

Galaxies in Isolation: Exploring Nature vs. Nurture

May 12th-15th, 2009 · Granada (Spain)



Isolated Elliptical Galaxies

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Swinburne University

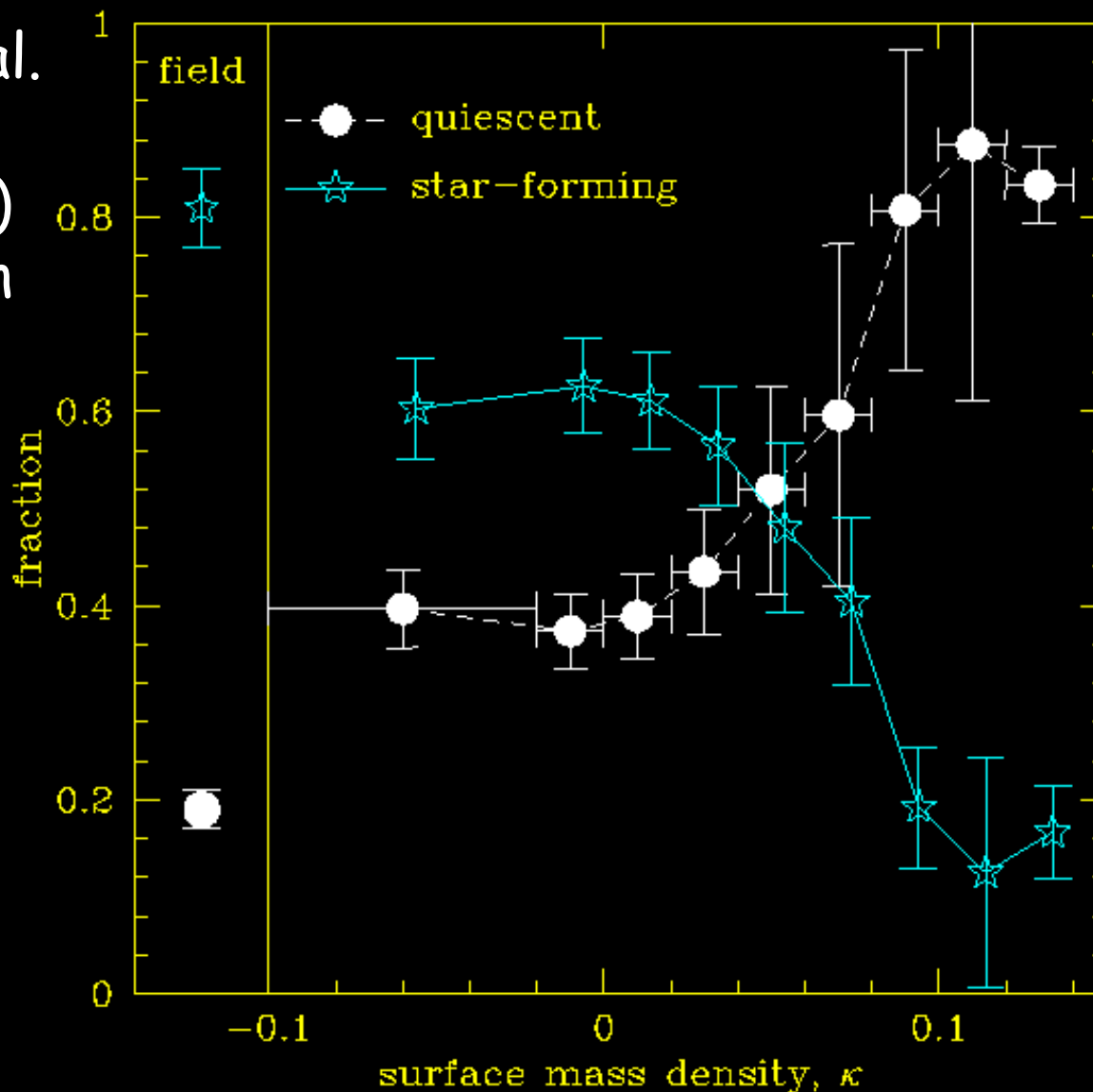
The background of the slide is a deep black space filled with numerous stars of varying colors and sizes. A bright yellow star is prominent in the upper left quadrant. In the lower right quadrant, there is a tilted elliptical galaxy with a bright central core and a diffuse, glowing disk. The text is centered in white, with the title in a larger font and the author's name and affiliation in a smaller font below it.

Isolated Elliptical Galaxies

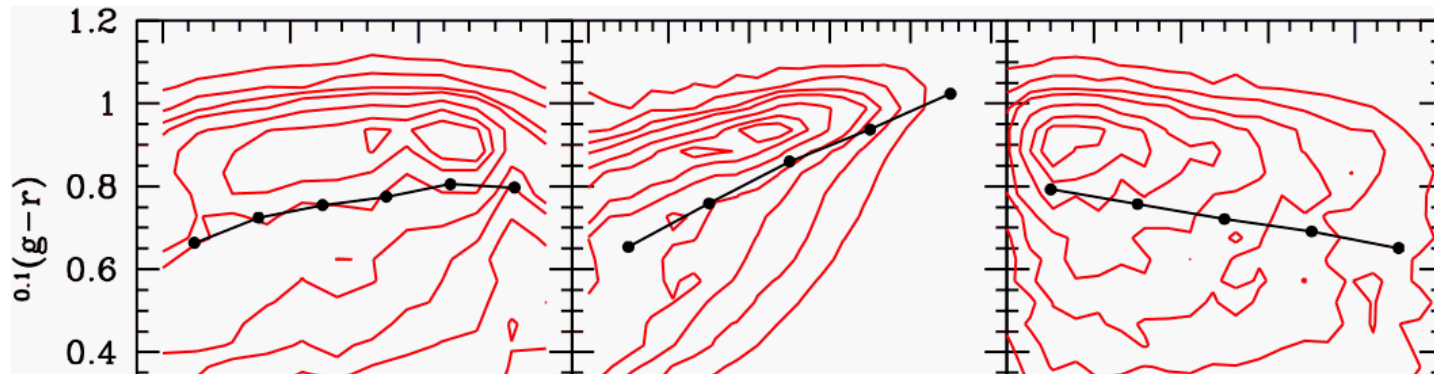
Duncan Forbes
Swinburne University

Supression at (group-like) densities

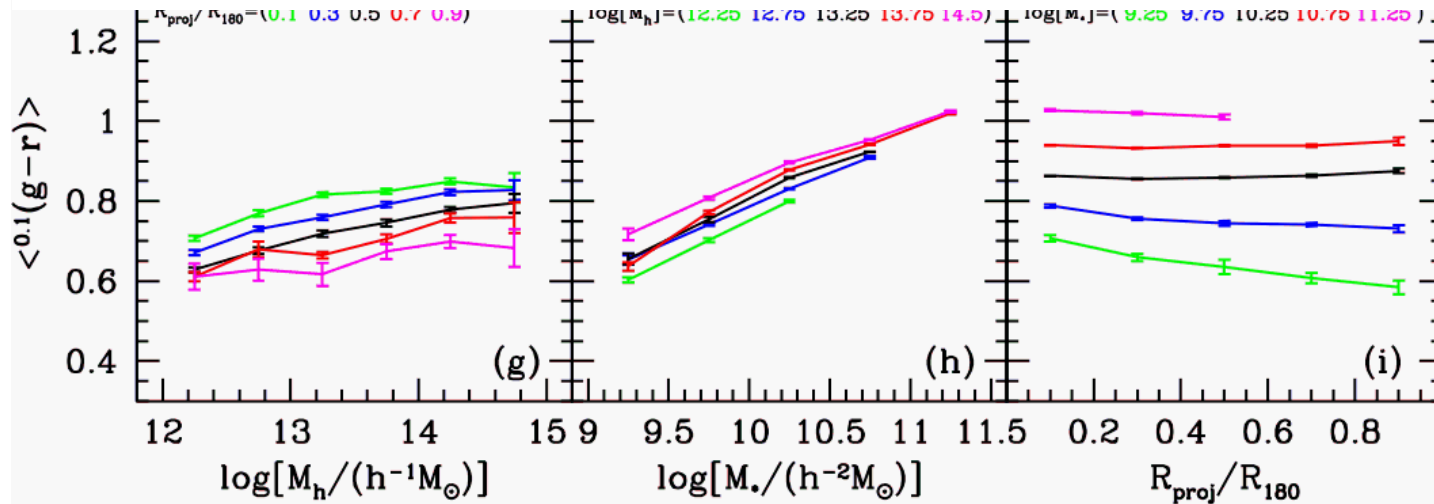
- 2dFGRS (Lewis et al. 2002) and SDSS (Gomez et al. 2003) => pre-processing in Groups ?
- The low density Field includes some quiescent galaxies (Gray et al. 2004)



Gray et al. 2004



The Dearth of Environment Dependence



Van den Bosch et al. 2008

Early-types in low density

- Karachentseva 1973 (Stocke et al. 2004; 98)
- Reduzzi et al. 1996; 42
- Colbert et al. 2001; 30
- Aars et al. 2001; 4
- Kuntschner et al. 2002; 9
- Smith et al. 2004; 32
- Collobert et al. 2006; 30 (+11 from Colbert)

Beware of catalogue limits!

