The Importance of Strangulation and Ram-Pressure Stripping in Groups and Clusters

John S. Mulchaey
(Carnegie Observatories)

Tesla Jeltema (UC Santa Cruz), Xuening Bai (Princeton), Jesper Rasmussen (Carnegie) and Daisuke Kawata (UCL)

Strangulation:

"the most important mechanism"

- R. Bower (this conference)

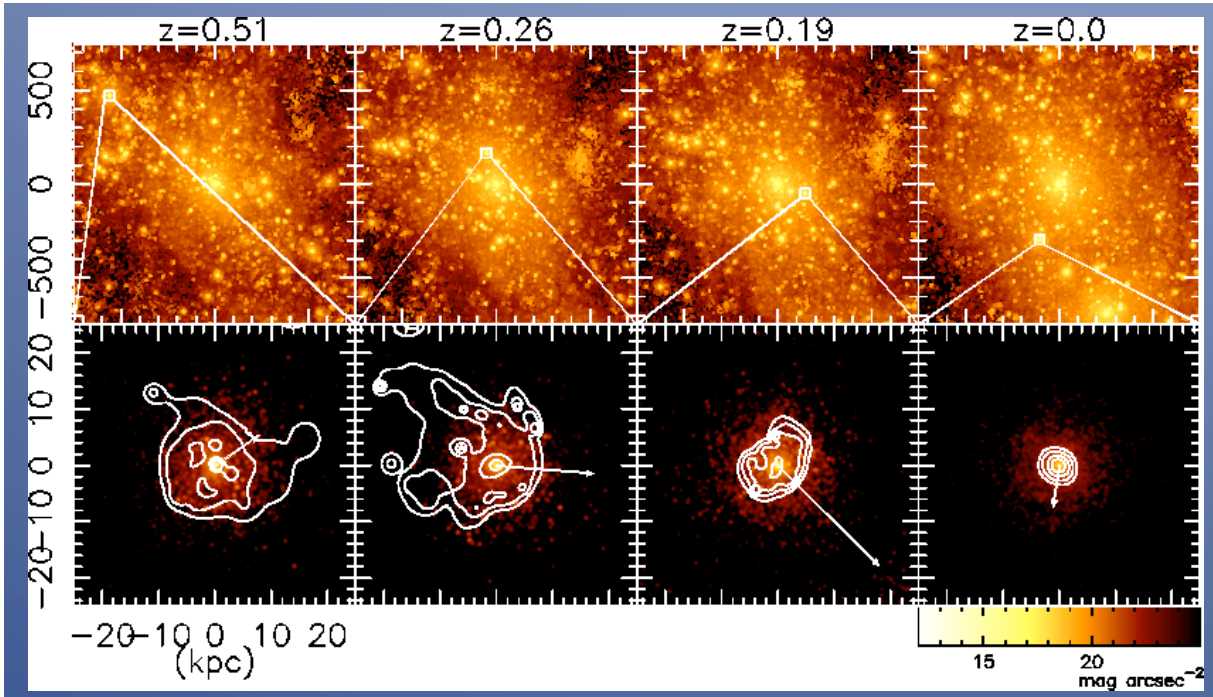
But also the most difficult to constrain observationally

How Important is the Stripping of Hot Gas Halos in Groups and Clusters?

Standard assumption in semi-analytic models: Halos stripped completely when a galaxy enters the group/cluster.

Some recent exceptions (e.g. Font et al. 2008)

Stripping may even be important in very small groups
(Kawata & Mulchaey 2008; Bekki, this conference)



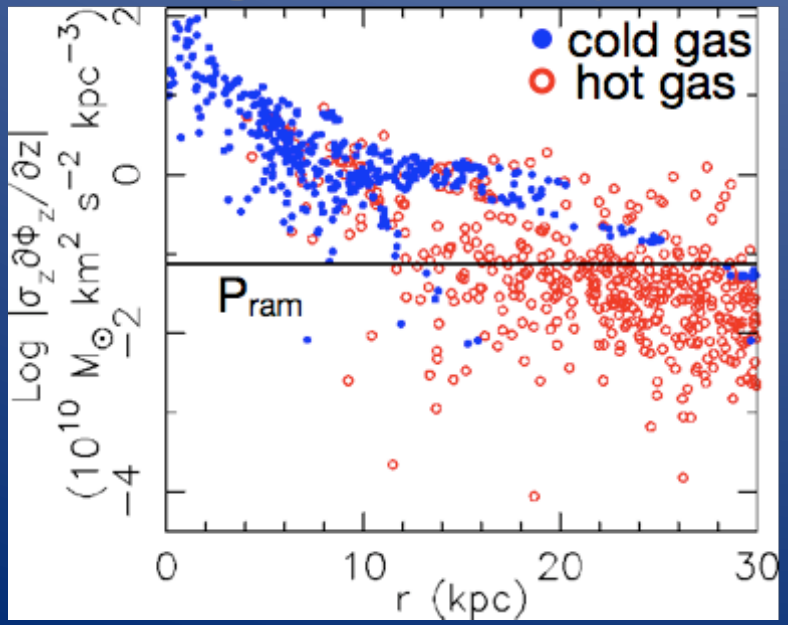
Cosmological simulation of a small galaxy group:

Mass ~ 8 x 10^{12} $M_{\odot}$

L_X ~ 10^{41} erg/s

Disk galaxy: V_{rot} ~ 150 km/s

restoring force vs. $P_{ram} = \rho_{IGM} v^2$



Hot gas halo stripped on first passage through group (less than a Gyr). However, cold gas not stripped.

