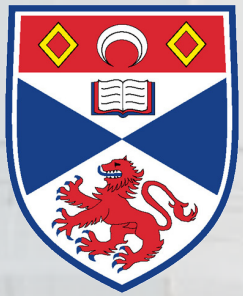
The GAMA Multi-Wavelength Survey: The Stellar-Mass Halo-Mass Paradigm

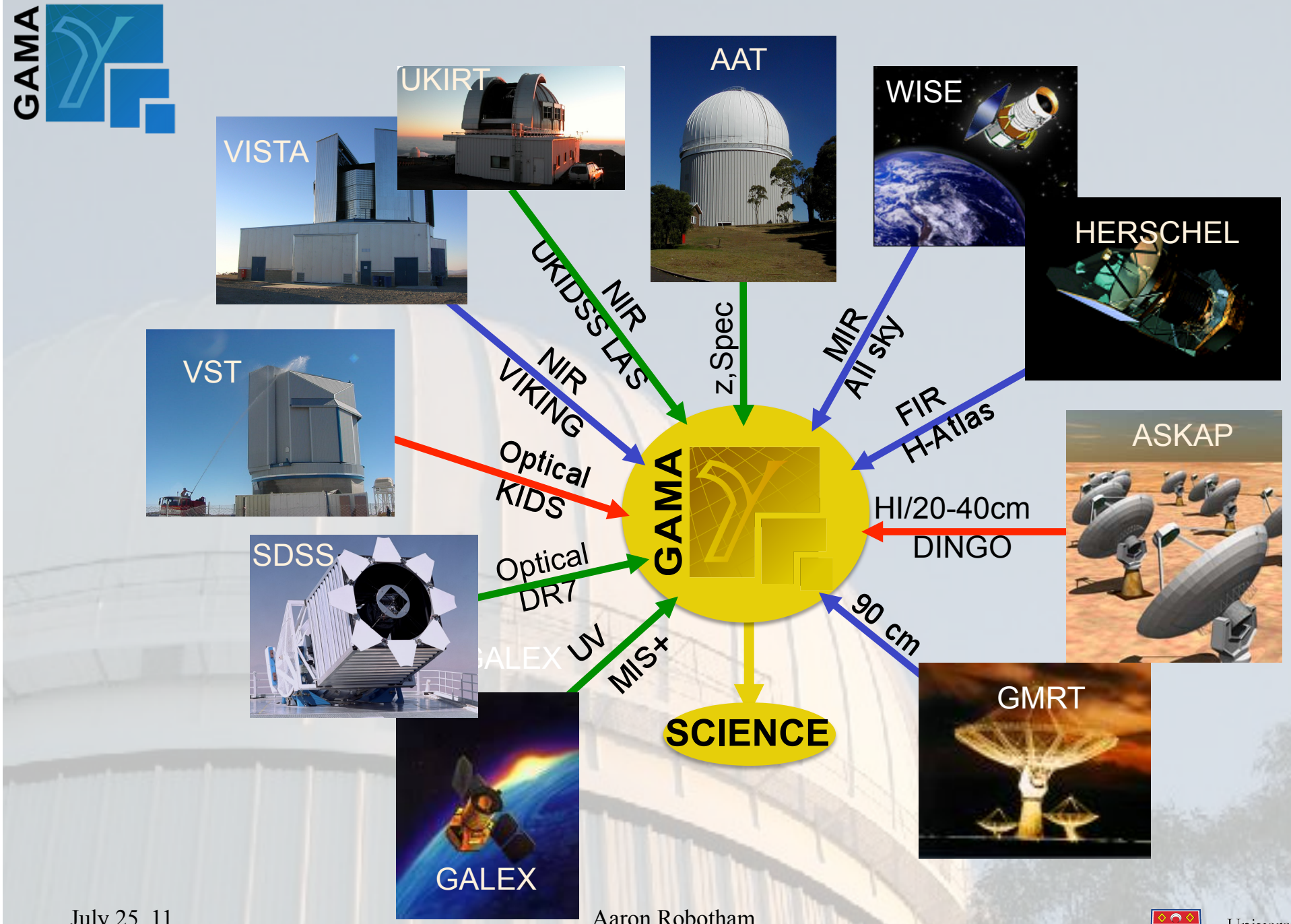


Aaron Robotham
University of St Andrews
&
The GAMA Team

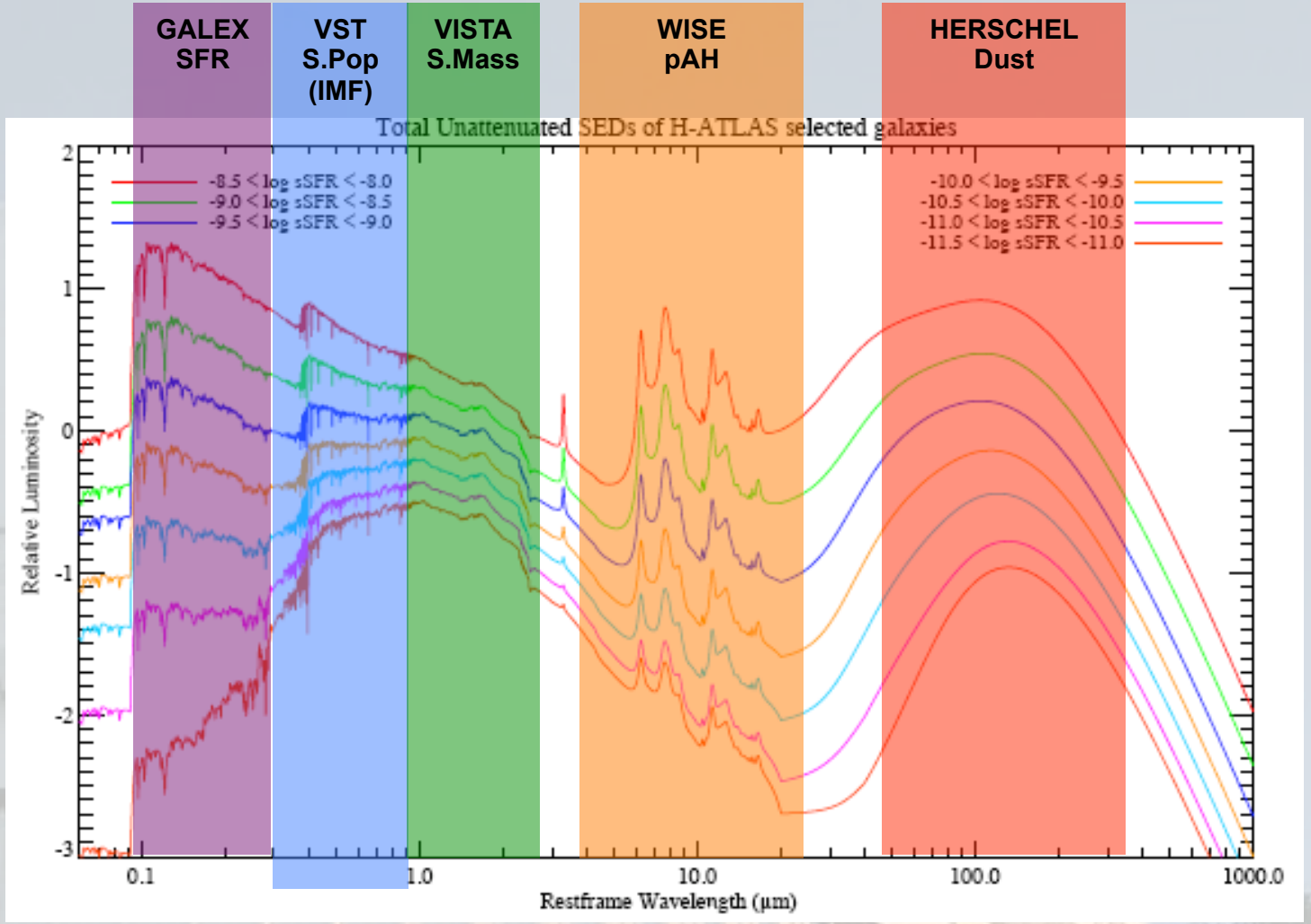
The GAMA Team

GAMA I (II) Outline

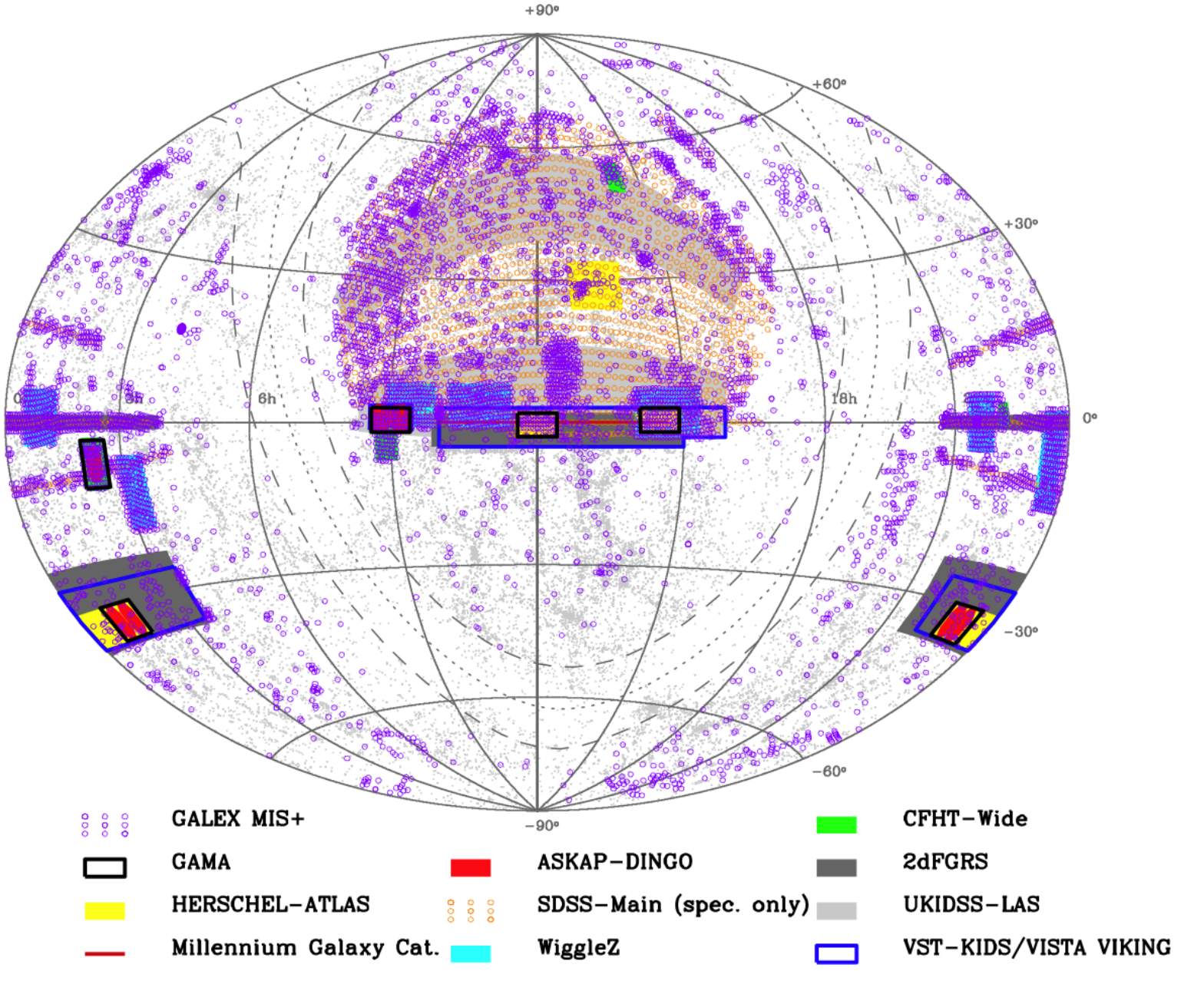
- An r-band selected redshift survey:
  - Three (Six) regions each ~ 4x12 deg (5x12 deg)
  - ~1000 targets per sq deg (2dFGRS~120, SDSS~70) ~8 tiles per unit area
  - Testing CDM via HMF, merger rates, and SFE
  - Total allocation 66 (178) nights
- A multi-wavelength study of galaxies:
  - FUV,NUV,ugrizYJHK,mid-IR,far-IR,20cm,21cm,1m (AGN, stars, gas, dust)
  - 1kpc resolution in ugrizYJHK to z<0.1 (structural analysis)