Isolated Ellipticals Sample

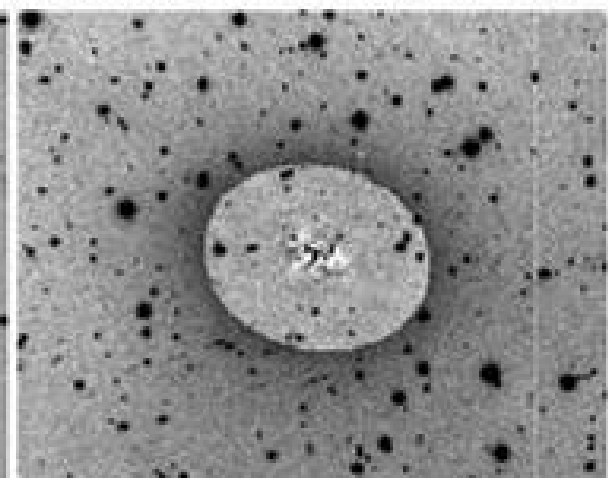
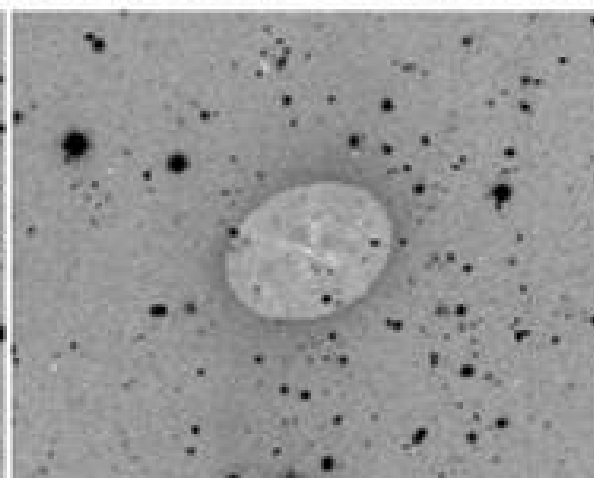
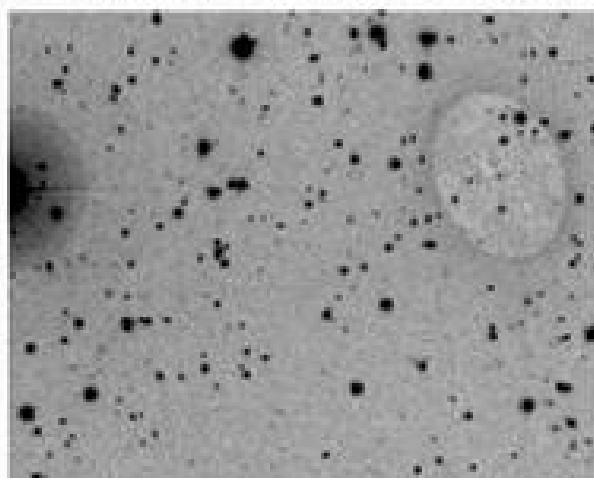
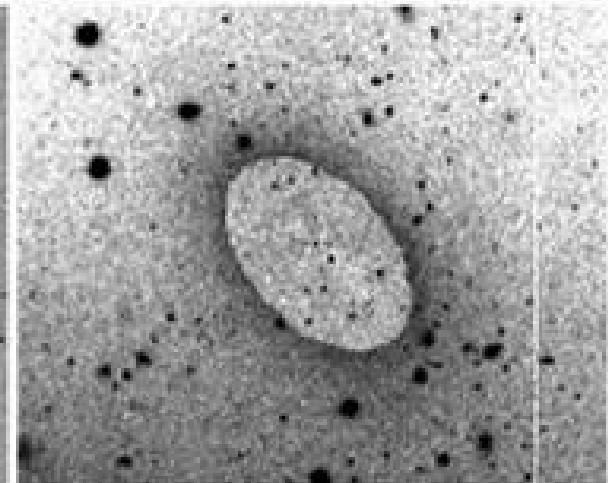
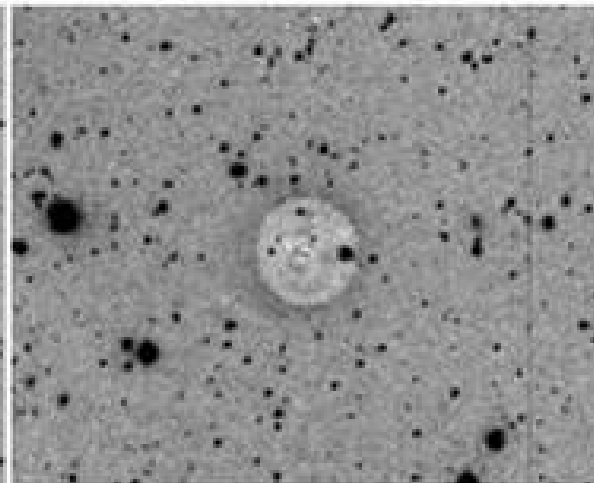
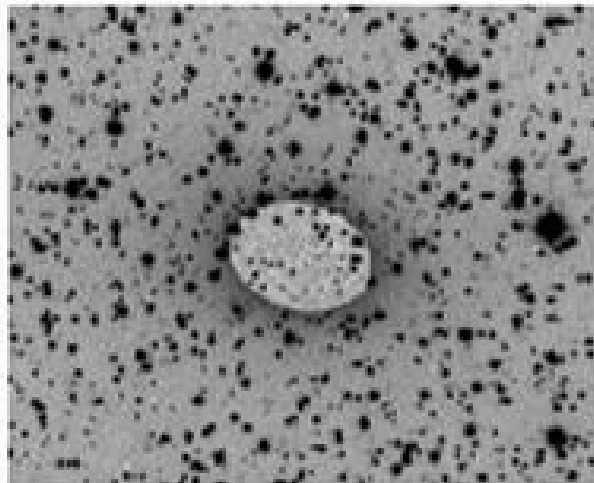
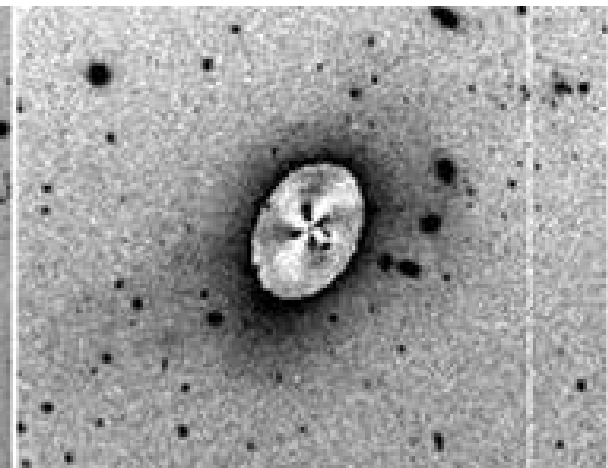
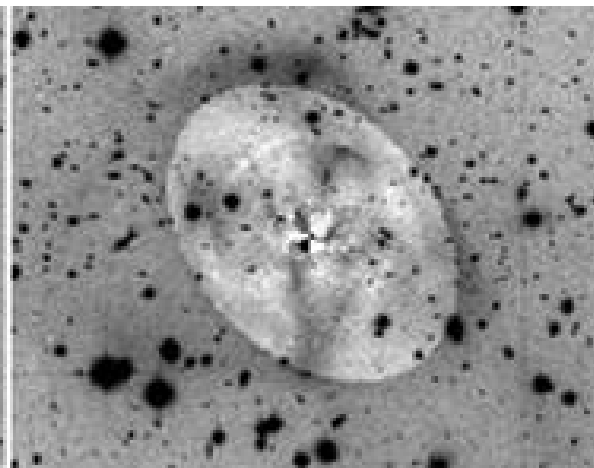
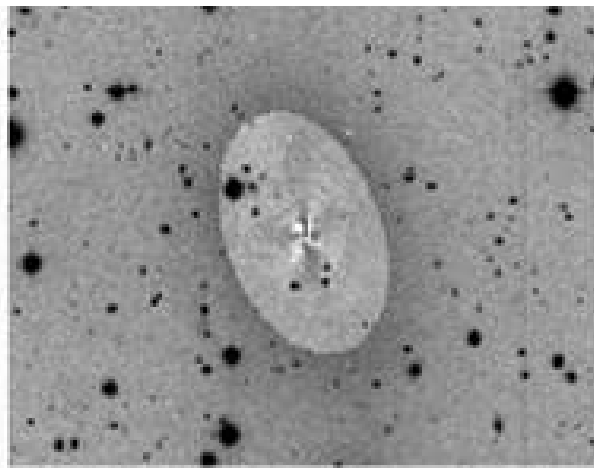
A 'control' sample unaffected by the group/cluster environment

- Reda, Forbes et al. (2004)
- E galaxy, $V < 9,000$ km/s, $B < 14$ (90% complete)

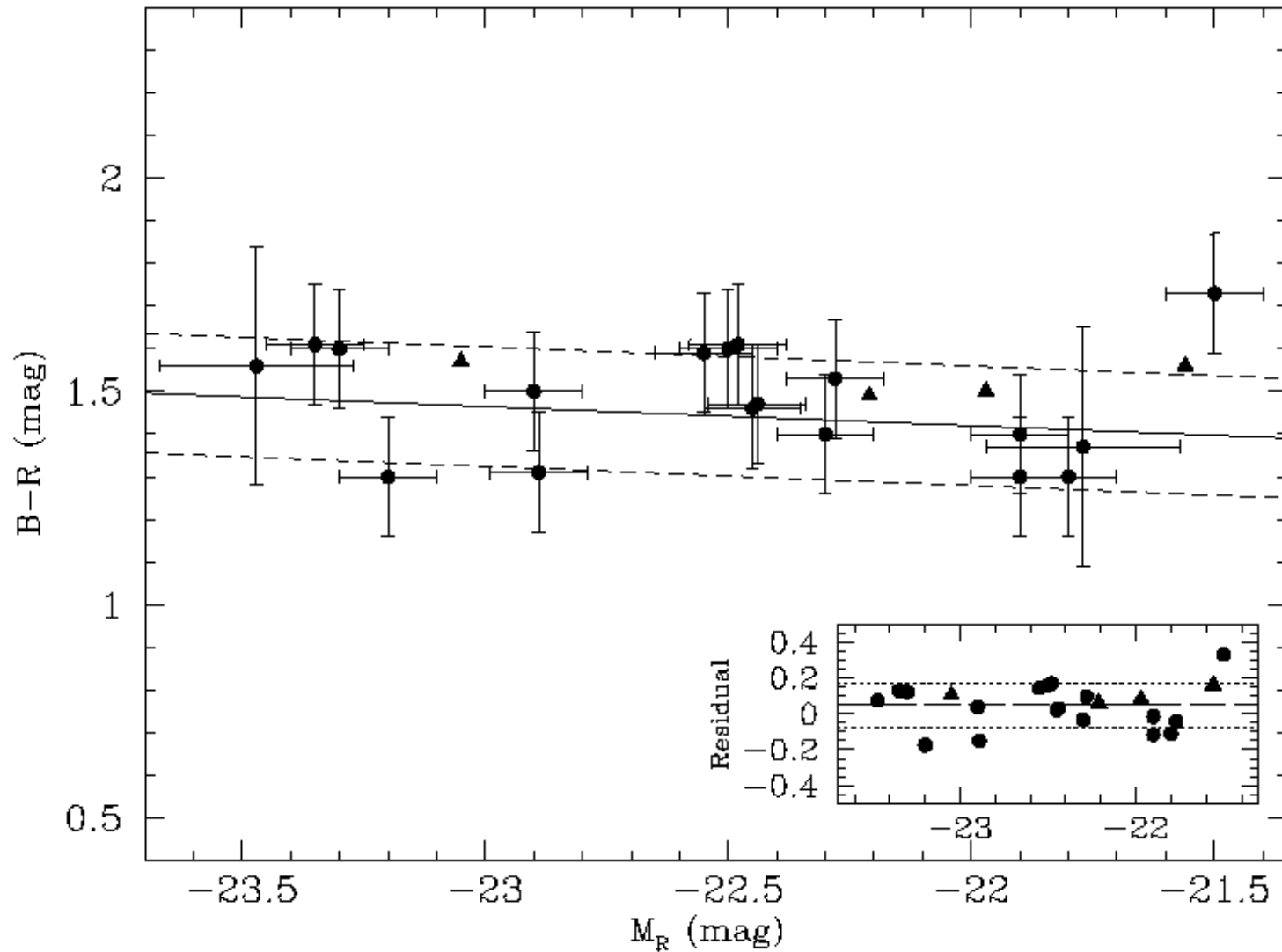
No neighbours within:

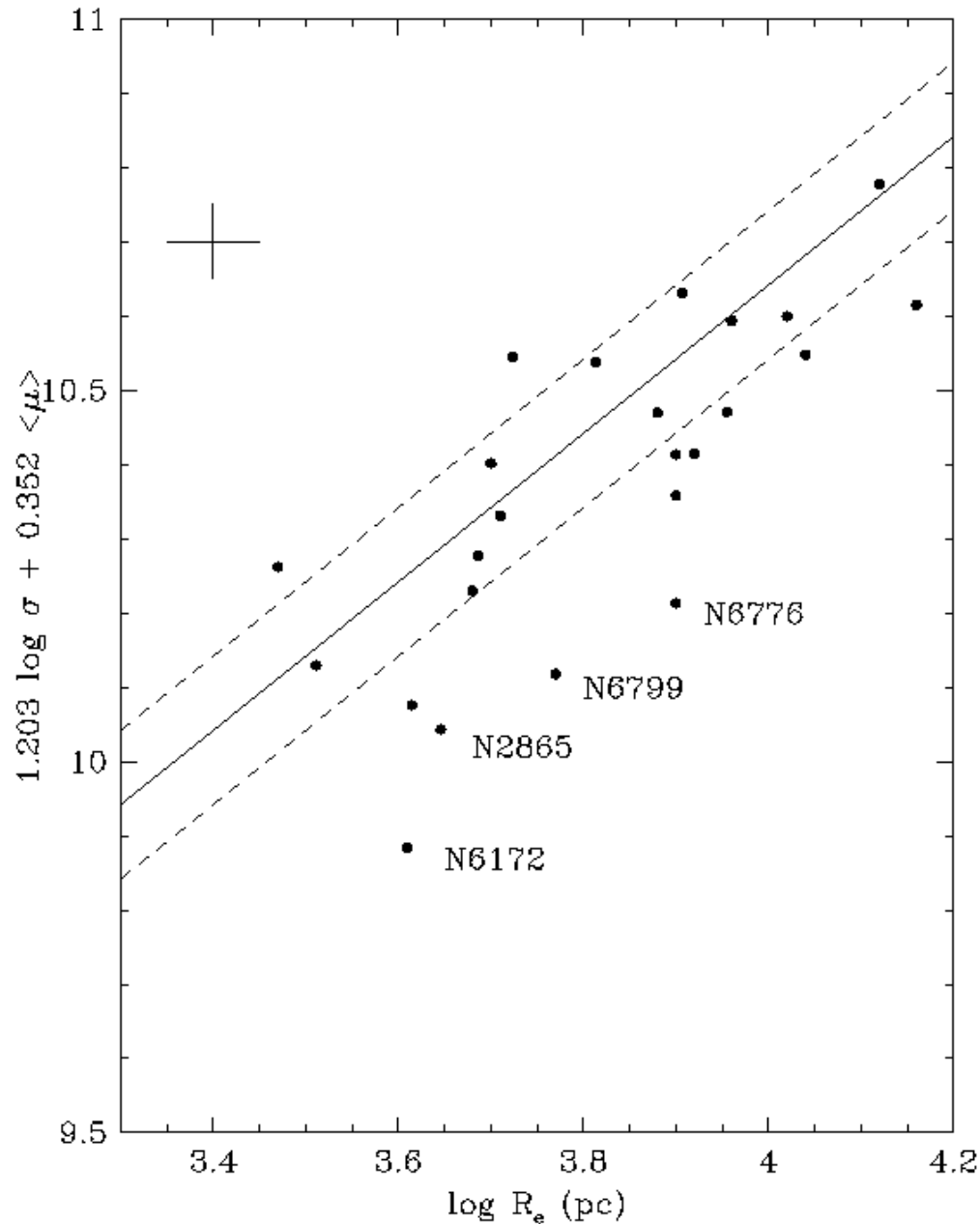
- 700 km/s
- 0.67 Mpc in plane of the sky ($\sim 1-2 R_{\text{virial}}$)
- 2 B mags (factor of 6 in mass)

