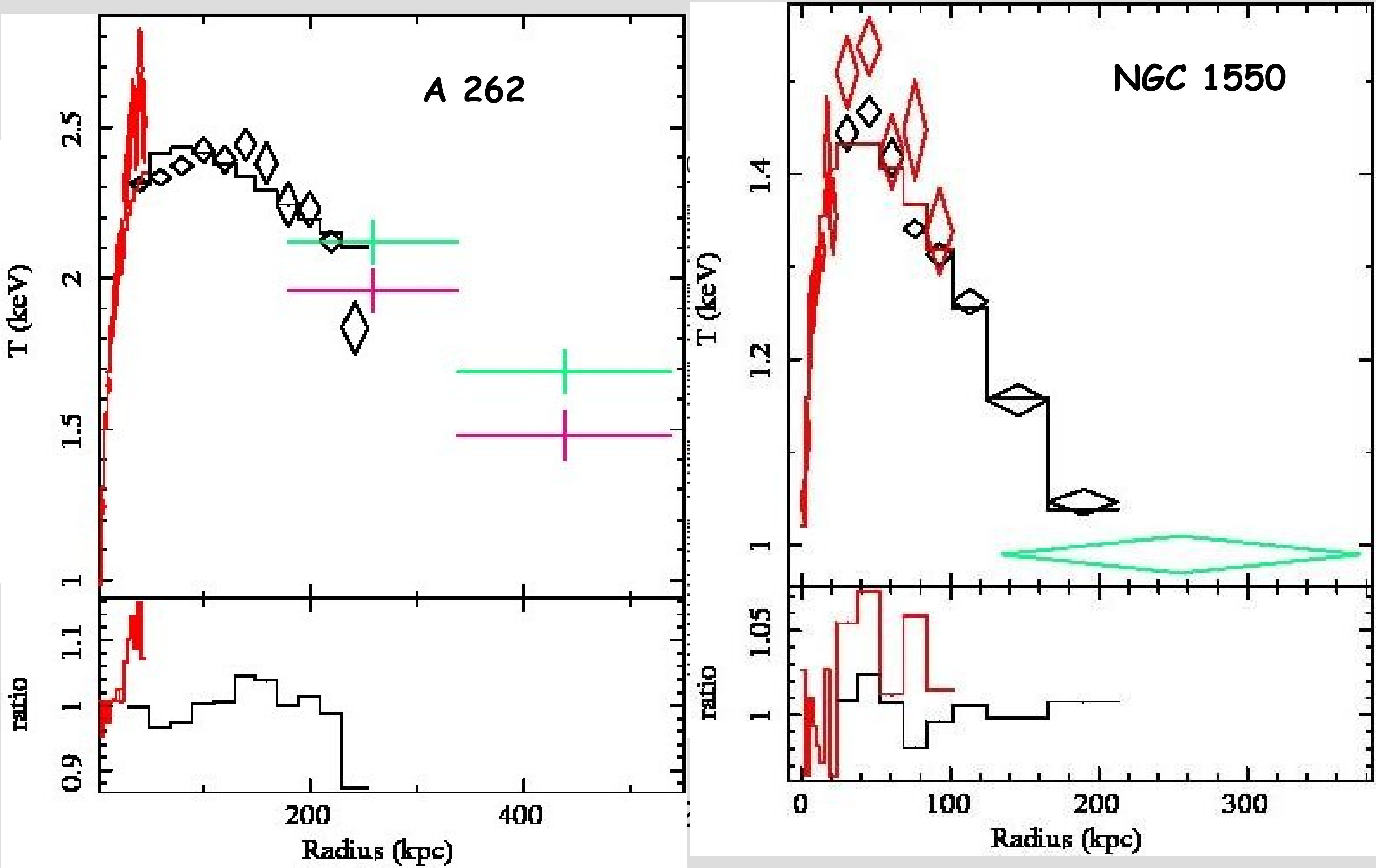
COMPARISON WITH MASSIVE CLUSTERS AND GRAVITATIONAL SIMULATIONS





(see also Sun+09)

LARGER RADII WITH SUZAKU



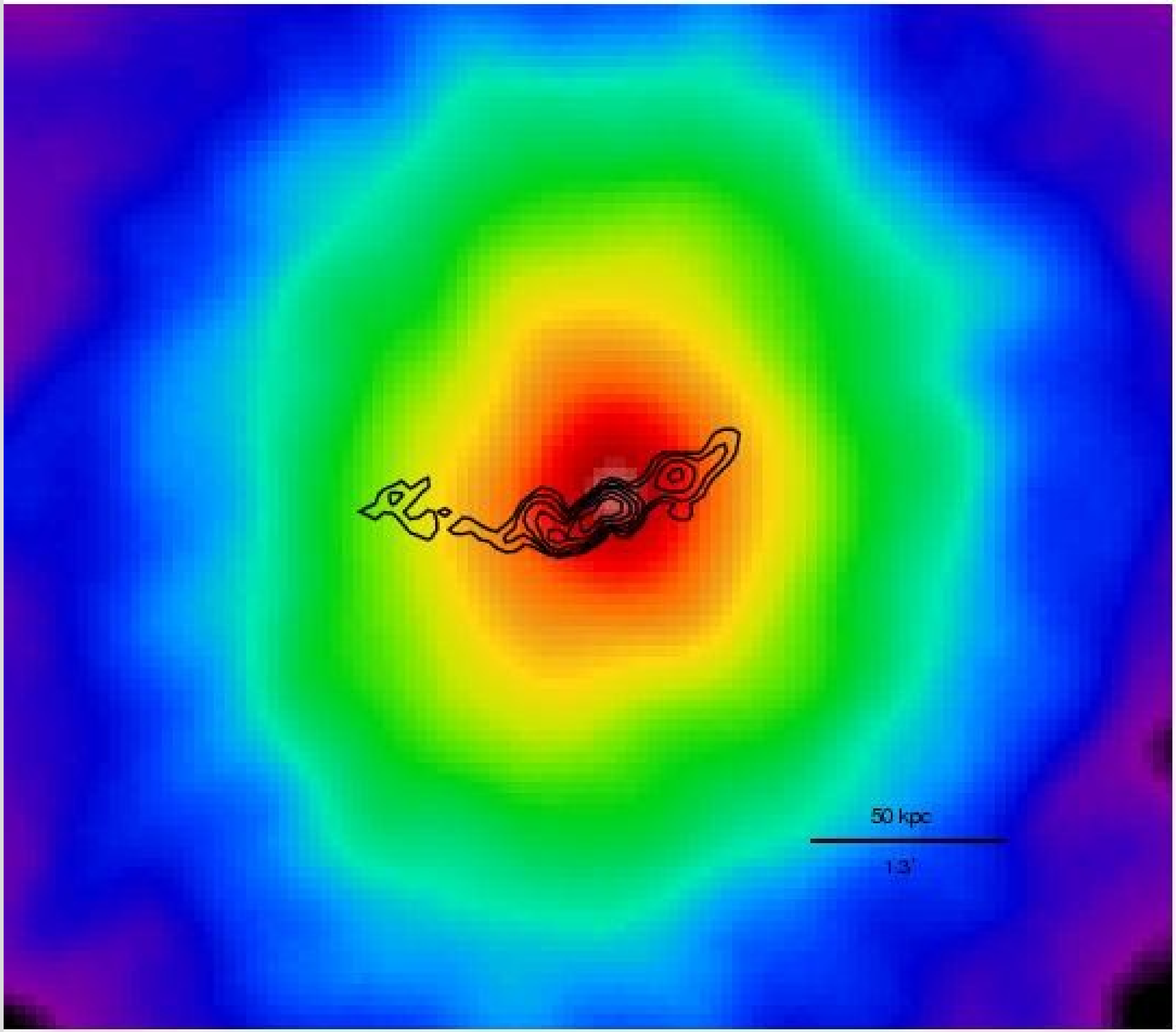
AGN FEEDBACK IN GROUPS

"UNFORTUNATELY, AGN HEATING IS NOT AS WELL STUDIED IN GROUPS AS IN CLUSTERS" (McNAMARA & NULSEN, ARAA). THIS IS RAPIDLY CHANGING (SEE NEXT TALKS).

NGC 5044 IS BRIGHT AND NEARBY (z=0.009), THE PERSEUS OF GROUPS. IDEAL TARGET TO STUDY AGN FEEDBACK.

