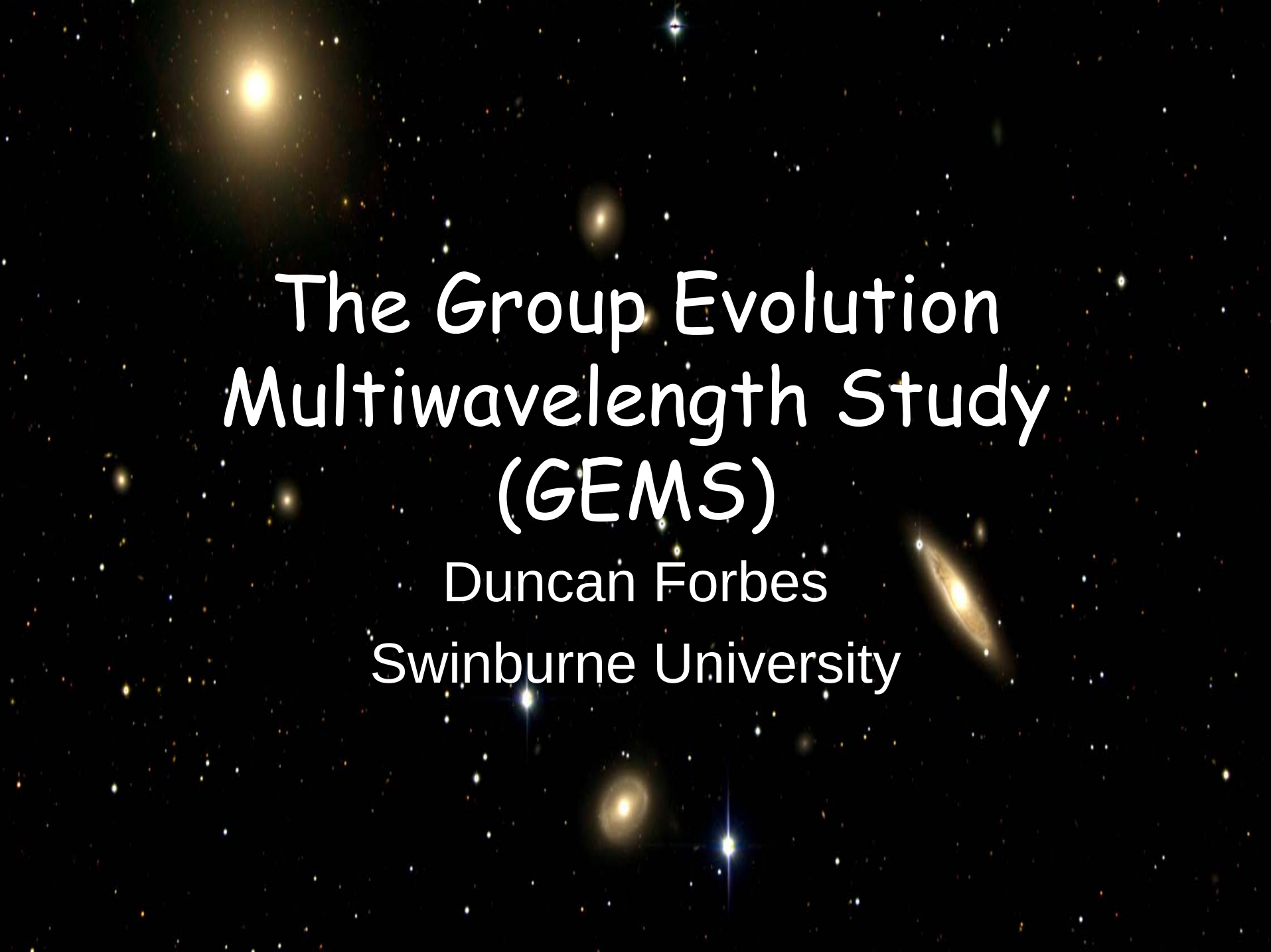


The Group Evolution Multiwavelength Study (GEMS)

Duncan Forbes

Swinburne University

Motivation

- Groups poorly studied relative to clusters, but most galaxies in groups
- Star formation suppressed at group-like densities (2dF, SDSS)
- Are galaxies in groups pre-processed ?
- What are the physical processes ?
- How do groups evolve ?

Physical Processes in Groups

- Ram pressure stripping
- Interactions & Harassment
- Mergers
- Group tidal field
- Strangulation/Suffocation
- Overlapping dark matter halos

Aim: to understand how the group environment affects galaxy evolution and how groups themselves evolve.

Method: multi-wavelength data for ~60 groups and mock catalogues.

Forbes etal. 2006

GEMS People in Santiago

Swinburne:

Forbes, Kilborn and Brough

Birmingham:

Ponman and Raychaudhury

IAP:

Mamon

GEMS Sample Selection

- Optical catalogue of Galaxy Groups
- 15 < D < 130 Mpc
- ROSAT PSPC 10,000 sec

⇒60 nearby groups with a range of X-ray properties, ie dynamically young to old groups.

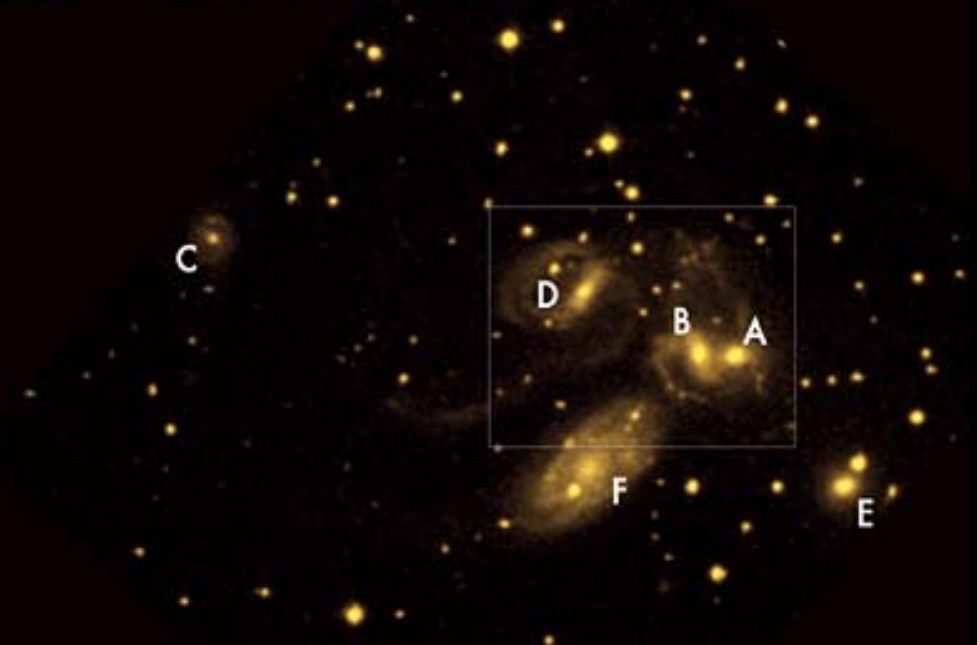
⇒Includes both compact and loose groups.