=> 36 ellipticals



Colour-magnitude relation

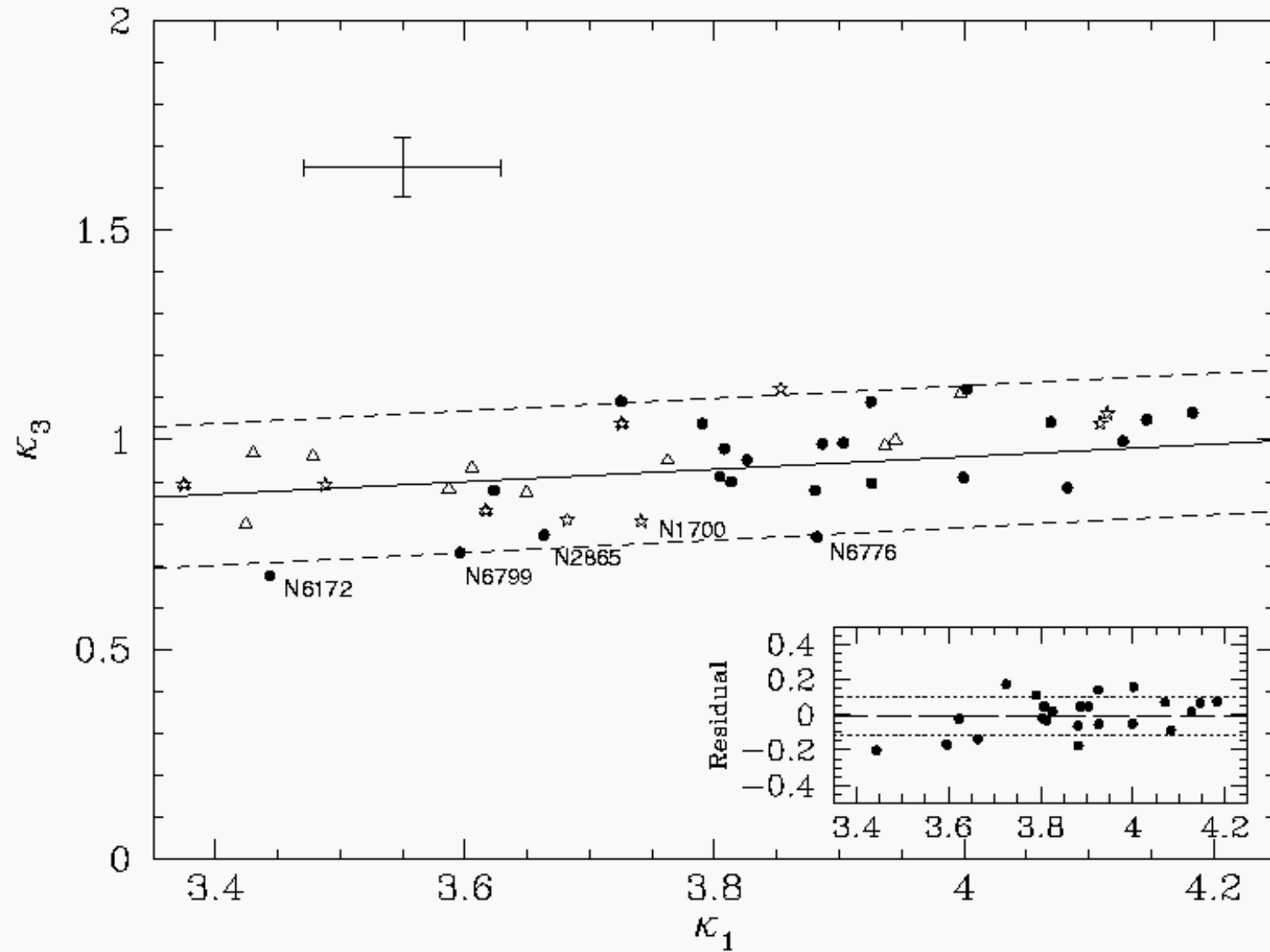




Fundamental Plane

Deviant galaxies have young stellar populations and/or disturbed morphology

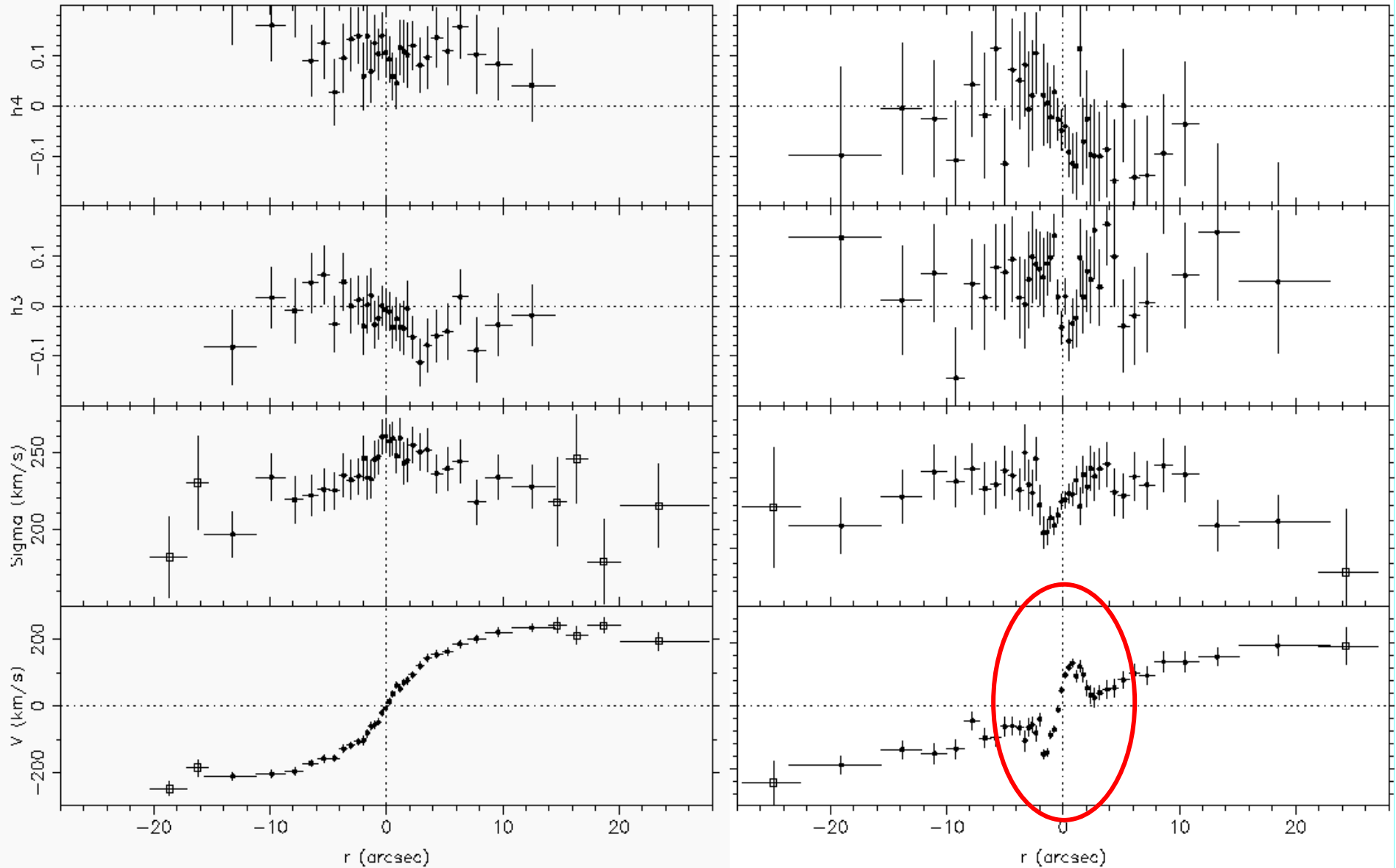
FP - Kappa style



Radial Kinematics

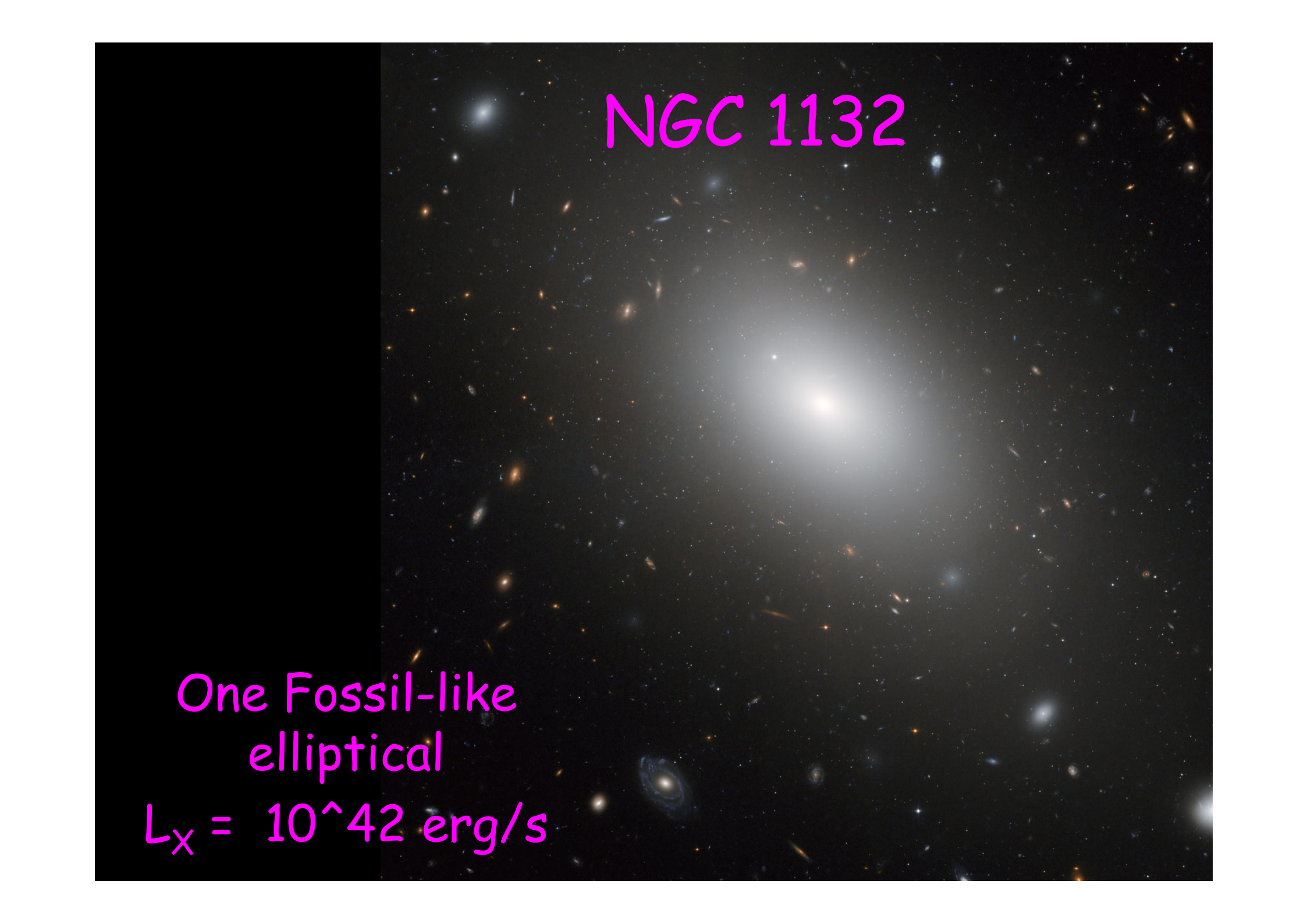
NGC 2271

NGC 2885



Hau & Forbes 2005

NGC 1132



One Fossil-like
elliptical

$$L_x = 10^{42} \text{ erg/s}$$

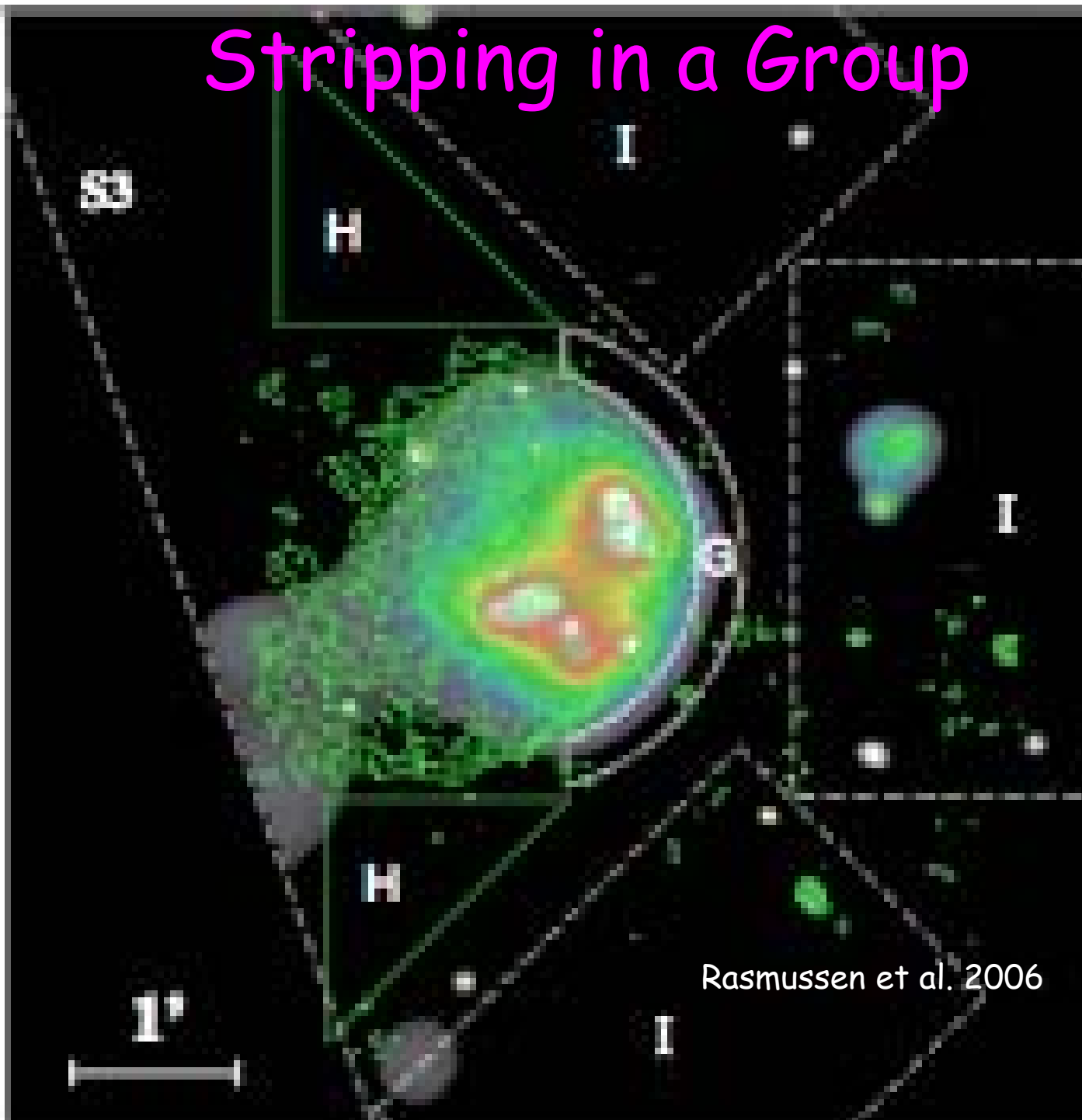
NGC 4555

O'Sullivan

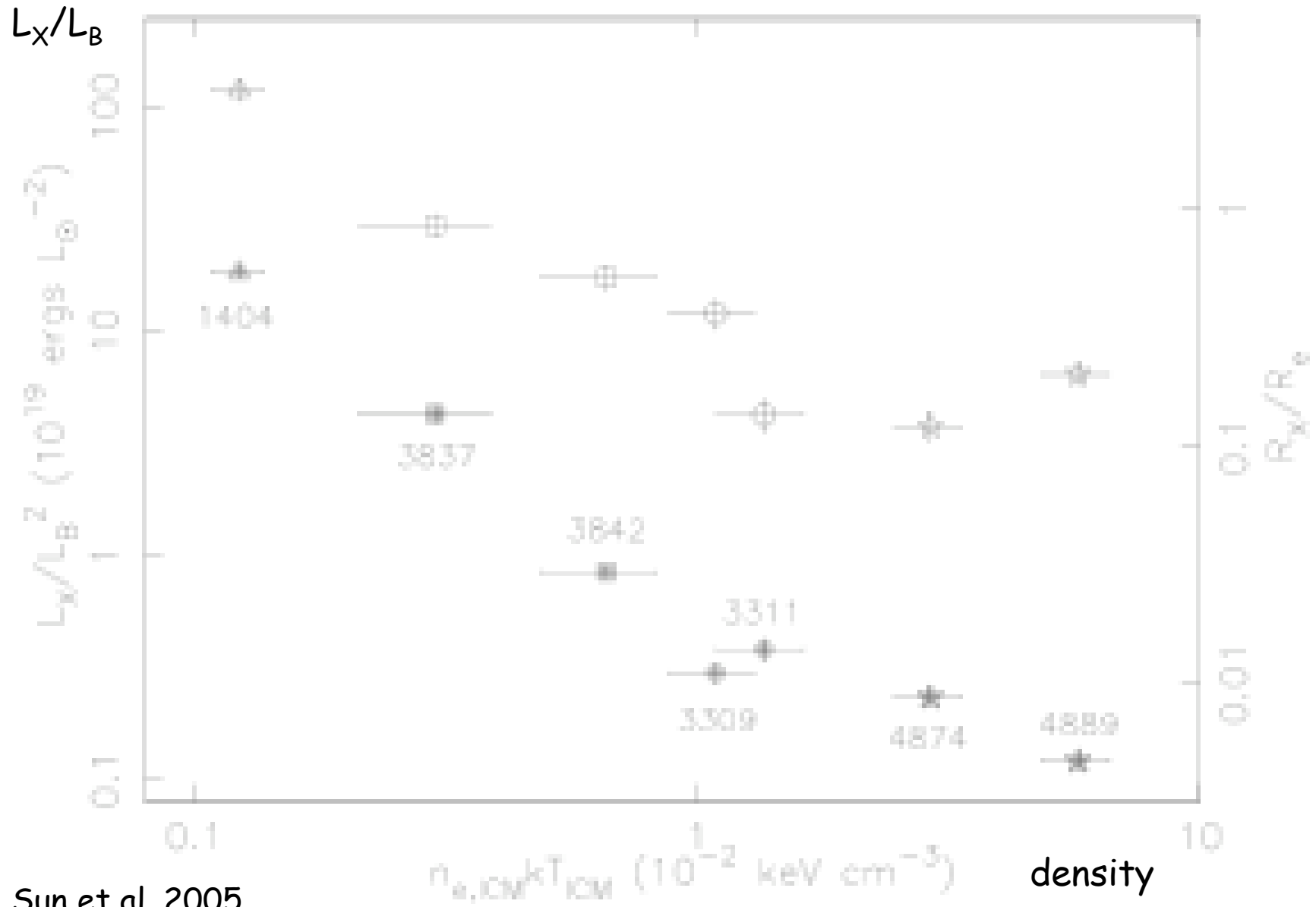
An Xray Control Sample

- What causes the scatter of 100x in L_x for a given L_B or L_K ? (Trinchieri Wednesday talk)
- Evidence of hot halo stripping in clusters and recently groups (Sun, Rasmussen, Hester)
- XMM study of isolated ellipticals found similar 100x scatter (Memola et al. 2009).
- New Chandra data (Mulchaey) and simulations (Crain) suggest a $\sim 10x$ intrinsic scatter.
- L_x vs halo mass may be the fundamental relation.

