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&
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.
Why do we need all this photometry?

Smith et al (2011)
• GAMA surveys will be extremely complimentary in terms of depth.

• Large variation in term of PSF size.

• Optical-NIR have matched aperture Sextractor photometry using seeing convolved mosaics.

• Bigger task is combining GALEX (Ellen Andrae)/ H-ATLAS (Nathan Bourne) and in the future ASKAP…
This range of photometry gives GAMA high fidelity stellar mass


- Currently have issues with optical to IR match, but work is ongoing to resolve this.

- Stellar masses have been used to create the GAMA GSMF (Baldry 2011, in prep).

- For the first time we see the GSMF upturn with K-band data!

Baldry et al. 2011, in prep
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
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AAO RESPONSIBLE FOR 35% OF ALL KNOWN REDSHIFTS
All 2.5 million known redshifts as of 01/08/2010

0.0 < z < 0.1
0.1 < z < 0.2
0.2 < z < 0.3
0.3 < z < 0.4
0.4 < z < 0.5
0.5 < z < 0.6
0.6 < z < 0.7
0.7 < z < 0.8
0.8 < z < 0.9
Where does GAMA fit in?
Pre-existing SDSS/2dFGRS (r<17.77)

Year 1 (r<19.0)

Year 2 (r<19.4)

Year 3 (r<19.8)
John Peacock

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Redshift Space Correlation Functions (\(\sigma, \pi\))
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.
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. This is a combination of the Millennium Simulation (MS) plus the GALFORM Semi-Analytic (SA) 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 (Richard Bower 2006).

• In some sense, we need an approaching to grouping that does “the best job” at recovering correct groupings.
Some technical points…

• Chosen approach is to optimise for both finding halos and accurately determining purity of halos

• To find halos we say match is successful when bijective: more than $\frac{1}{2}$ of mock group is in same group as more than $\frac{1}{2}$ of FoF group
  - Find fraction of bijective FoF and mock groups where N>5 (because this is hard)

• To find halo purity find fraction of galaxies that are common as a fraction of best matching FoF/ mock group
  - Scale by multiplicity and calculate overall purity for FoF and mock groups
• This approach penalises over AND under grouping!
How good do we expect our groups to be?
$M \propto \sigma^2 r$
Group Dynamical Mass and Luminosity using global correction
Even if we perfectly recover the groups, scaling is not constant!

\[ M = A \sigma^2 r \]

<table>
<thead>
<tr>
<th>$2 \leq N_{\text{FoF}} \leq 4$</th>
<th>$5 \leq N_{\text{FoF}} \leq 9$</th>
<th>$10 \leq N_{\text{FoF}} \leq 19$</th>
<th>$20 \leq N_{\text{FoF}} \leq 1000$</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.0 19.4 19.8</td>
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</tr>
<tr>
<td>0 \leq z_{\text{FoF}} \leq 0.1</td>
<td>20.00 18.98 18.00</td>
<td>11.78 10.84 10.85</td>
<td>11.37 12.00 11.51</td>
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<tr>
<td>0.1 \leq z_{\text{FoF}} \leq 0.2</td>
<td>20.18 19.45 19.17</td>
<td>10.34 10.52 10.71</td>
<td>10.96 11.07 10.91</td>
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<tr>
<td>0.2 \leq z_{\text{FoF}} \leq 0.3</td>
<td>21.21 21.53 19.82</td>
<td>8.99 10.28 11.17</td>
<td>8.00 8.56 9.89</td>
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<tr>
<td>0.3 \leq z_{\text{FoF}} \leq 0.5</td>
<td>13.56 17.37 17.76</td>
<td>4.37 6.11 7.85</td>
<td>3.45 5.43 6.72</td>
</tr>
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<td>1.01 1.03 1.05</td>
<td>1.01 1.02 1.02</td>
<td>1.23 1.18 1.11</td>
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<tr>
<td>0.1 \leq z_{\text{FoF}} \leq 0.2</td>
<td>0.79 0.85 0.90</td>
<td>0.76 0.83 0.87</td>
<td>0.88 0.92 0.96</td>
</tr>
<tr>
<td>0.2 \leq z_{\text{FoF}} \leq 0.3</td>
<td>0.46 0.58 0.68</td>
<td>0.47 0.57 0.66</td>
<td>0.55 0.63 0.74</td>
</tr>
<tr>
<td>0.3 \leq z_{\text{FoF}} \leq 0.5</td>
<td>0.21 0.31 0.40</td>
<td>0.23 0.34 0.42</td>
<td>0.31 0.40 0.49</td>
</tr>
</tbody>
</table>
Cluster

$Z \sim 0.26$

23 w. GAMA

4 pre GAMA

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Fossil Group

Z ~ 0.11

22 w. GAMA

1 pre GAMA
Fossil Group

$Z \sim 0.23$

13 w. GAMA

1 pre GAMA
Large group

Z ~ 0.26

13 w. GAMA

0 pre GAMA

Perfect group!
Cluster

$Z \sim 0.24$

34 w. GAMA

5 pre GAMA

Perfect cluster!
Large Group

$Z \sim 0.25$

14 w. GAMA

1 pre GAMA

2 groups?
Fossil Group

Z ~ 0.33

9 w. GAMA

1 pre GAMA

Tip of the iceberg.
Small Group

$Z \sim 0.32$

4 w. GAMA

0 pre GAMA

All within 2dF fibre collision radius.
Group

$Z \sim 0.41$

4 w. GAMA

0 pre GAMA

Huge number of background members.

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Small Group

$Z \sim 0.14$

3 w. GAMA

1 pre GAMA

Mergers?
How do we do overall?
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GAMA

SDSS:
$r<17.77$

GAMA I:
G09/G15 $r<19.4$
G12 $r<19.8$
SDSS versus GAMA: \( N \geq 5 \) (high fidelity groups)

- SDSS DR7 (done):
  8000 sqdeg \( r < 17.77 \)
  \(~ 60 \rightarrow 70\%\) comp. in dense regions

- GAMA I (done):
  144 sqdeg \( r < 19.4 \) (for this plot)
  \(~ 99\%\) comp.

- GAMA II (doing):
  360 sqdeg \( r < 19.8 \)
  \(~ 95 \rightarrow 99\%\) comp.
Problem appears to be that the mocks (MS + SA) produce far too many compact groups.

It would appear that the recipe used for “simulating” dynamical friction is far too crude, and doesn’t merge groups rapidly enough.
What next…
• 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$^3$C).
  • 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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