  - Robust halo masses (internal/external environmental markers)
  - Estimated data value A$55 million
- GAMA Team now includes >50 scientist across >30 institutions.


GAMA
UKIRT
AAT
WISE
VISTA
HERSCHEL
UKIDSS LAS
NIR
z,Spec
MIR
All sky
VST
NIR
VIKING
FIR
H-Atlas
Optical
KIDS
ASKAP
GAMA
HI/20-40cm
DINGO
SDSS
Optical
DR7
90 cm
GALEX
UV
MIS+
SCIENCE
GMRT
GALEX

Why do we need all this photometry?



Smith et al (2011)


+90°
+60°
+30°
0°
−30°
−60°
−90°
0h
3h
6h
18h
GALEX MIS+
GAMA
HERSCHEL−ATLAS
Millennium Galaxy Cat.
ASKAP−DINGO
SDSS−Main (spec. only)
WiggleZ
CFHT−Wide
2dFGRS
UKIDSS−LAS
VST−KIDS/VISTA VIKING

Why do we need all this spectroscopy?

Photo-z versus spectro-z

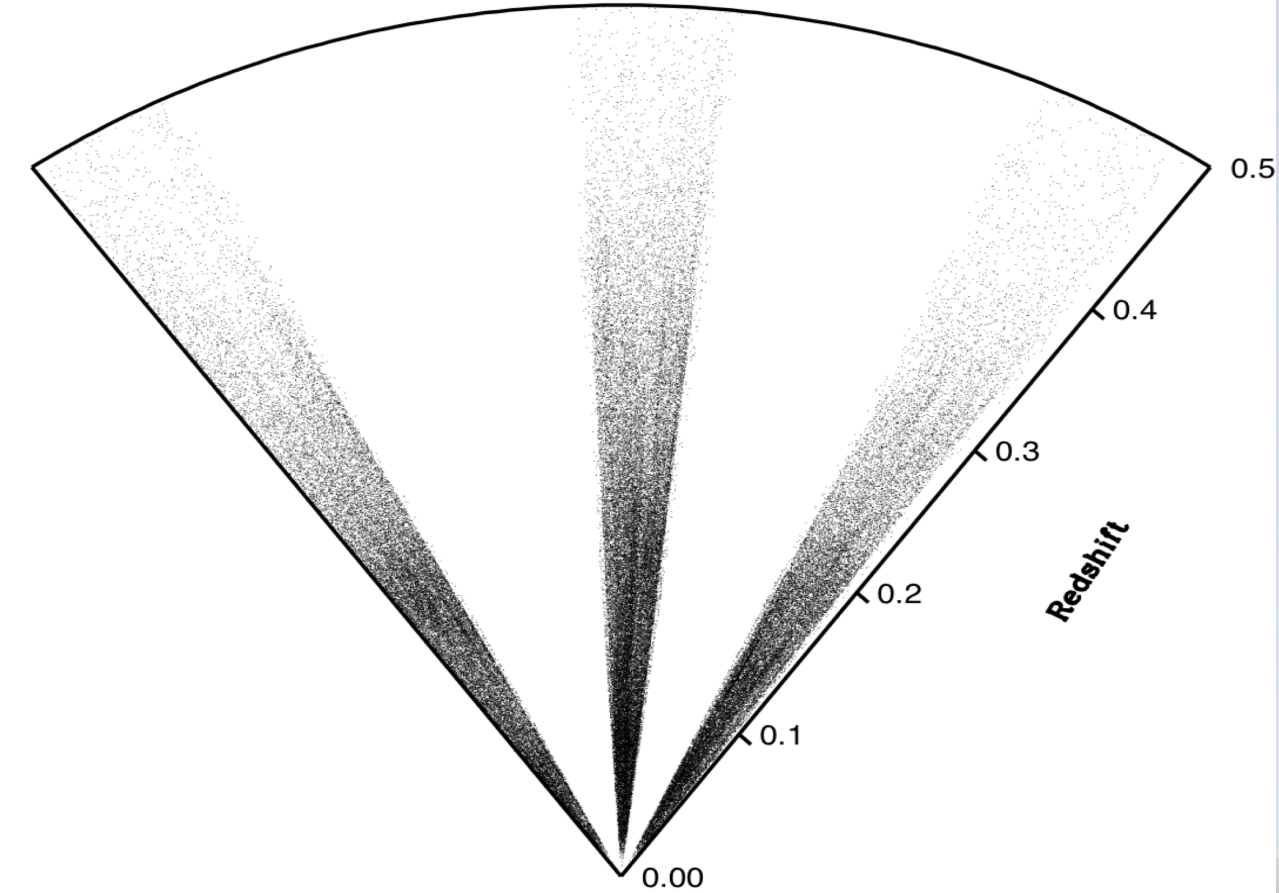


Photo-z credit:
Hannah Parkinson

Why do we need all this spectroscopy?

