Evolution of galaxy clustering in the ALHAMBRA Survey

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Meeting on Fundamental Cosmology
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Outline

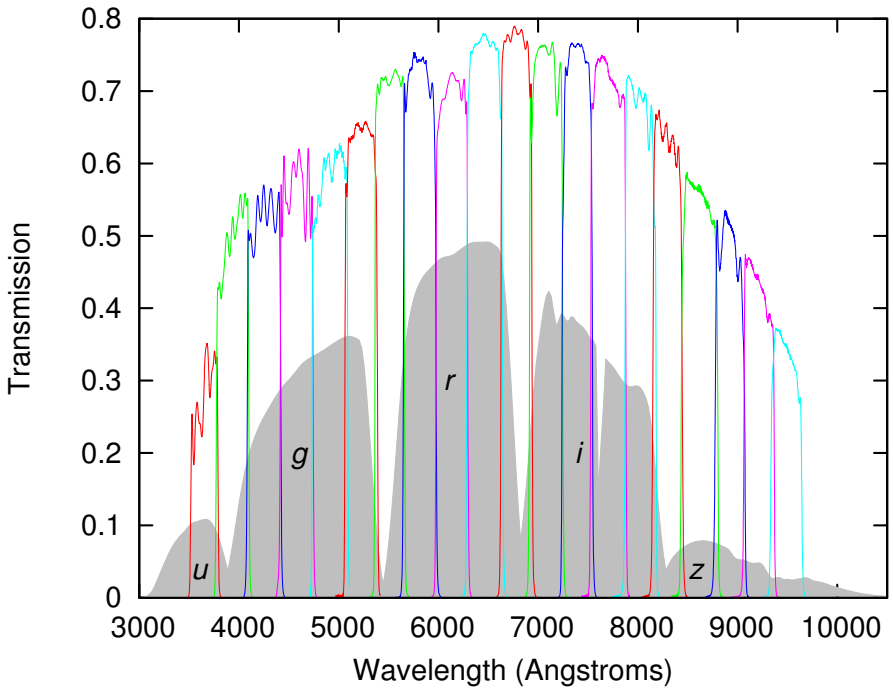
ALHAMBRA

Advanced, Large Homogeneous Area, Medium-Band, Redshift Astronomical survey

A pencil-beam, multi-band photometric survey with the aim of providing a *cosmic tomography* to study cosmic evolution

- Exploit photo-z techniques at maximum
- Precursor and ideal testbench for J-PAS and PAU@WHT