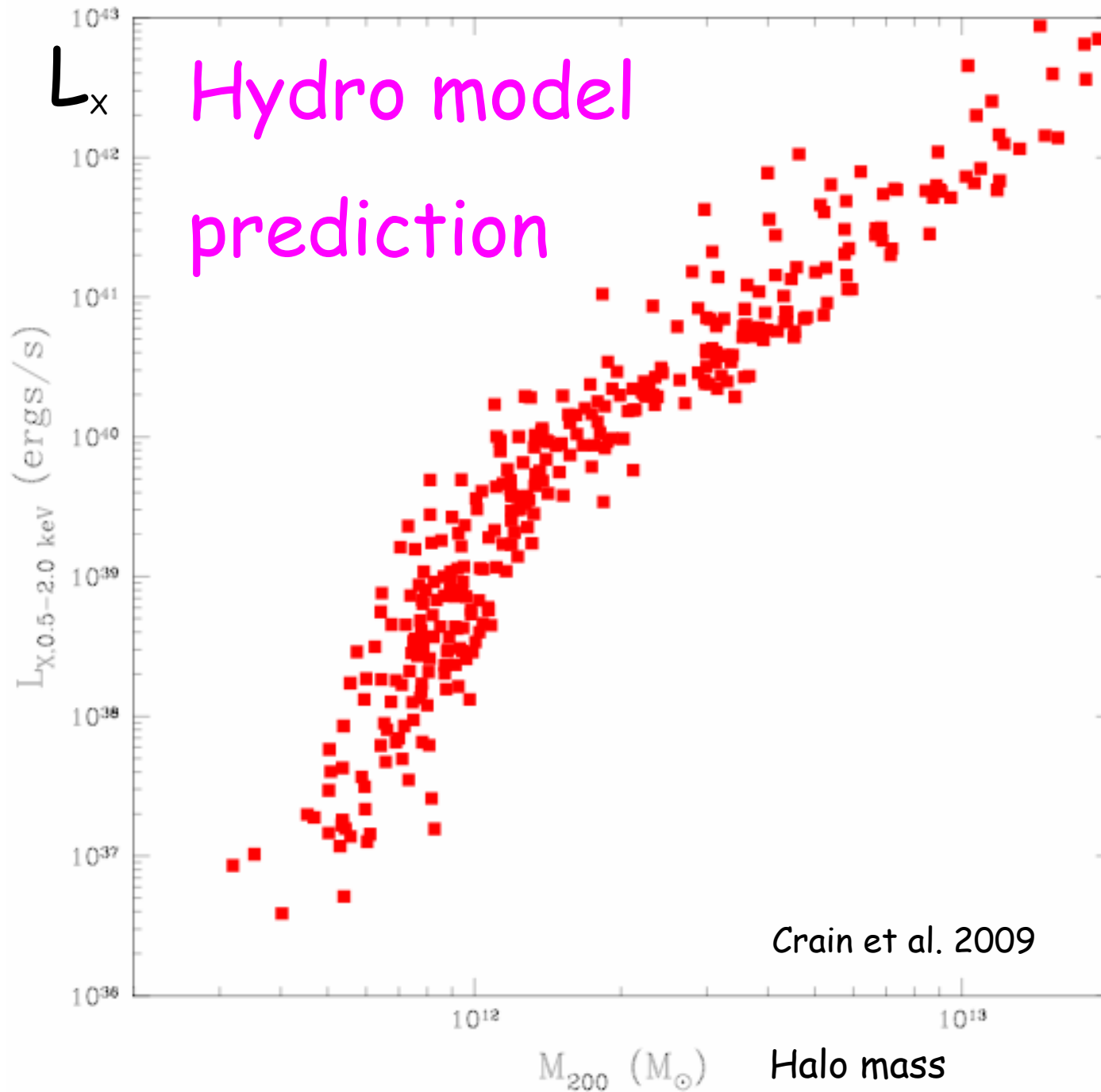
Stripping in a Group



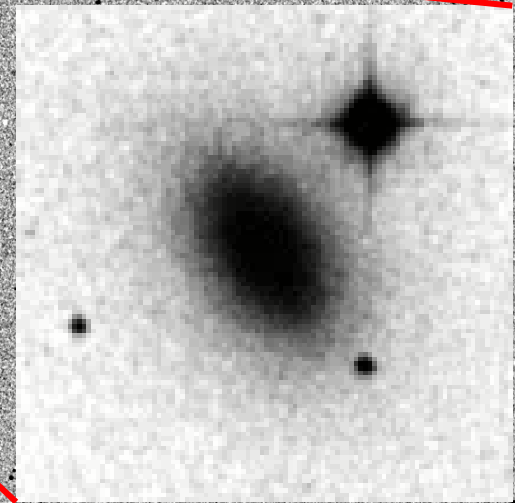
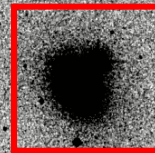
Stripping in clusters



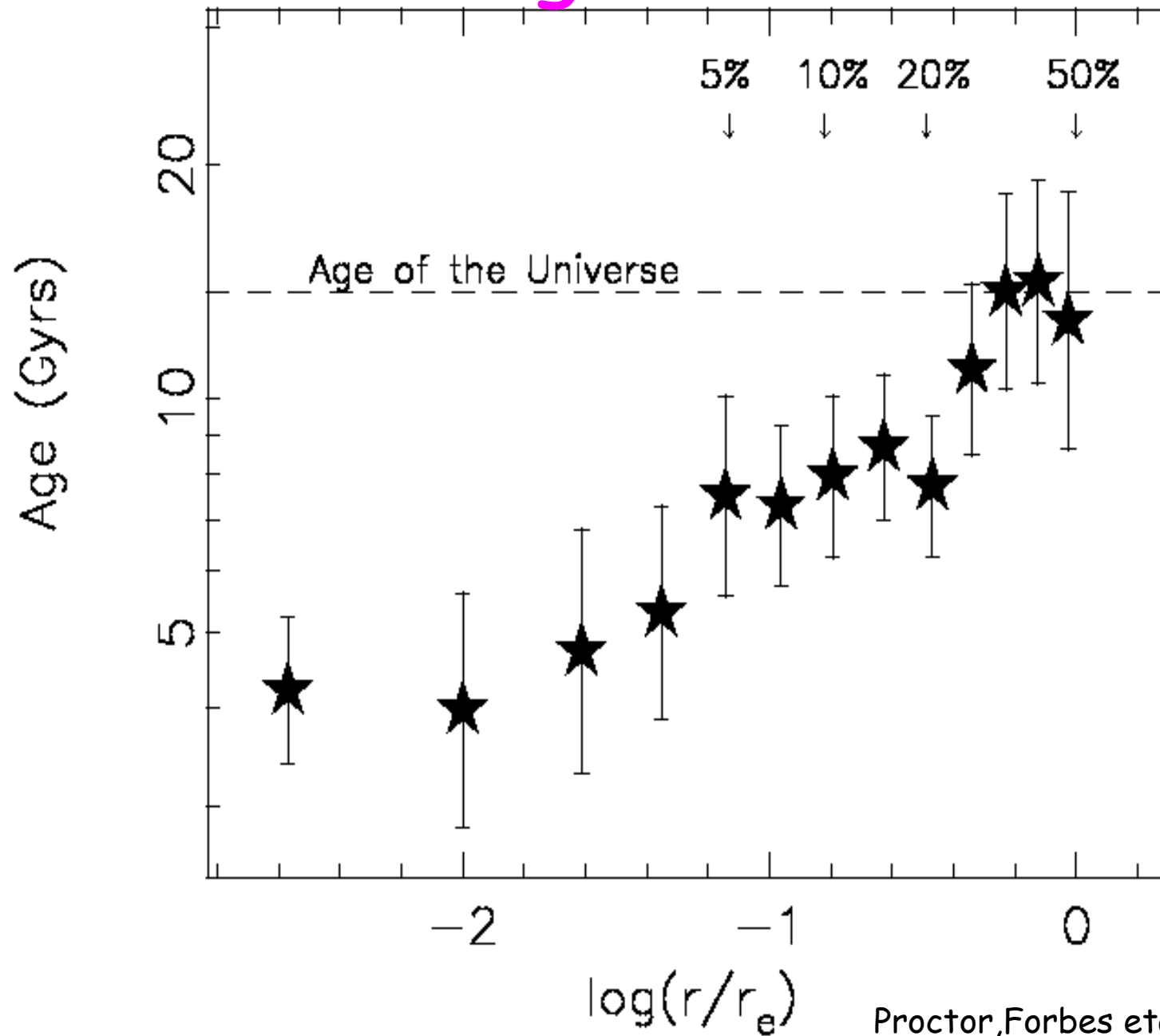
Sun et al. 2005



NGC 821 - the nearest
isolated elliptical galaxy ?