Photo-z versus spectro-z

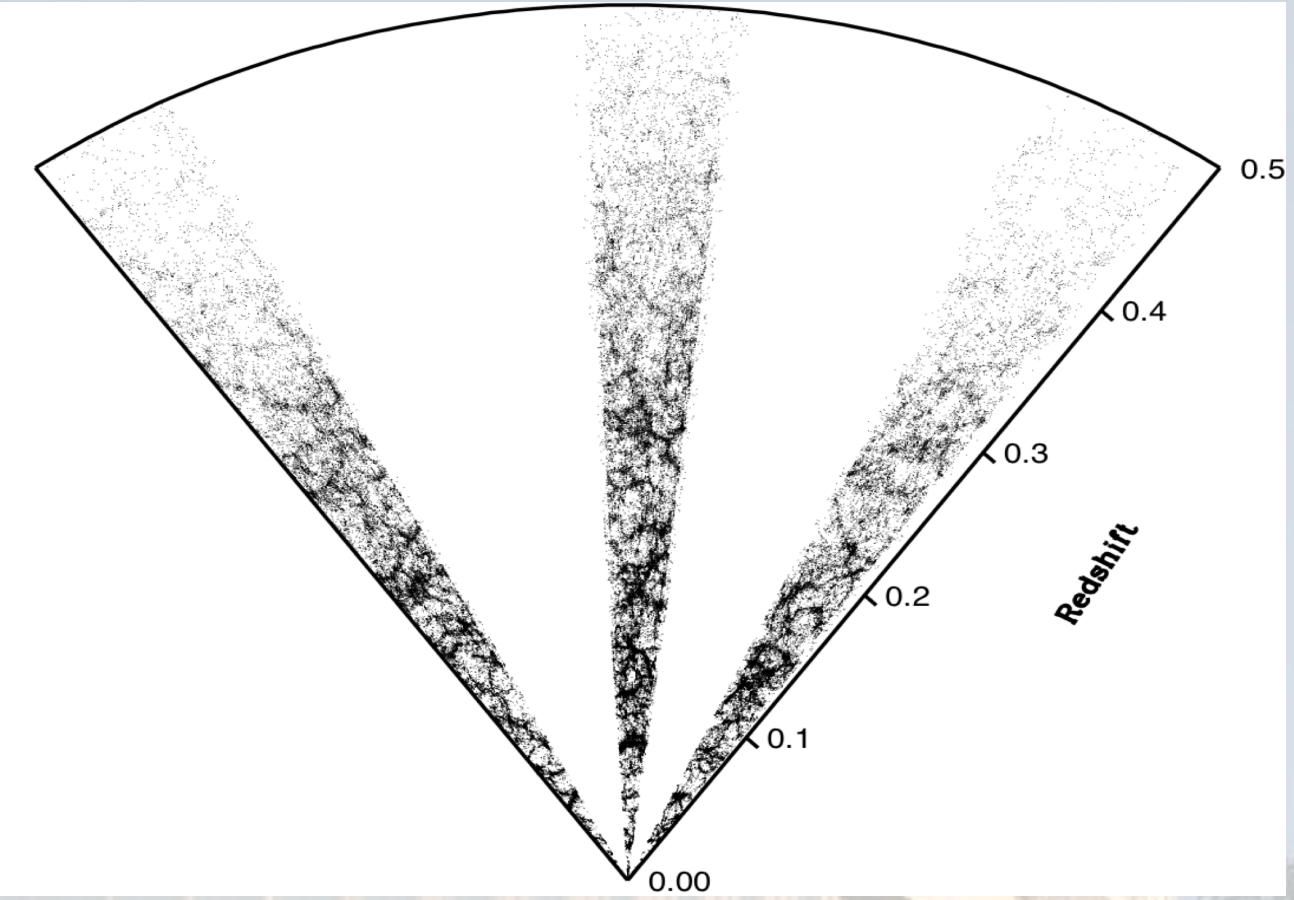


Photo-z credit:
Hannah Parkinson

GAMA Galaxy Group Catalogue Alias: G^{3}C (Robotham et al. 2011)

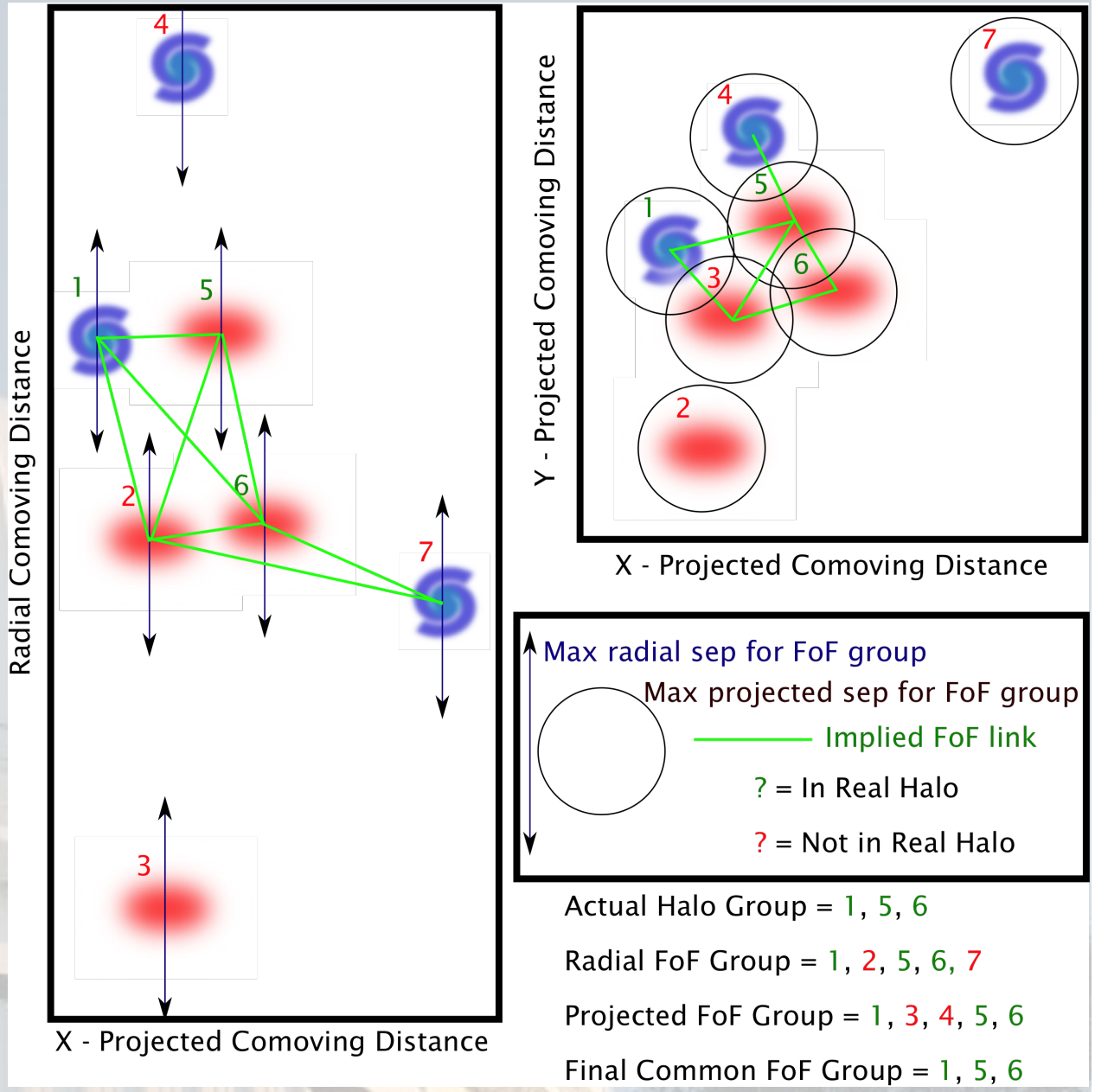
- Tried various implementations of FoF and halo based grouping

- FoF: - Links built between individual galaxies
  - Groups built from finding common links

- Halo: - Cores of groups found by constructing the voronoi tessellation
  - Scale core membership to define group extent

- FoF grouping much more flexible and successful when tested against mocks, used as the basis of the final group catalogue algorithm.

- At the simplest level we:
  - Calculate the GAMA luminosity function (LF).
  - Require that galaxies are significantly linked when they are locally overdense.
  - Do this separately radially and in projection.
  - We then construct groups out of common linking.



Robotham et al. 2011
MNRAS in press

Some technical points…

• To create meaningful group catalogues we need to understand the biases expected by choosing different approaches to grouping

• Solution is to test on mock catalogues- created by Alex Merson (Durham) and Peder Norberg (Edinburgh). This is a combination of the Millennium Simulation plus a GALFORM semi-analytic (Bower et al. 2006) galaxy formation recipe on top.

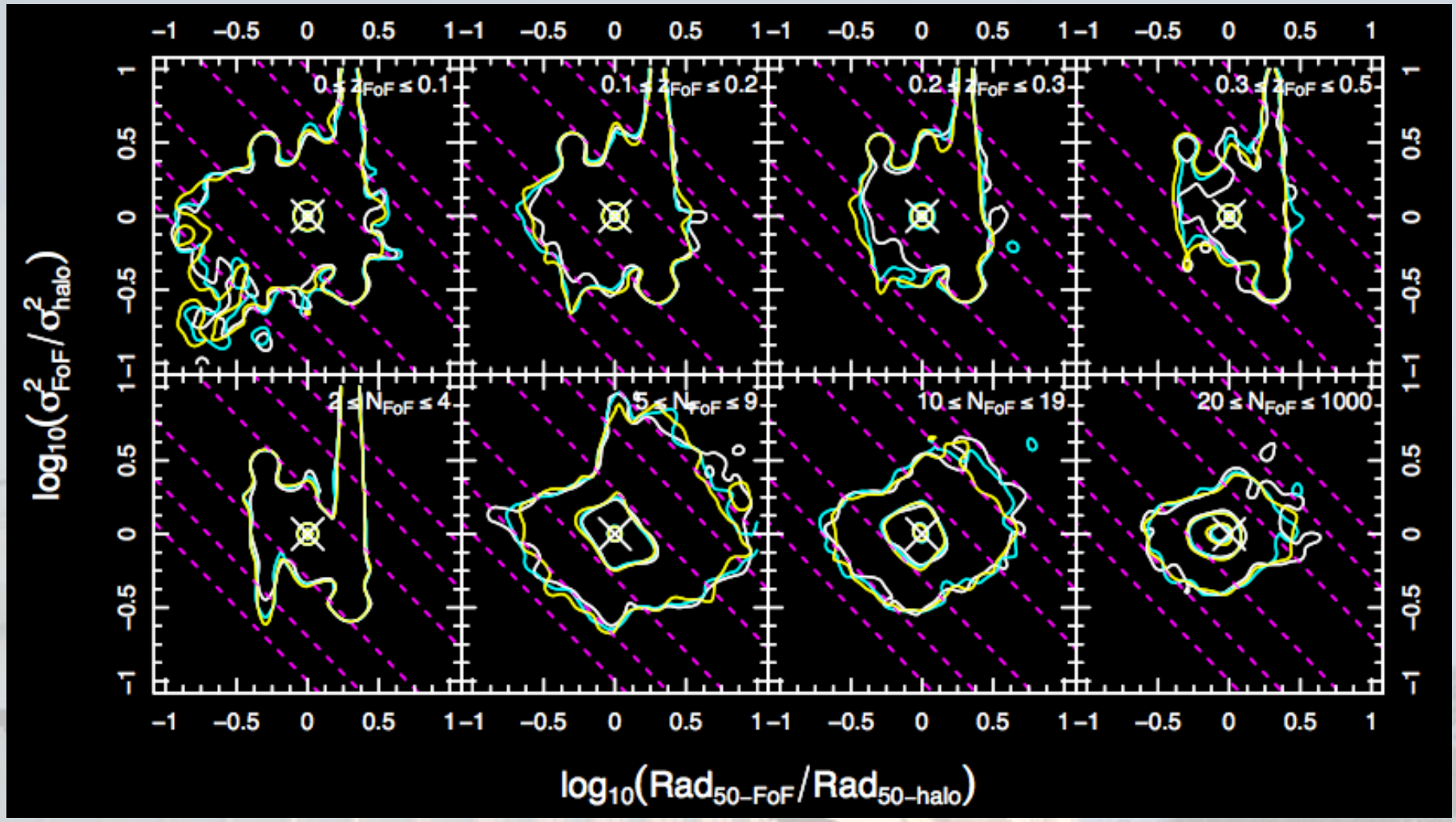
• 27 GAMA like volumes (z= 0 -> 0.5, 48 sqdeg) exist with known associations between dark matter halos and semi-analytic galaxies.