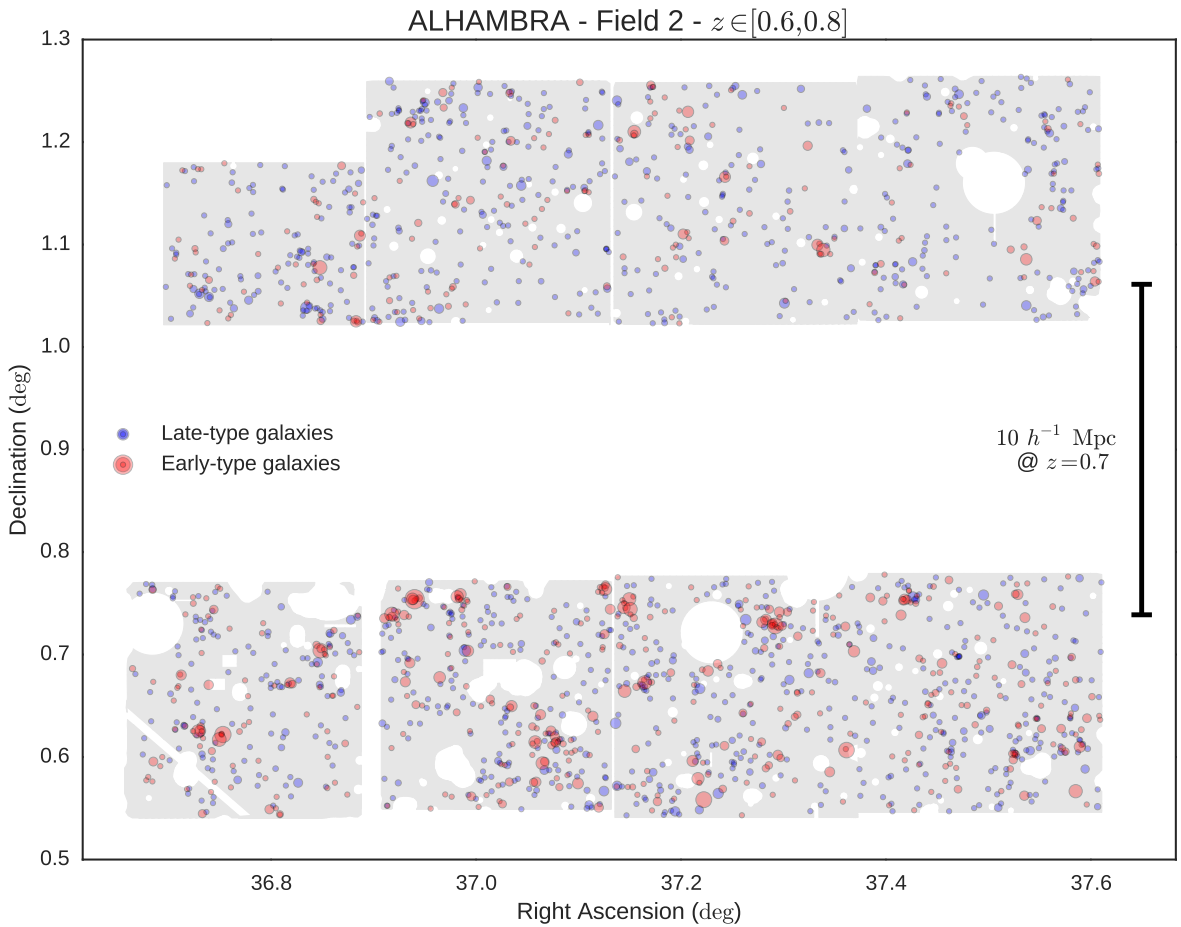
- Total effective area: $\sim 2.4\,\mathrm{deg}^2$, distributed in 7 separate fields
- 20 optical filters + JHK_s
- Catalogue (I-band selected): Molino et al. (2014)
  - Photo-z: $\sigma_z \leq 0.014(1+z)$ (to $I < 24.5$)
  - $z_{\mathrm{med}} = 0.75$



ALHAMBRA

Depth, photo-z quality: ideal dataset for study of clustering at scales $\lesssim 10\,h^{-1}\,\mathrm{Mpc}$ and its evolution in $z \sim [0.3-1.2]$

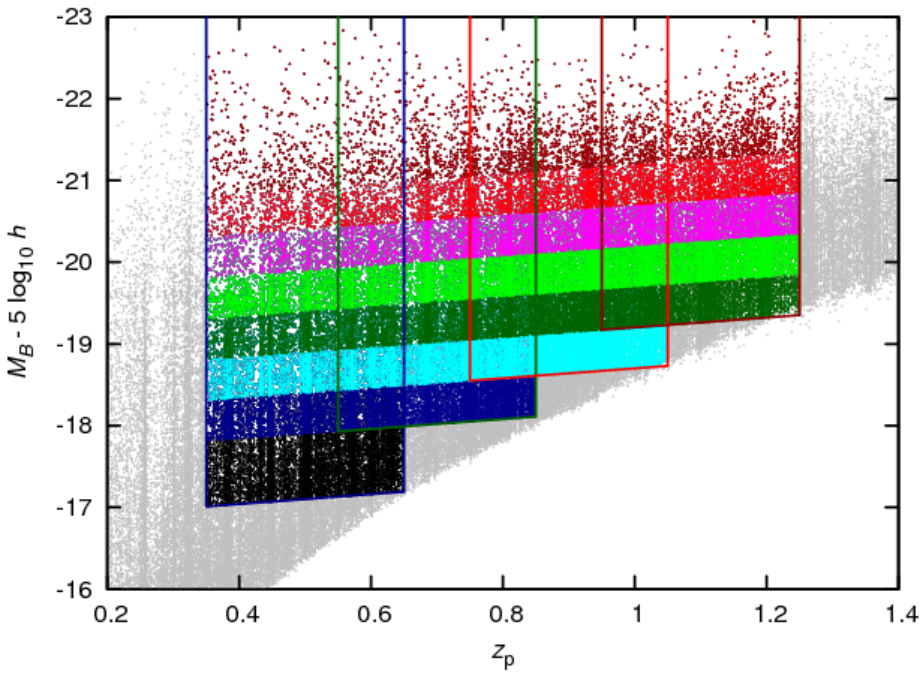
We estimate clustering using the projected correlation function $w_p(r_p)$ (adapted for the photo-z data)



