

Durham-Edinburgh eXtragalactic VIII Workshop

Synthetic Galaxy Catalogues From A Galaxy Formation Model

Alex Merson

(& Carlton Baugh, John Helly,
Violeta González-Pérez, Shaun Cole,
Peder Norberg)

12th January 2012



Durham
University



Synthetic Galaxy Catalogues From A Galaxy Formation Model

- Lightcone synthetic “mock” catalogues
- Applications of mock catalogues
- Lightcones for photometric galaxy surveys

Galaxy "mock" catalogues

- Set of synthetic galaxies emulating a real galaxy sample (e.g. a galaxy survey)
- Broad range of applications:

Prediction

Relate observations to galaxy formation theory

Predictive power

Calibration

Calibration of statistical estimators

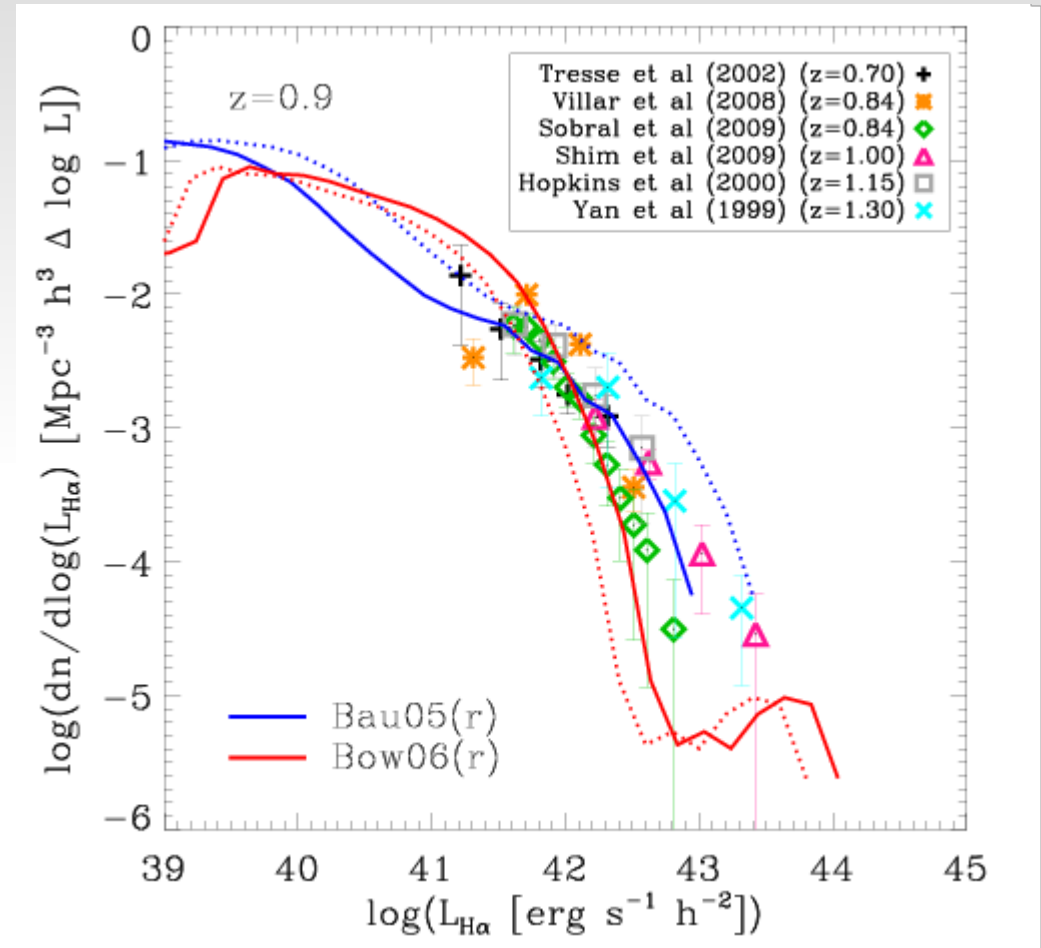
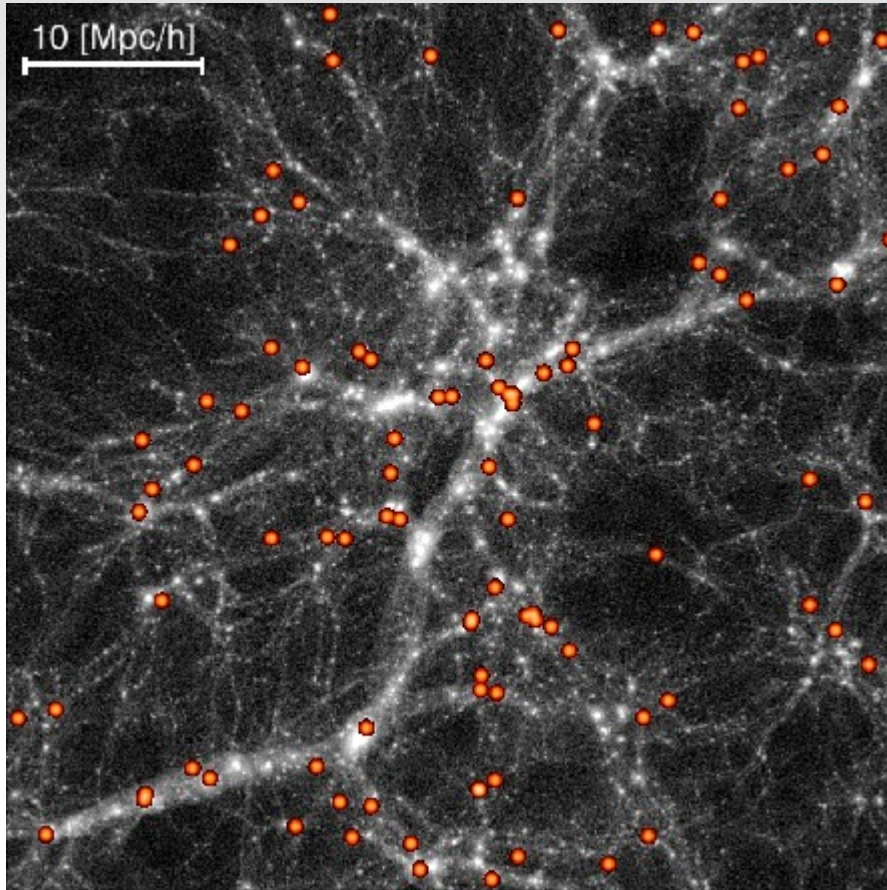
Training sets