• In some sense, we need an approaching to grouping that does “the best job” at recovering correct groupings – lots to say on that subject, interested parties should read the G3C paper.

How good do we expect our groups to be?

GAMA

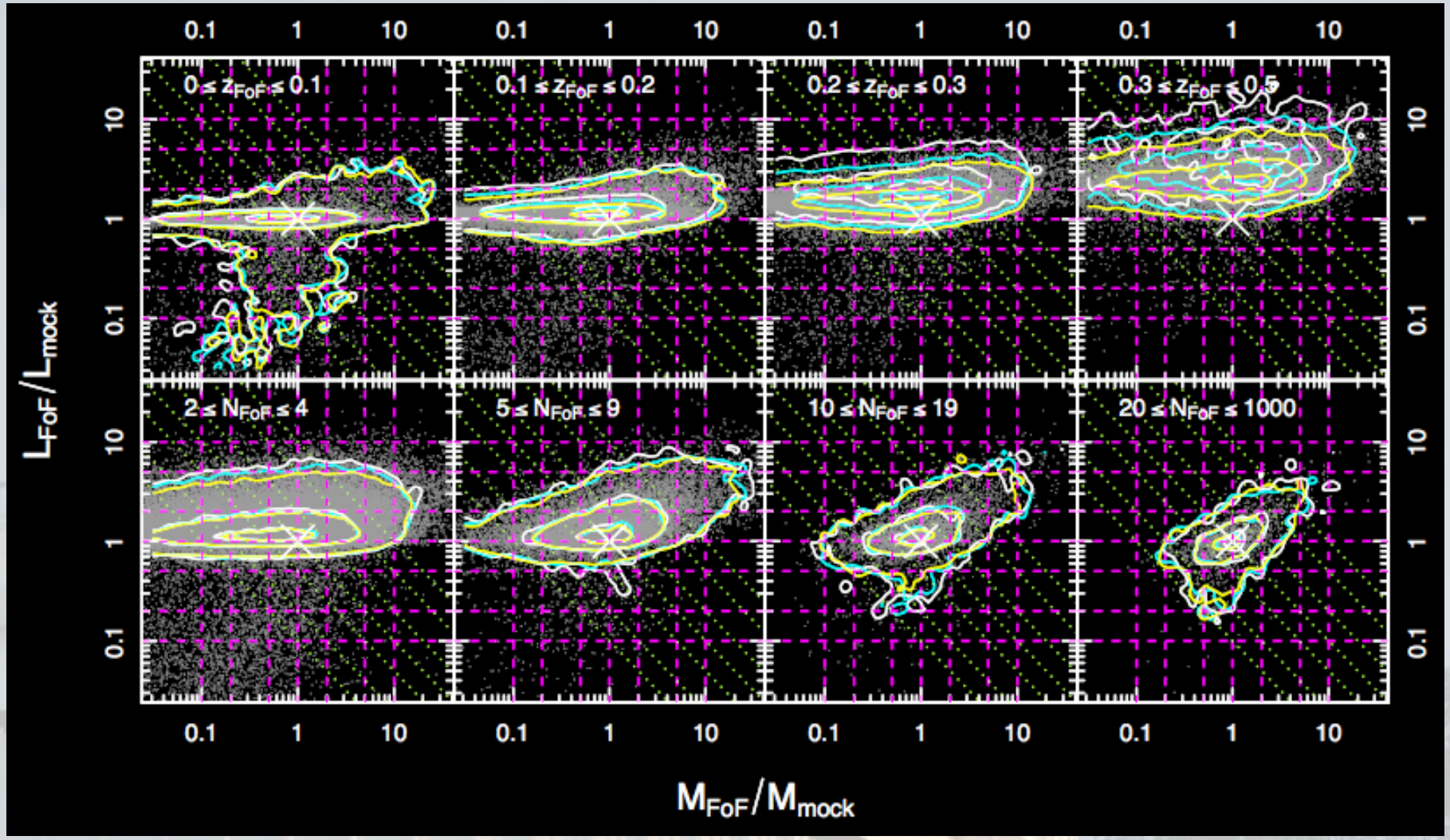
$$M \propto \sigma^2 r$$



Robotham et al. 2011
MNRAS in press

University of St Andrews