Evolution of clustering and segregation by luminosity

Arnalte-Mur et al. (2014) MNRAS 441-1783

- ALHAMBRA catalogue to $I_{AB} < 24$
- Select samples by B-band absolute magnitude and redshift
- $1-2$ mags deeper than spectroscopic surveys

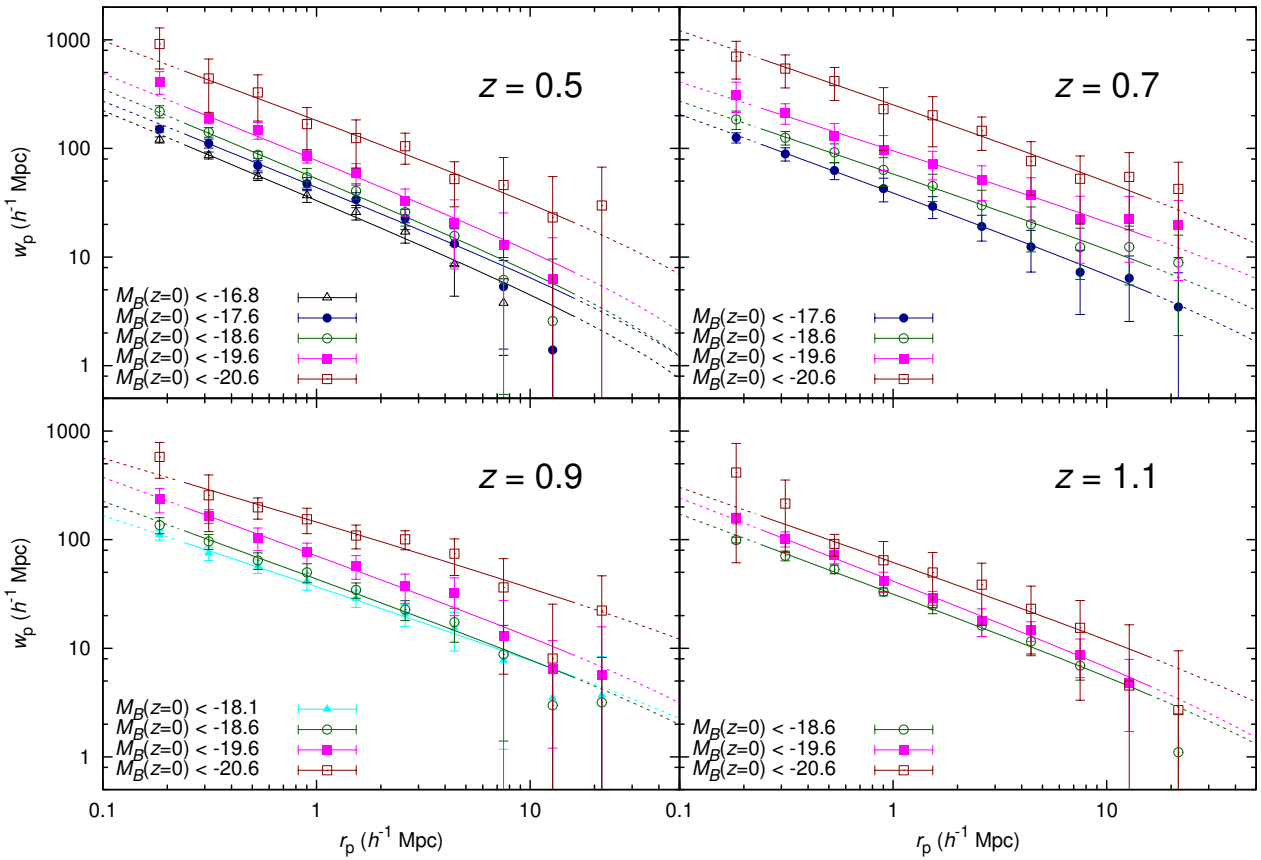


Evolution of clustering and segregation by luminosity

Arnalte-Mur et al. (2014) MNRAS 441-1783

Projected correlation function $w_p(r_p)$ measured at $r_p \sim [0.3, 15]\, h^{-1}\,\mathrm{Mpc}$