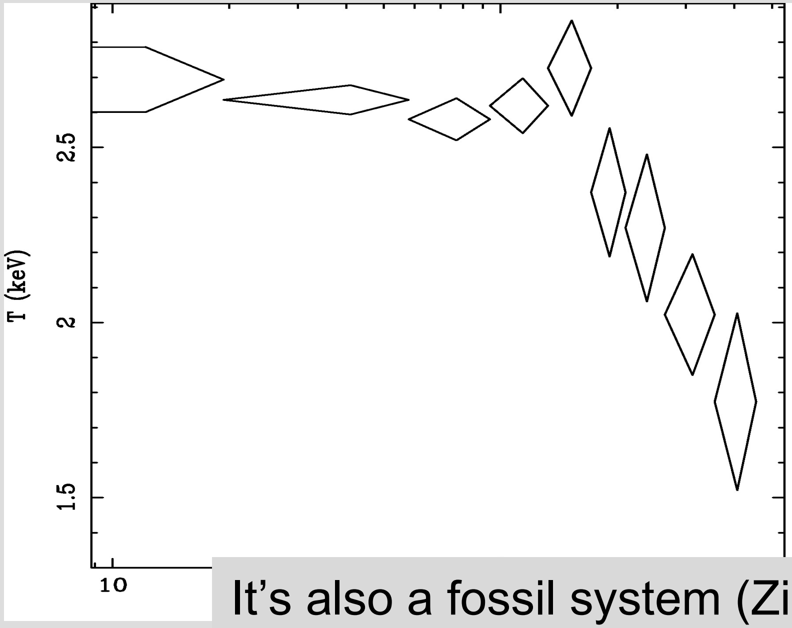
AWM4 IS A CHALLENGE FOR THE IDEA OF AN AGN FEEDBACK LOOP

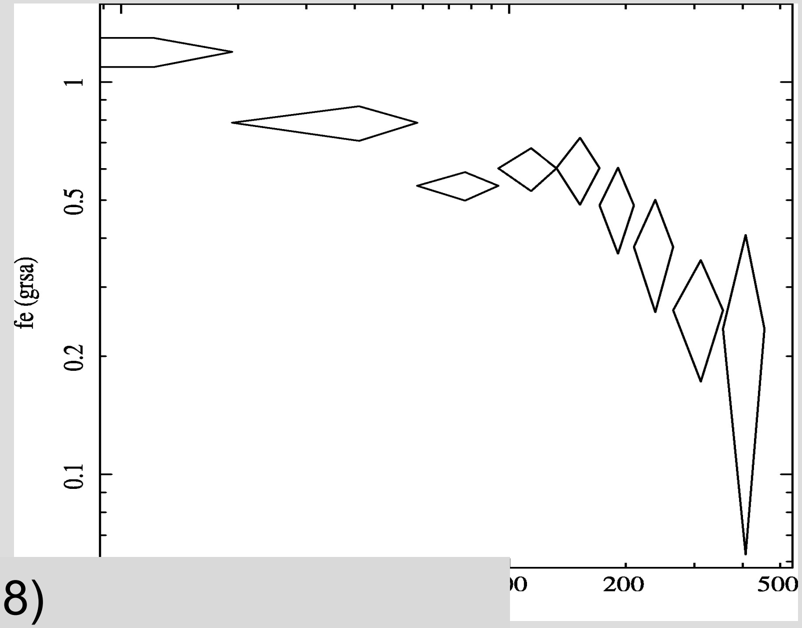
AWM4 AND AGN FEEDBACK



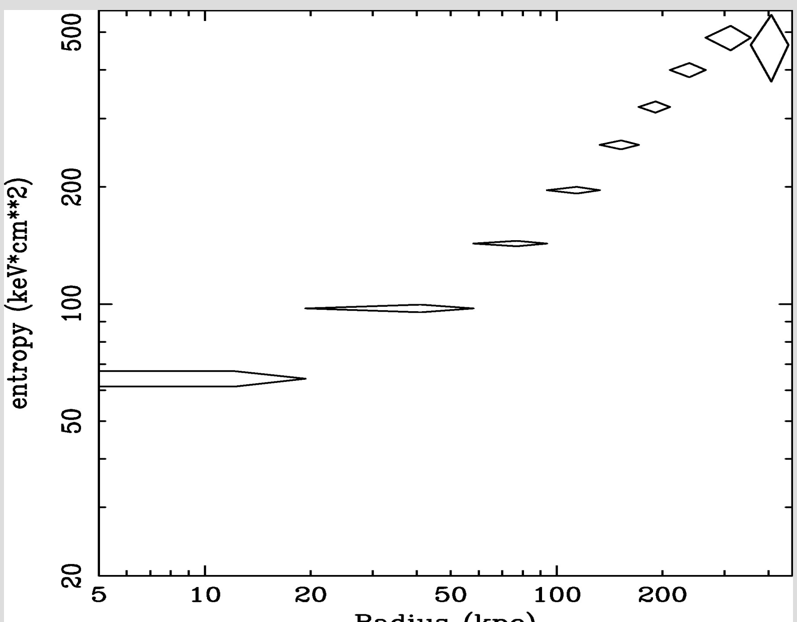
Gastaldello+08, see also O'Sullivan+05, Giacintucci+08