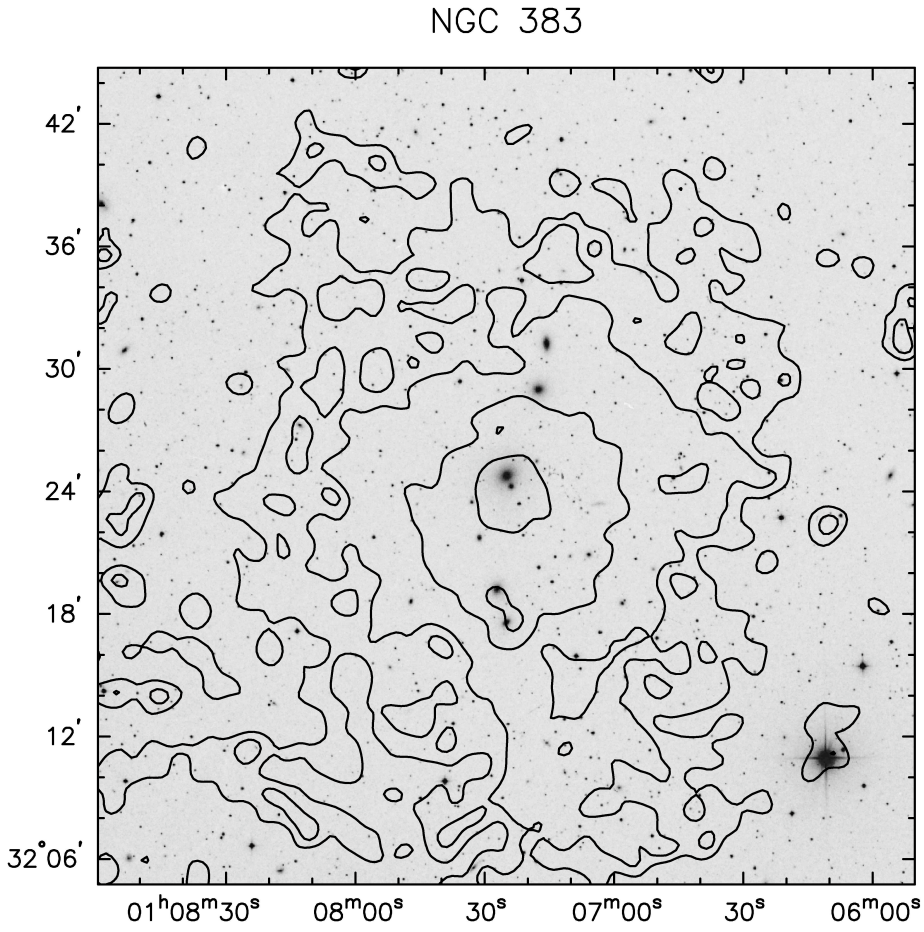
(Kawata & Mulchaey 2008)

Evidence for Hot Gas Halos

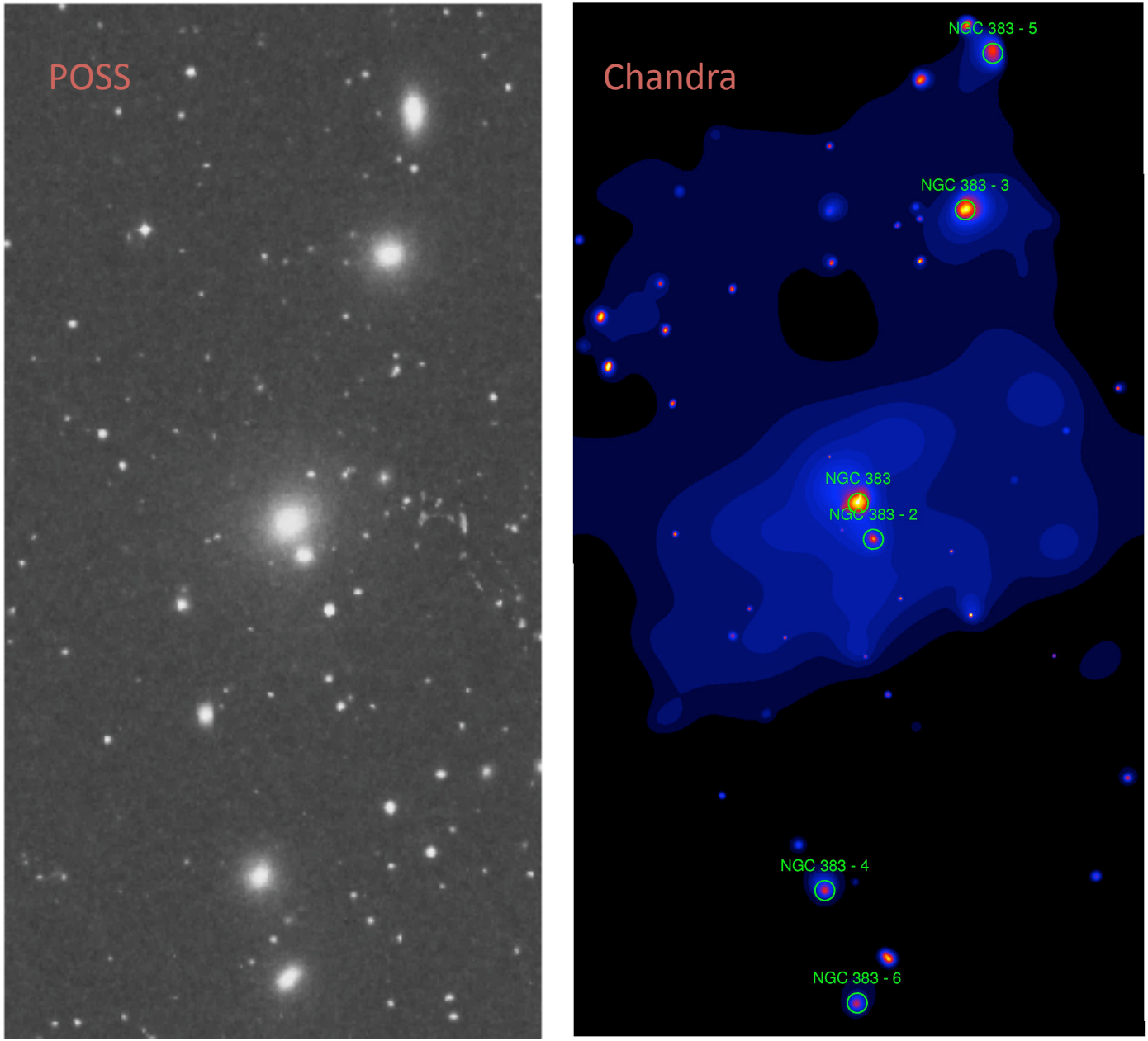
Late-Type galaxies: Still no direct detection of hot gas halos (e.g. Rasmussen et al. 2009)

Early-type galaxies: Well-established from X-ray observations (e.g. Fabbiano et al. 1992, many others)

The high spatial resolution of Chandra allows us to study the halos of individual galaxies in groups and clusters for the first time.