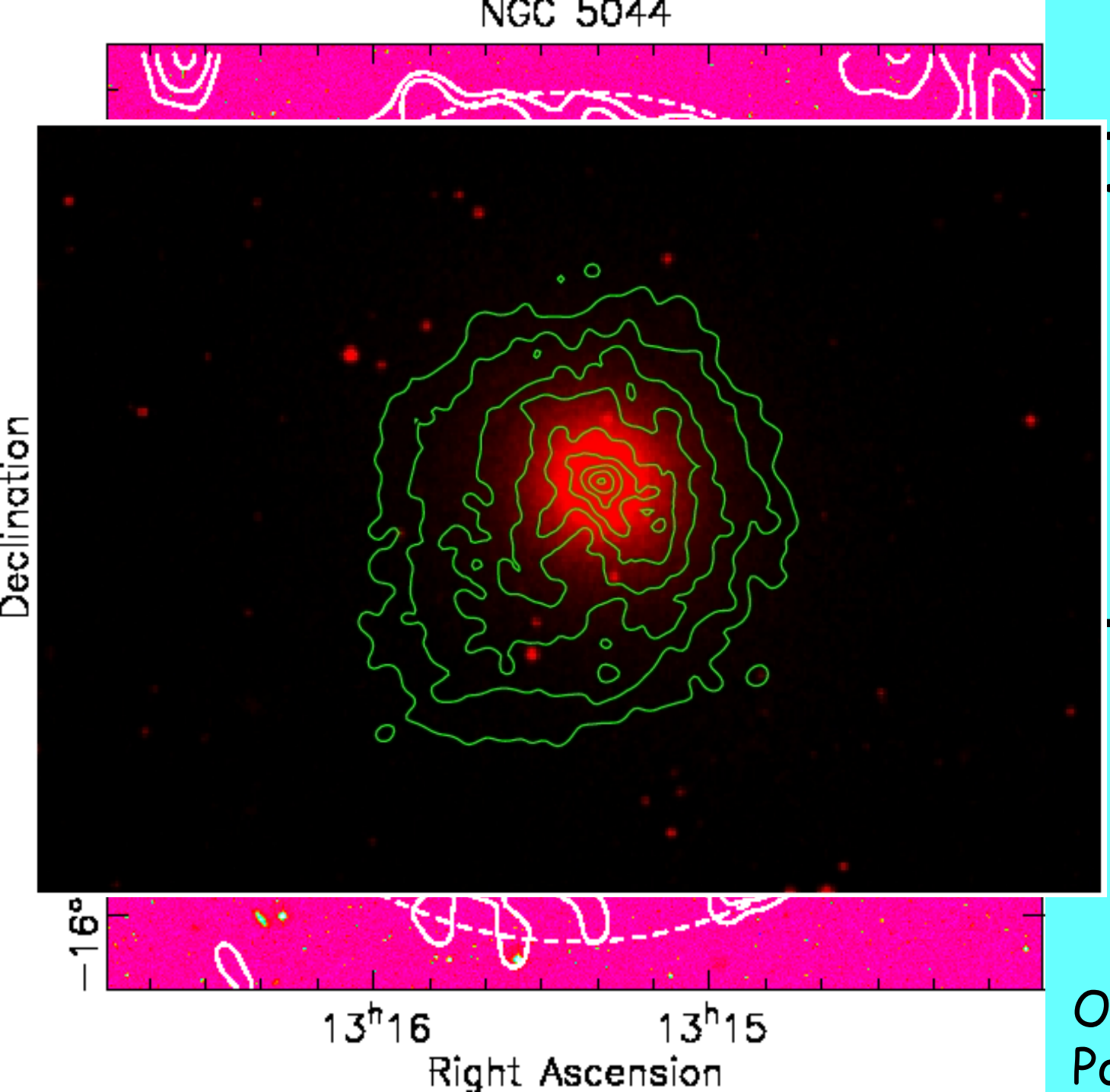
GEMS Dataset

- ROSAT imaging (1.5 degrees)
- Wide-field optical imaging (0.5 degrees)
- Parkes HI mapping (5.5 degrees)
- ATCA HI follow-up
- 6dFGS spectra
- 2MASS K-band photometry
- XMM/Chandra imaging
- Mock catalogues