Group Dynamical Mass and Luminosity using global correction



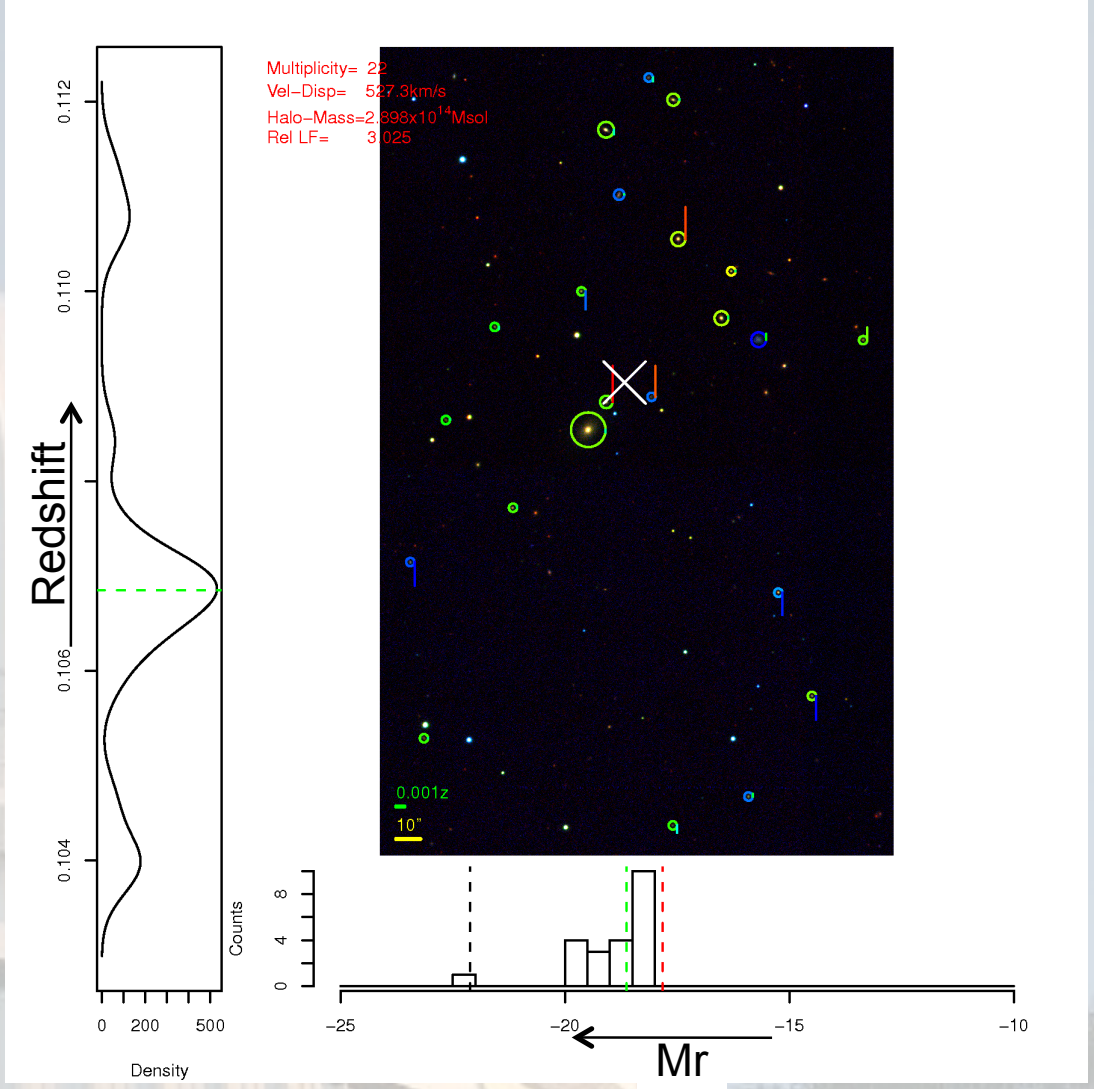
Robotham et al. 2011
MNRAS in press

Fossil Group

Z ~ 0.11

22 w. GAMA

1 pre GAMA



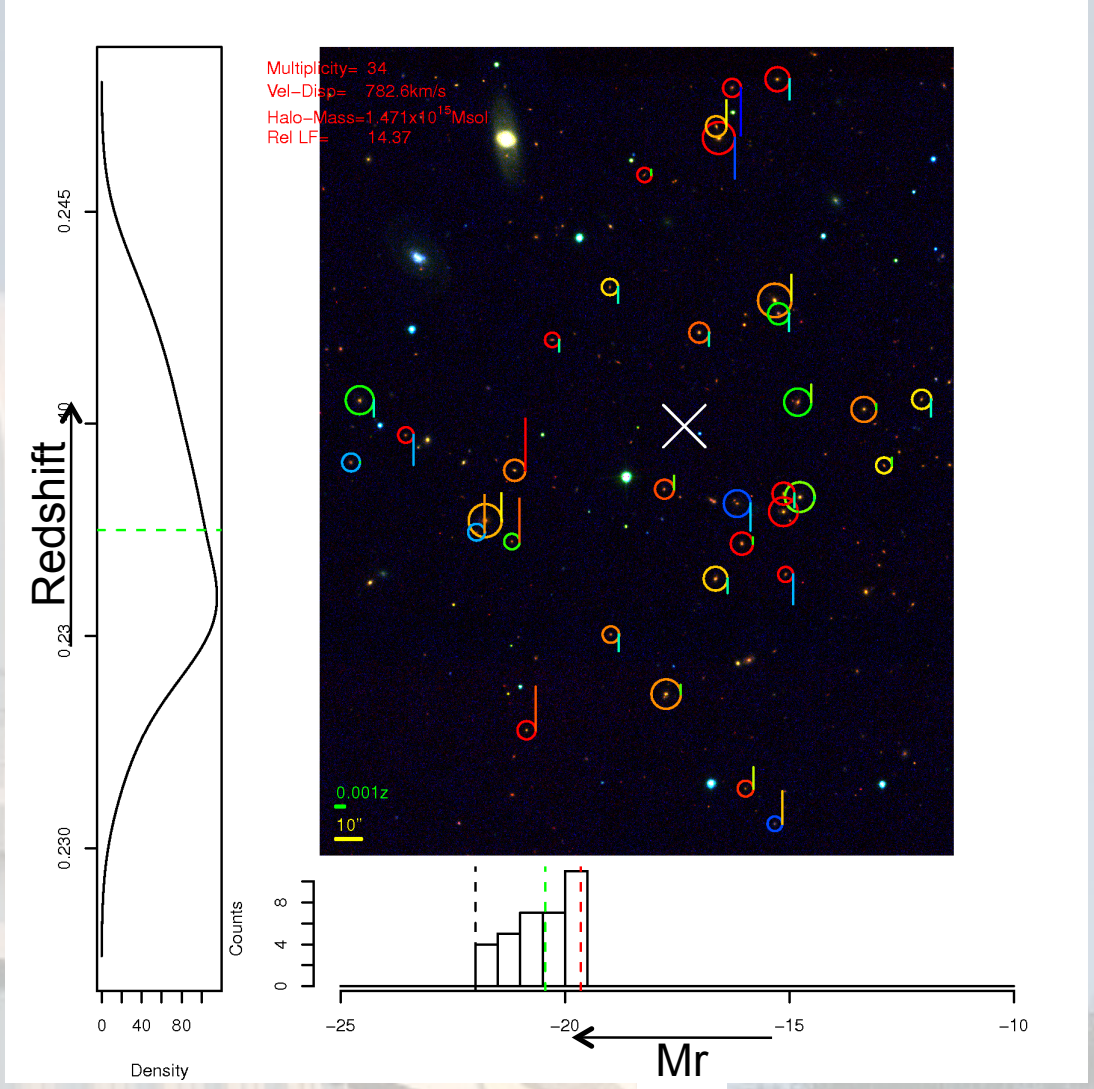
Cluster

Z ~ 0.24

34 w. GAMA

5 pre GAMA

Perfect cluster!



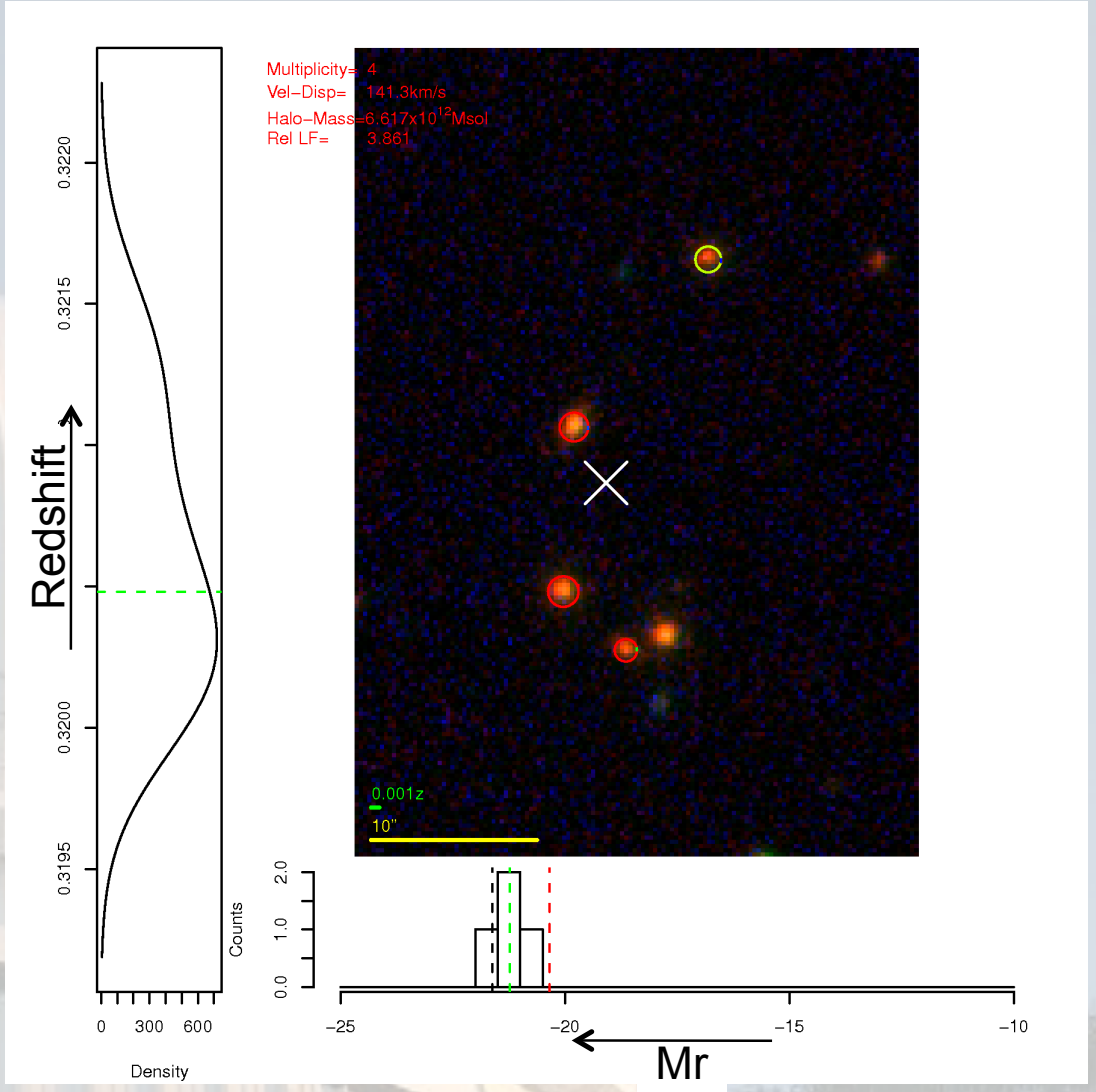
Small Group

Z ~ 0.32

4 w. GAMA

0 pre GAMA

All within 2dF fibre collision radius.