Mulchaey et al. (2003)

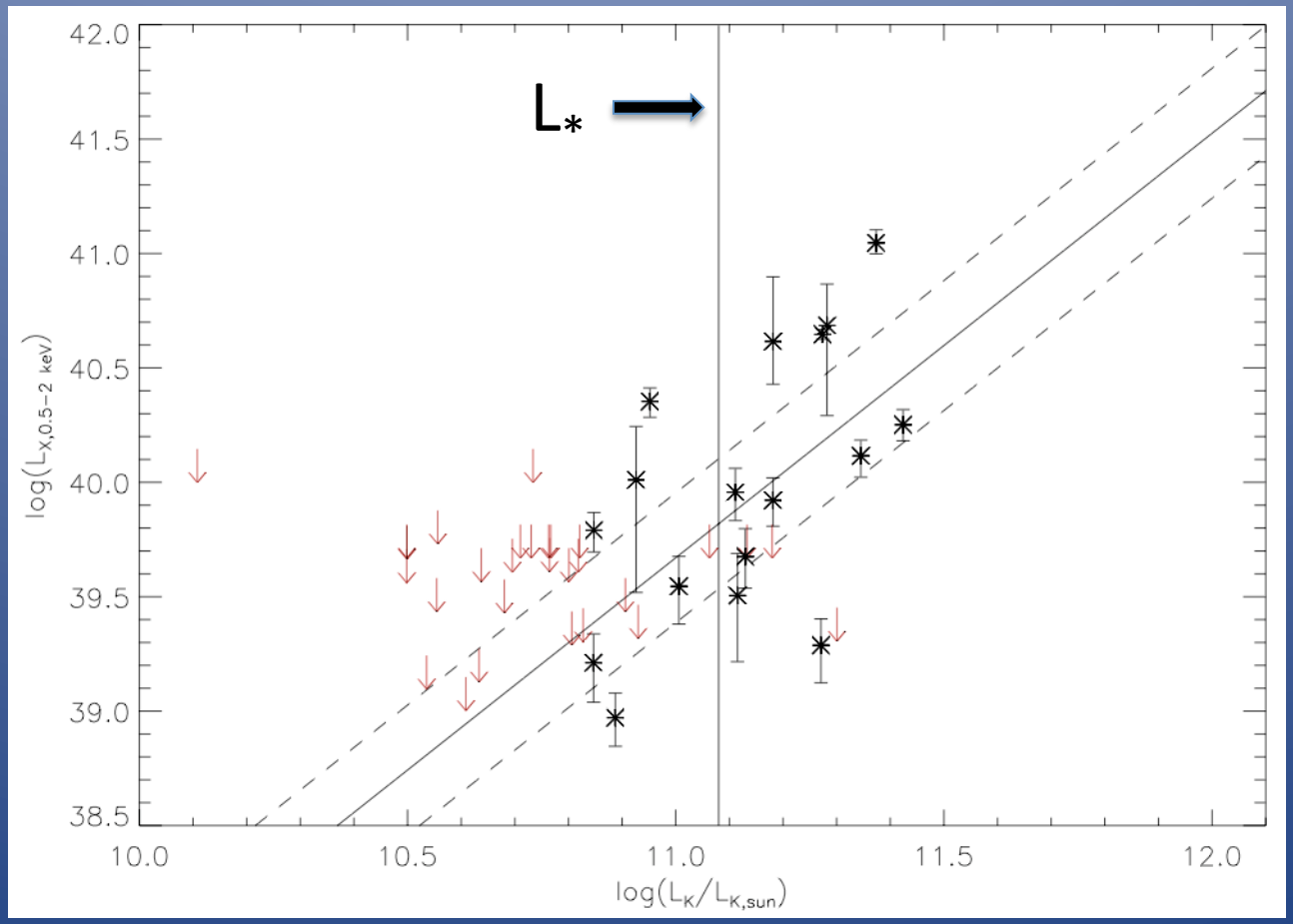


NGC 383 Group

Group Sample

- 13 groups selected from the Chandra archive ($z < 0.035$)
- All groups are X-ray luminous (i.e. contain an intragroup medium)
- Detect 17 early-type galaxies in total
- Fit spectra with thermal + powerlaw model to estimate halo luminosities

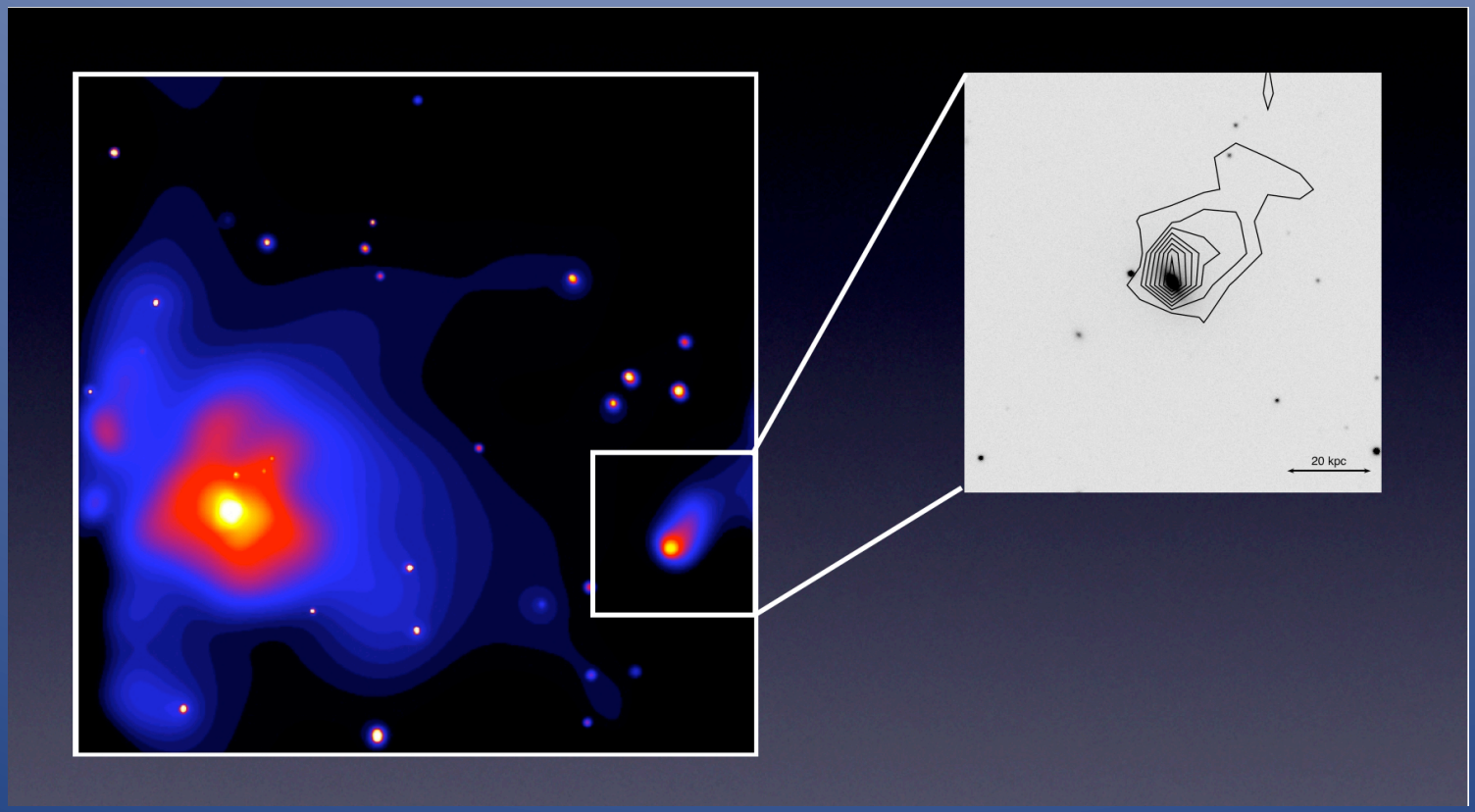
Early-Type Galaxies in Groups



Jeltema, Binder & Mulchaey (2008)