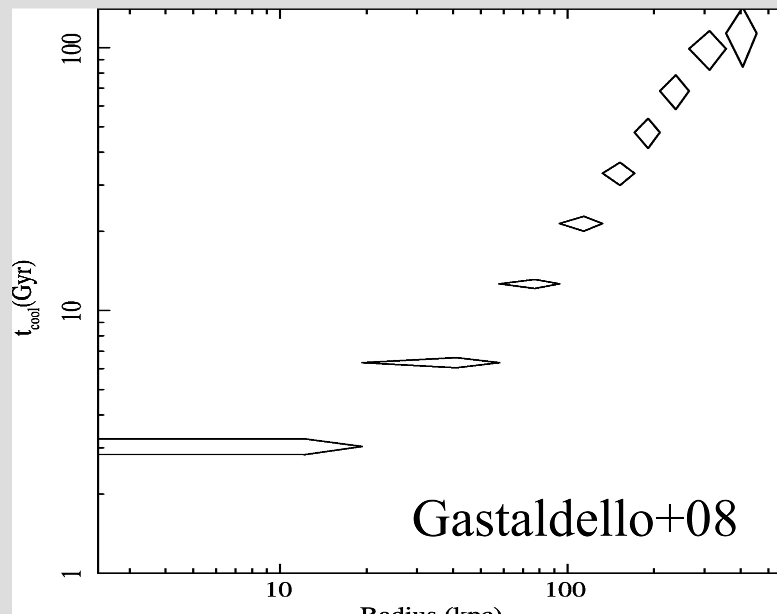
AWM4 AND AGN FEEDBACK



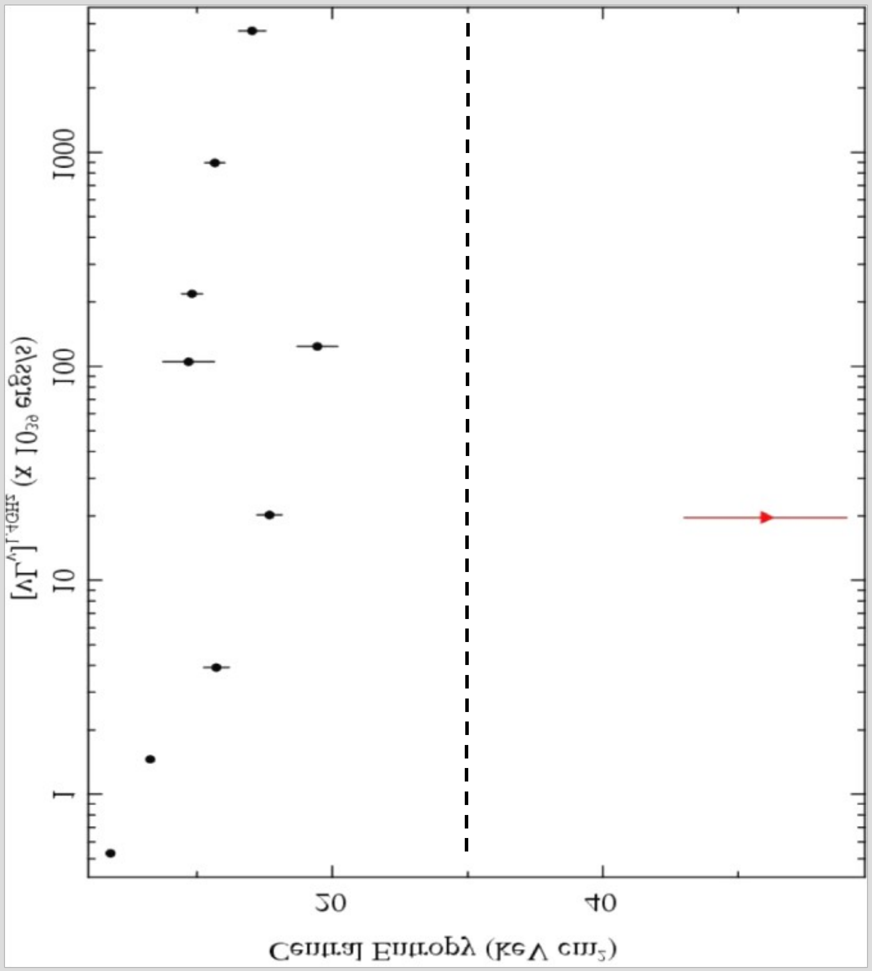


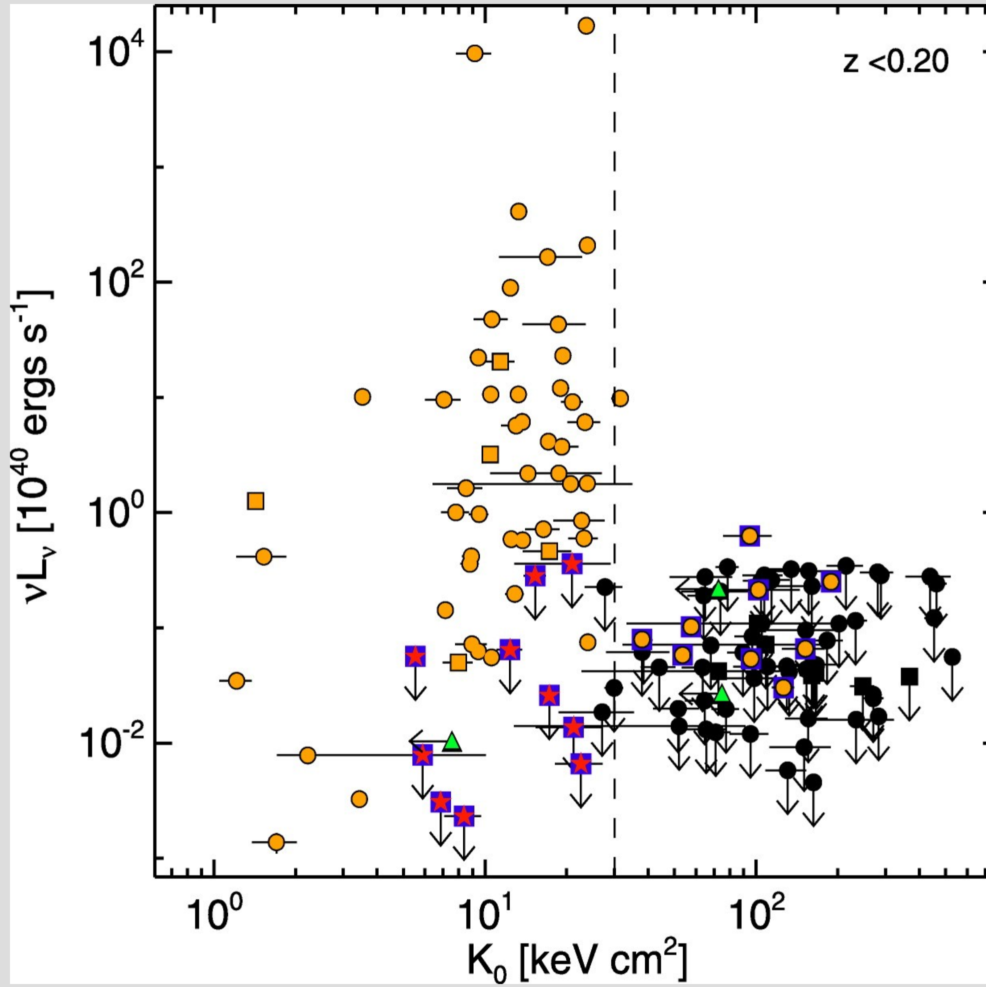
It's also a fossil system (Zibetti+08)