- Clear segregation by luminosity
- No change of slope

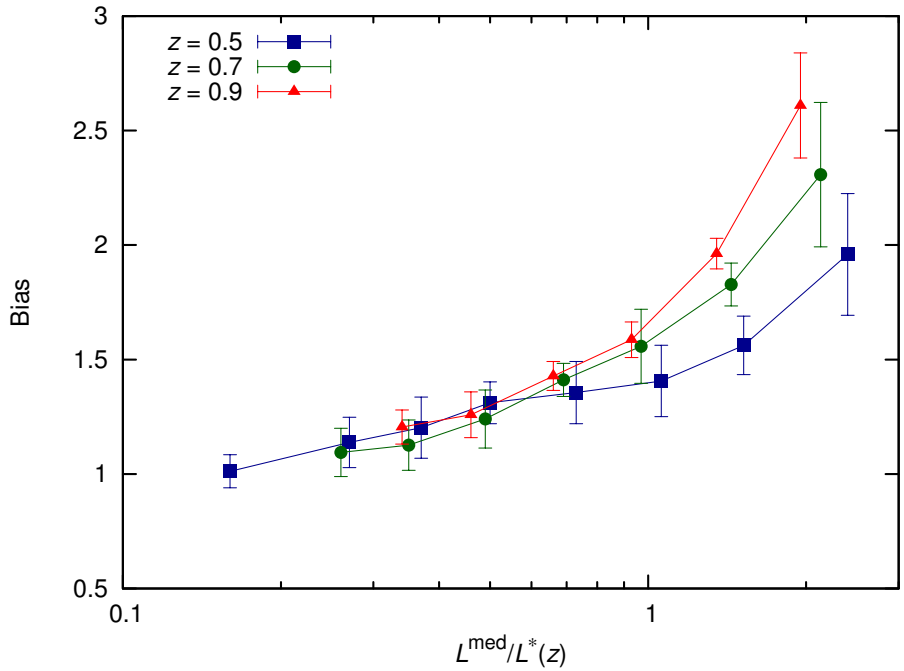


Evolution of clustering and segregation by luminosity

Arnalte-Mur et al. (2014) MNRAS 441-1783

Quantify luminosity segregation: galaxy bias
($r_p \in [1-10]\,h^{-1}\,\mathrm{Mpc} \rightarrow$ 2-halo term)

- Broad agreement with previous works (VIPERS, CFHTLS-Wide, PRIMUS), and extending to fainter luminosities
- Steeper luminosity dependence than low z (and previous works)
- Can broadly identify host haloes $\rightarrow L^*$ galaxies reside in haloes with $M_h \gtrsim 10^{12.2}\,h^{-1}\,\mathrm{M}_\odot$