~80% of L_* galaxies in groups have hot halos

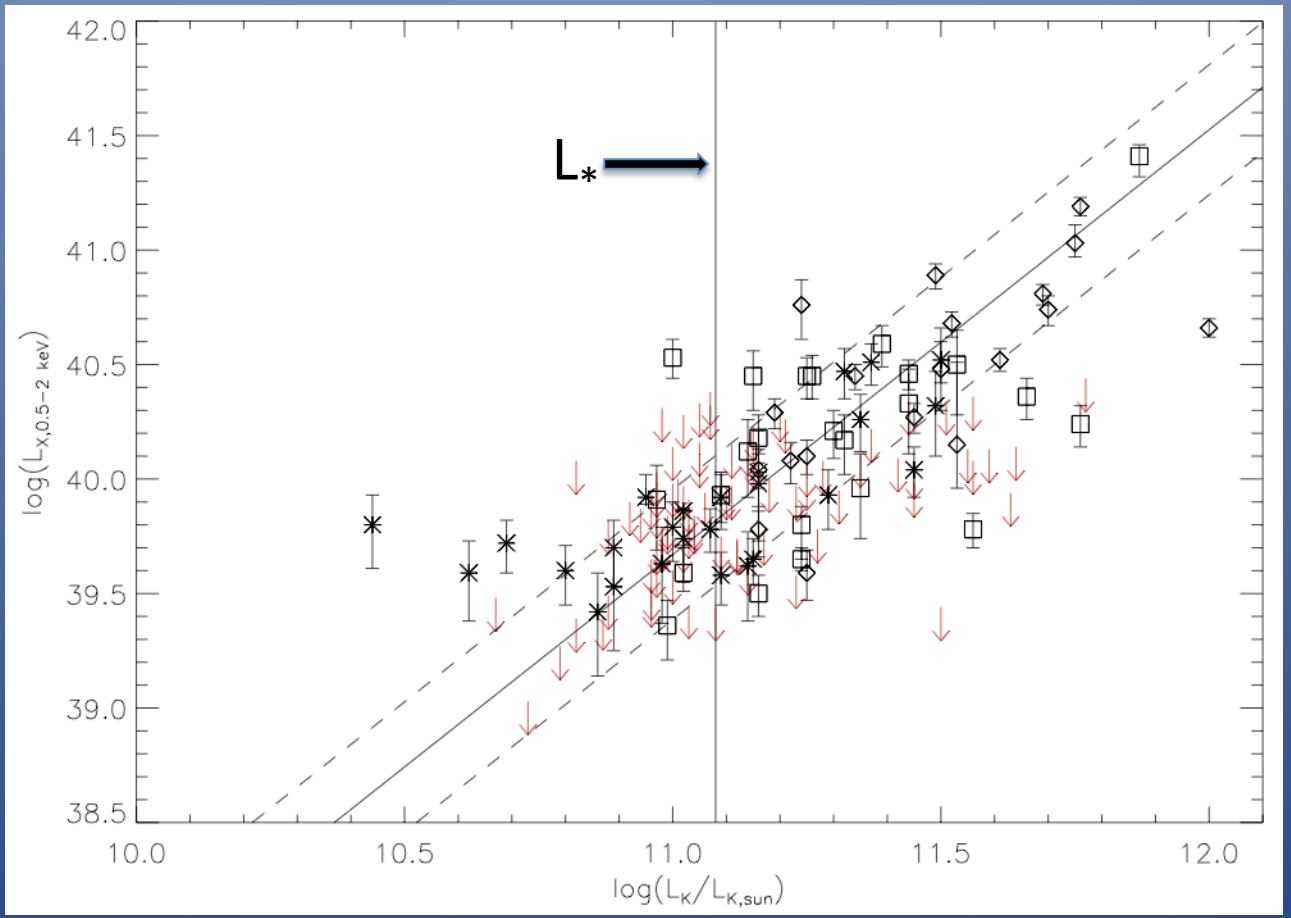
Although most massive galaxies retain hot halos in groups, there is some direct evidence for on-going stripping



~50 kpc X-ray tail from an S0 galaxy falling in to NGC 6269 group.

Jeltema, Binder & Mulchaey (2008)

Early-Type Galaxies in Clusters



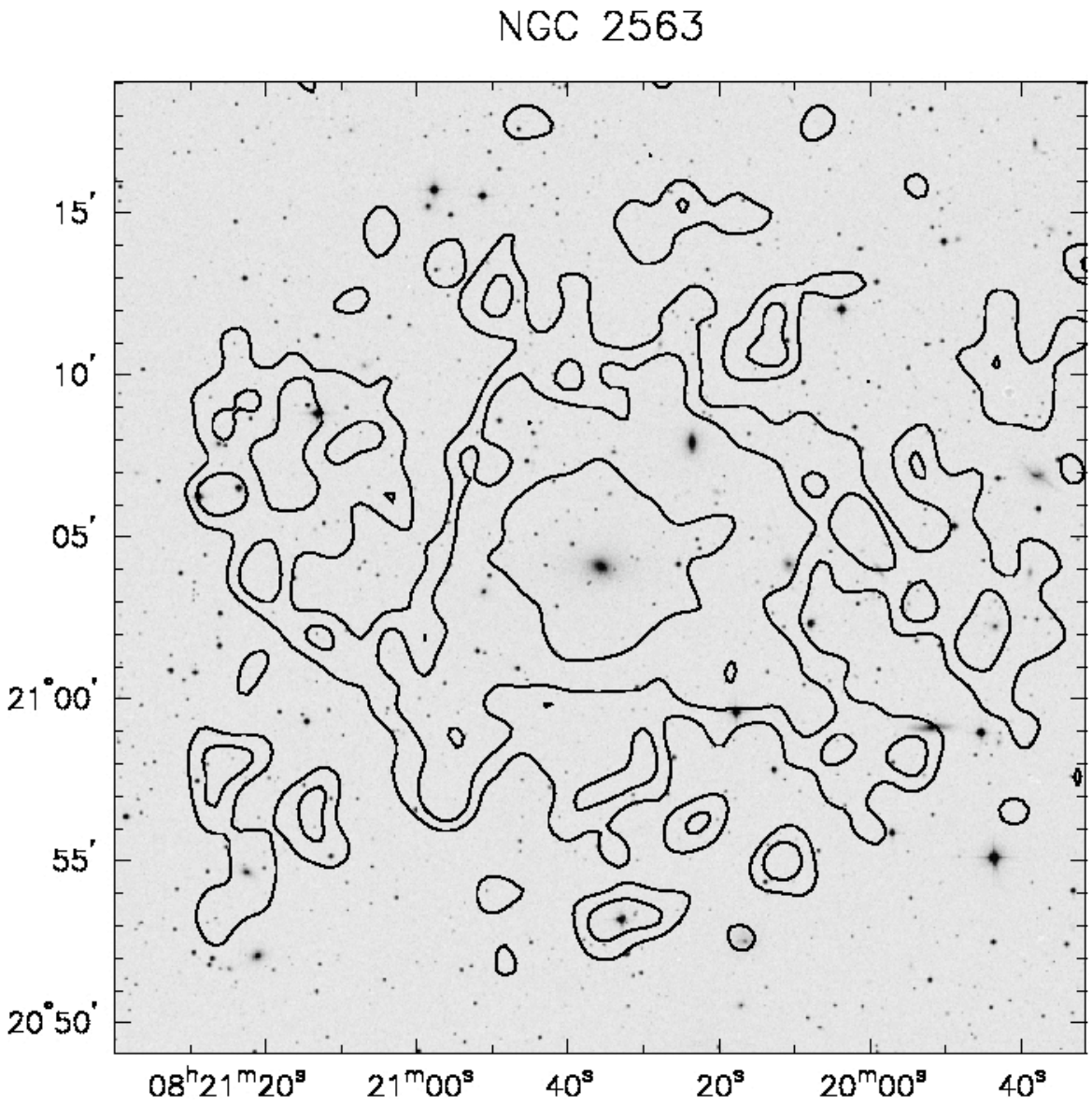
Sun et al. (2007)