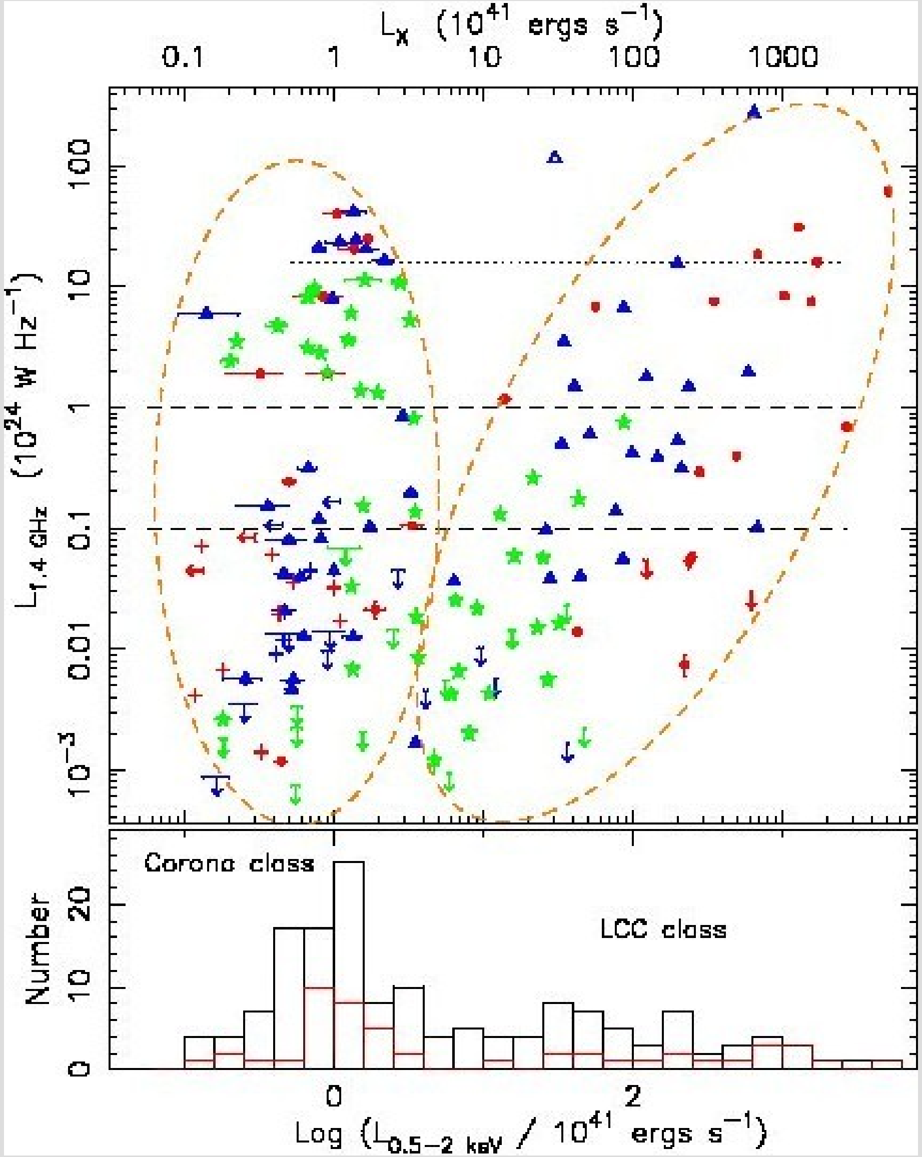
AWM4 AND AGN FEEDBACK





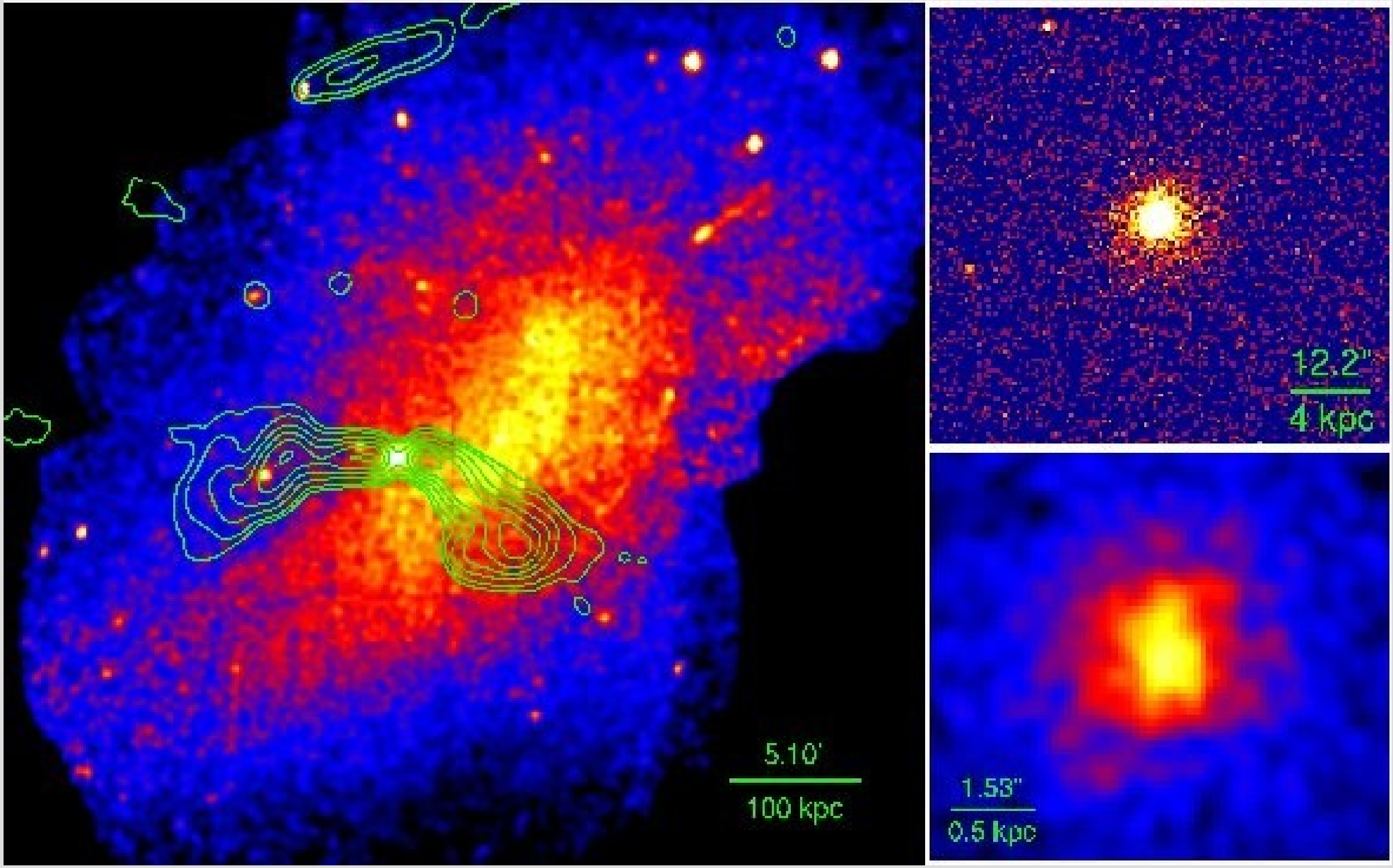
Cavagnolo+08

EVERY RADIO BCG HAS A COOL CORE



Sun+09

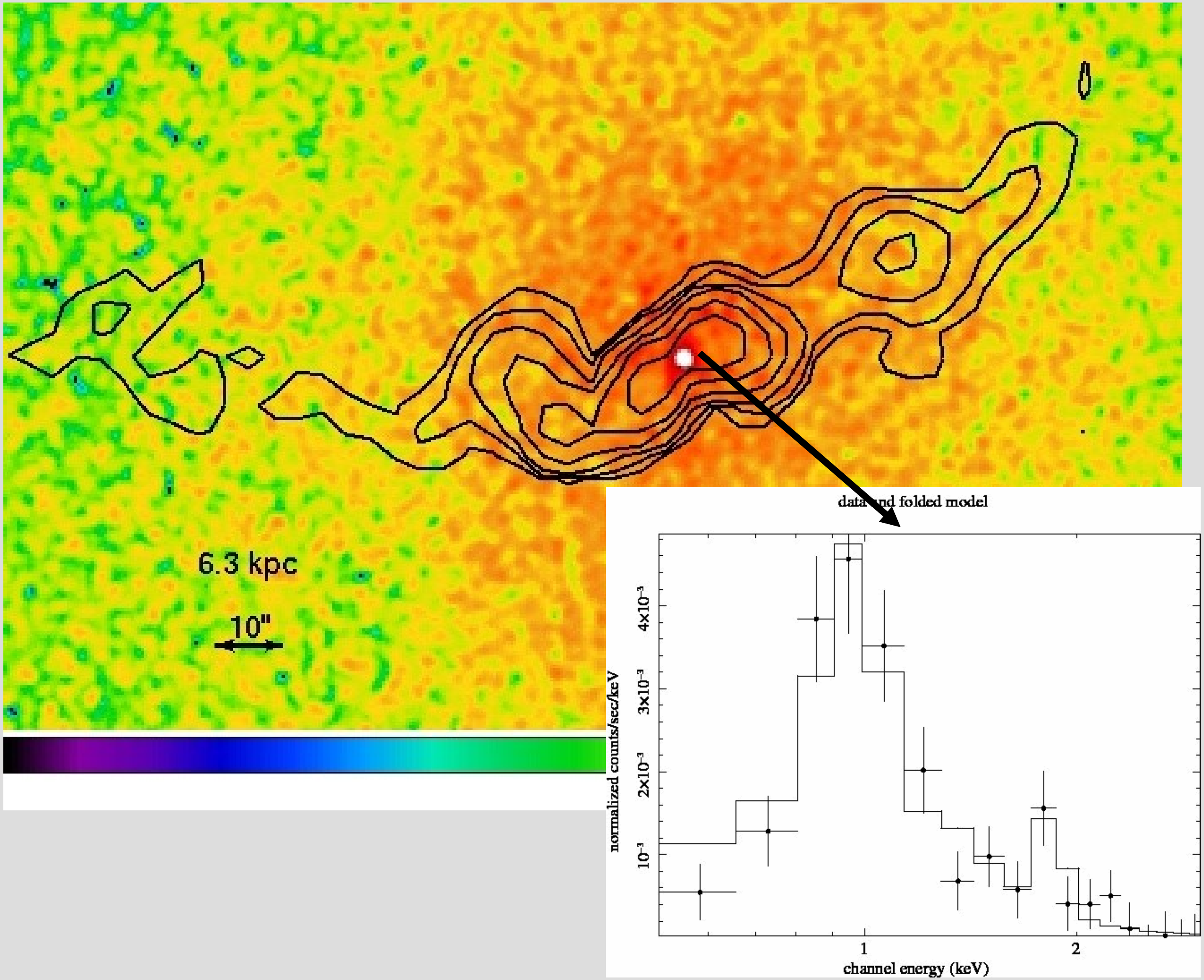
X-RAY CORONAE