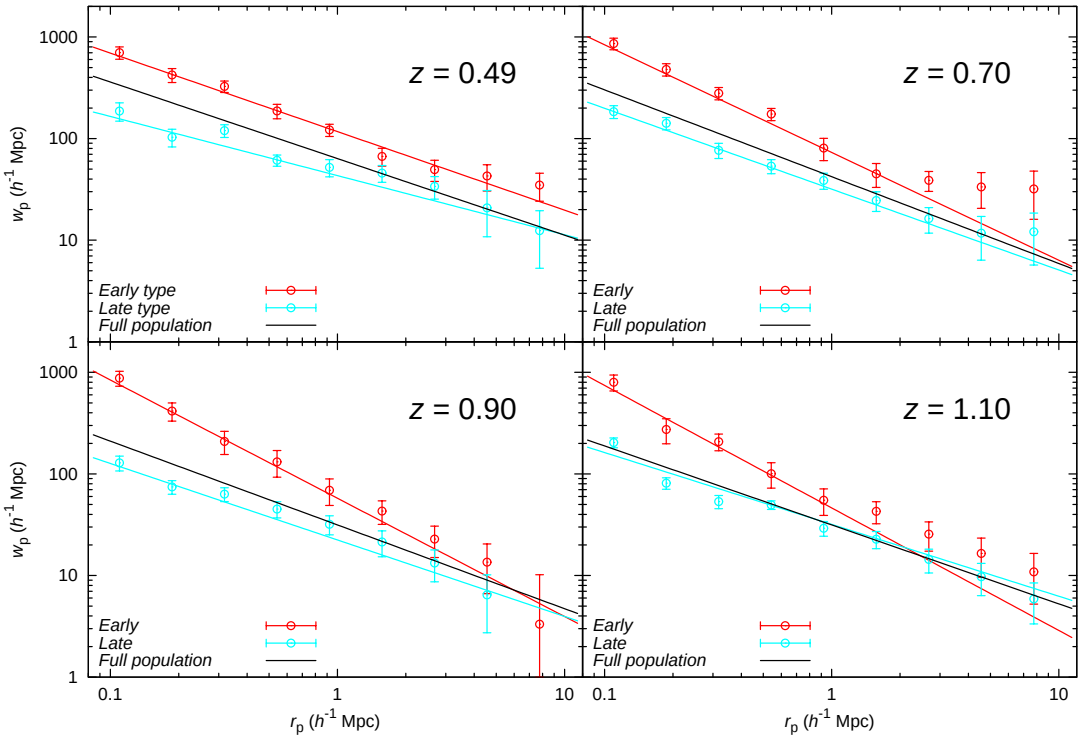
Evolution of segregation by spectral type

Hurtado-Gil et al. (2015, in prep.)

At fixed luminosity, select galaxies by spectral type

- Selection from best-fit template in photo-z estimation (BPZ)
- Similar to selection by broad-band colour

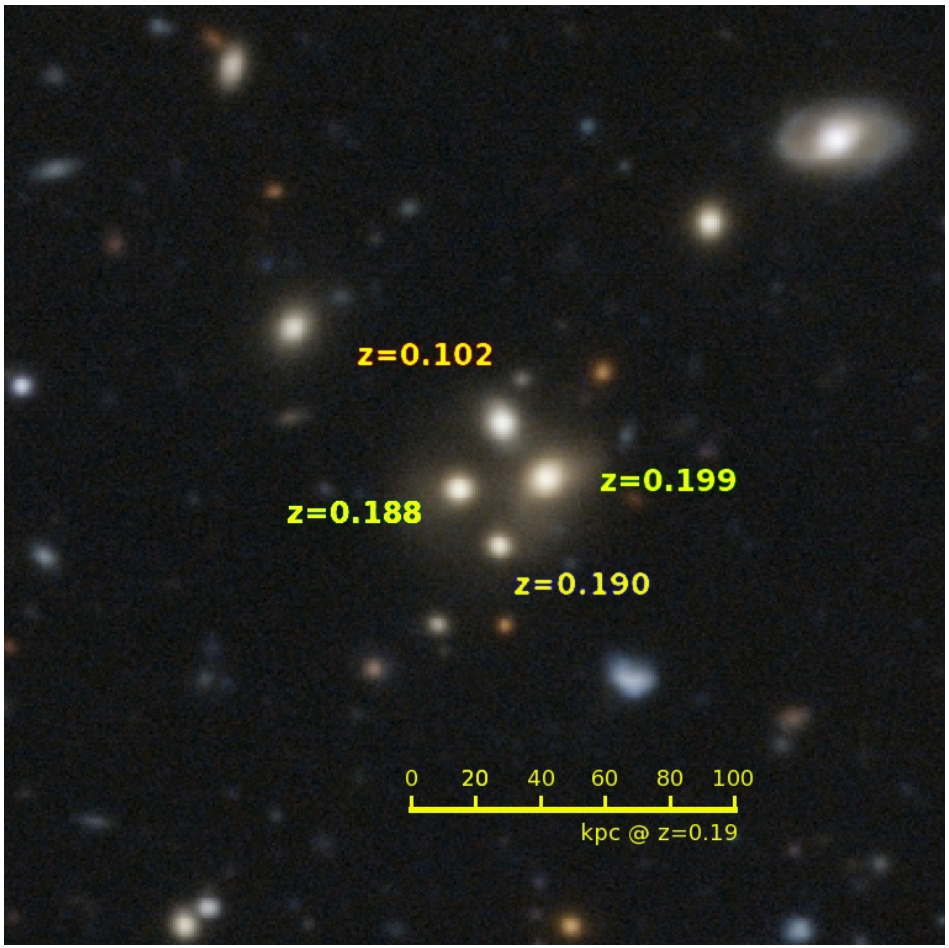
- Passive/early-type galaxies are more clustered than active/late-type at all z
- Changes in both amplitude and slope
- Much faster clustering evolution for early-type