Removal of systematics

Lightcone catalogues

- Multi-wavelength synthetic galaxy catalogues
→ "lightcone mocks"
- Halo merger trees from **Millennium Simulation**
→ include spatial information
- Galaxy properties from **GALFORM**:
 - trace star-formation history from high- z
 - incorporate galaxy evolution
 - low computational cost (c.f. SPH, AMR codes)
 - multi-wavelength predictions

Emission Line Properties



Galaxies selected by H α luminosity as predicted by GALFORM ($z \sim 1$)
→ allows construction of EUCLID mock catalogues

Orsi et al. (2010)

Millennium Lightcones (I)

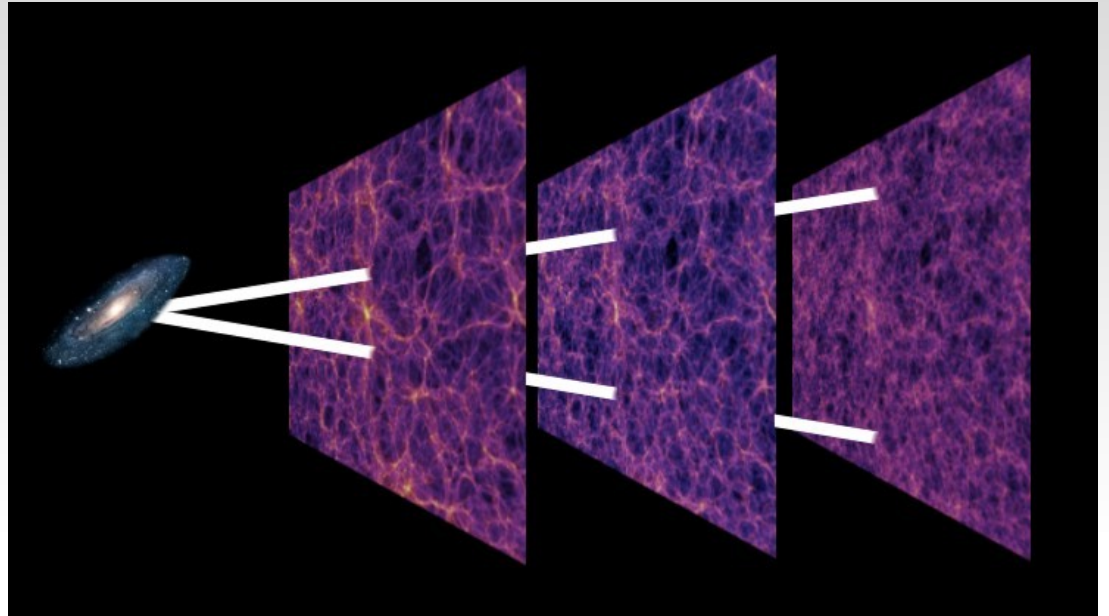
Cosmology:

$$\Omega_M = 0.25 \quad \Omega_\Lambda = 0.75$$

$$\Omega_b = 0.045 \quad h = 0.73$$

$$L_{\text{box}} = 500h^{-1} \text{ Mpc}$$

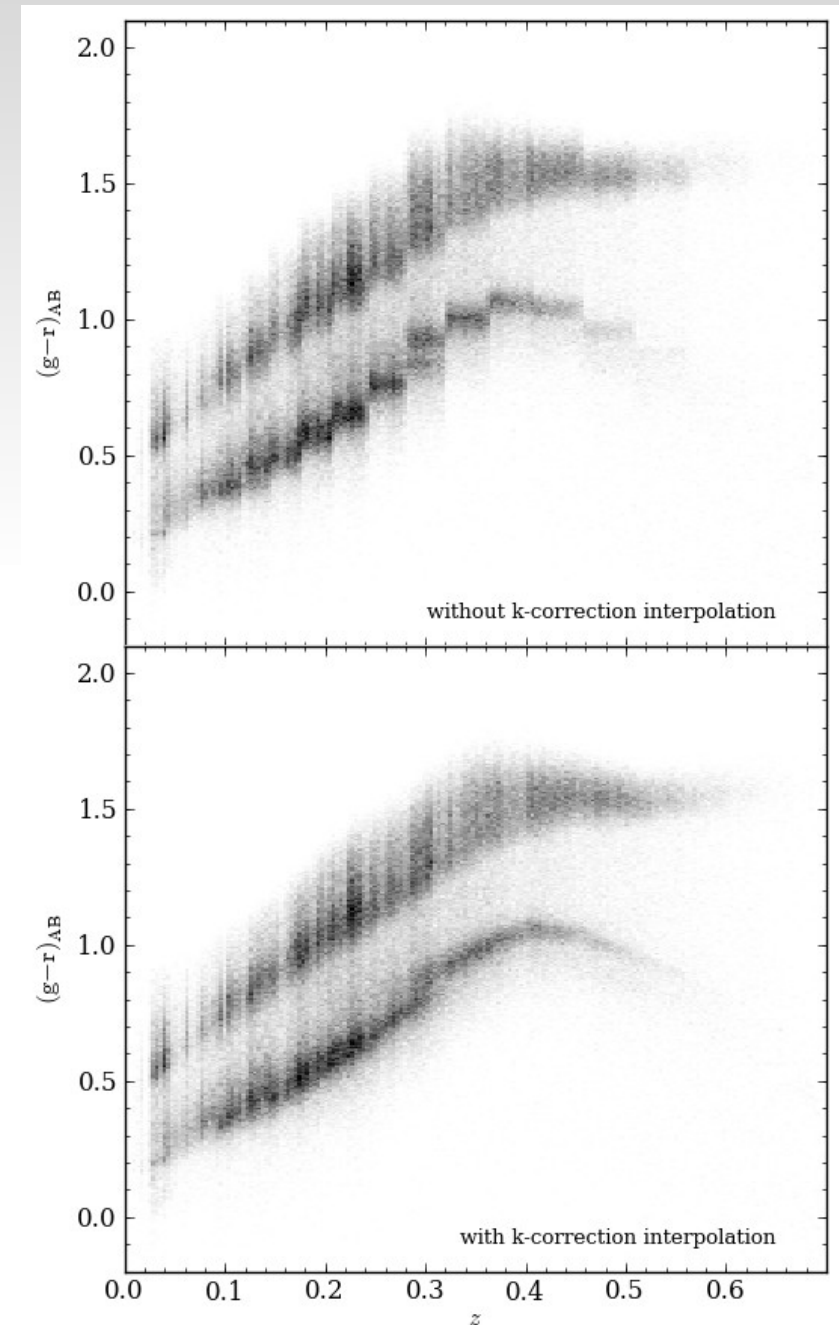
$$\Rightarrow z \sim 0.17$$



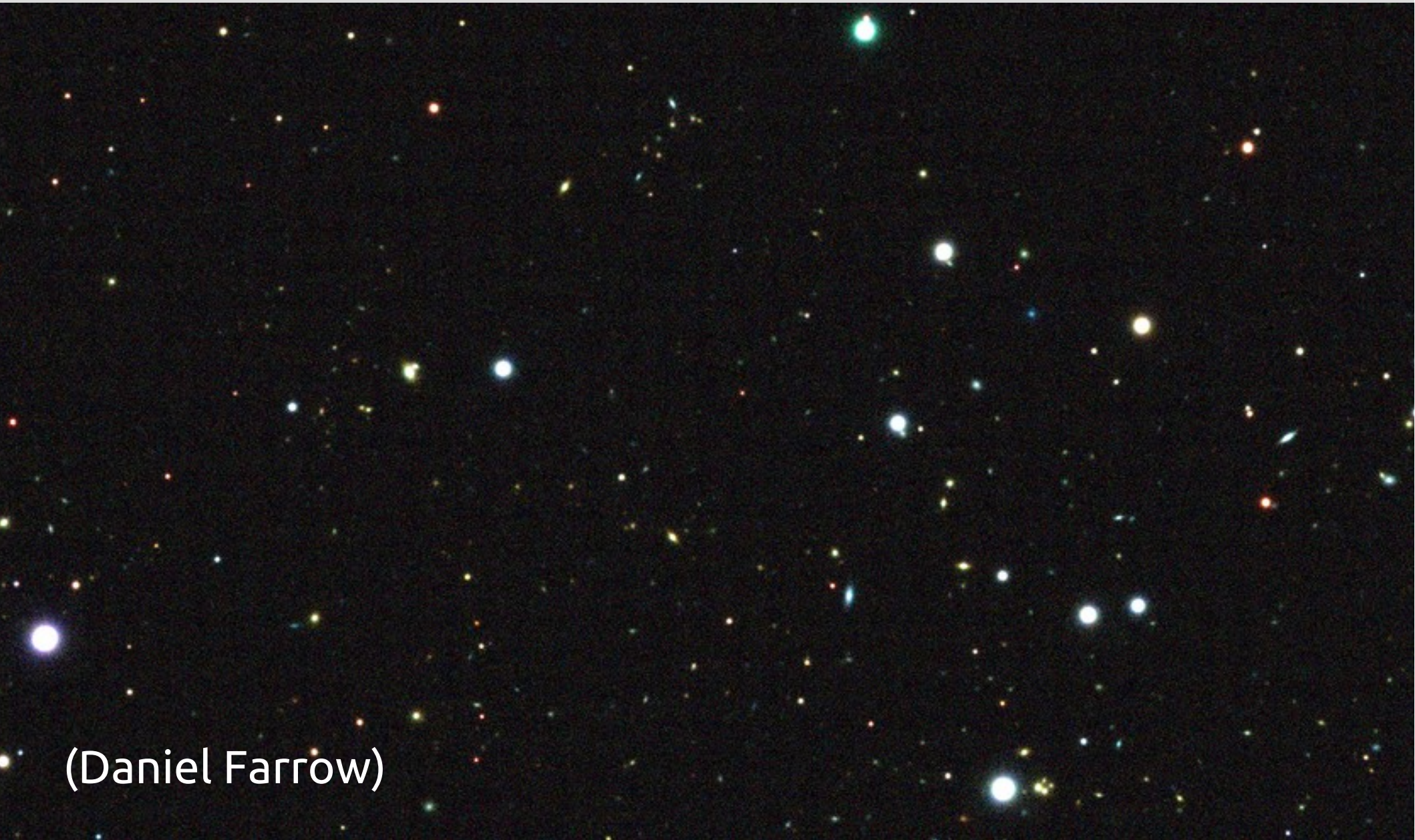
- i. Run GALFORM model on simulation snapshots
- ii. Place observer & replicate copies of simulation box
 - generate sufficient volume to contain survey
- iii. Determine where galaxies enter observer's light cone
 - interpolate positions between simulation snapshots

Millennium Lightcones (II)

- iv. Apply angular mask
 - match solid angle of survey
- v. Assign galaxy properties
 - smooth k-correction:
interpolate between magnitudes
- vi. Apply radial selection
 - select galaxies according to
multiple bands simultaneously
- vii. Post-processing
 - completeness mask, photo-zs,
images ...