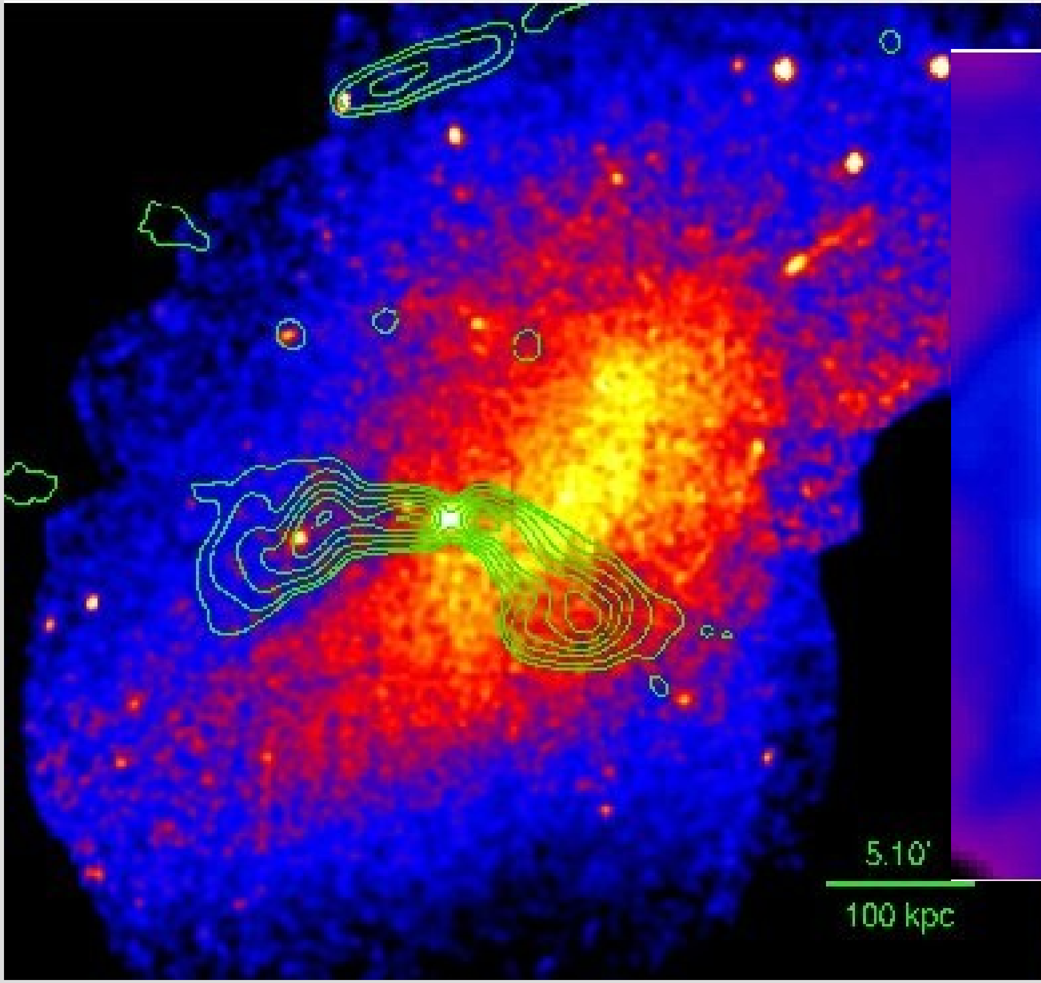
Abell 3627

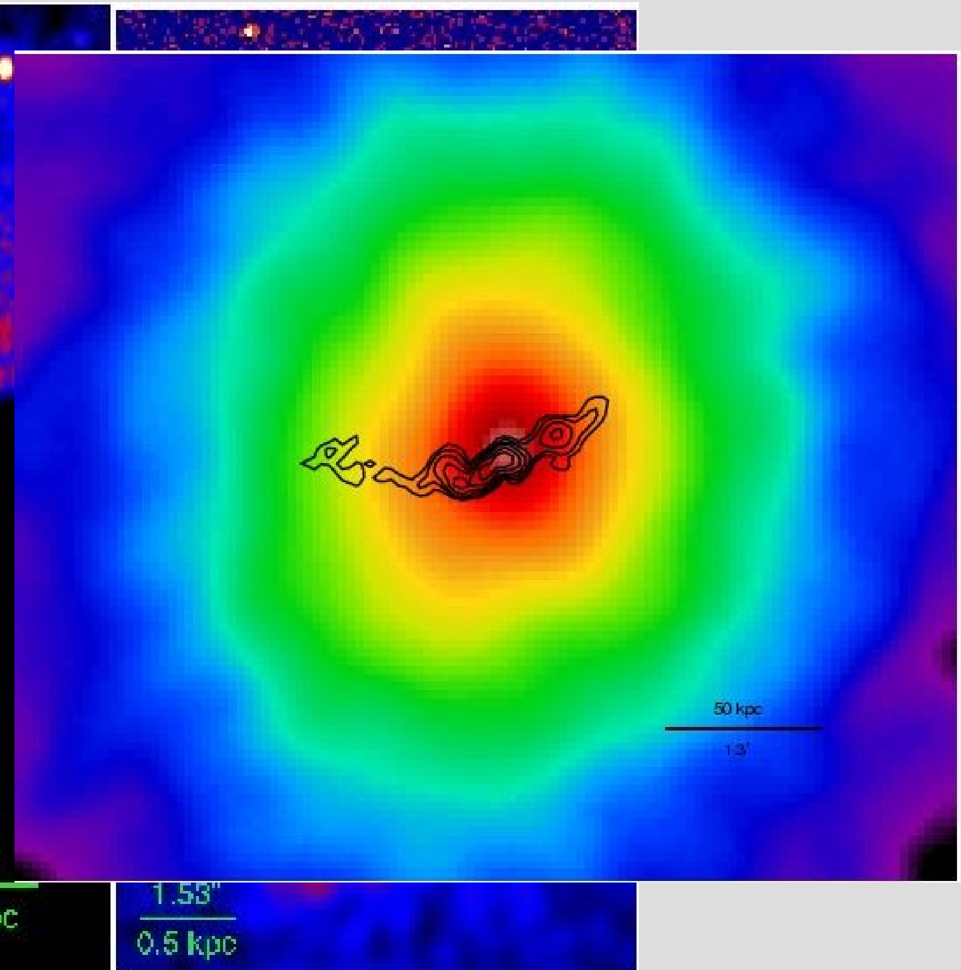
Sun+09

AWM4 AND AGN FEEDBACK



AWM4 AND AGN FEEDBACK

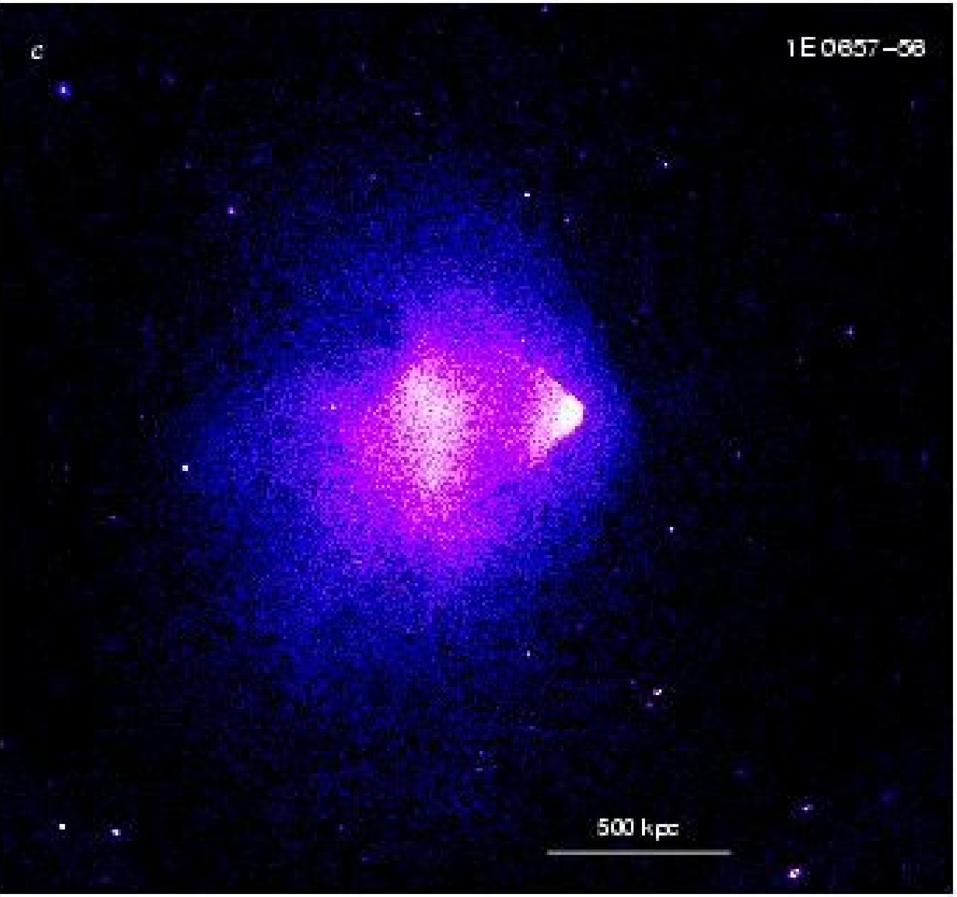