~ 45% of L_* galaxies detected in clusters

Hot Halos in Groups and Clusters

A significant fraction of luminous ellipticals in groups (~80%) and clusters (~45%) retain hot gas halos.

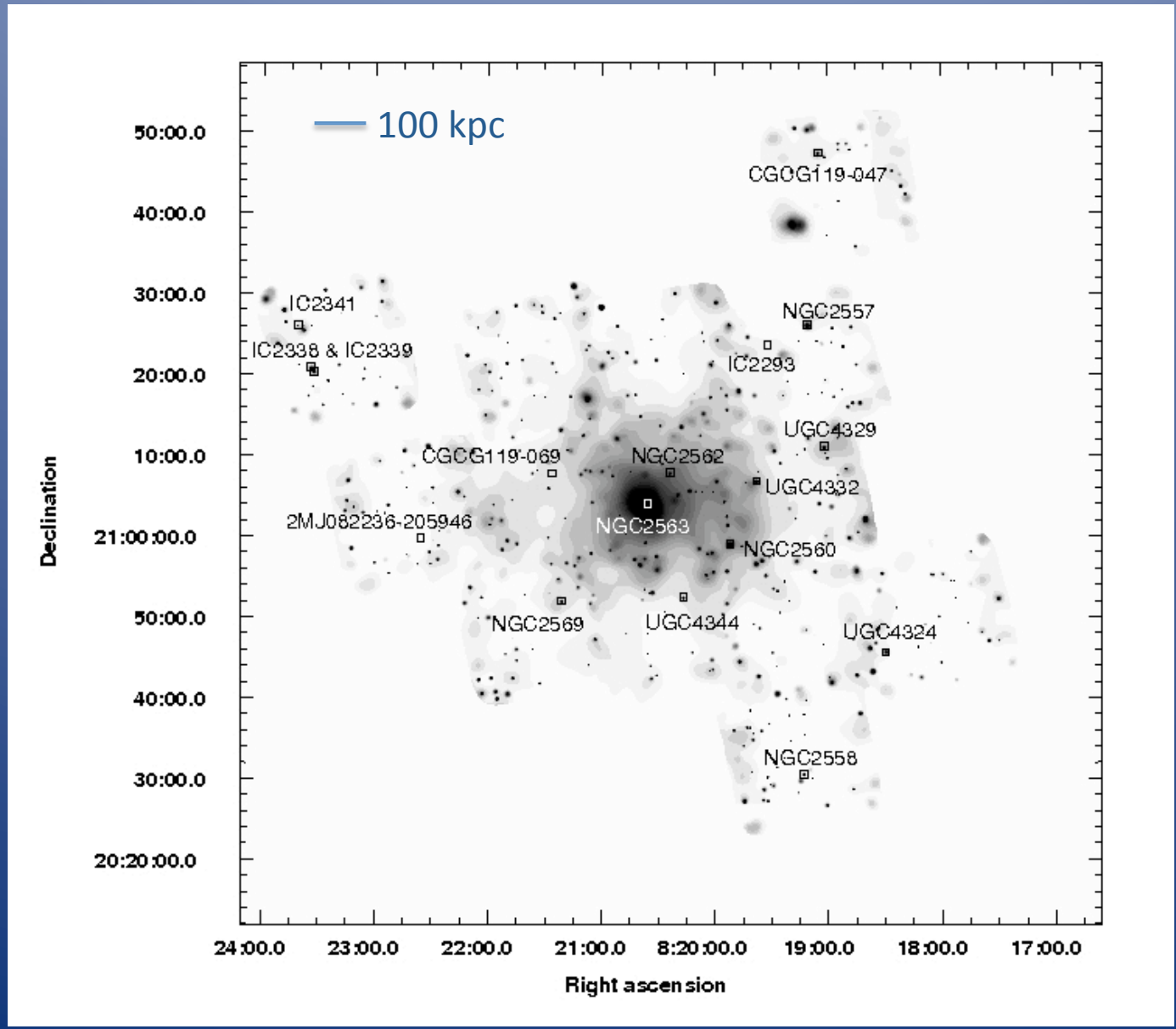
However, Chandra archival studies usually limited to the central few hundred kpc.