X-ray Imaging

60 Groups





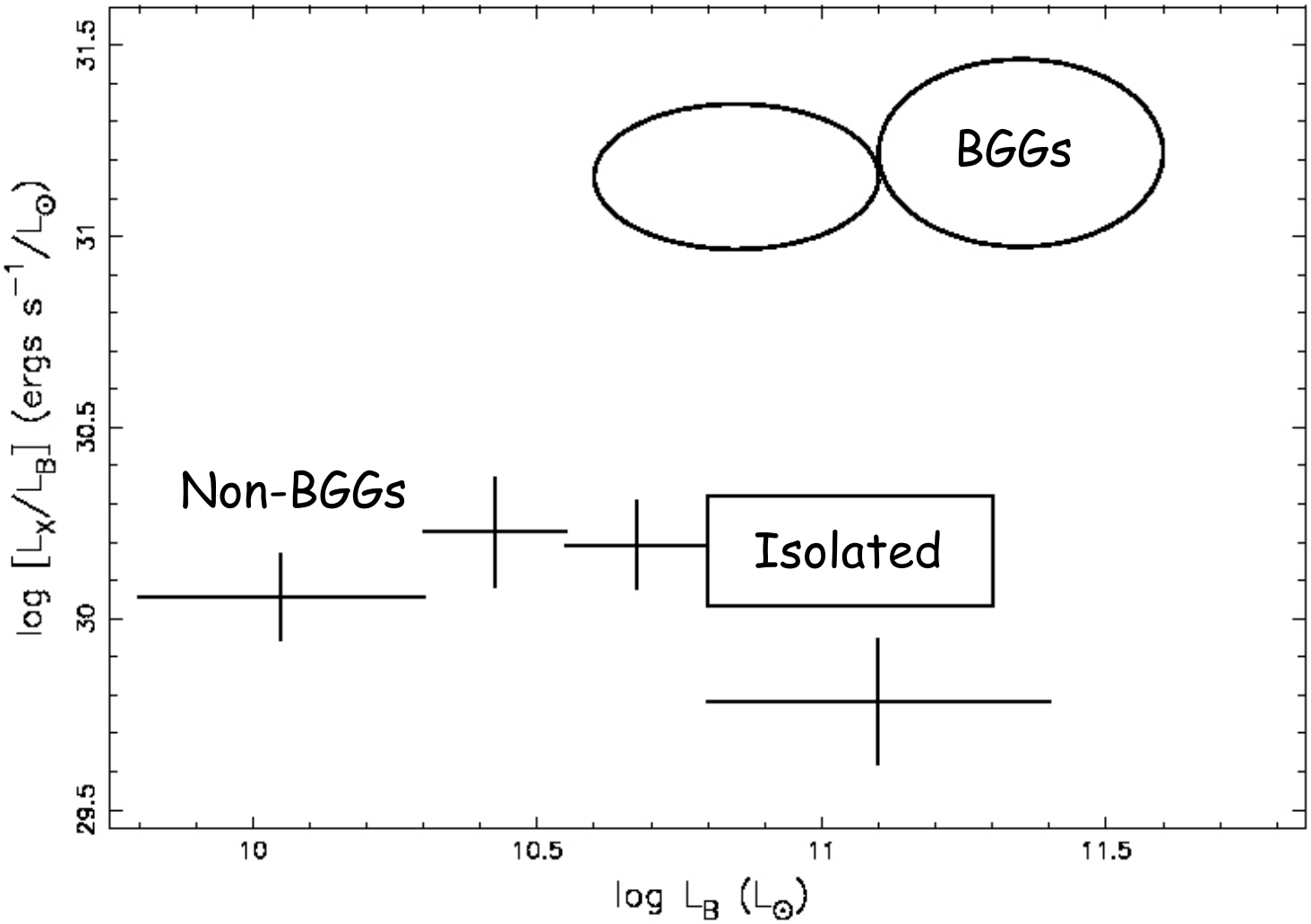
X-ray Imaging

60 Groups

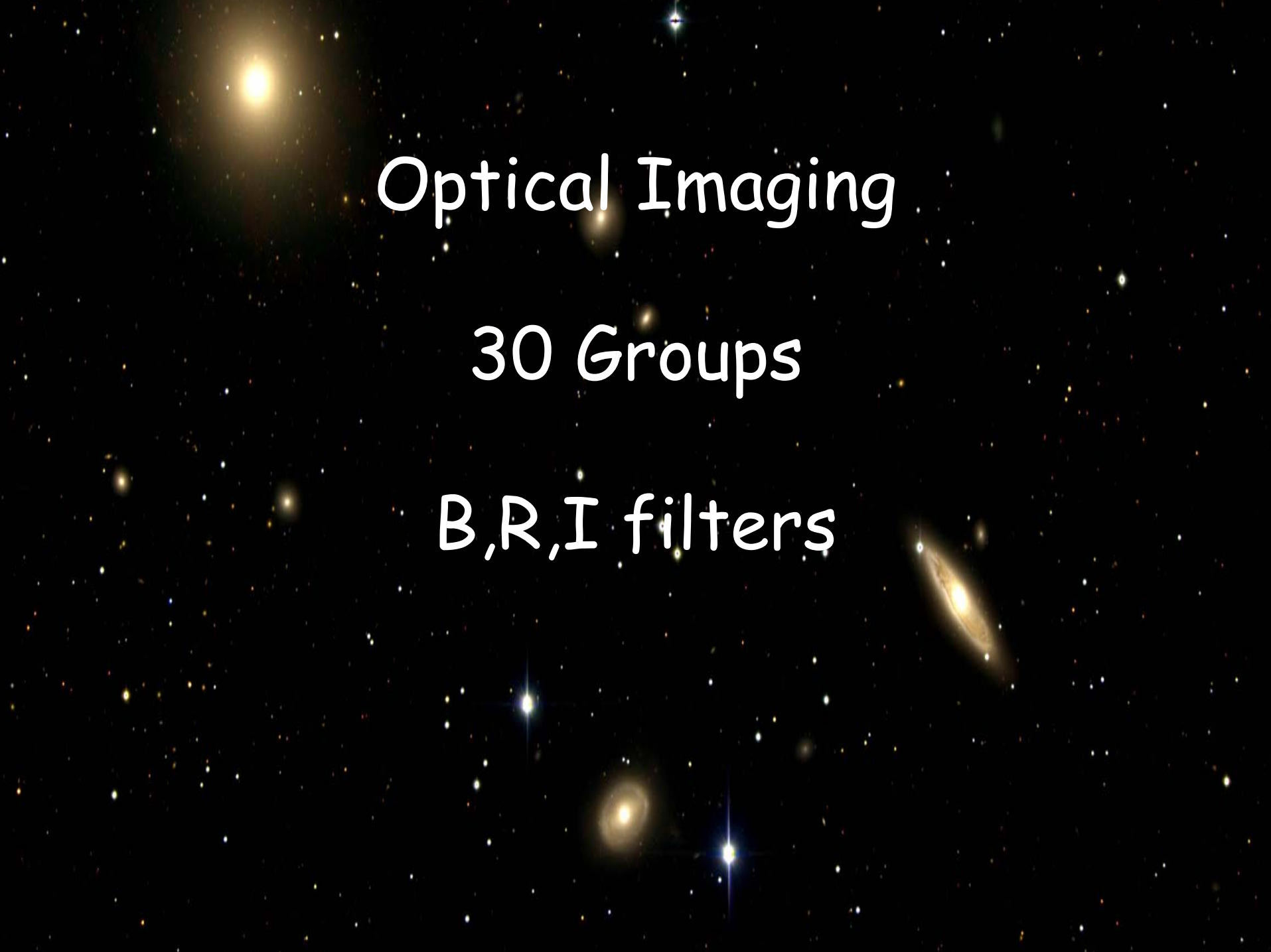
T_X, L_X, Z to R_{500}

Osmond & Ponman 2004

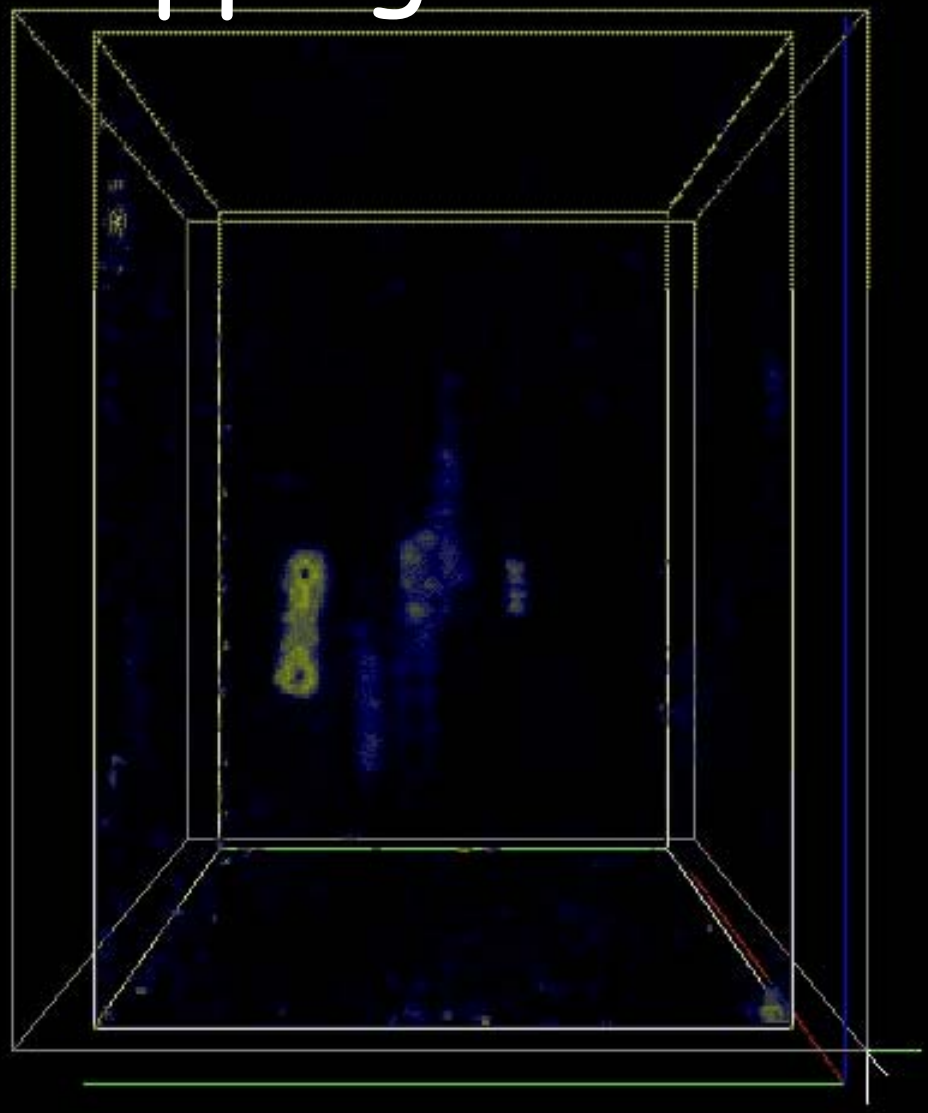
No X-ray Halo Stripping in Groups



Helsdon et al. 2001


Optical Imaging
30 Groups
B,R,I filters

HI Mapping - 16 Groups



Kilborn, Forbes et al. 2005

HI Mapping

- 16 Groups mapped with the Parkes multibeam instrument over 5.5 degrees
- Mass limit of ~ 10^8 M_{sun}
- 2x deeper than HIPASS survey
- 10x better velocity resolution than HIPASS
- 15 arcmin beam (hence ATCA followup)