Clustering at the smallest scales: the 1-halo term

ALHAMBRA ideal to study clustering at the smallest scales

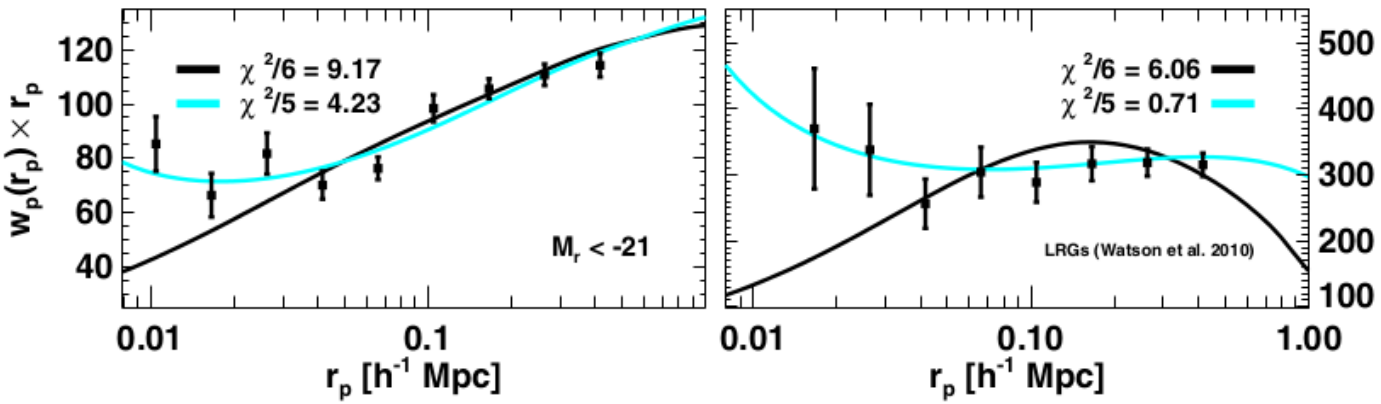
- Depth $\leftrightarrow$ number density
- Have 'pseudo-spectrum' for every object in the sky: no fiber collisions, undersampling
- Small scale limit set by seeing: $\langle FWHM \rangle = 1.1'' \rightarrow$ $r_p \gtrsim 10 - 20\, h^{-1}\,\mathrm{kpc}$



Clustering at the smallest scales: the 1-halo term

Why are small scales $r \sim 0.01 - 1\,h^{-1}\,\mathrm{Mpc}$ interesting?