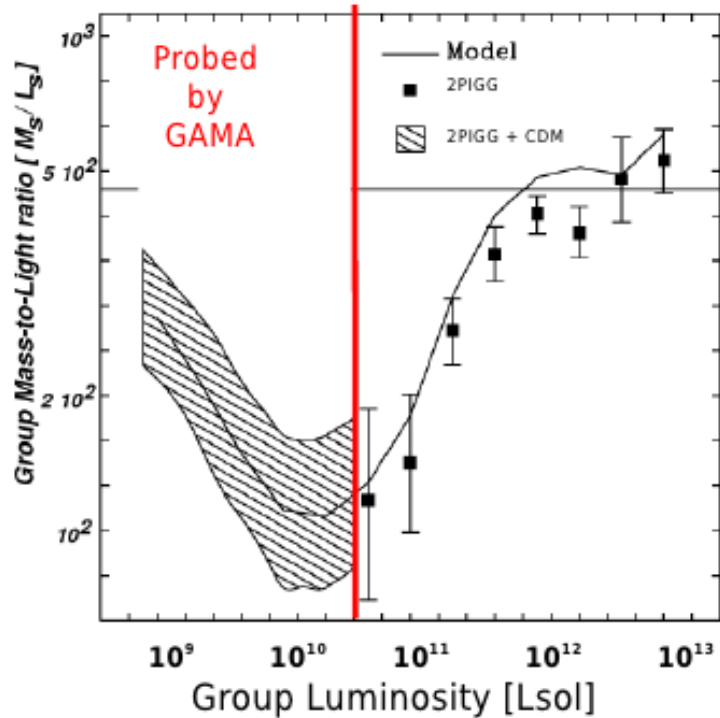
Mock Images



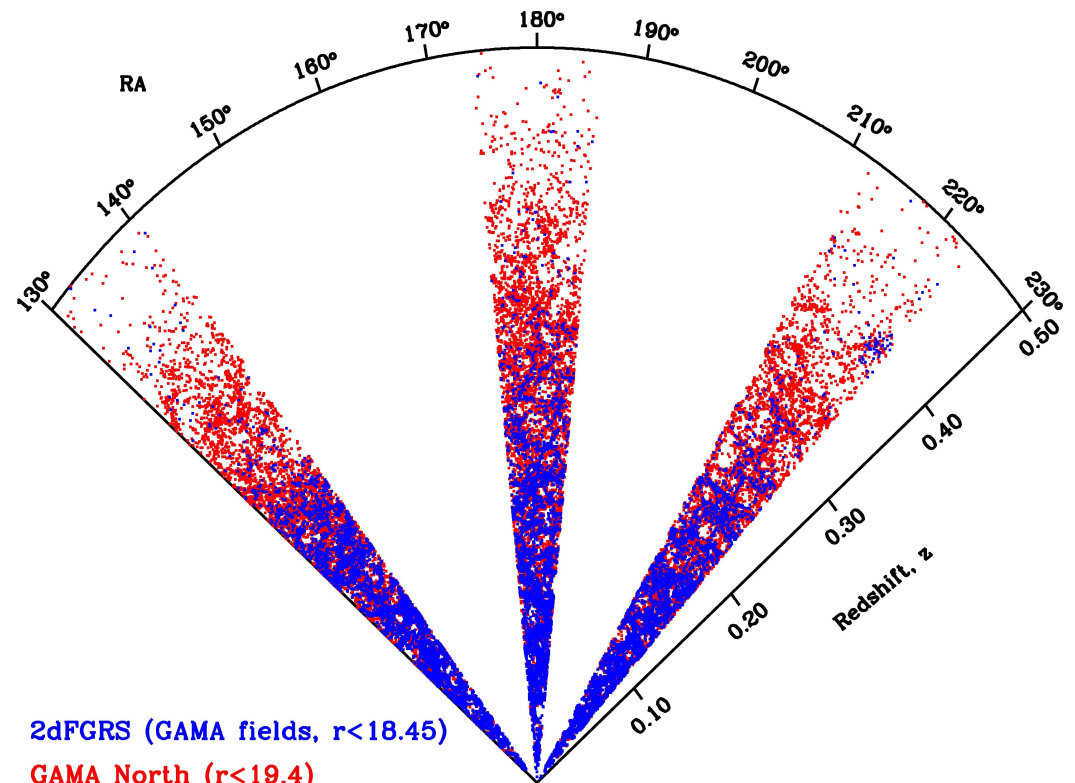
(Daniel Farrow)

GAMA lightcone

- Used to calibrate FOF group finder → GAMA galaxy groups catalogue (Robotham et al. 2011)
- Mock groups already known
→ adjust FOF parameters until mock groups recovered



Eke et al. (2004)