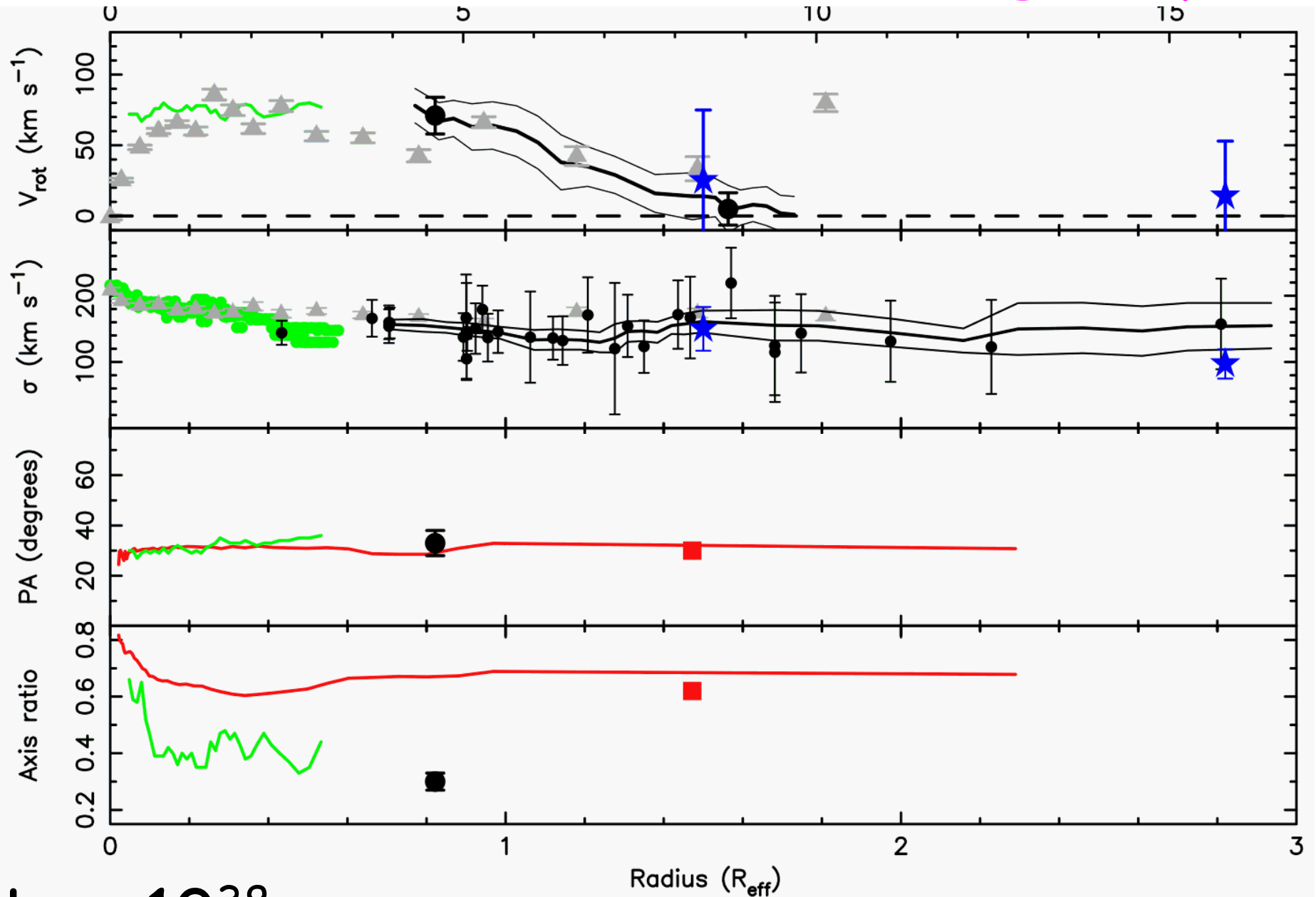


Radial Ages - NGC 821



Proctor, Forbes et al. 2005

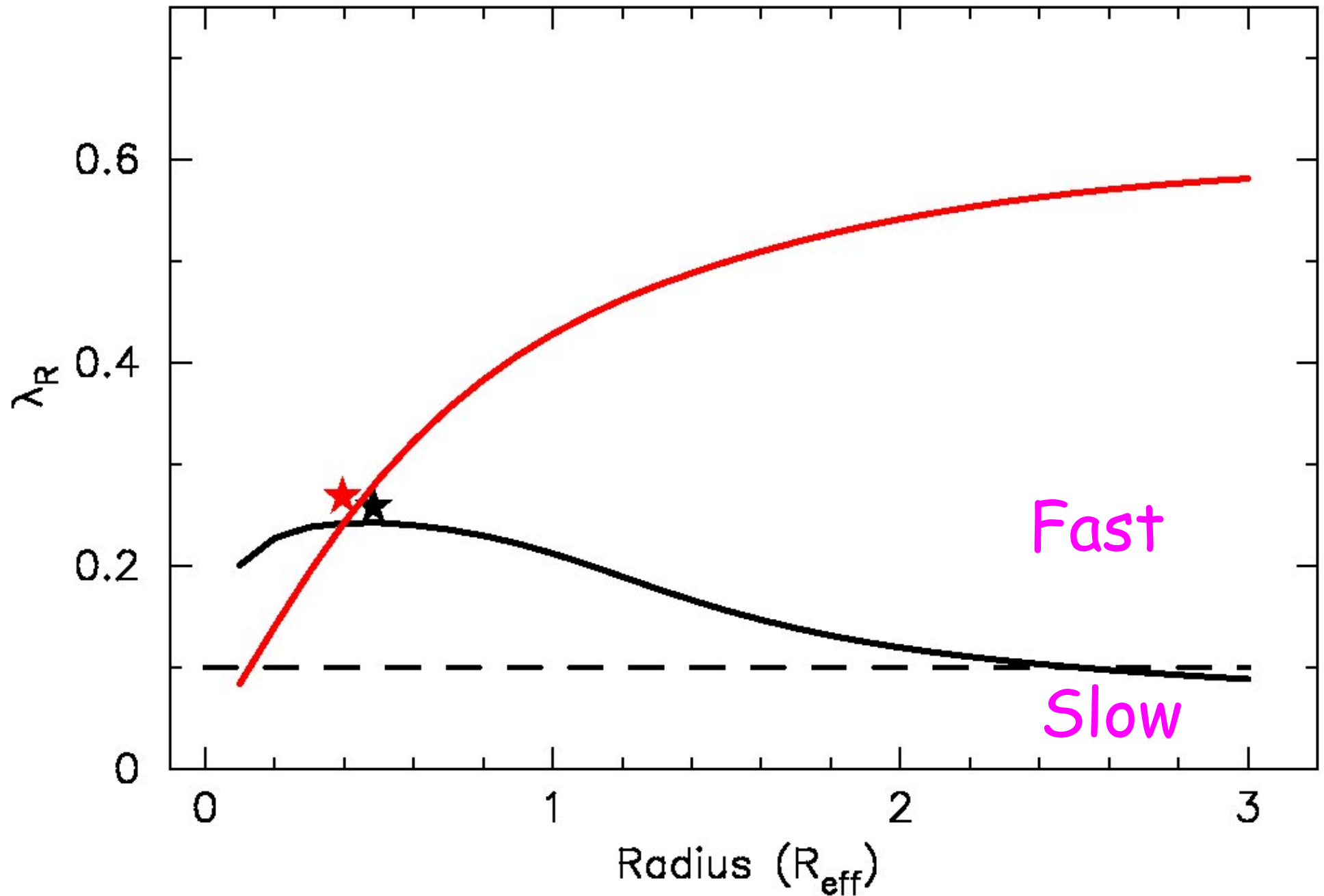
NGC 821 - a low dark halo mass galaxy?



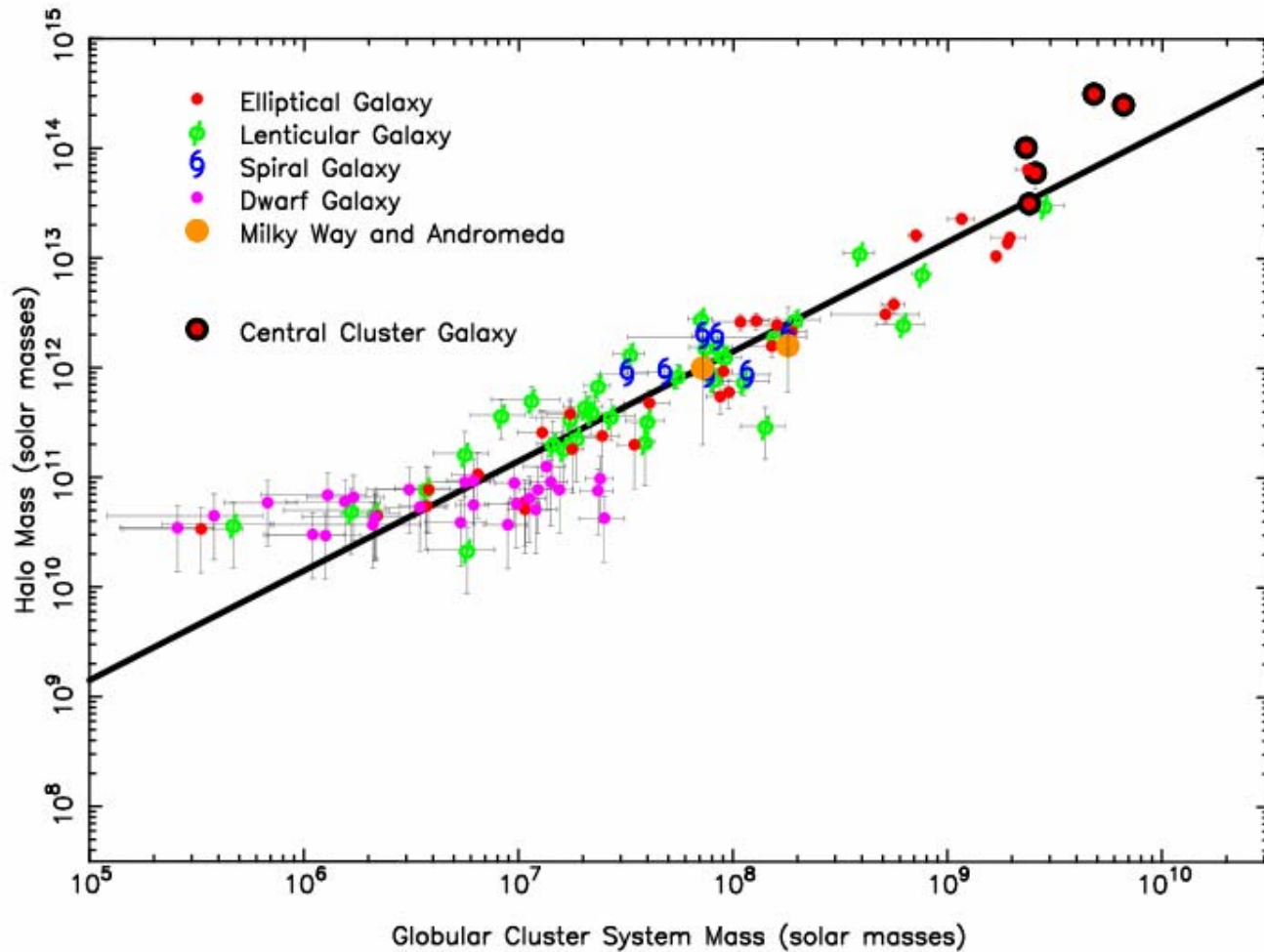
$L_X < 10^{38}$

Proctor, Forbes et al. 2009

NGC 821 (and NGC 2768)