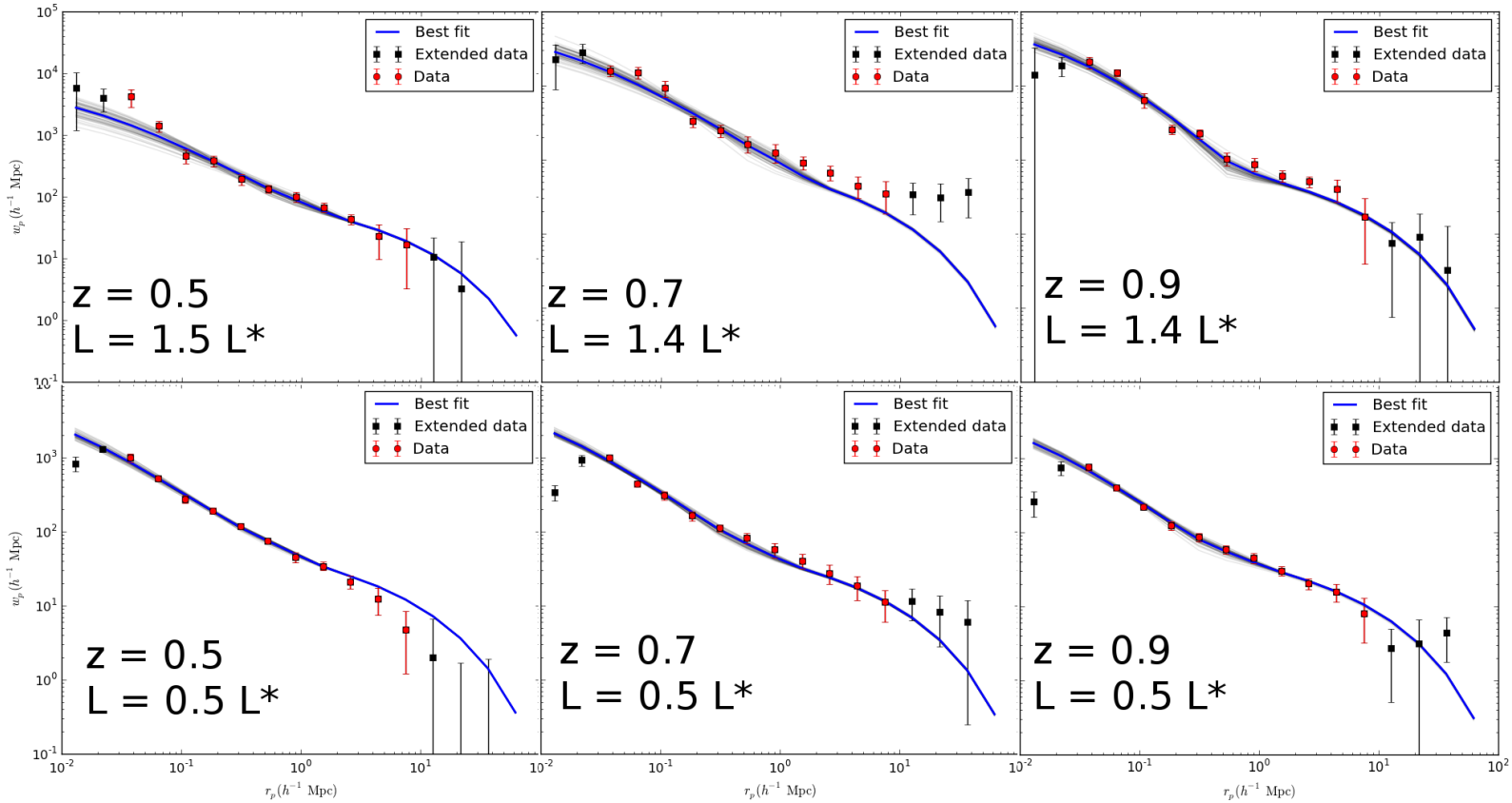
- Probes clustering inside haloes: can use HOD models to study how host haloes are populated by galaxies
- Do satellite galaxies follow dark matter density profiles (NFW)? Watson et al. (2010, 2012) found steeper profiles at $r_p \lesssim 50\,h^{-1}\,\mathrm{kpc}$ for brightest samples in SDSS ($\rightarrow$ most massive haloes)



Clustering at the smallest scales: the 1-halo term

Preliminary results

Fit standard 3-parameter HOD model (with NFW profile) to our $w_p(r_p)$ measurements