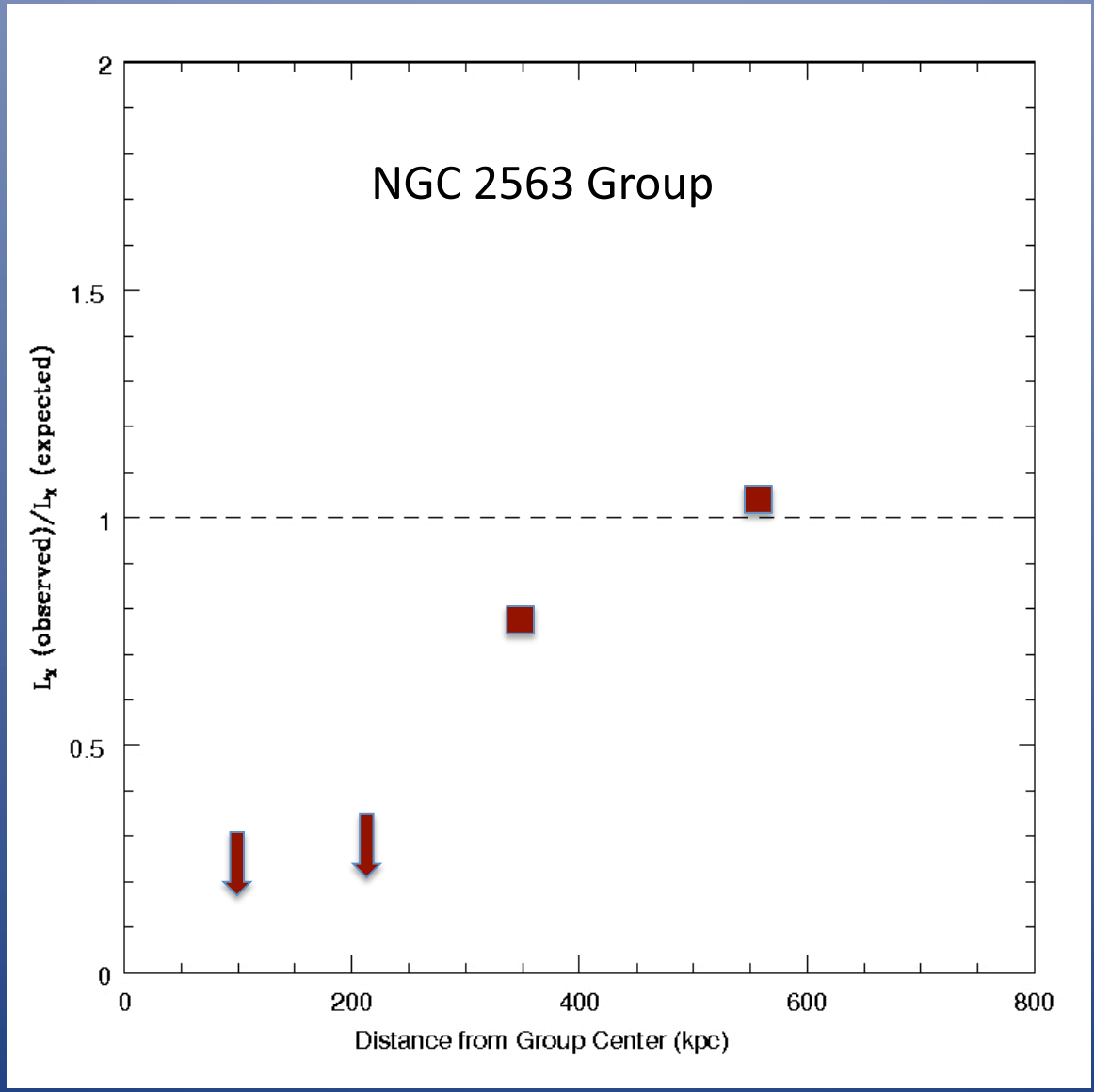
NGC 2563 Group

63 members (to M_R=-17)
σ = 361 km/s
$L_X = 5 \times 10^{42}$ erg/s

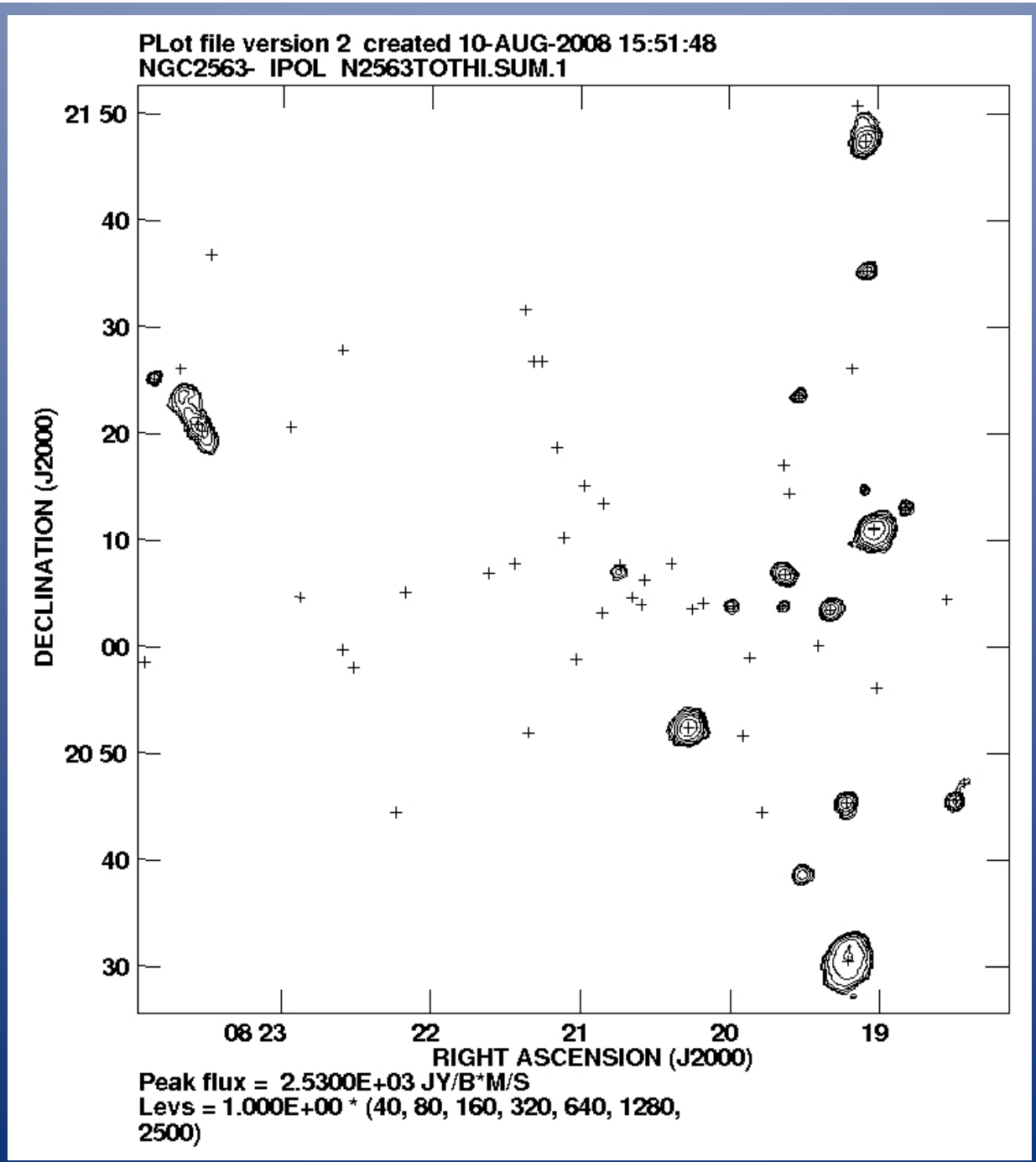
NGC 2563 Group



X. Bai et al. (2009)



X. Bai et al. (2009)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NGC2563- IPOL N2563TOTHI.SUM.1
21 50
40