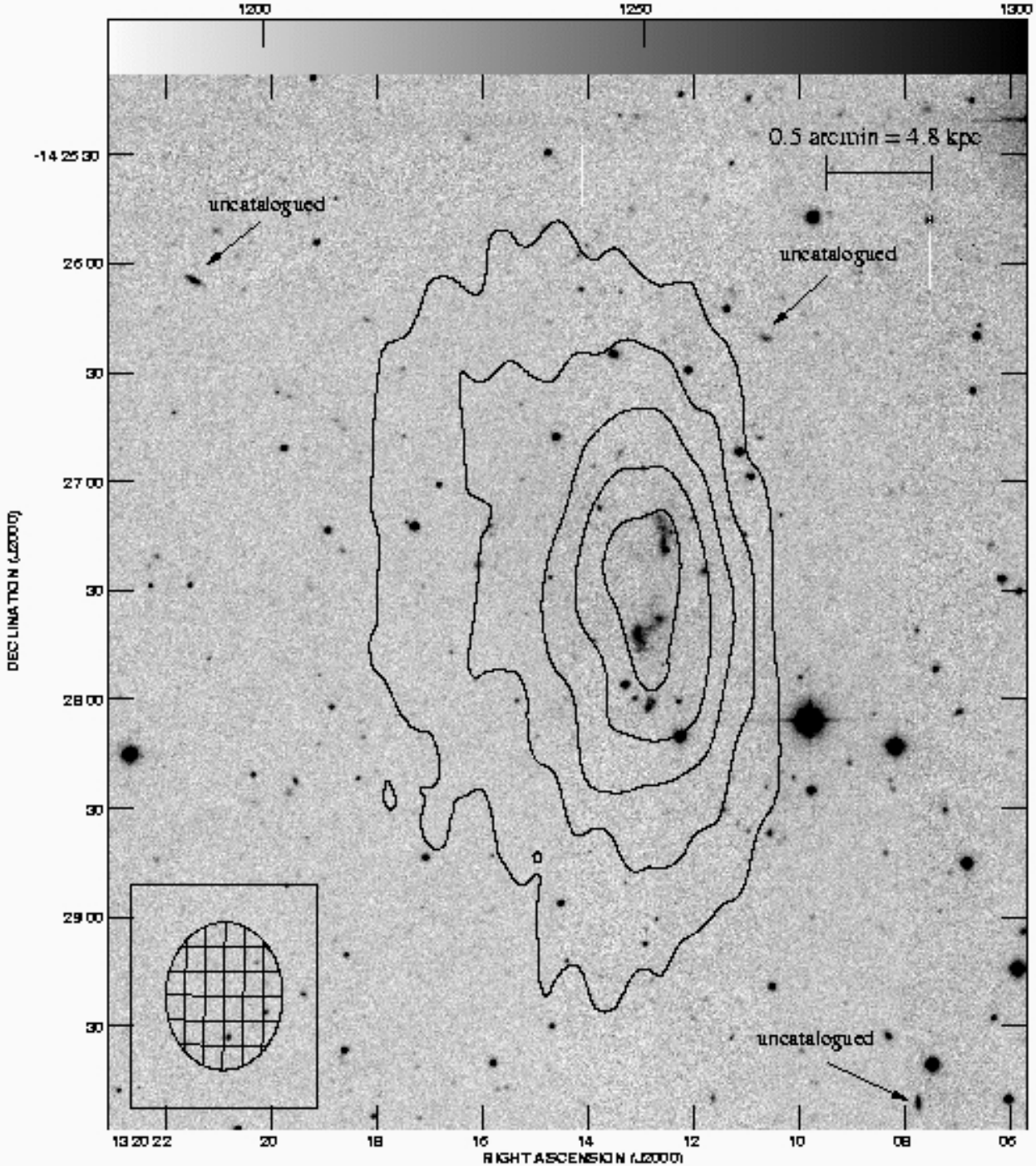
HI Census

- In 16 groups mapped in HI:
- 204 HI detections
- 21 (10%) new group members

=> Few gas-rich galaxies in LF faint end

=> `missing satellites' are not HI-rich dark galaxies

Kilborn, Forbes etal. 2006



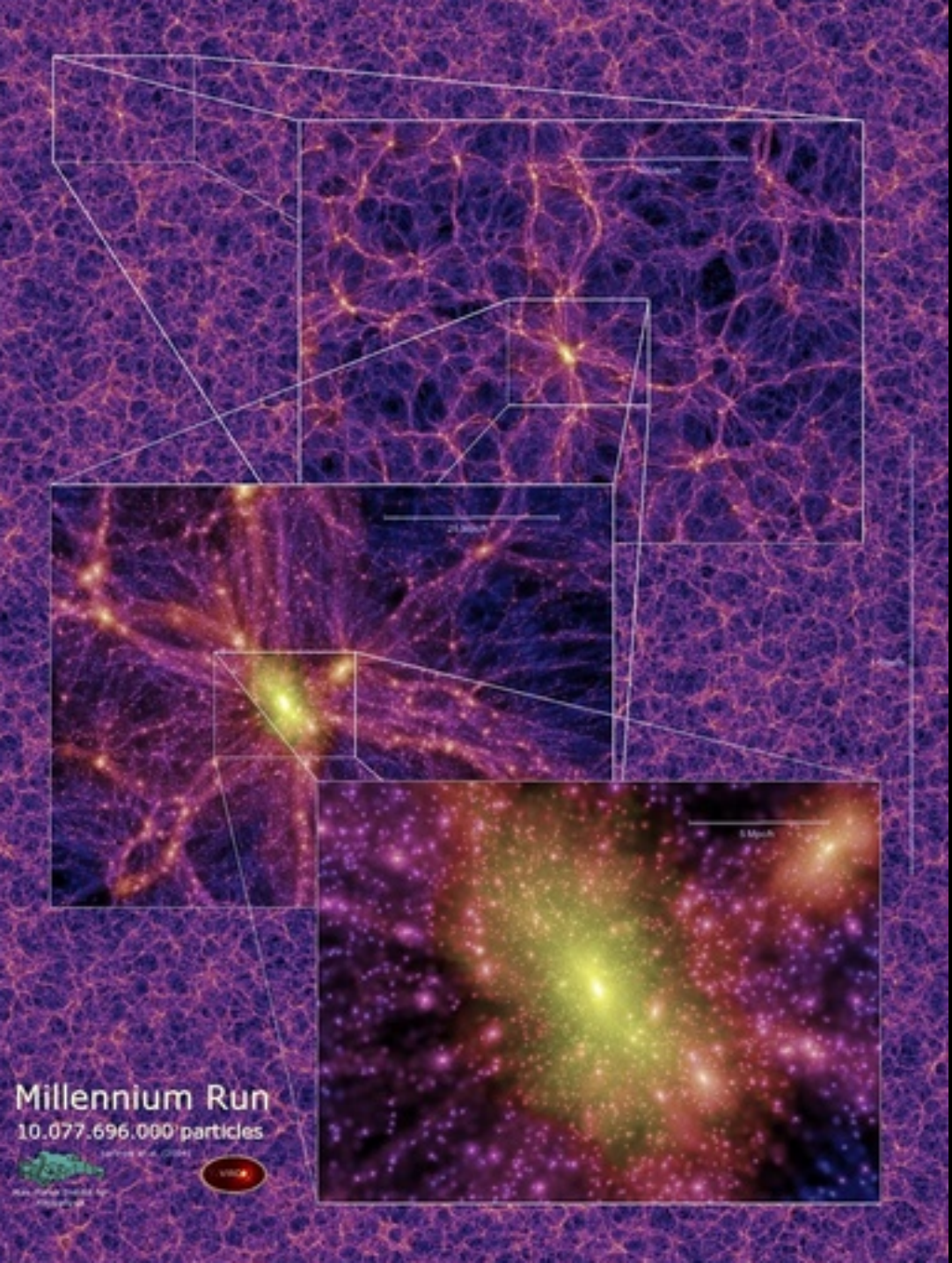
NGC 5044 group

New group member

$M_{HI} = 10^9\ M_o$

$M_{HI}/L_B = 1.7$

McKay et al. 2004



Mock Catalogues:

Millennium simulation

+

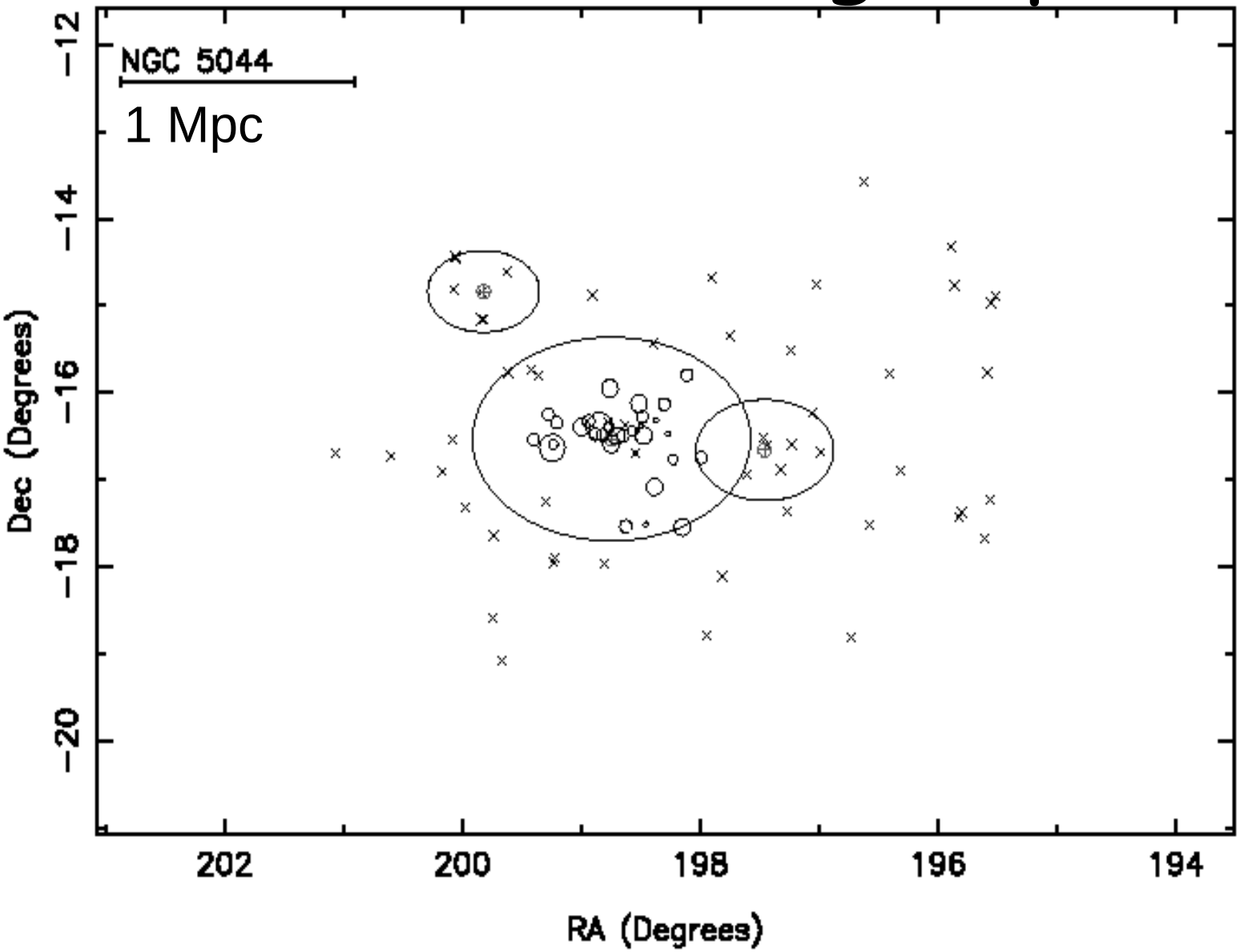
semi-analytical models

Group Dynamics - 16 groups

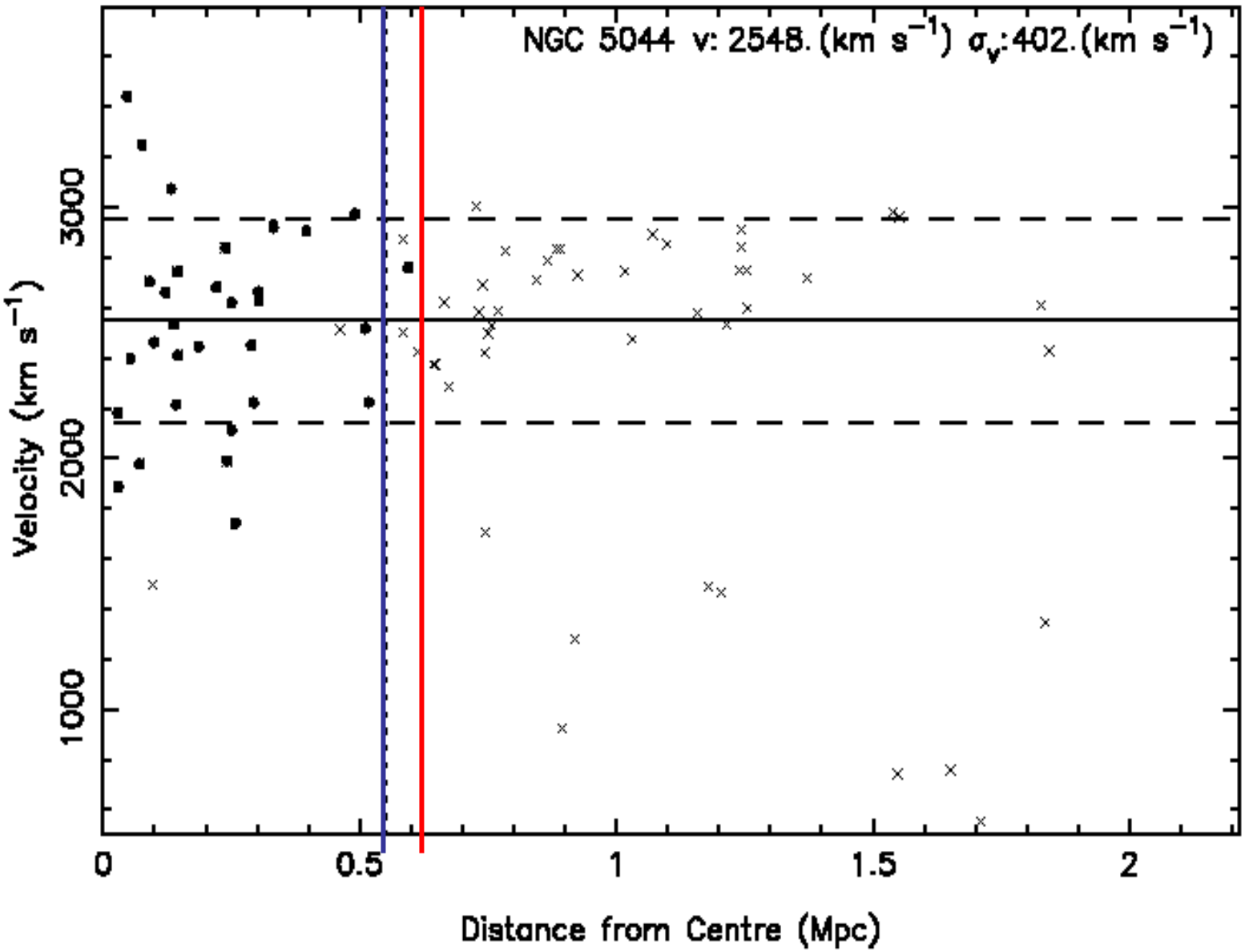
- Group membership from 6dFGS, new HI galaxies and NED
- 2MASS K-band luminosities
- FOF algorithm to define groups
- Calculate group properties, eg $R_{500,}$ Mass
- Examine virialisation state
- Create composite group