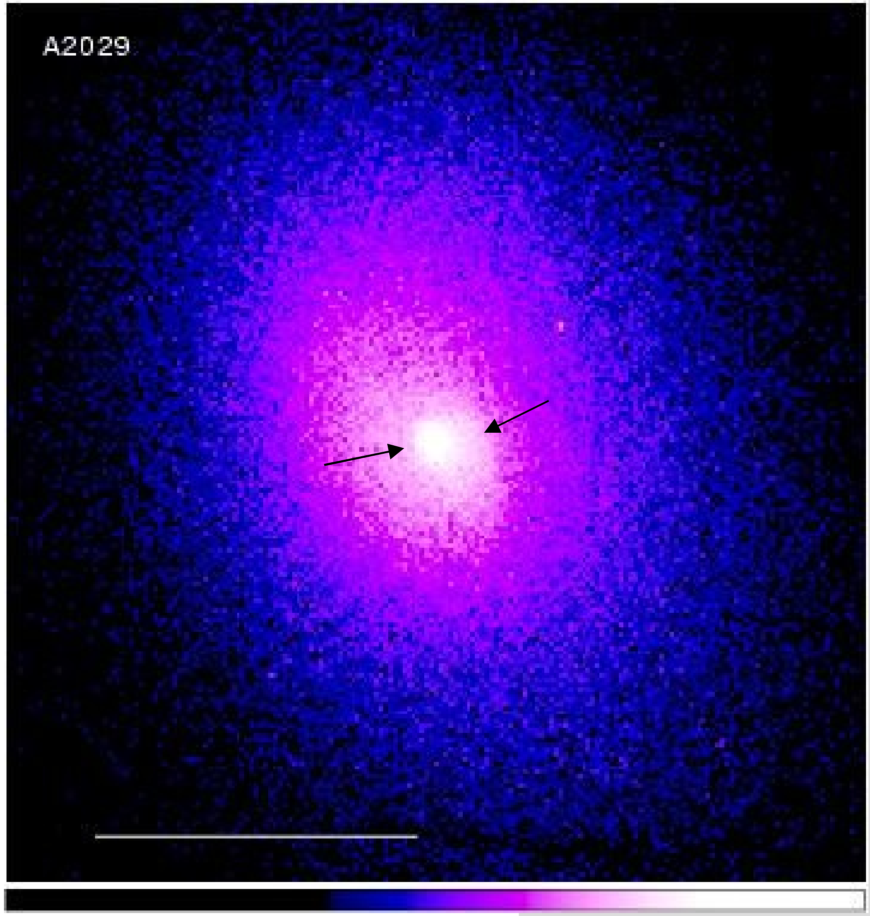
Sun+09

Gastaldello+08

COLD FRONTS IN CLUSTERS



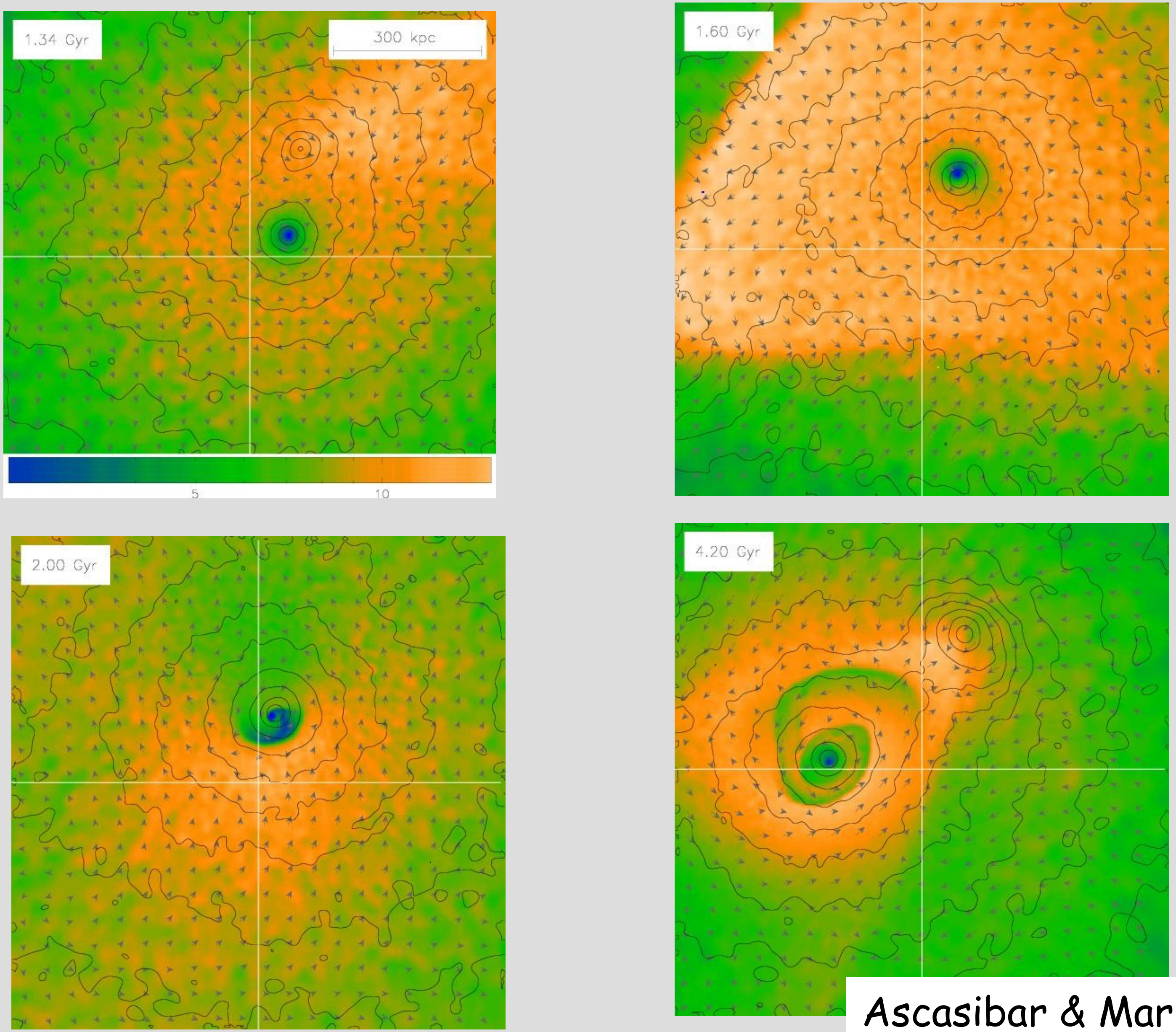
IN MERGING CLUSTERS



IN RELAXED CLUSTERS

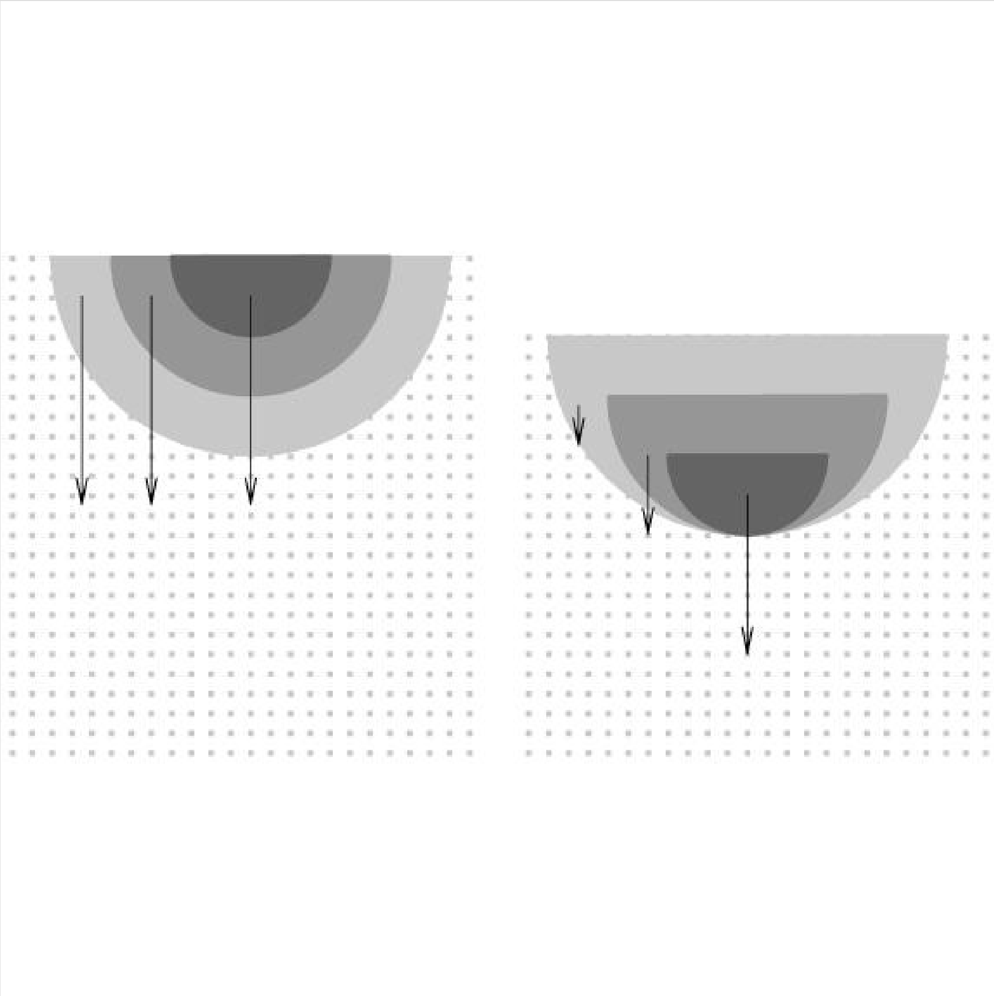
Markevitch & Vikhlinin 07