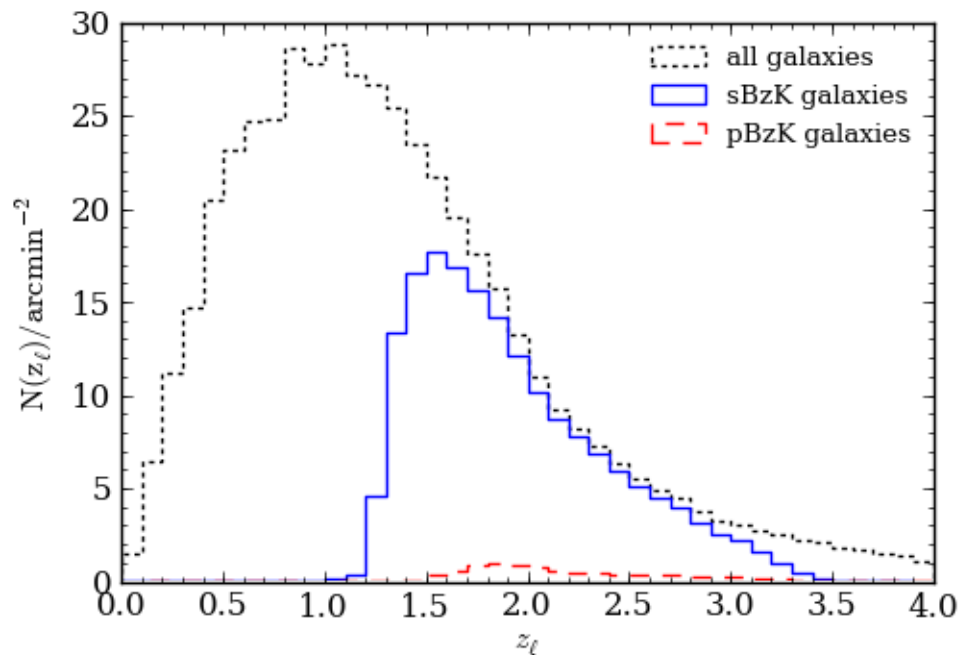
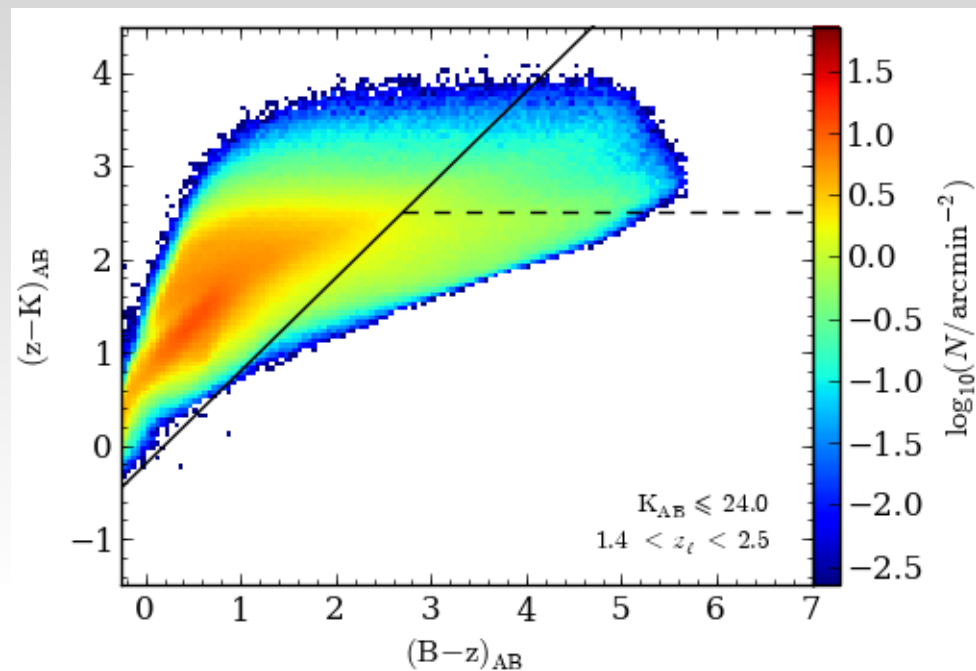
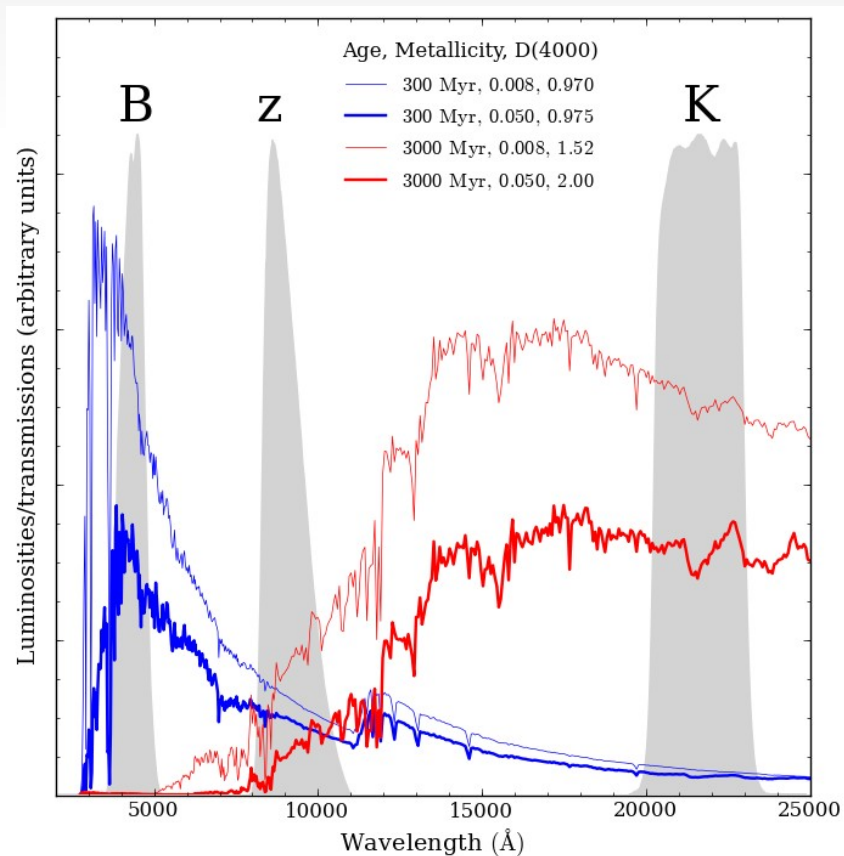
2dFGRS (GAMA fields, $r < 18.45$)

GAMA North ($r < 19.4$)