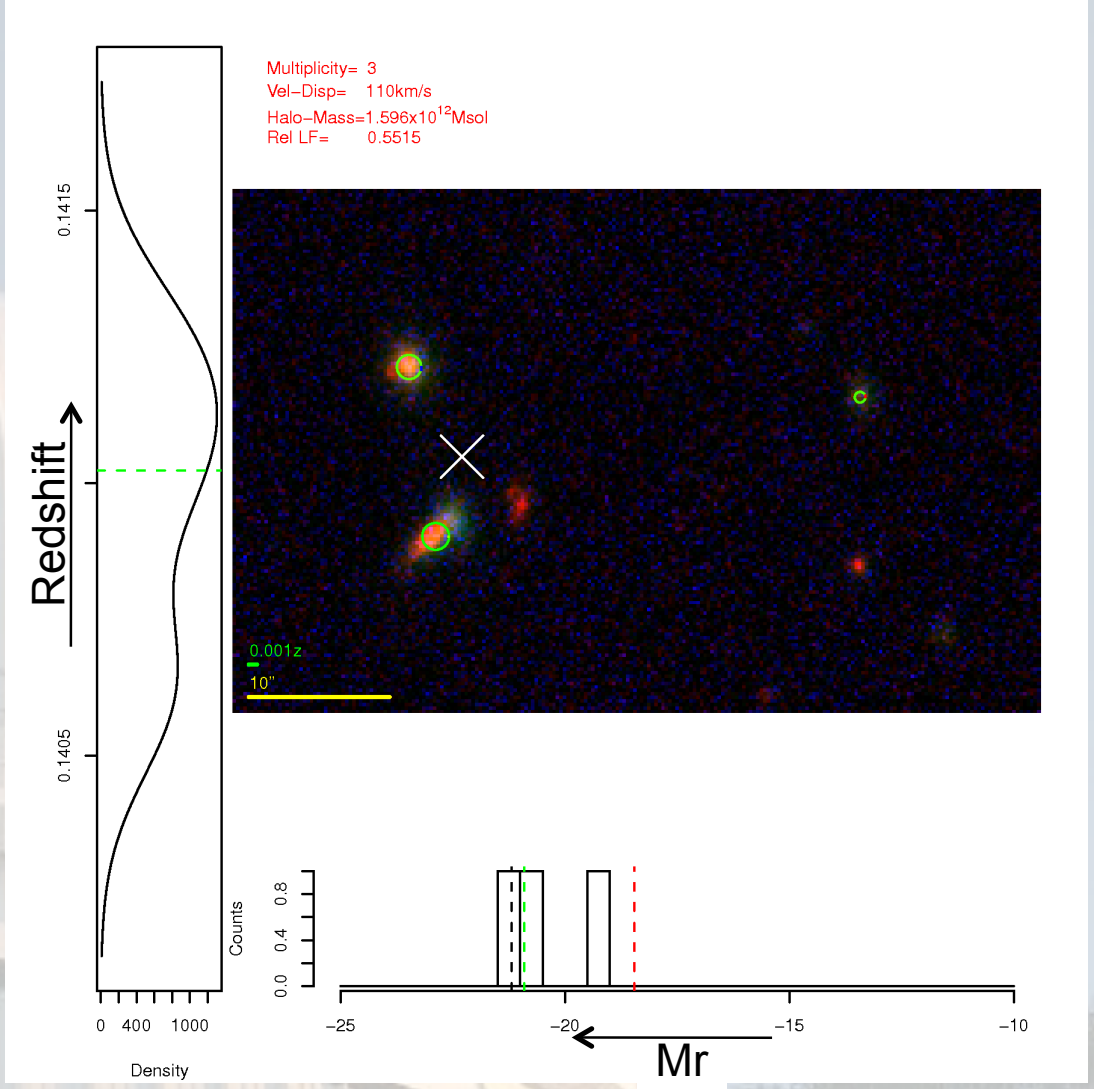
Small Group

Z ~ 0.14

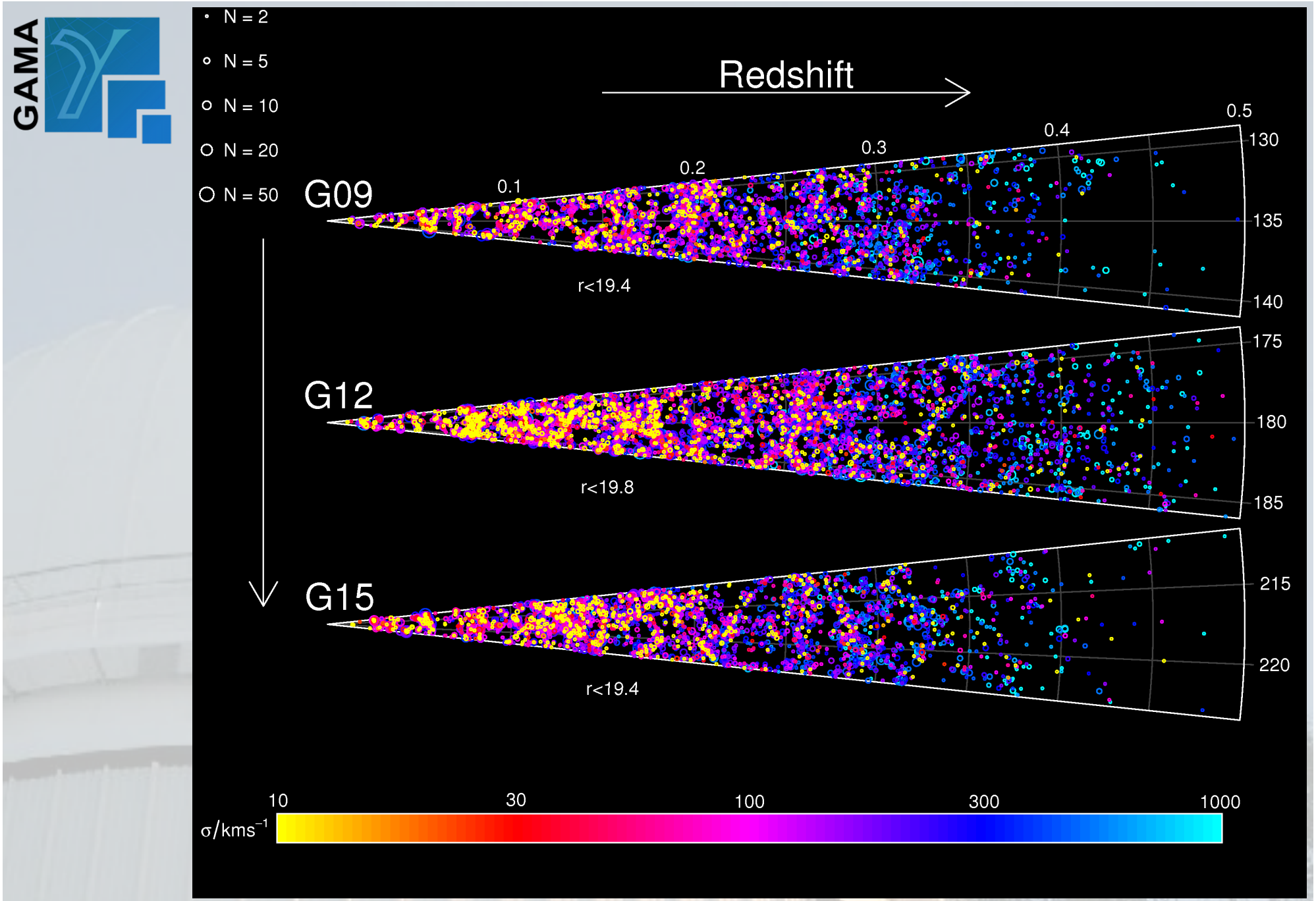
3 w. GAMA

1 pre GAMA

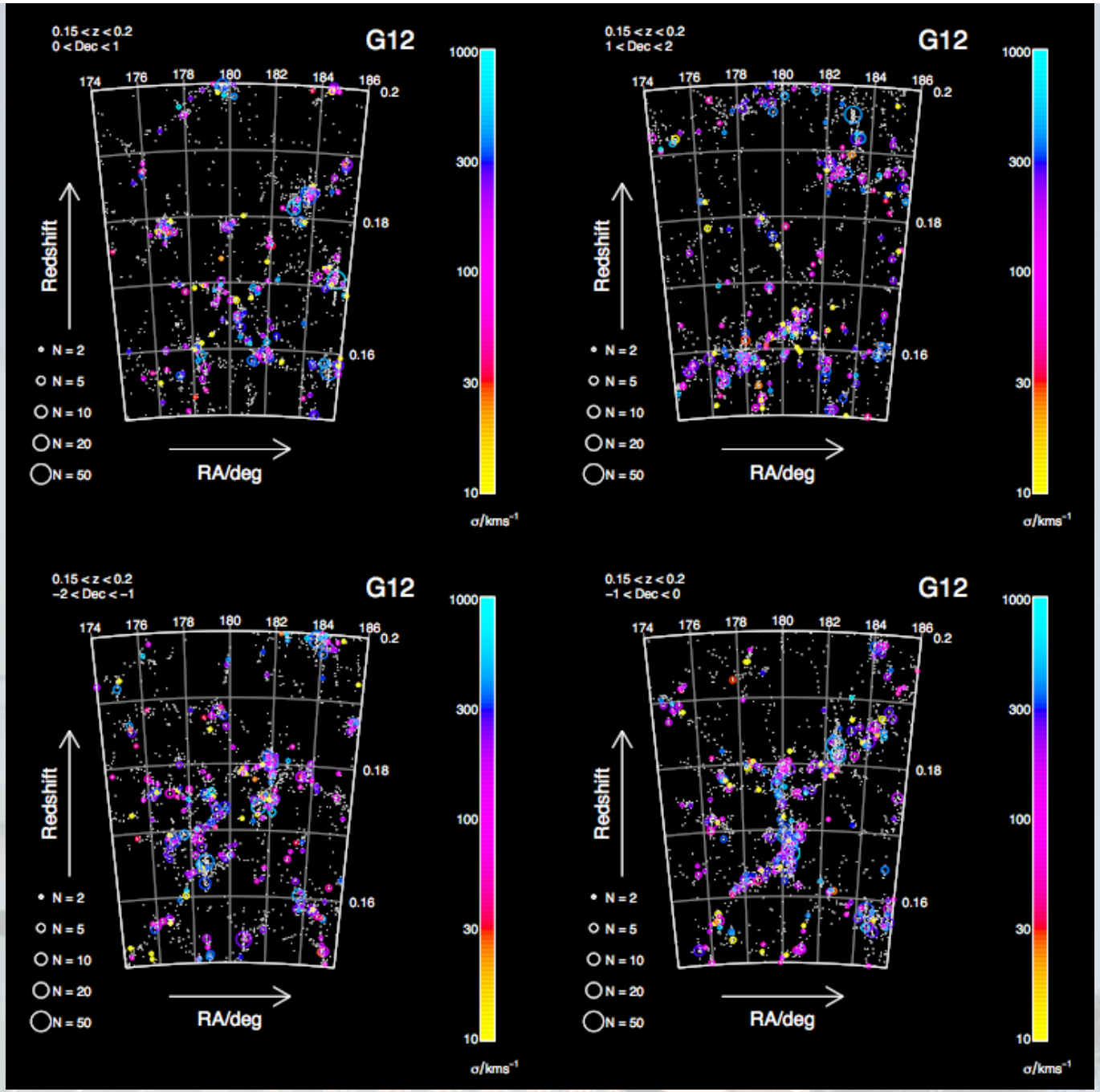
Mergers?