Brough, Forbes etal. 2006

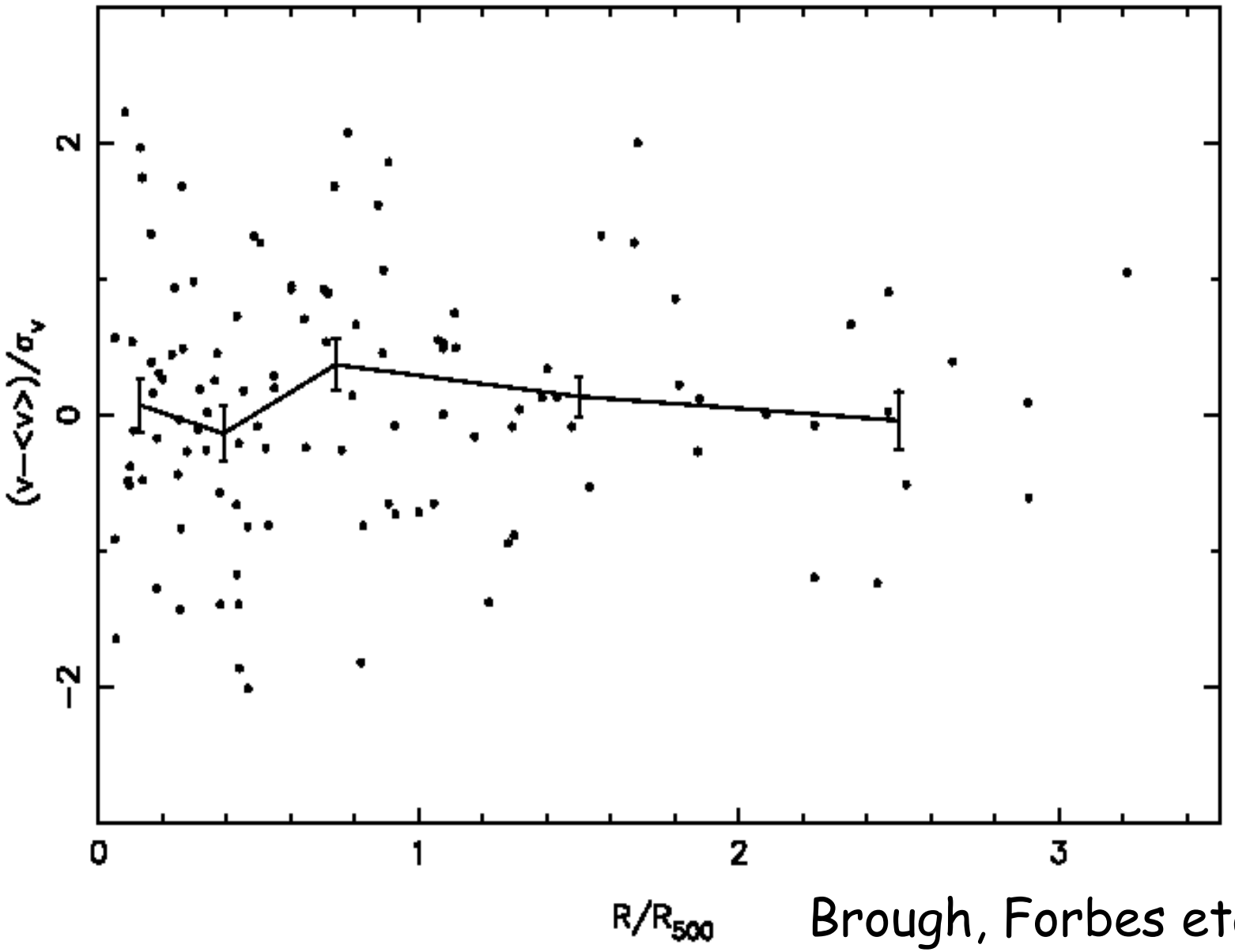
NGC 5044 group



NGC 5044 group

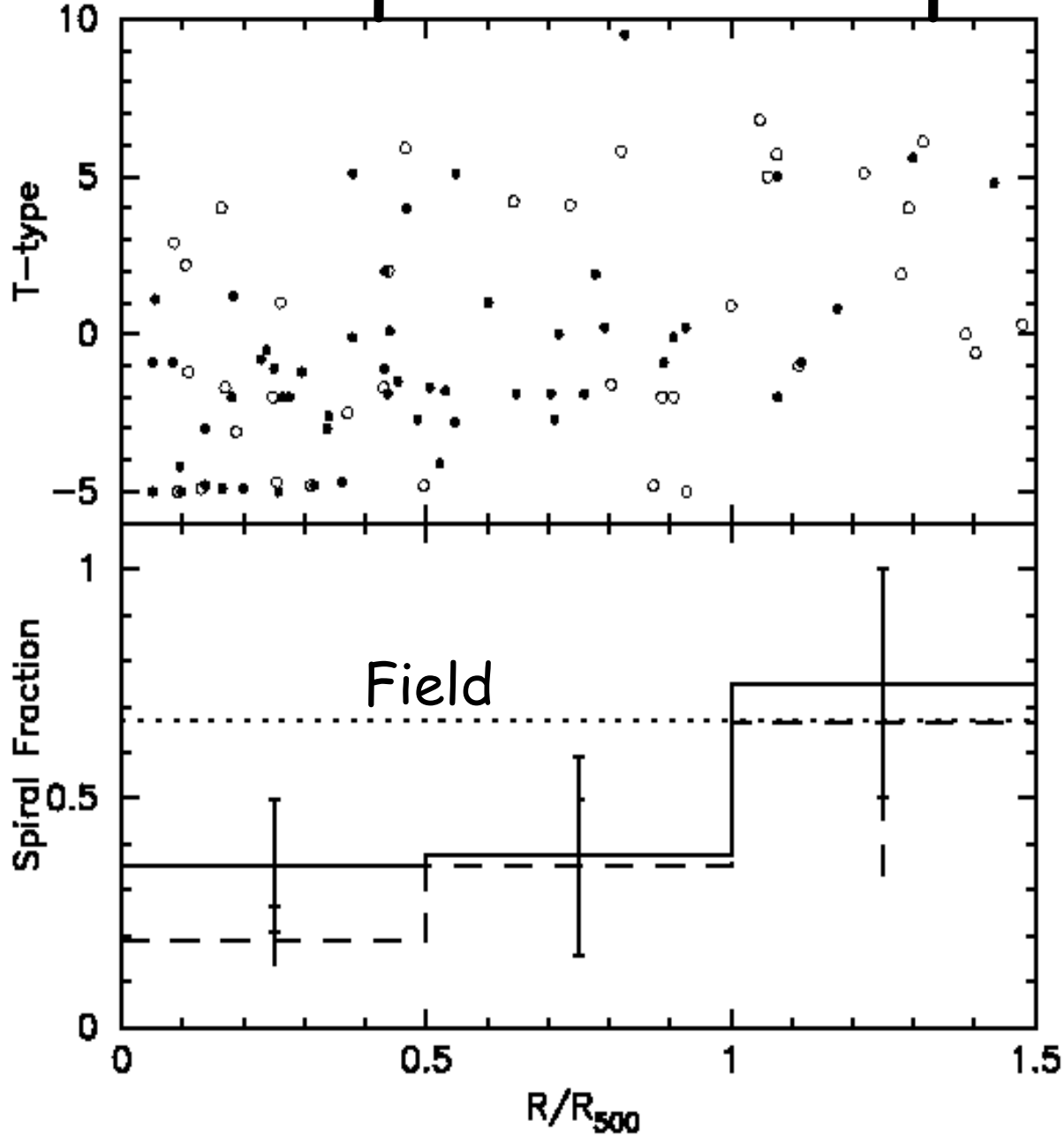


Composite Group

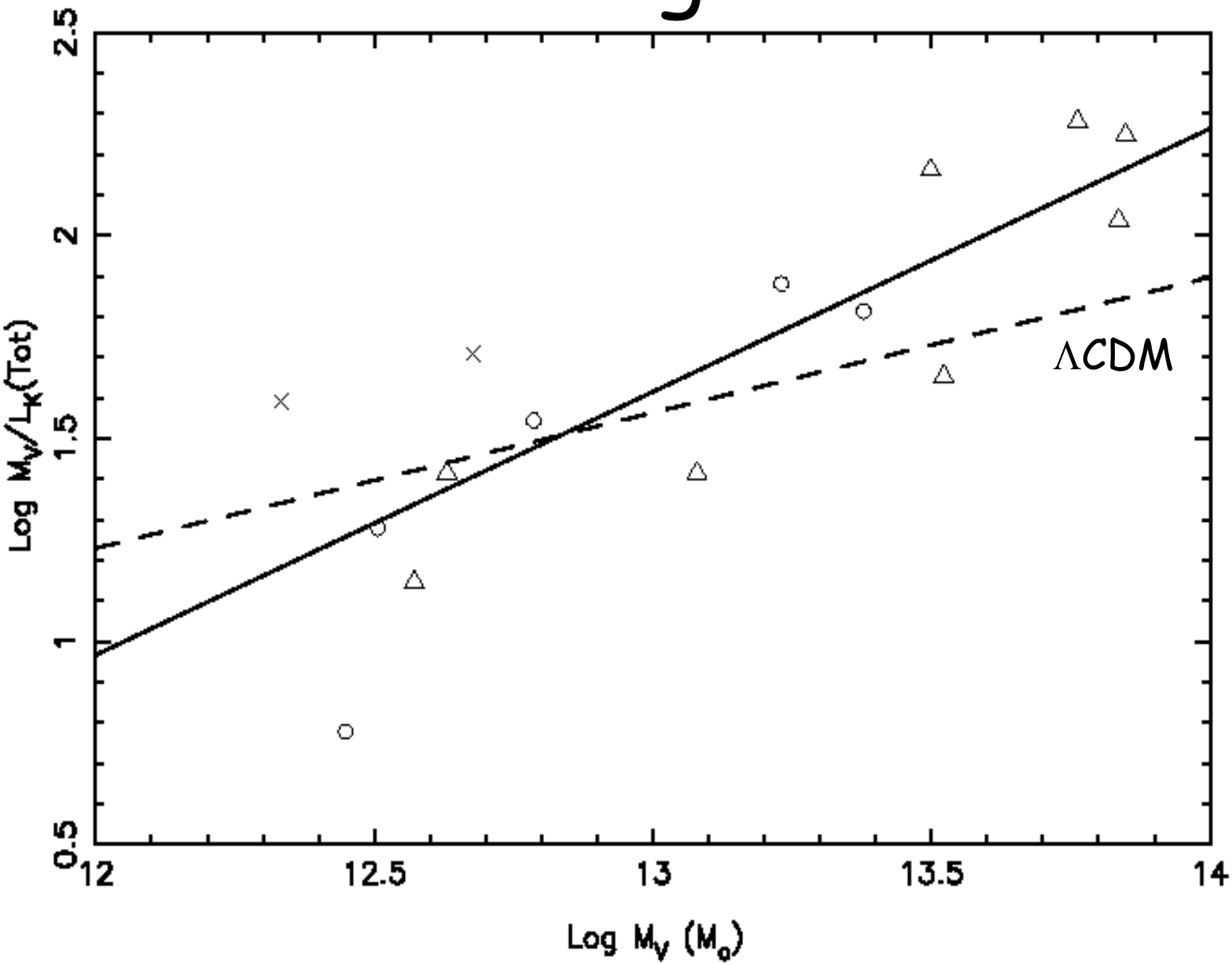


Brough, Forbes etal. 2006

Composite Group



Mass-to-light Ratios



Isolated Galaxies

- Early-type galaxy, V < 9,000 km/s, B < 14

No neighbours within:

- 700 km/s
- 0.67 Mpc in plane of the sky
- 2 B mags (factor of 6 in mass)

Formation?