150 deg², $r < 19.4$

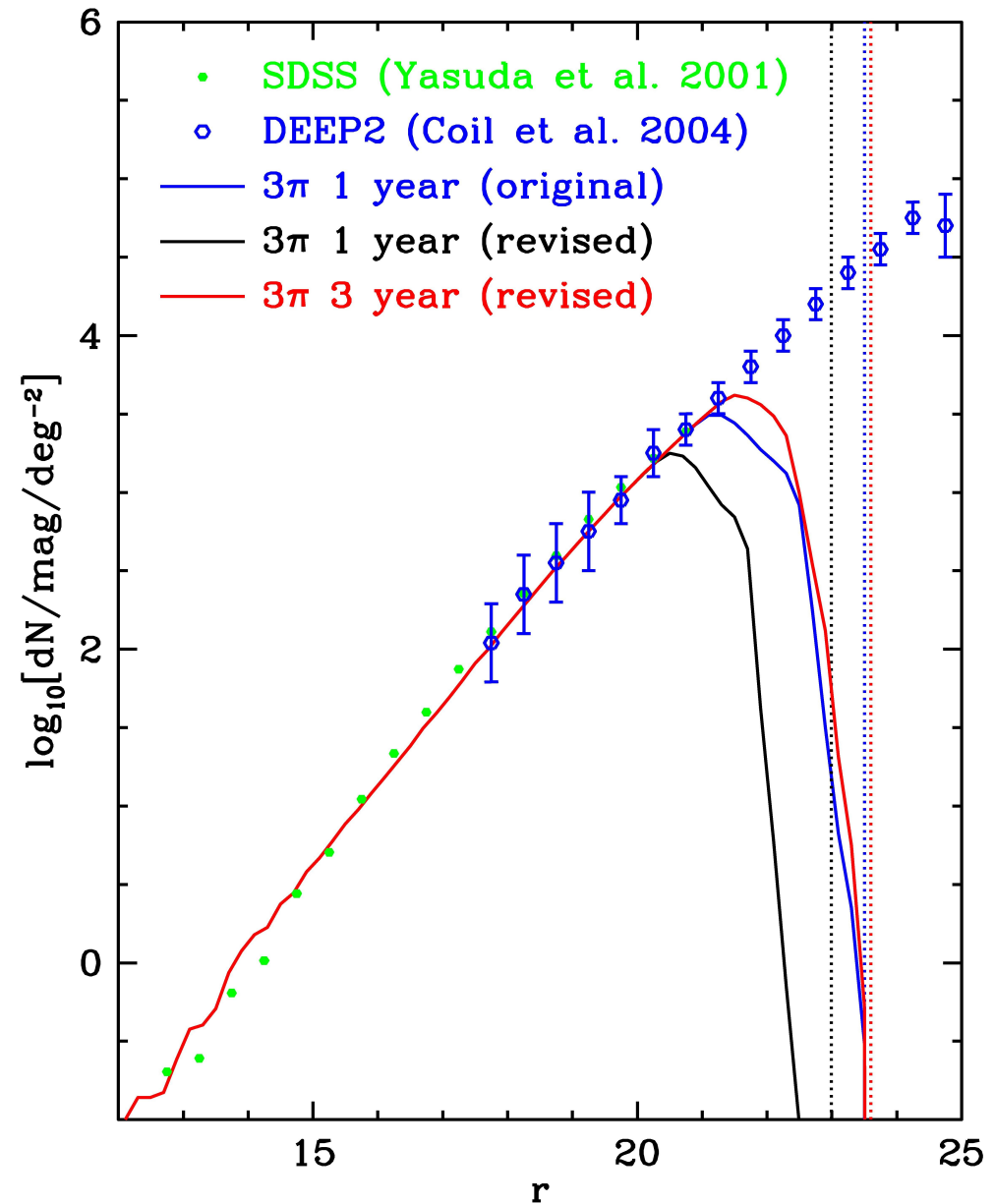
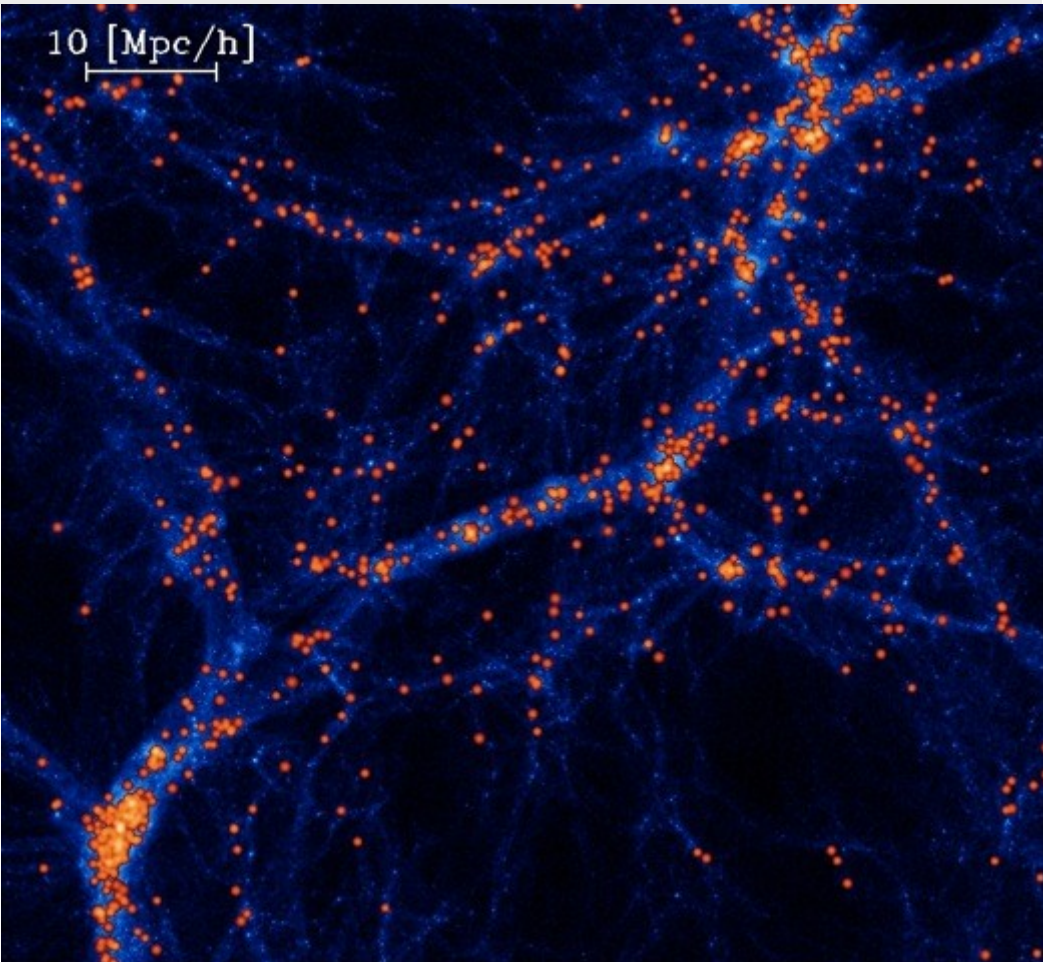
Galaxy colour selection