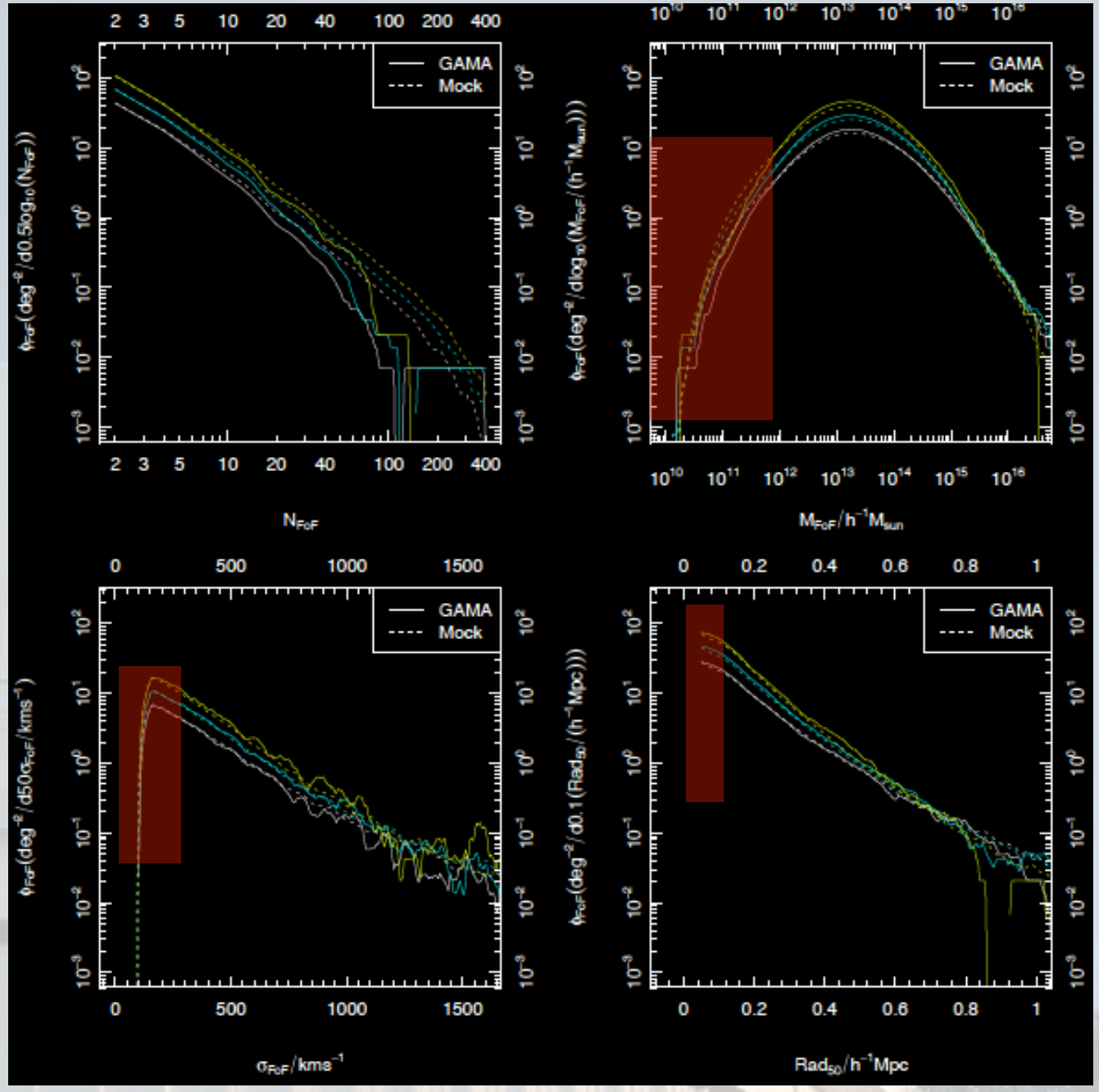
How do we do overall?



Robotham et al. 2011
MNRAS in press



Robotham et al. 2011
MNRAS in press



Robotham et al. 2011
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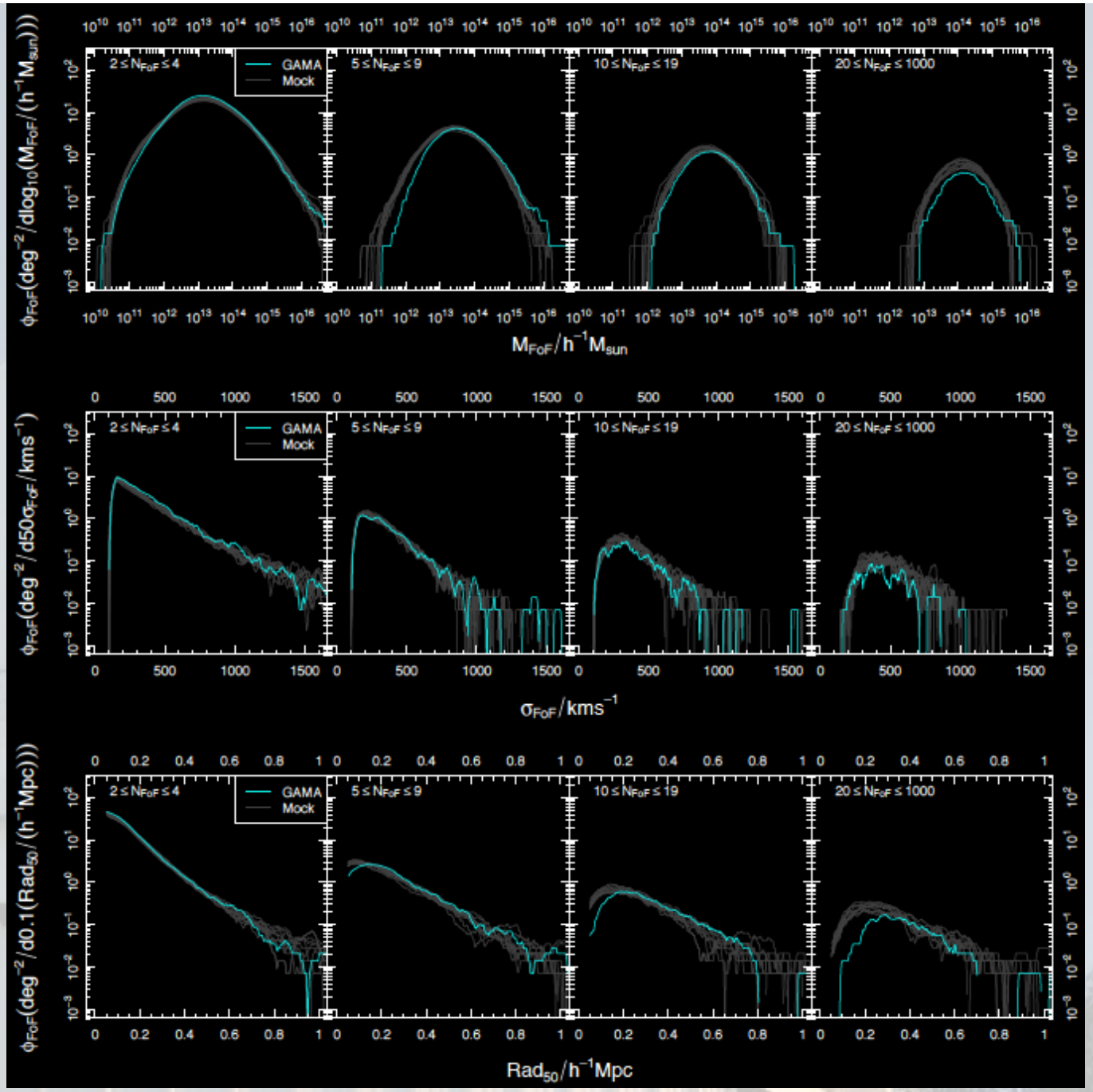
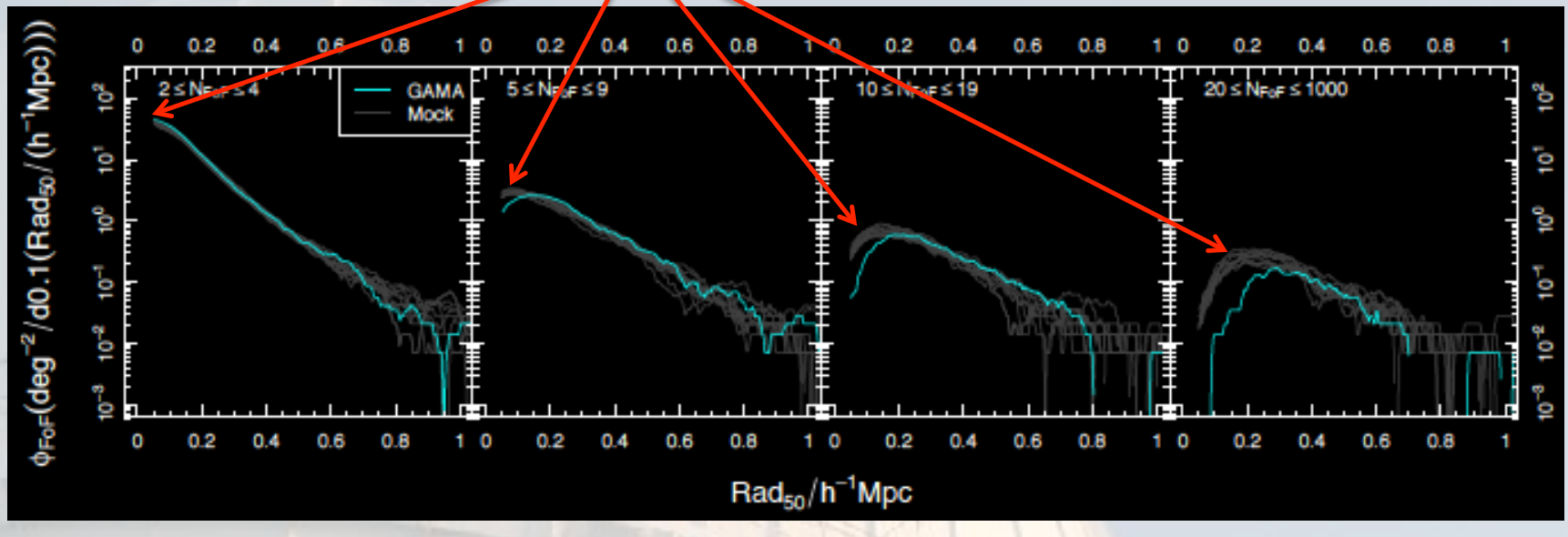


Robotham et al. 2011
MNRAS in press

So what is going on at low mass?