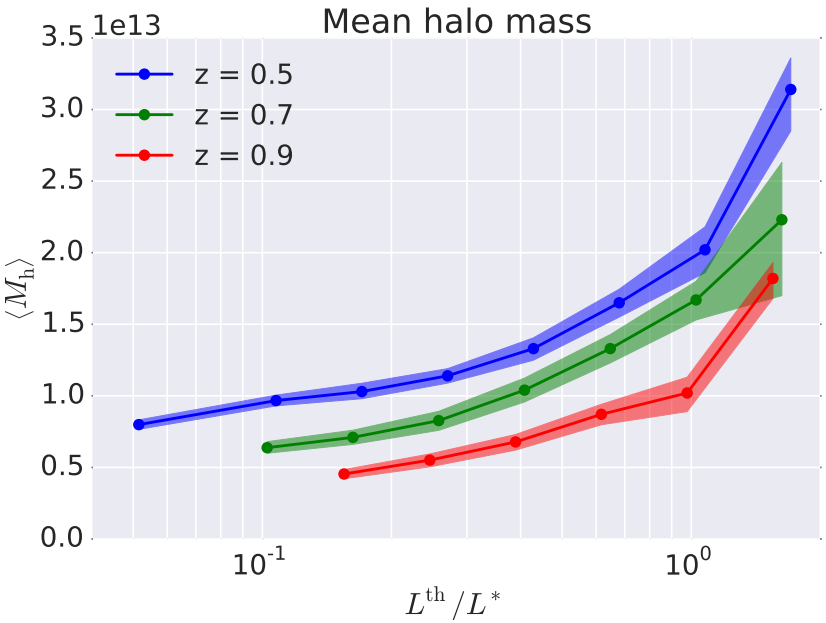
- Excellent agreement overall
- Possible hint of steeper inner profile at low z, high luminosity

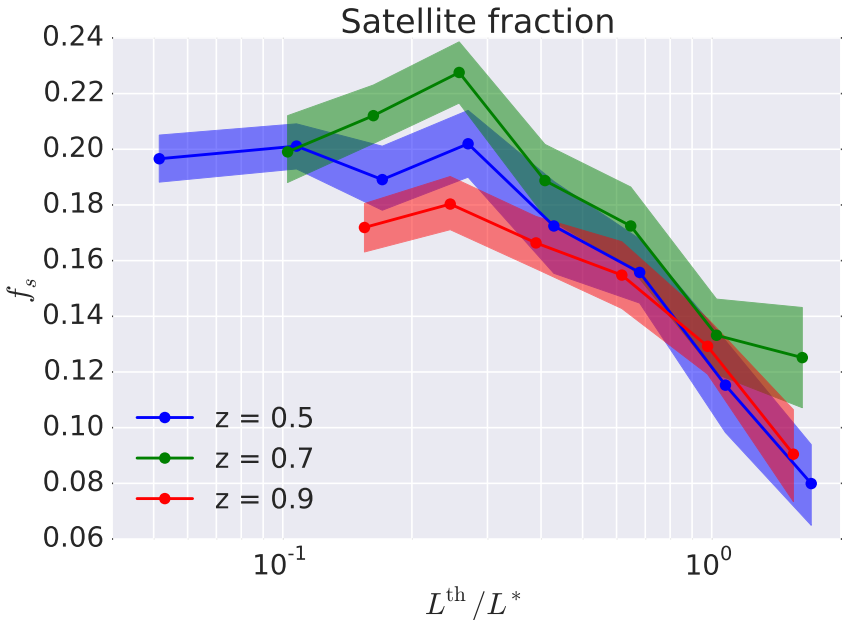
Clustering at the smallest scales: the 1-halo term

Preliminary results

We can constraint physical properties of the galaxy/halo relation from our HOD fits

- Strong evolution of the mean mass of host haloes
- No significant evolution of the fraction of satellite galaxies





Conclusions

- Can obtain reliable clustering measurements for $r_p \in [0.02, 15]\, h^{-1}\,\mathrm{Mpc}$ in ALHAMBRA $\rightarrow$ good prospects for upcoming cosmological multi-band surveys (J-PAS, PAU@WHT)
- Can constraint galaxy segregation by luminosity and spectral type up to $z \sim 1$, competitive with spectroscopic surveys
- Standard HOD model + NFW profile in excellent agreement with data
  - Possible excess at low z, high luminosity
- Other LSS-related ALHAMBRA work:
  - Catalogue of groups and clusters: Ascaso et al. [arXiv:1506:03823]
  - Galaxy bias from cosmic variance: López-Sanjuan et al. (submitted)
- More information and public data:
  `http://www.alhambrasurvey.com`