- BzK colour selection (Daddi et al. 2004)
- Select SF and passive galaxies at $1.4 < z < 2.5$

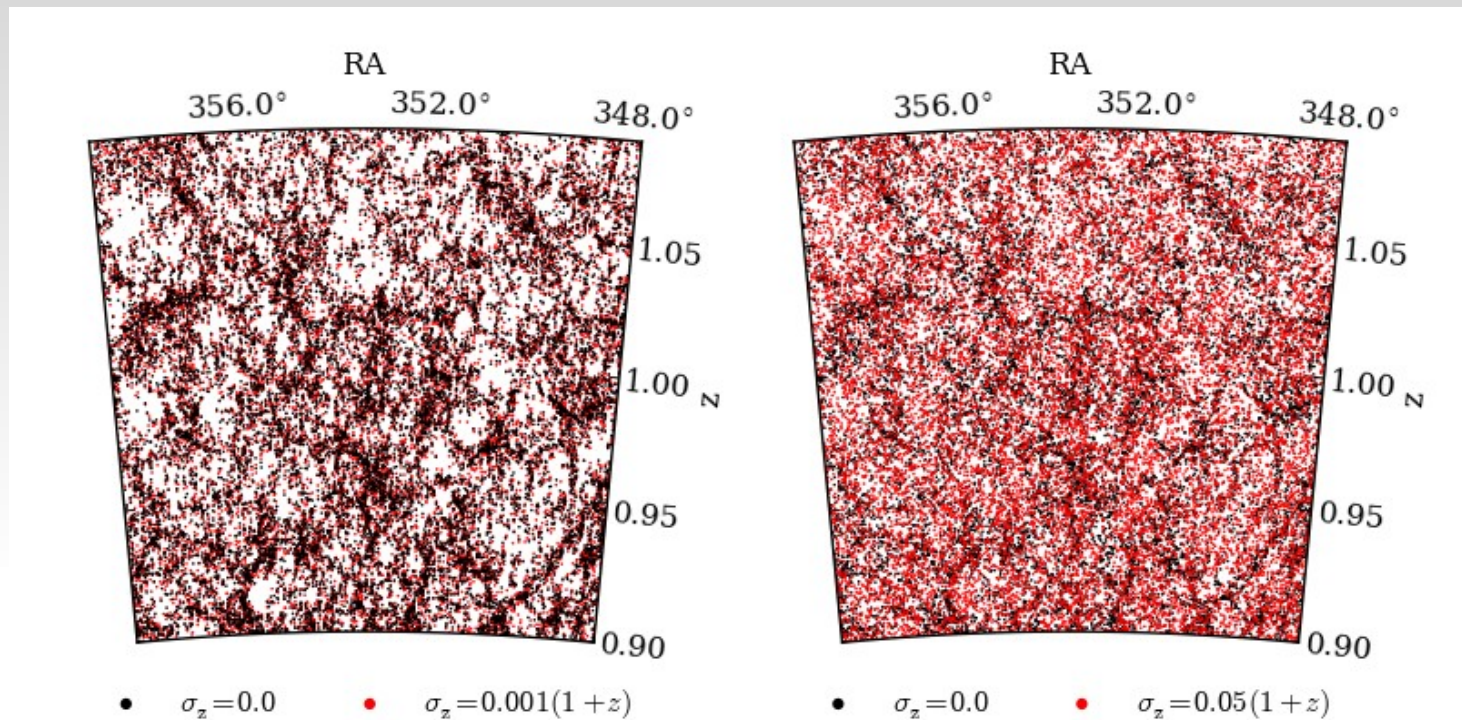


Lightcones for photometric surveys (I)

- 1000 deg² lightcone, grizy selection



Lightcones for photometric surveys (II)



- Are photo-z training sets a representative sample of the galaxy population?
- Does choice of training set affect photo-z errors?
- How does size of photo-z error affect the recovered clustering signal?
→ could be investigated with Pan-STARRS, PAU, ...

Summary

- Lightcone synthetic "mock" catalogues
 - constructed from Millennium Sim. + GALFORM model
 - incorporating evolution of galaxy properties
 - select galaxies in multiple bands simultaneously
 - post-processing (images, photo-zs)
- Applications of mock catalogues
 - calibration of statistical estimators (e.g. group finders)
 - assess effectiveness of galaxy selection techniques
 - effect on photo-z errors?
 - photo-z error -- effect on galaxy clustering?