COLD FRONTS IN CLUSTERS



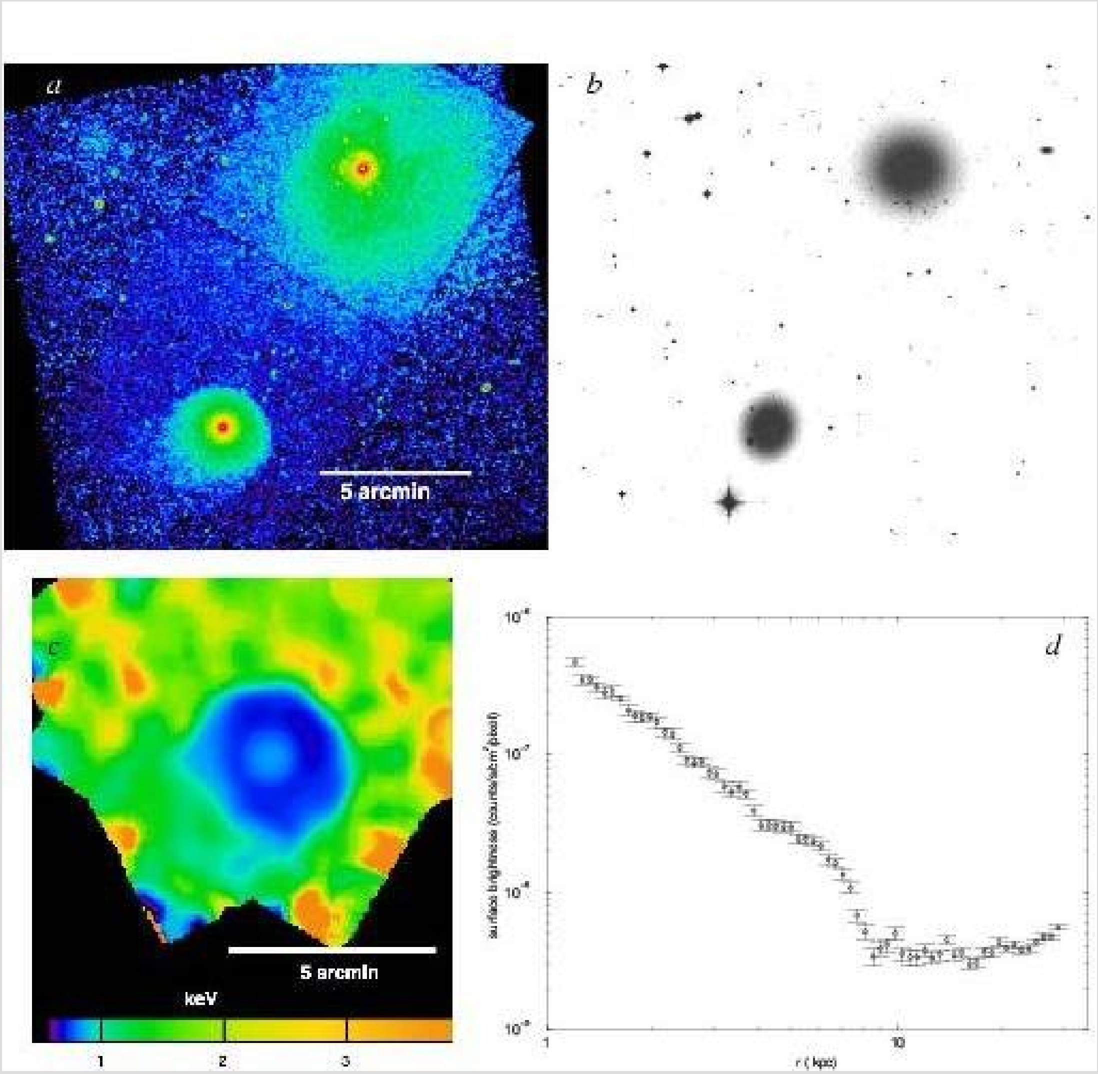
Ascasibar & Markevitch 06

COLD FRONTS IN CLUSTERS



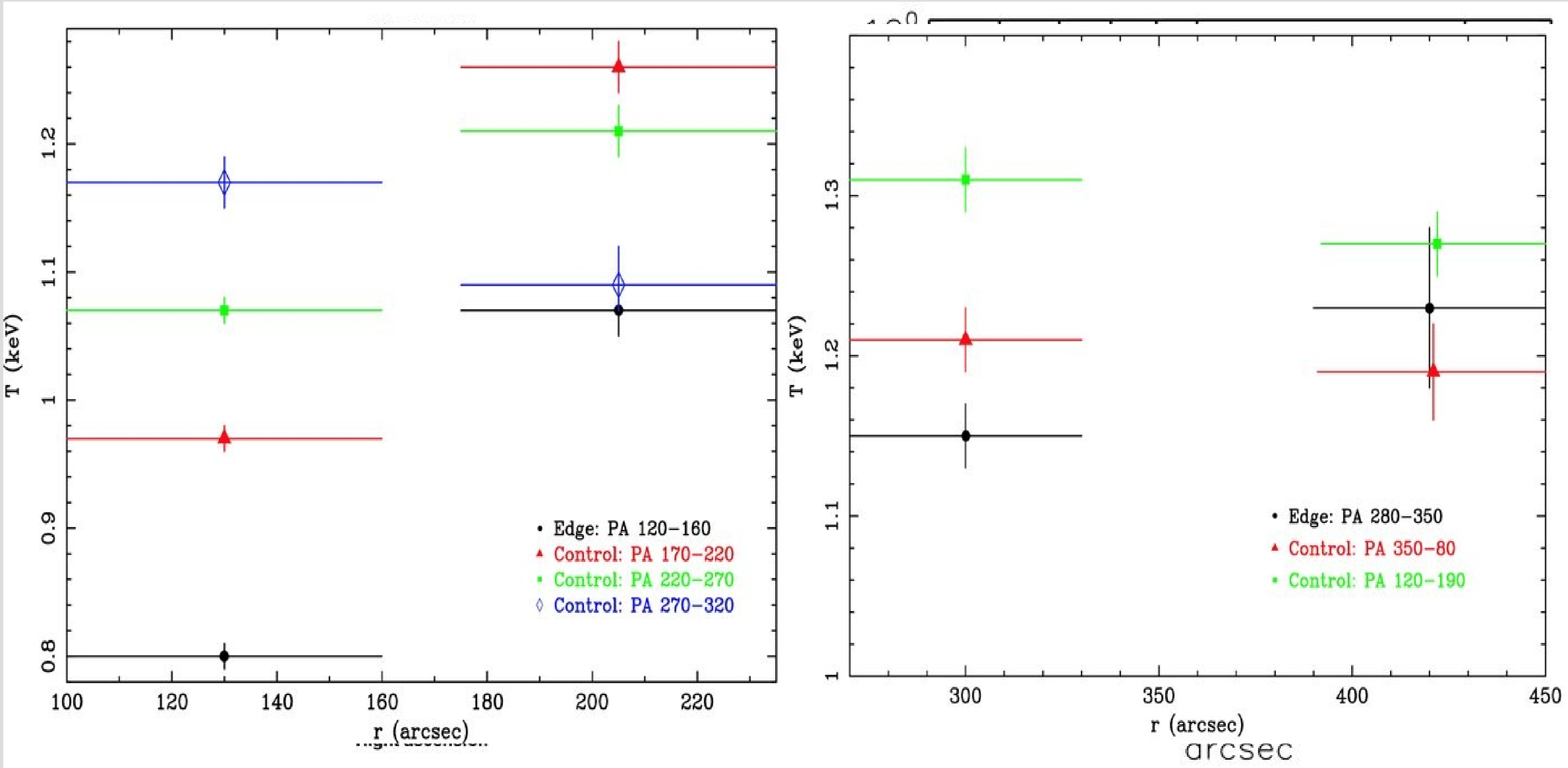
Markevitch & Vikhlinin 07

HOW ABOUT GROUPS ?