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20 50
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DECLINATION (J2000)
08 23
22
21
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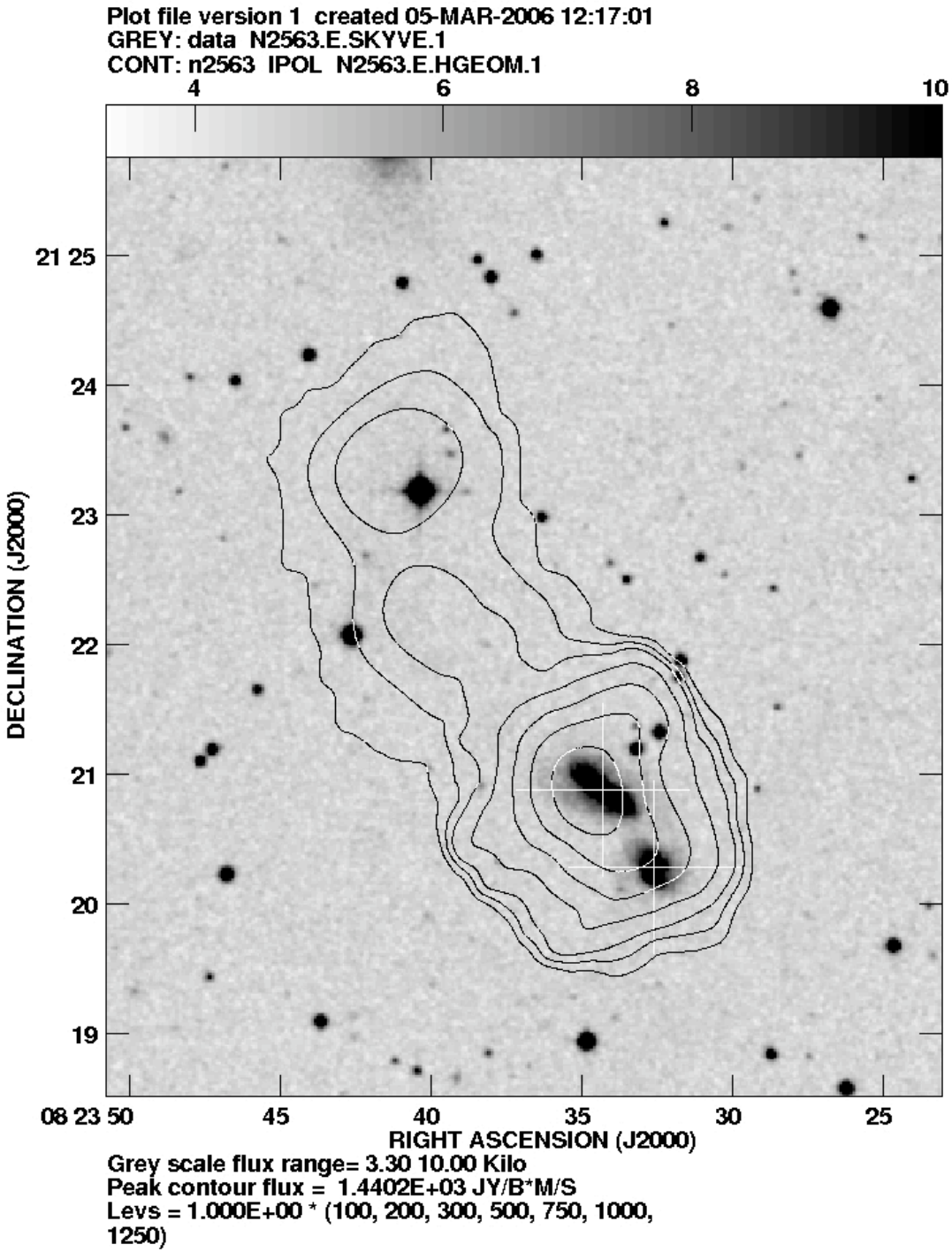
19
RIGHT ASCENSION (J2000)
Peak flux = 2.5300E+03 JY/B*M/S
Levs = 1.000E+00 * (40, 80, 160, 320, 640, 1280,
2500)