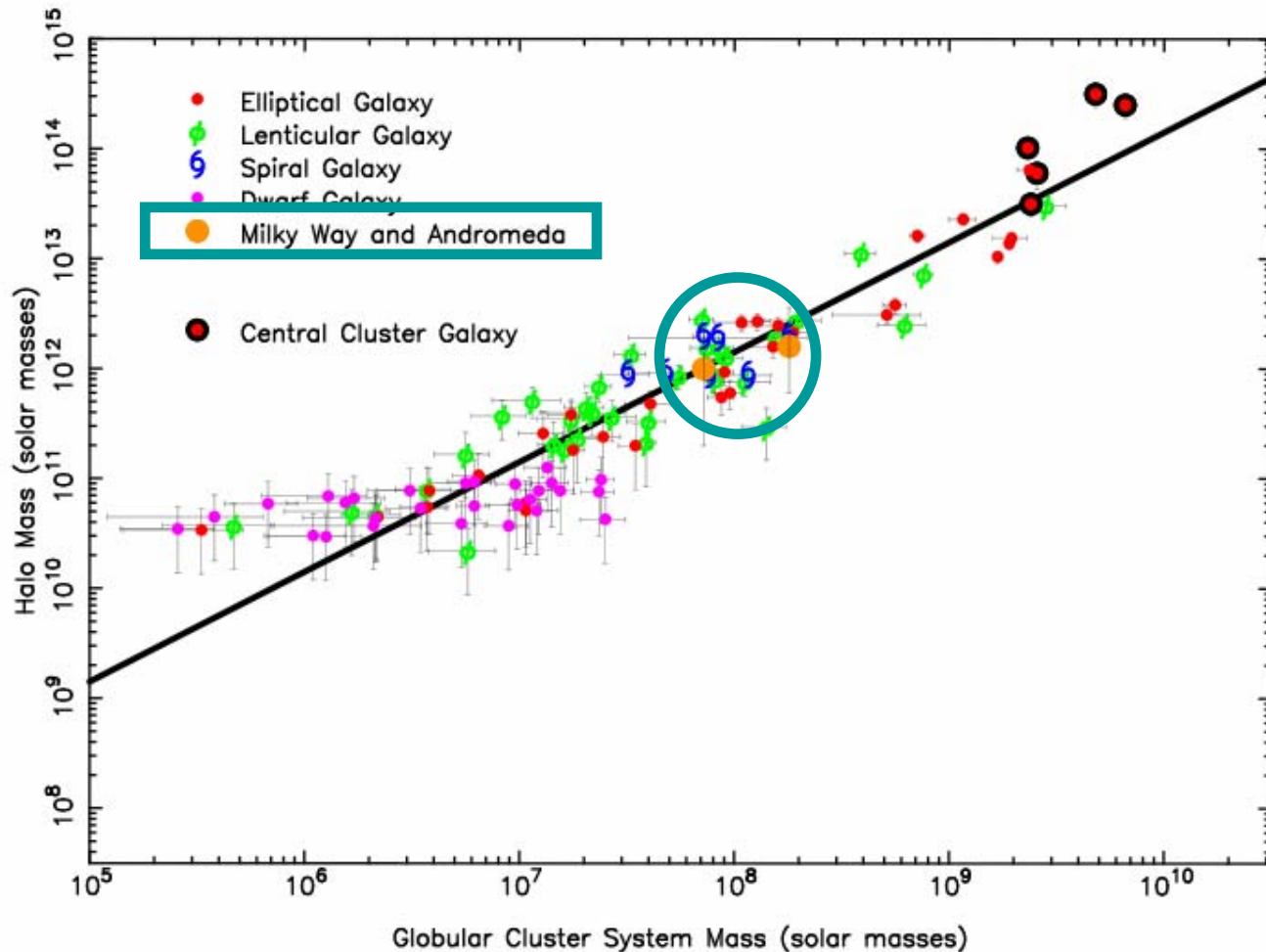
Galaxy Halo Mass



Globular Cluster System Mass

globular clusters are $\sim 0.007\%$ of a halo's mass

Galaxy Halo Mass

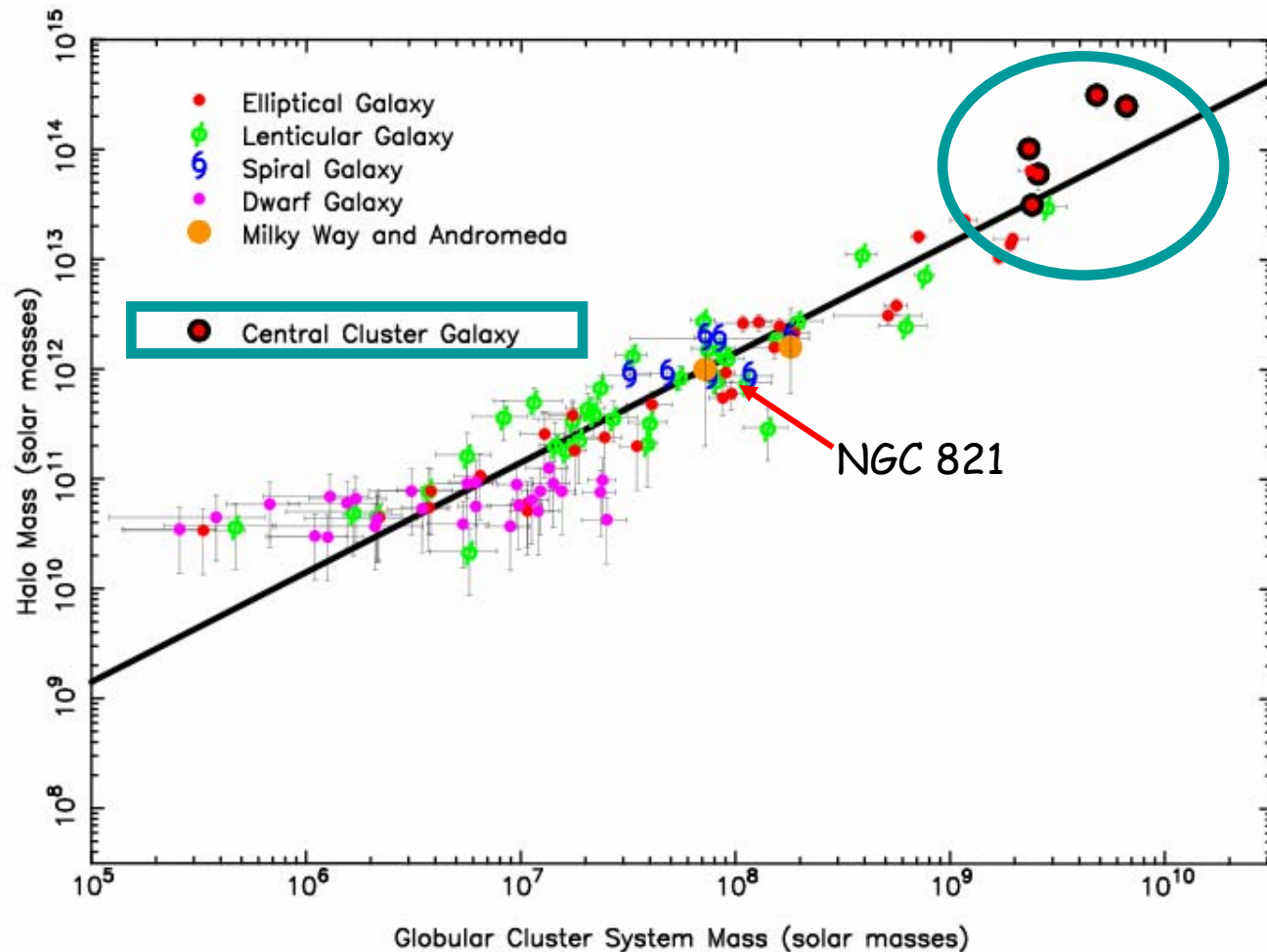


MW & M31
halo masses from
Xue et al. 2008 & Lee et al. 2008

Globular Cluster System Mass

globular clusters are $\sim 0.007\%$ of a halo's mass

Galaxy Halo Mass

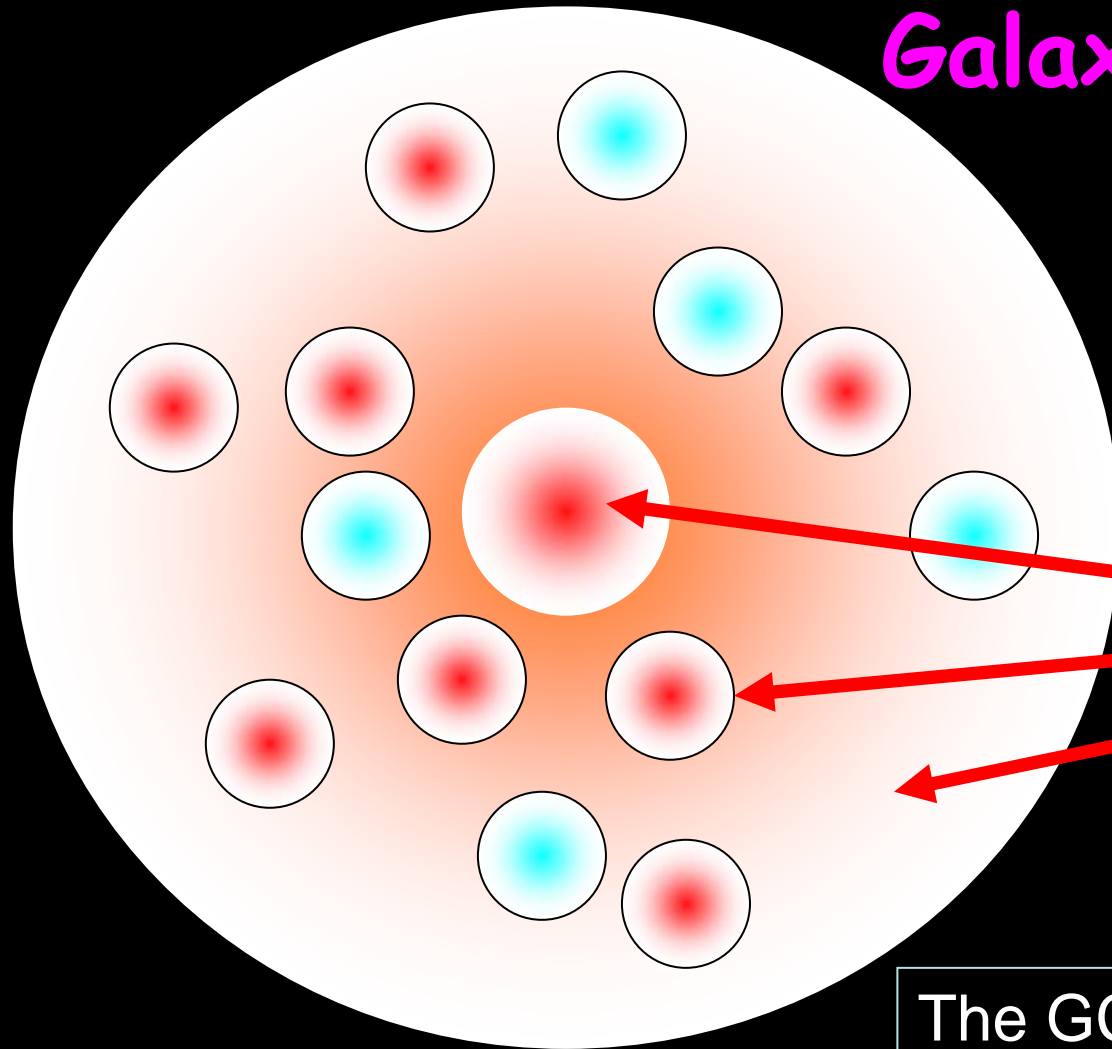


Globular Cluster System Mass

No clear environment trend

Spitler & Forbes 2009

Globular Clusters in Galaxy Clusters



Where are the GCs in the Virgo galaxy cluster?