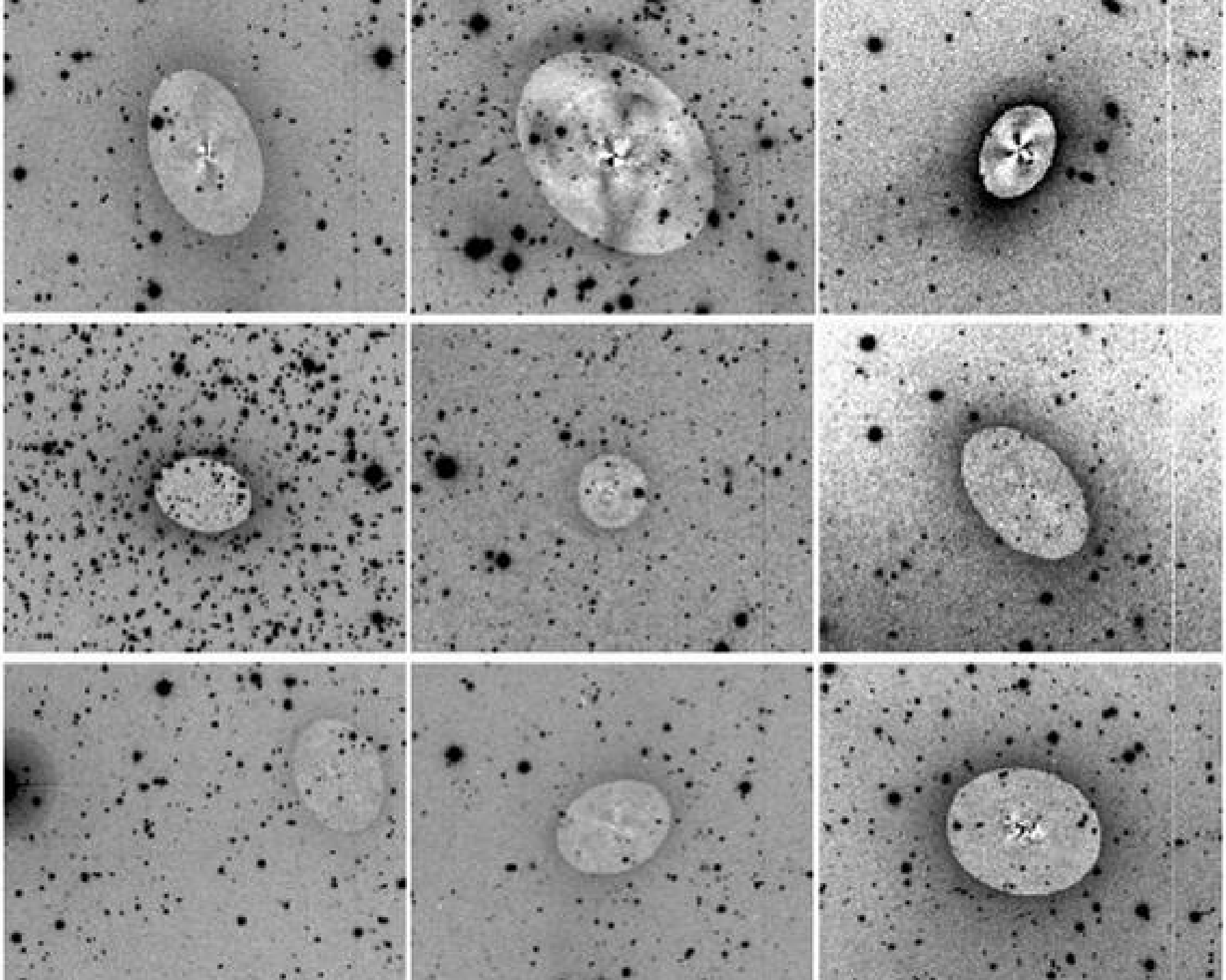
- old collapse, undisturbed since
- recent pair merger
- merged group ("fossil")