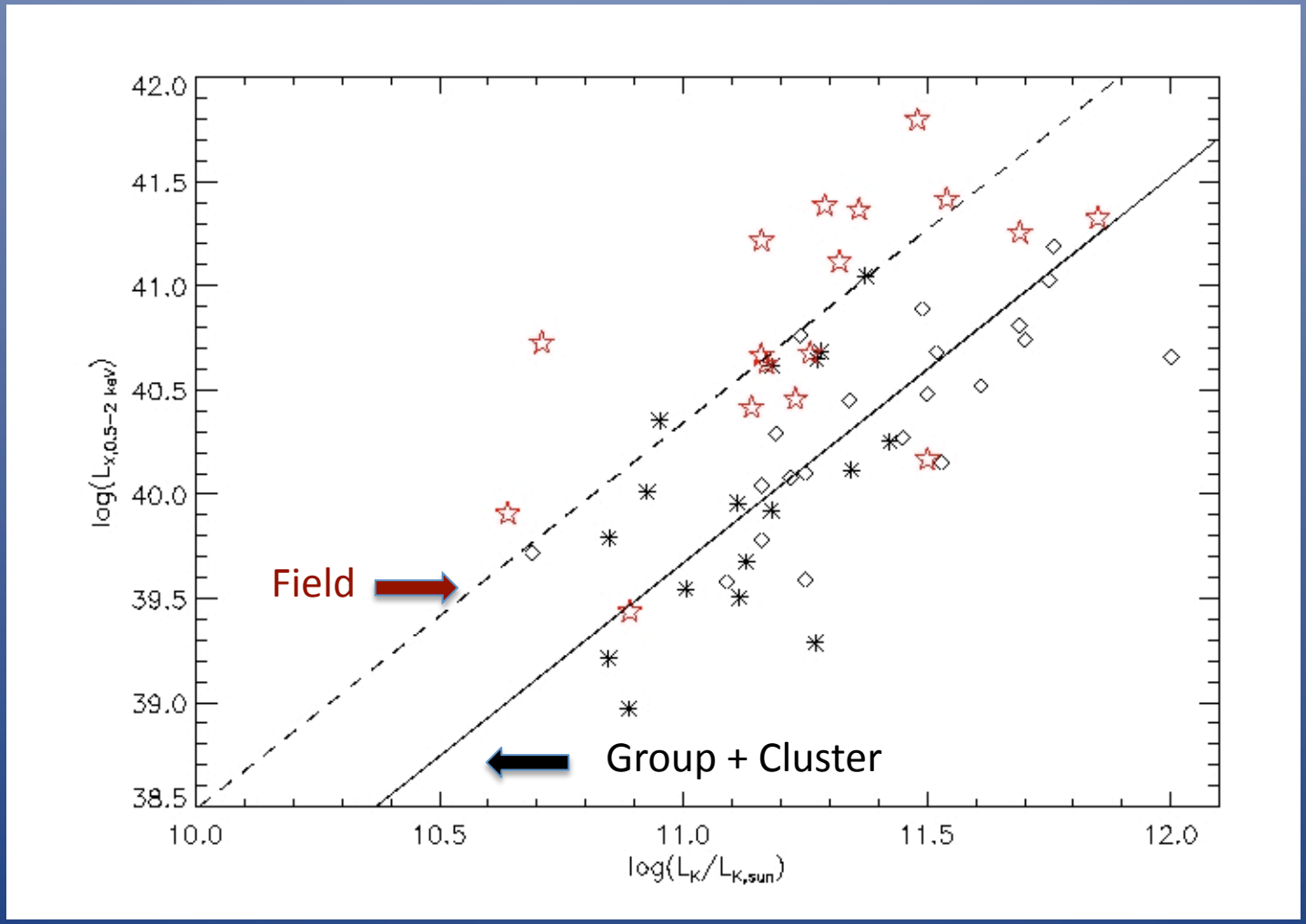
All HI tails consistent with a tidal origin. No evidence for ram-pressure stripping.

A significant fraction of early-type galaxies retain hot gas halos in groups and clusters.

What about the field?

We attempted to address this in Jeltema et al. (2008), but no Chandra field samples existed.

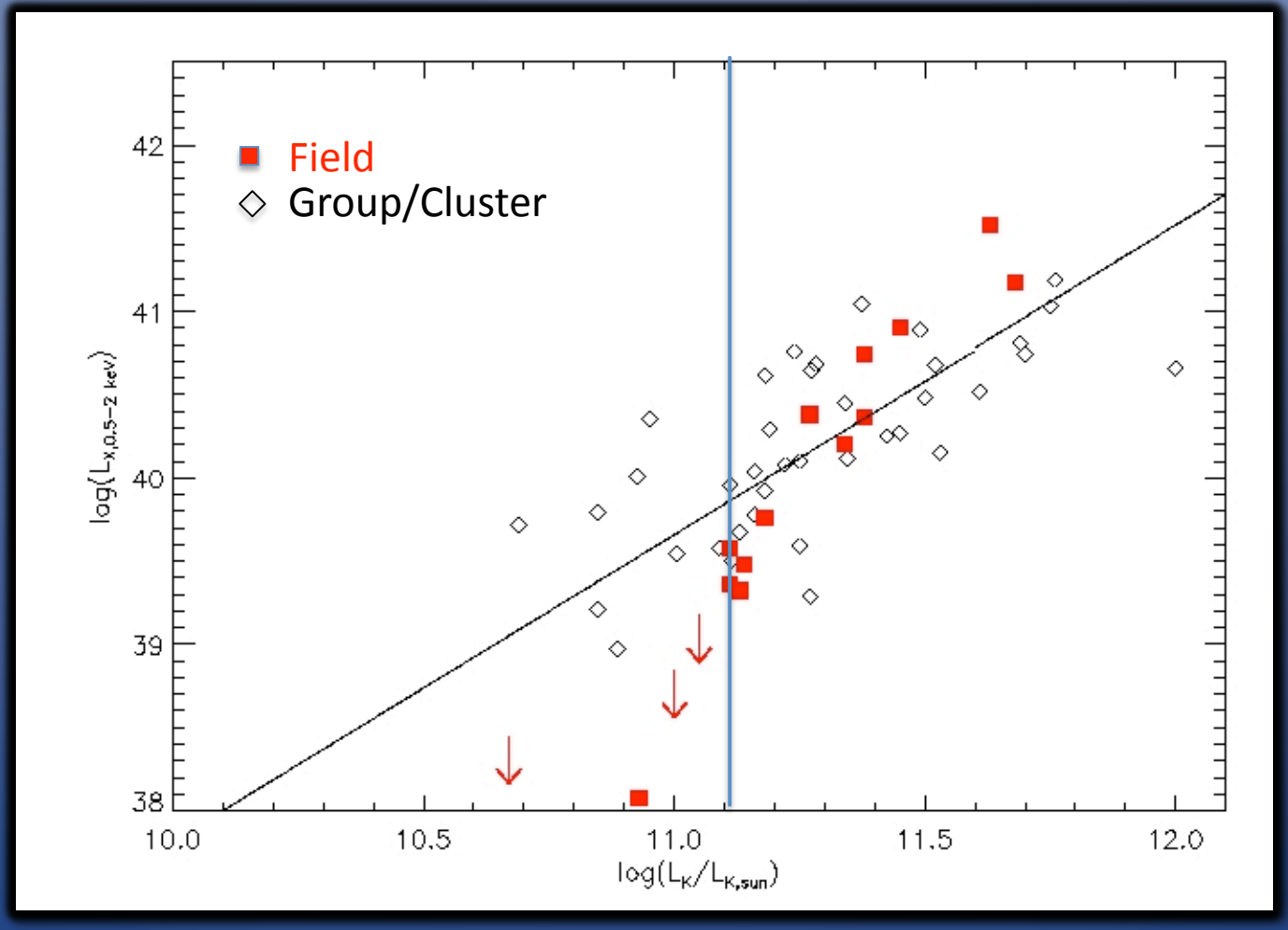
What about the field?



Jeltema, Binder & Mulchaey (2008)

Warning: Field sample based on ROSAT!!!

What about the field?



Mulchaey. Jeltema & Kollmeier (2009)

Chandra/XMM field sample

Summary

1. A significant fraction of massive galaxies in groups and clusters retain hot gas halos. A higher fraction of group galaxies (~80%) have halos compared to clusters (~45%).

2. Massive field galaxies have hot gas halos comparable to or slightly more luminous than group/cluster galaxies.

3. The turnover in the L_X-L_K relationship for field galaxies suggests winds/feedback are able to expel the hot gas component in ~ L_* galaxies.