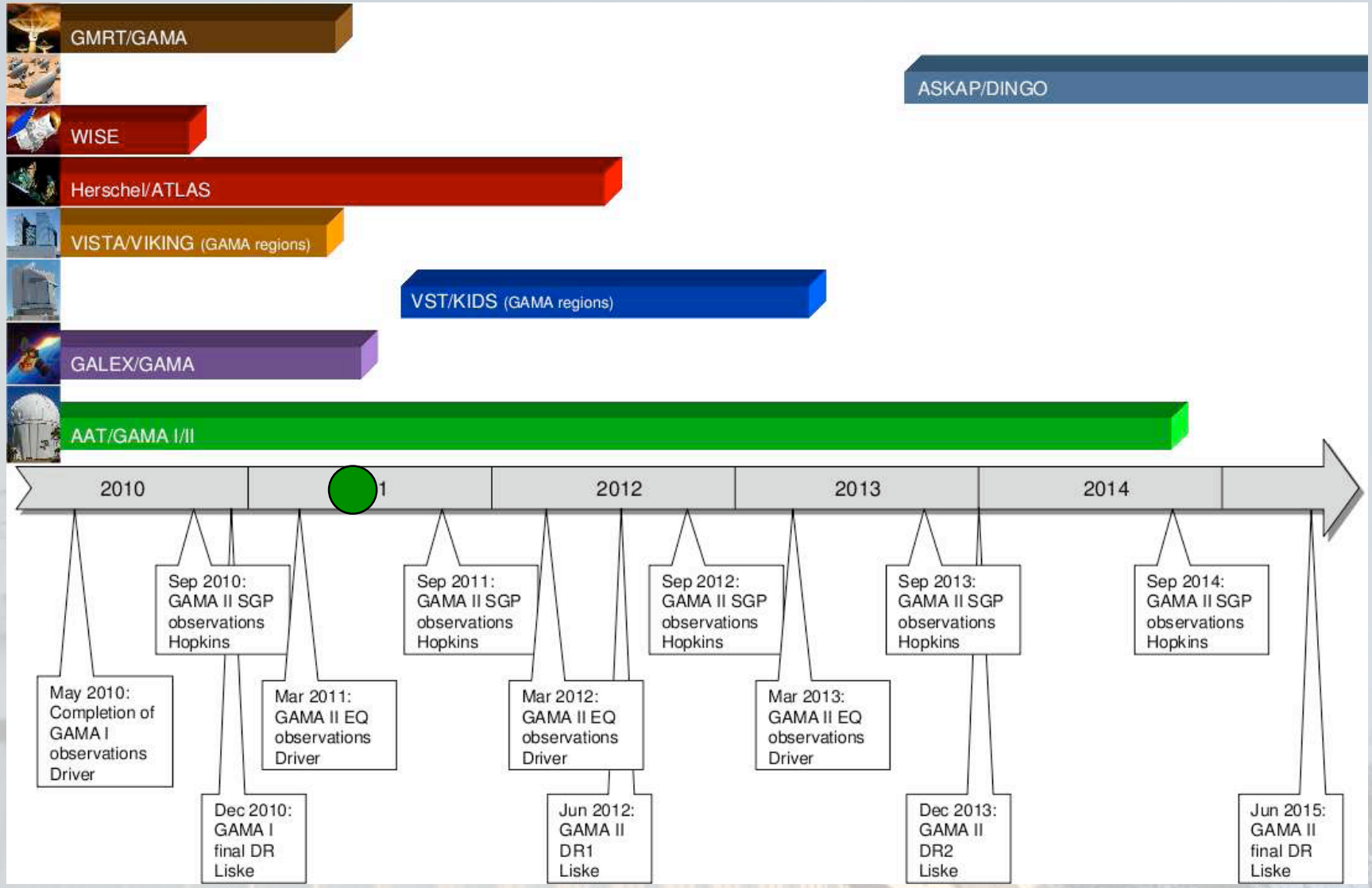
- Problem appears to be that the mocks (MS + SA) produce far too many compact groups.



- A few possibilities:
  - CDM clustering
  - Dynamical friction recipe

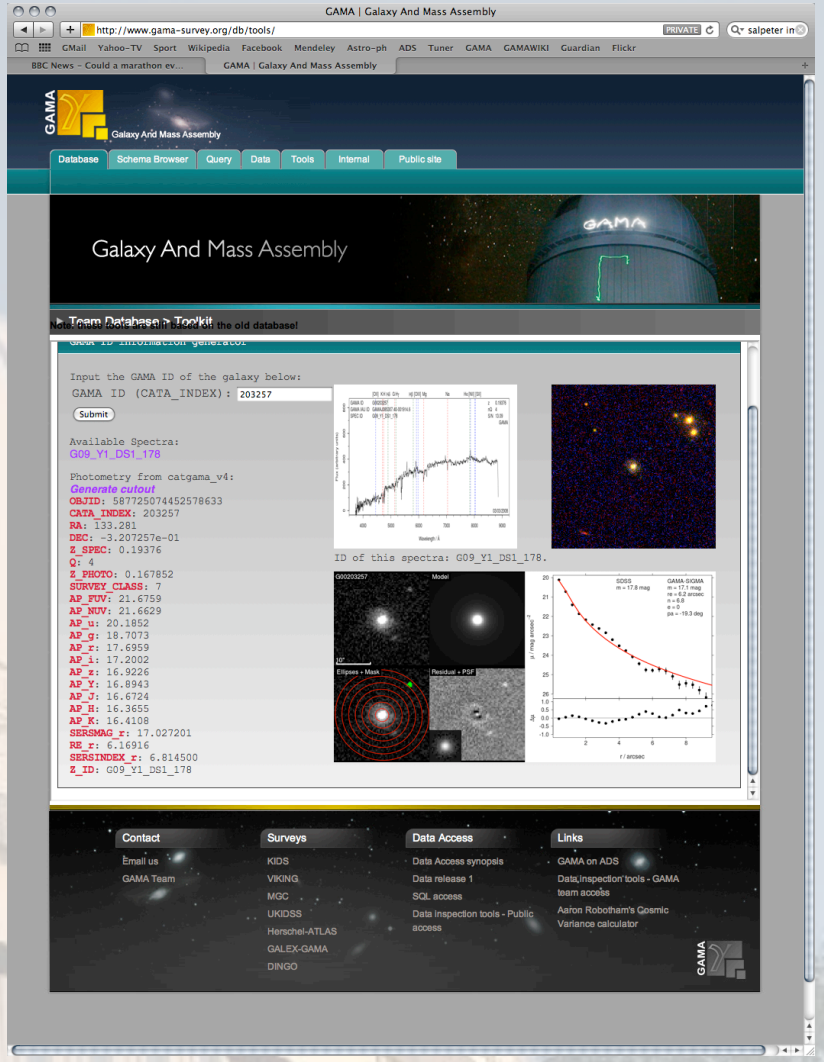
Robotham et al. 2011
MNRAS in press

What next…


GMRT/GAMA
ASKAP/DINGO
WISE
Herschel/ATLAS
VISTA/VIKING (GAMA regions)
VST/KIDS (GAMA regions)
GALEX/GAMA
AAT/GAMA I/II
2010
2012
2013
2014
May 2010: Completion of GAMA I observations Driver
Sep 2010: GAMA II SGP observations Hopkins
Dec 2010: GAMA I final DR Liske
Mar 2011: GAMA II EQ observations Driver
Sep 2011: GAMA II SGP observations Hopkins
Mar 2012: GAMA II EQ observations Driver
Jun 2012: GAMA II DR1 Liske
Sep 2012: GAMA II SGP observations Hopkins
Mar 2013: GAMA II EQ observations Driver
Sep 2013: GAMA II SGP observations Hopkins
Dec 2013: GAMA II DR2 Liske
Sep 2014: GAMA II SGP observations Hopkins
Jun 2015: GAMA II final DR Liske

GAMA Database/Website
http://www.gama-survey.org/

- GAMA website is up and running.
- It includes the first public release of data.
- We have SQL server to search catalogues.
- Other data products:
  - Spectra
  - Swarp mosaics
  - 2D profiles
  - SFR
  - Stellar Mass



Conclusions

- GAMA is offering the astronomical community the definitive low-z galaxy database.

- Phase I is complete, and many papers based on this data are about to be released.

- My work has included producing the GAMA Galaxy Group Catalogue (G^3C) see arXiv:1106.1994 (MNRAS in press).
  - We find discrepancies between the data and the MS-SA mocks. Work ongoing to discover origin.

- Now moved on to observing GAMA-II (N+S).

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