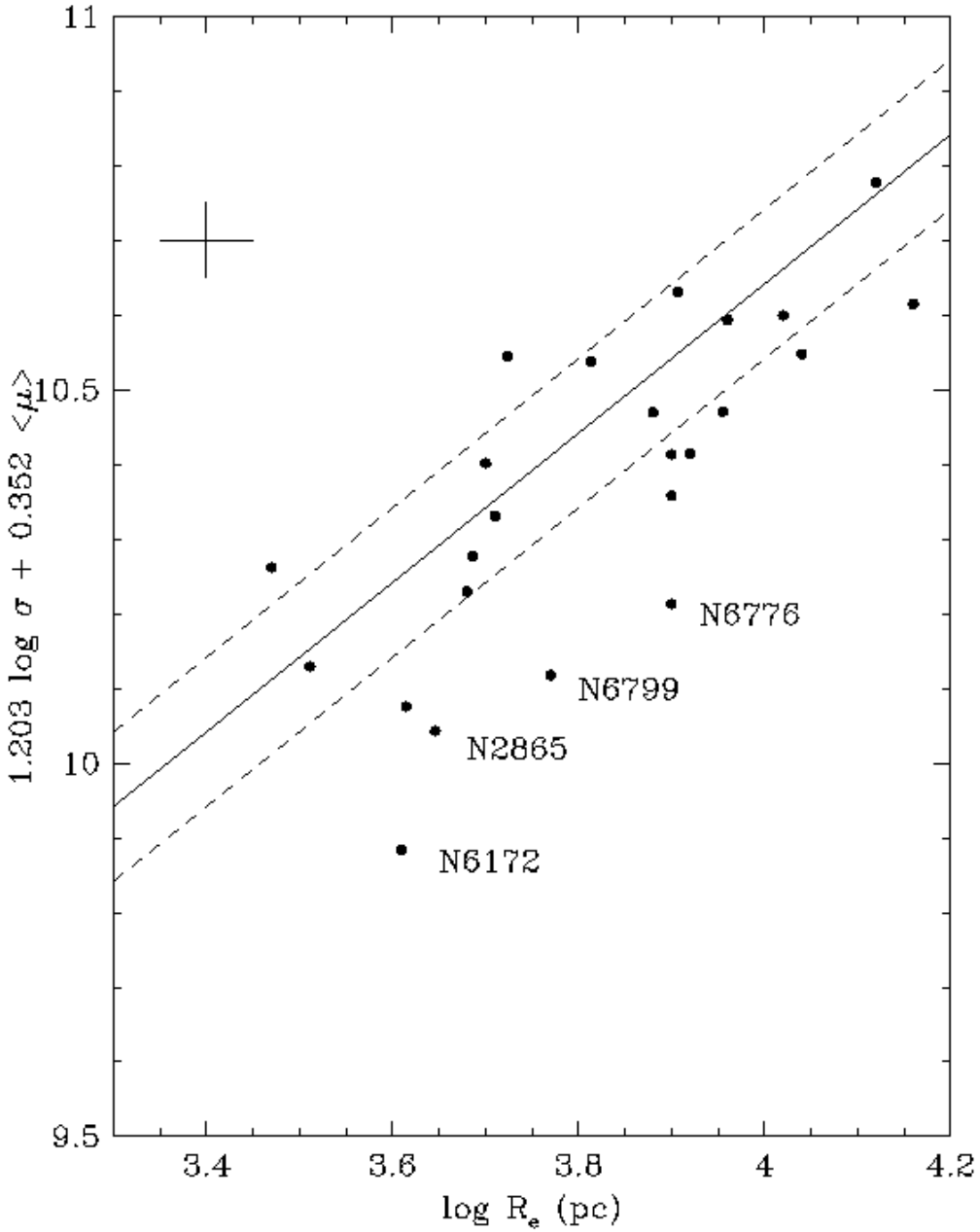
Hermits

Swinburne:
Forbes, Reda, Proctor

Harvard:
O'Sullivan

Durham:
Hau



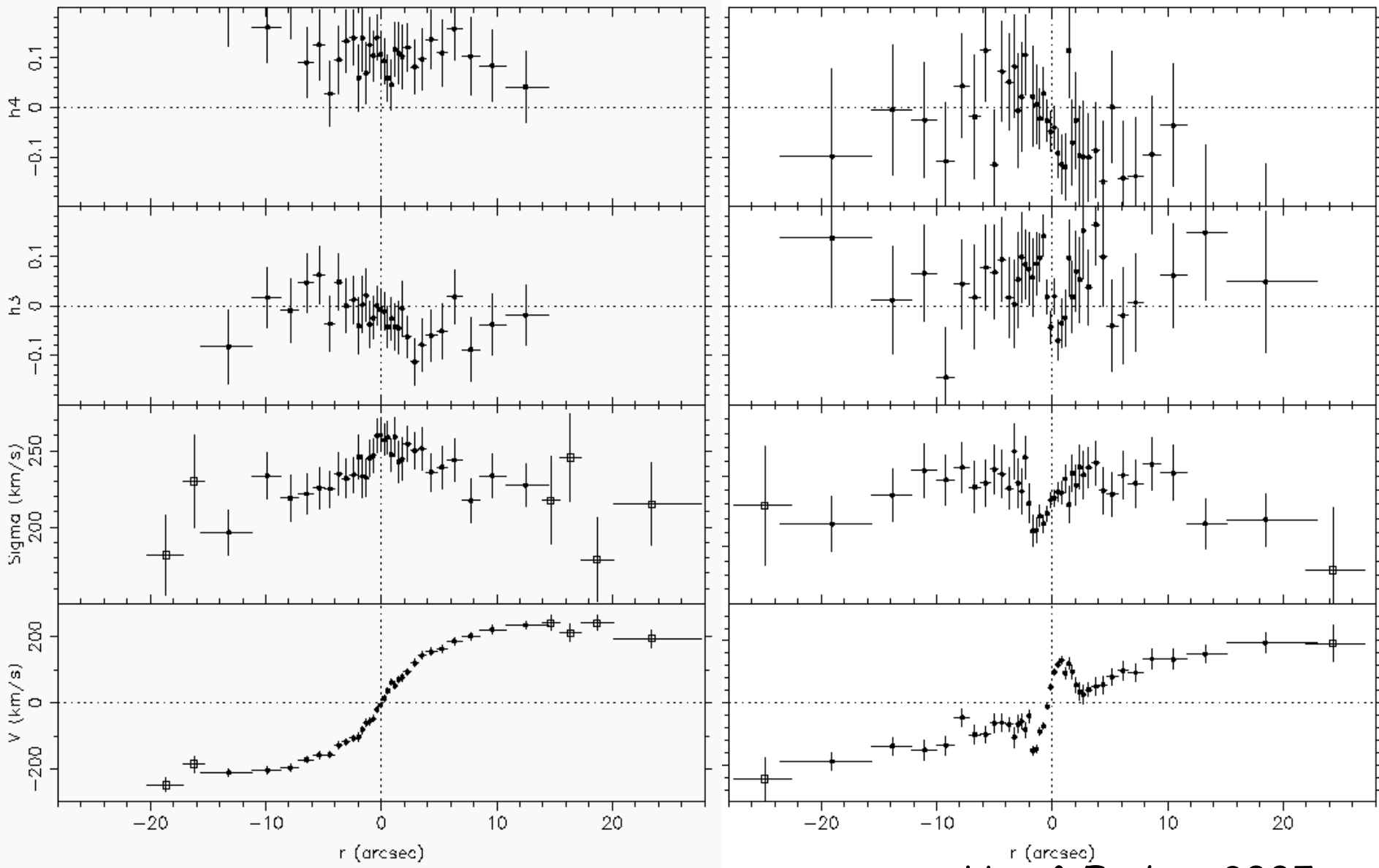


Fundamental Plane

Deviant galaxies have young stellar populations and/or disturbed morphology

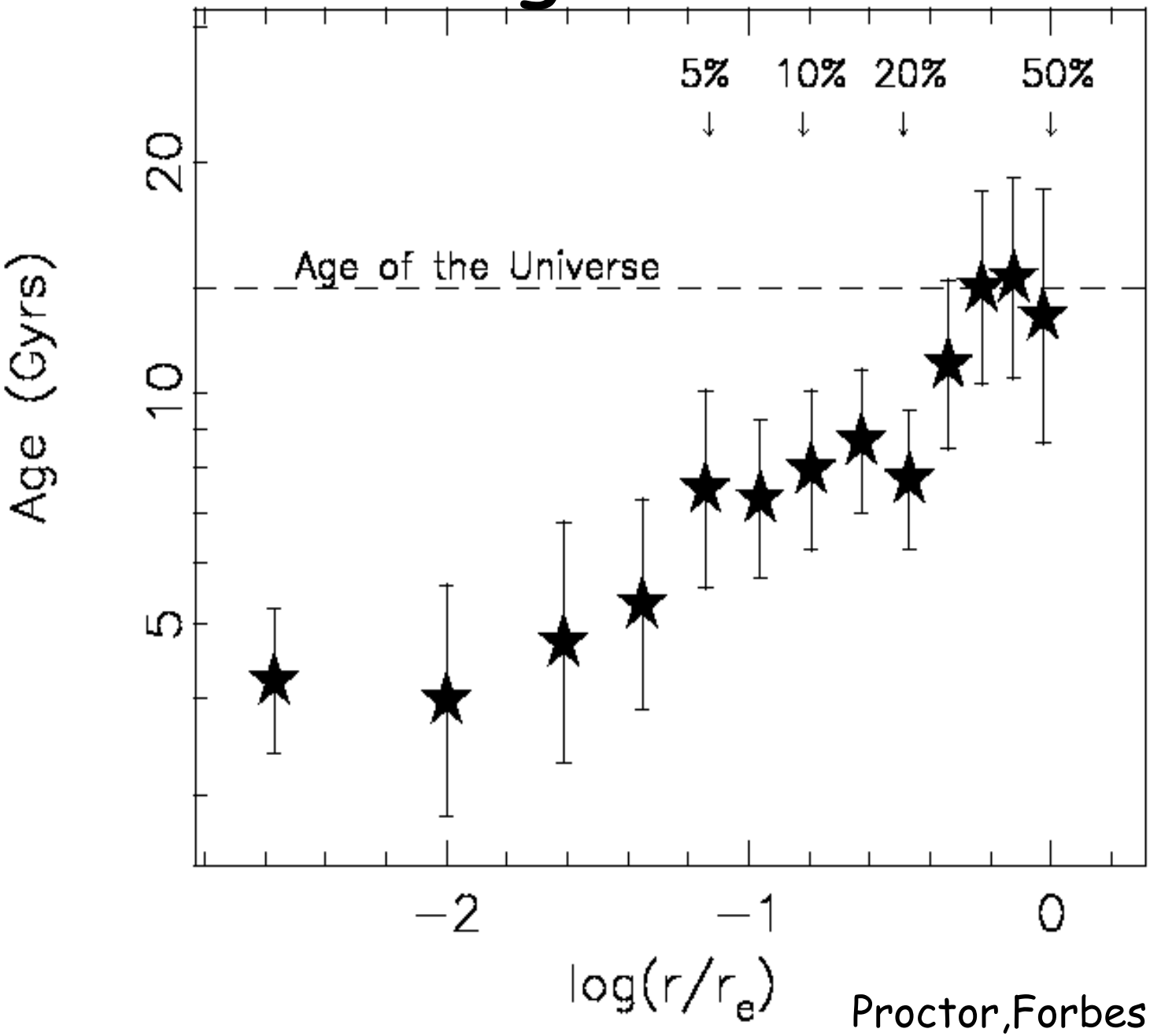
Reda, Forbes & Hau 2005

Radial Kinematics



Hau & Forbes 2005

Radial Ages - NGC 821



Proctor,Forbes etal. 2005

Collapsed Groups ?

- Typical isolated galaxy
- M_B = -20.5, L_X/L_B = 30

- One potential collapsed group:

NGC 1132

M_B = -22.0, log L_X = 43.0 erg/s, L_X/L_B = 32

ΔM_{12} = 2.2, featureless morphology,

old stellar population

Conclusions

- X-ray halos not stripped away
- No large population of `missing' galaxies
- Lots of dark matter at large radii
- Filament galaxies beyond R_{virial} have similar V and σ to group galaxies
- Galaxies beyond R_{virial} have field-like morphologies
- Most isolated ellipticals obey scaling relations, and are not collapsed groups