EXAMPLES IN MERGING SYSTEMS, e.g. NGC 1404 IN FORNAX (Machacek+05)

NGC 5044

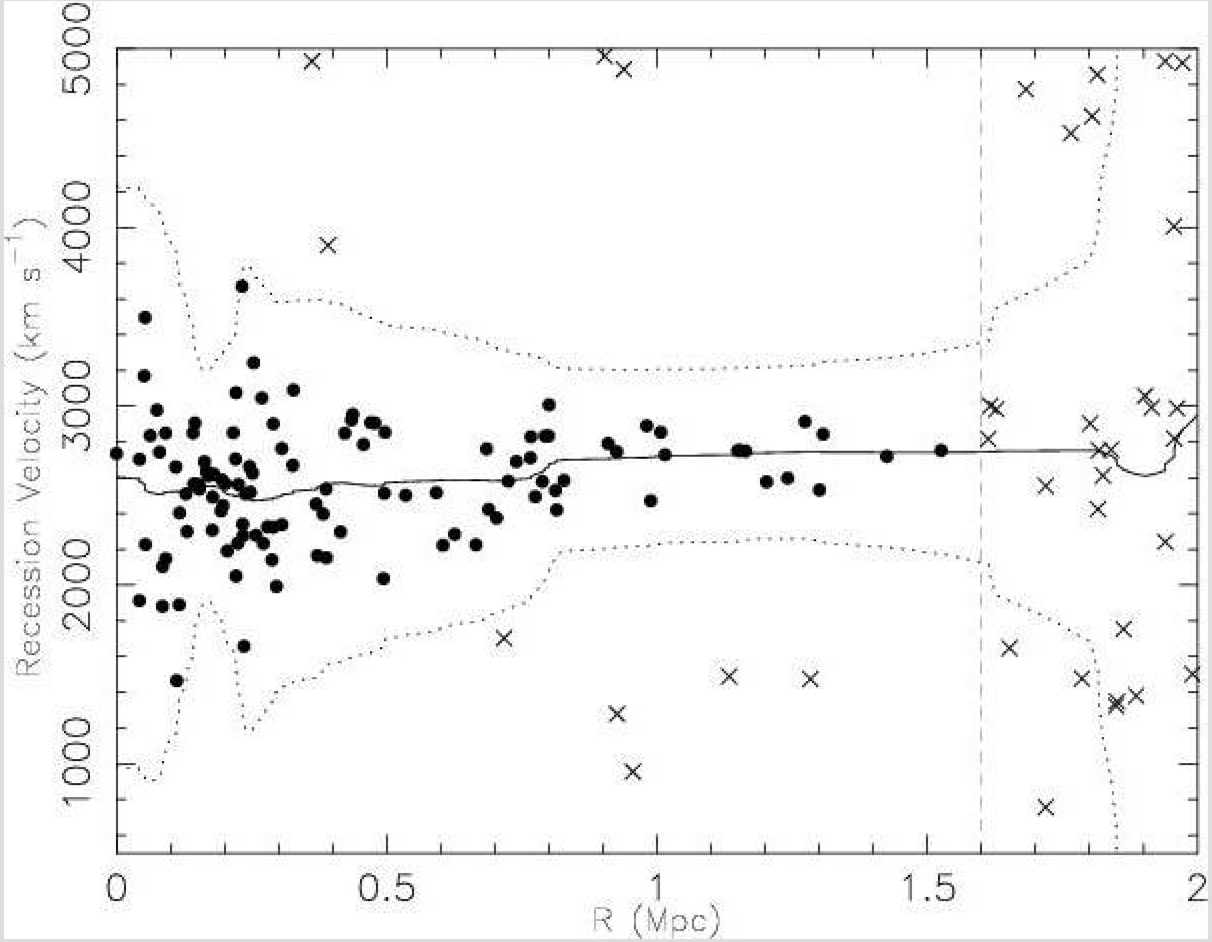


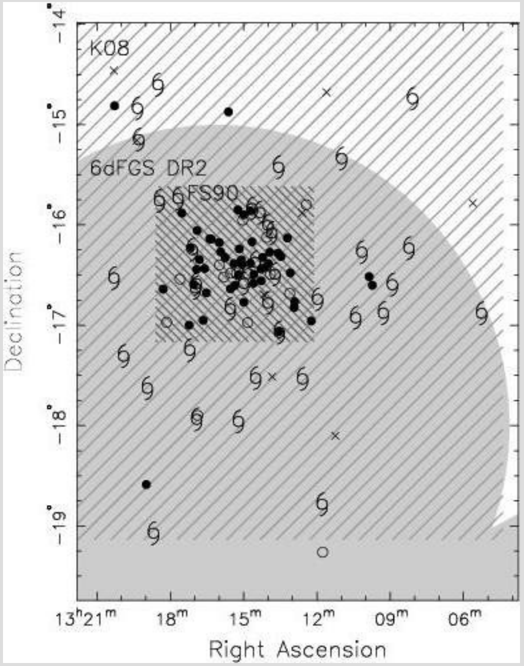
Gastaldello+09

COLD FRONTS IN NGC 5044

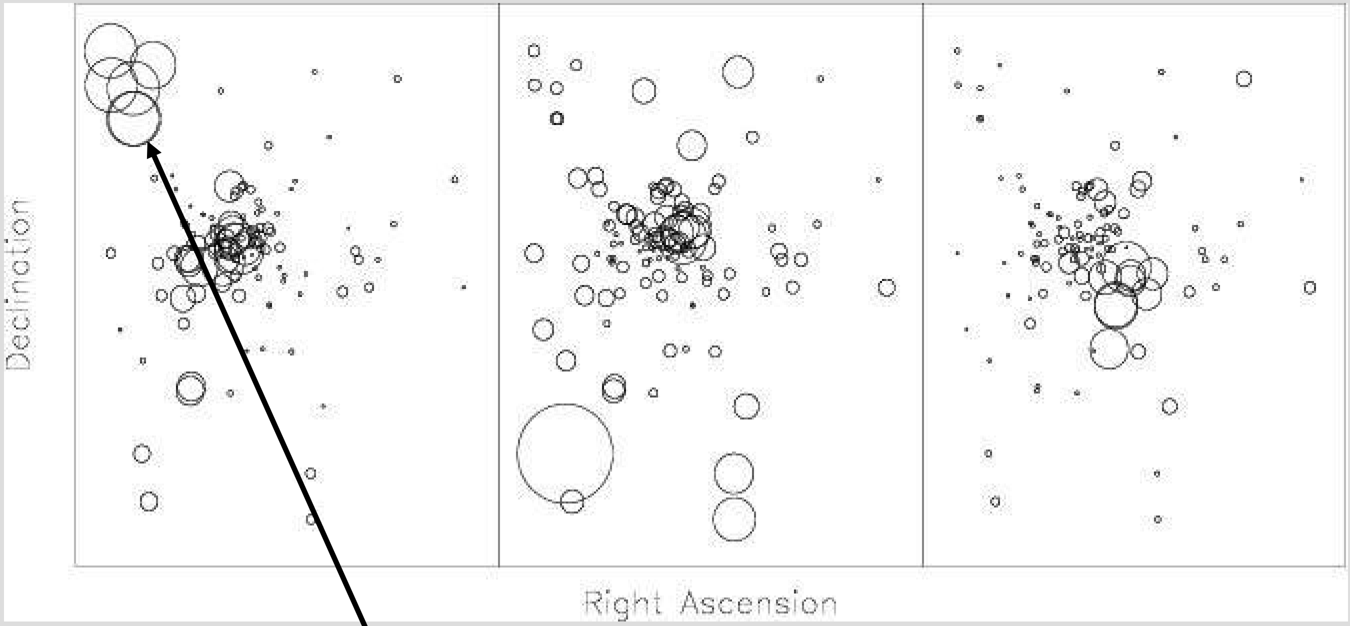
MENDEL+08 STUDY OF 111 MEMBERS:

PECULIAR VELOCITY OF 150 km/s WRT THE MEAN VELOCITY





COLD FRONTS IN NGC 5044



DETECTION OF A SUBSTRUCTURE (99.9 %) AT 1.4 Mpc
MENDEL+08

SUMMARY

- DETAILED MASS PROFILES FOR A SAMPLE OF X-RAY BRIGHT GROUPS ARE WELL FITTED BY NFW+STARS. GAS FRACTIONS ARE LOWER AND WITH MORE SCATTER COMPARED TO CLUSTERS. COMPARABLE QUALITY WITH CLUSTERS, WE CAN GO OUT TO R_{500}

- BROKEN POWER LAW BEHAVIOR OF ENTROPY PROFILES POINTS TO MORE IMPORTANT LOCAL MODIFICATIONS (AGN).

- AGN FEEDBACK IN GROUPS EXTREMELY INTERESTING AND IT IS STARTING TO BE INVESTIGATED WITH HIGH QUALITY DATA. SLOSHING COLD FRONTS SEEM A RATTHER COMMMON FEATURE OF COOL CORES, WE ARE STARTING TO SEE THEM ALSO IN GROUPS (NGC 5098, aka RGH 80, Randall+09).