25% in M87

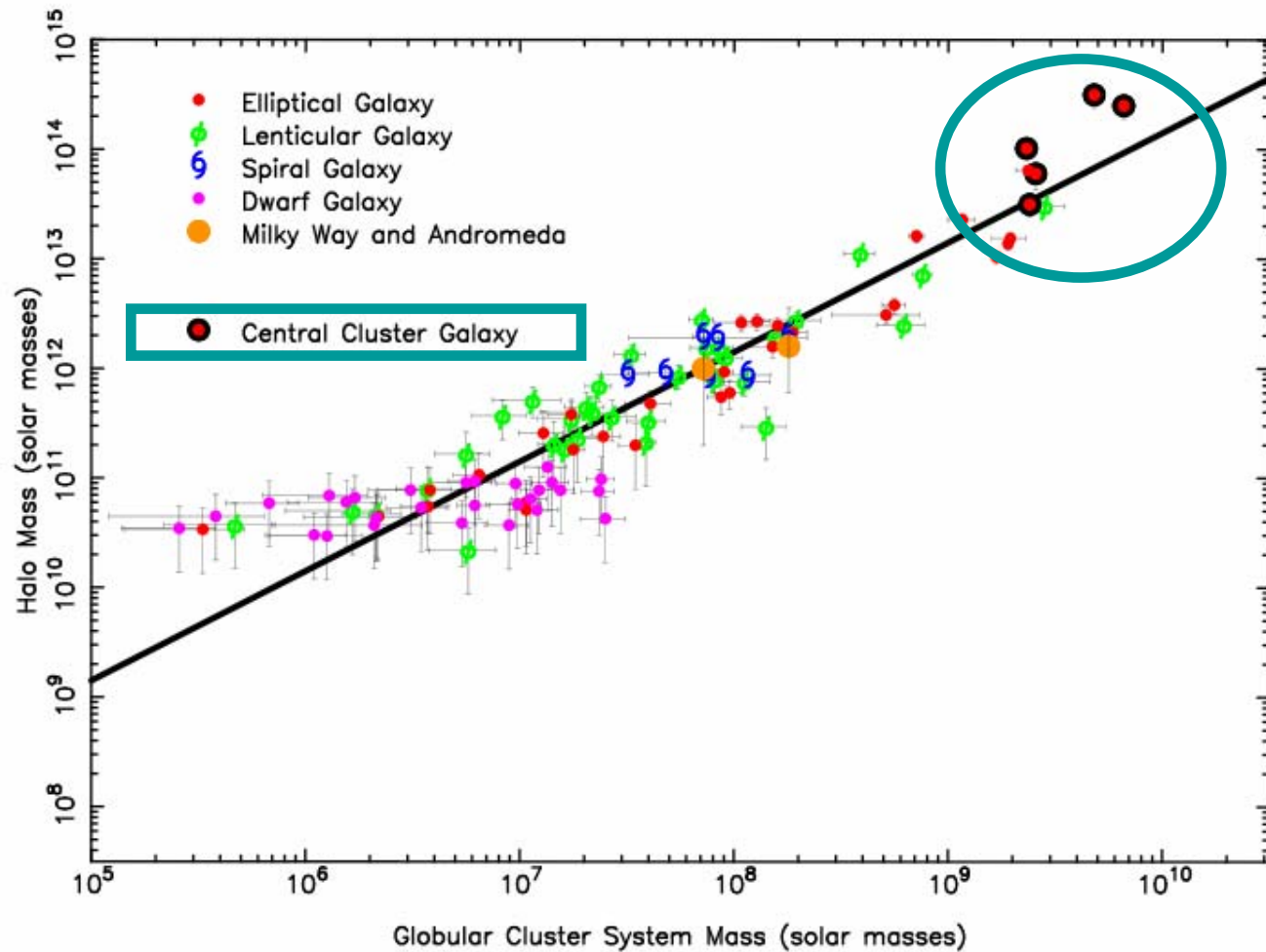
46% satellites

29% intracluster (Bekki et al. 2006)

100%

The GC mass of a cluster-sized halo should include these 3 components.

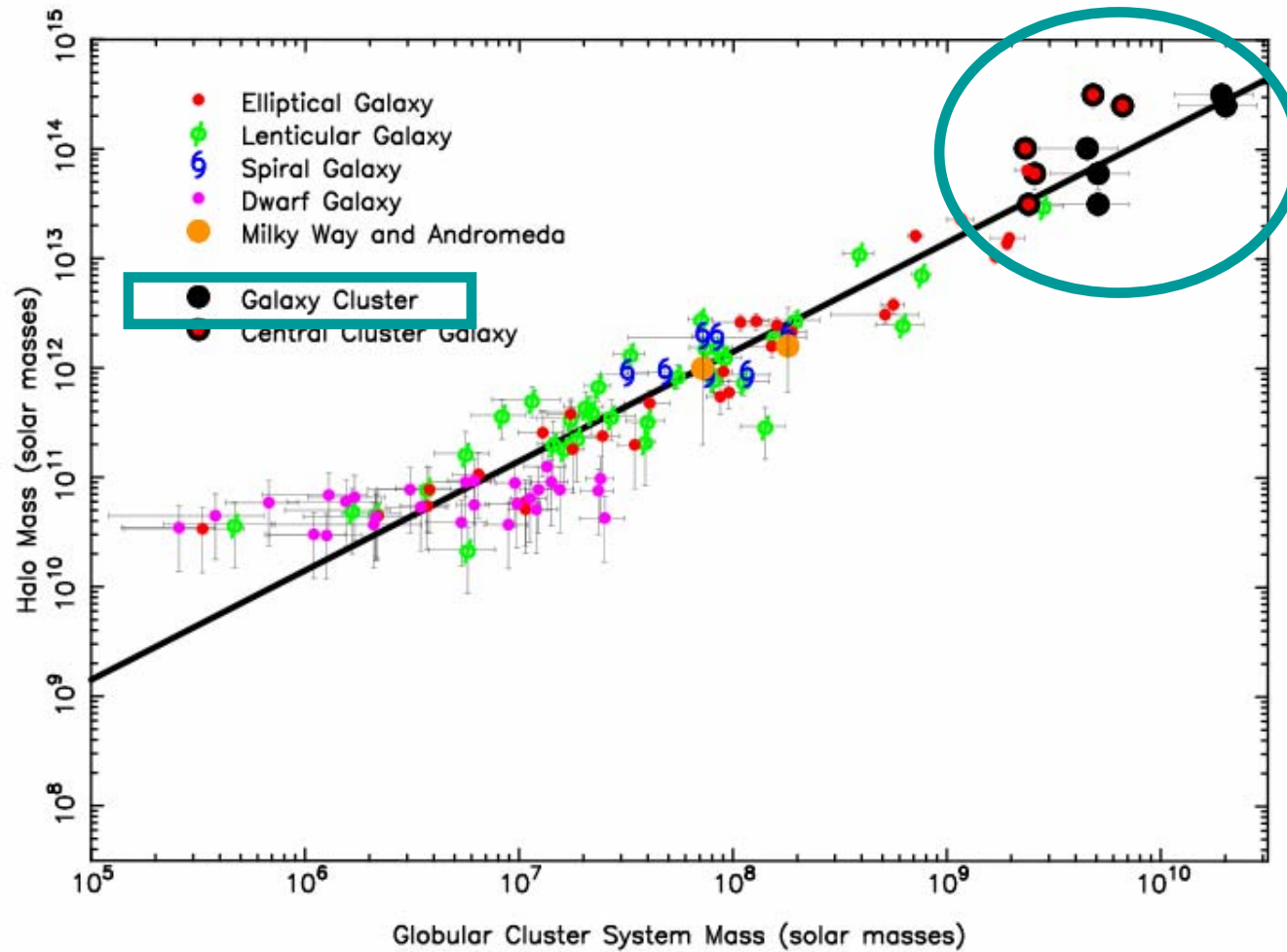
Galaxy Halo Mass



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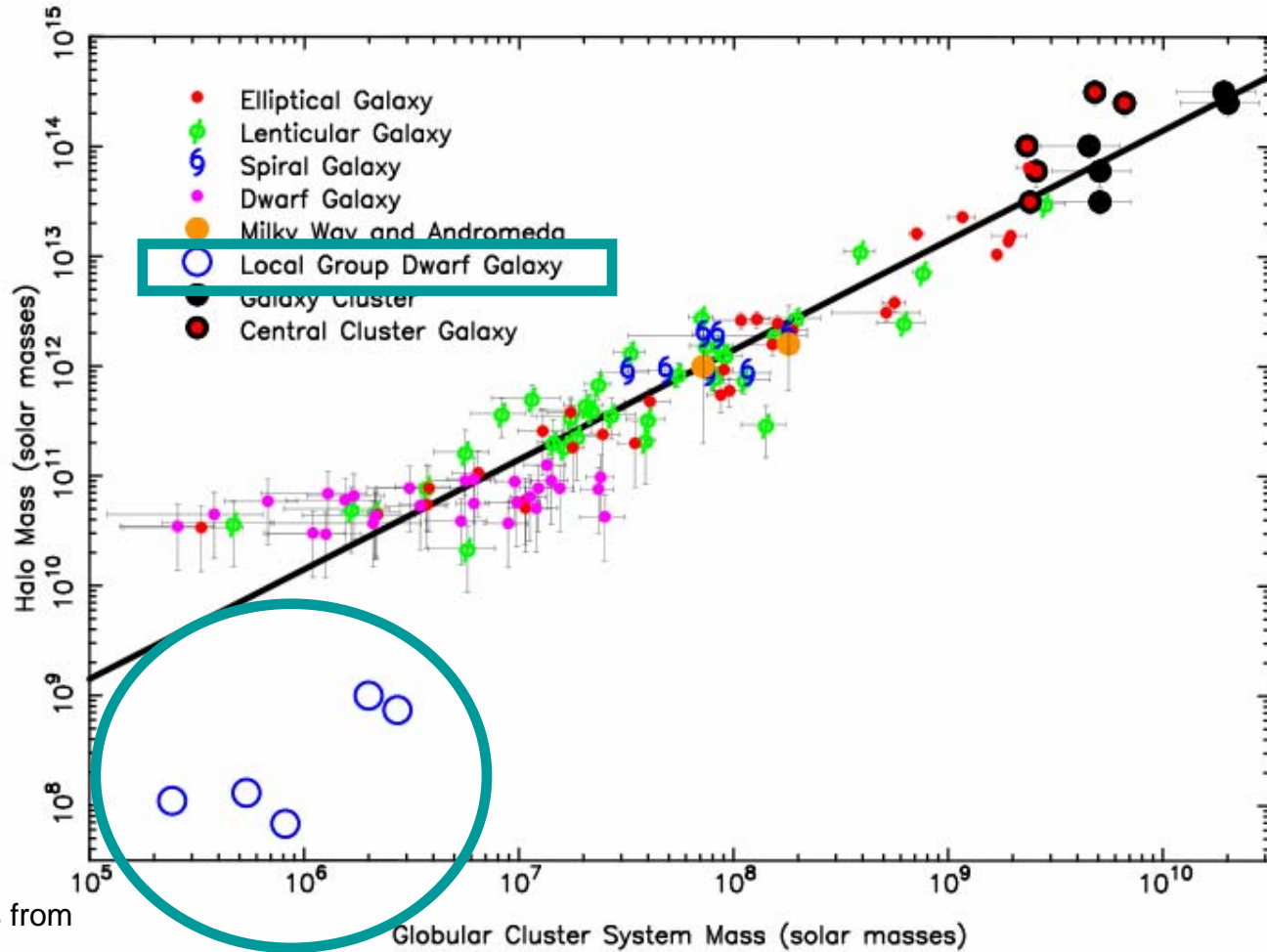
Galaxy Halo Mass



Globular Cluster System Mass

globular clusters are $\sim 0.007\%$ of a halo's mass

Galaxy Halo Mass



LG "total" masses from Mateo 1998

Globular Cluster System Mass

globular clusters are ~0.007% of a halo's mass

Fornax
Sag.
N147
N185
N205

Globular Cluster Formation

GC formation is directly proportional to the host halo mass with little environmental trend

0.007% of Halo Mass = (Globular Cluster System Mass)

0075



Conclusions

Isolated elliptical galaxies provide a useful 'control' sample, free from cluster/group environment processes.

Such galaxies are a mixed bag of passive and recently assembled ellipticals.

Xray luminosity, globular cluster system mass and assembly history may depend more on halo mass than environment.

