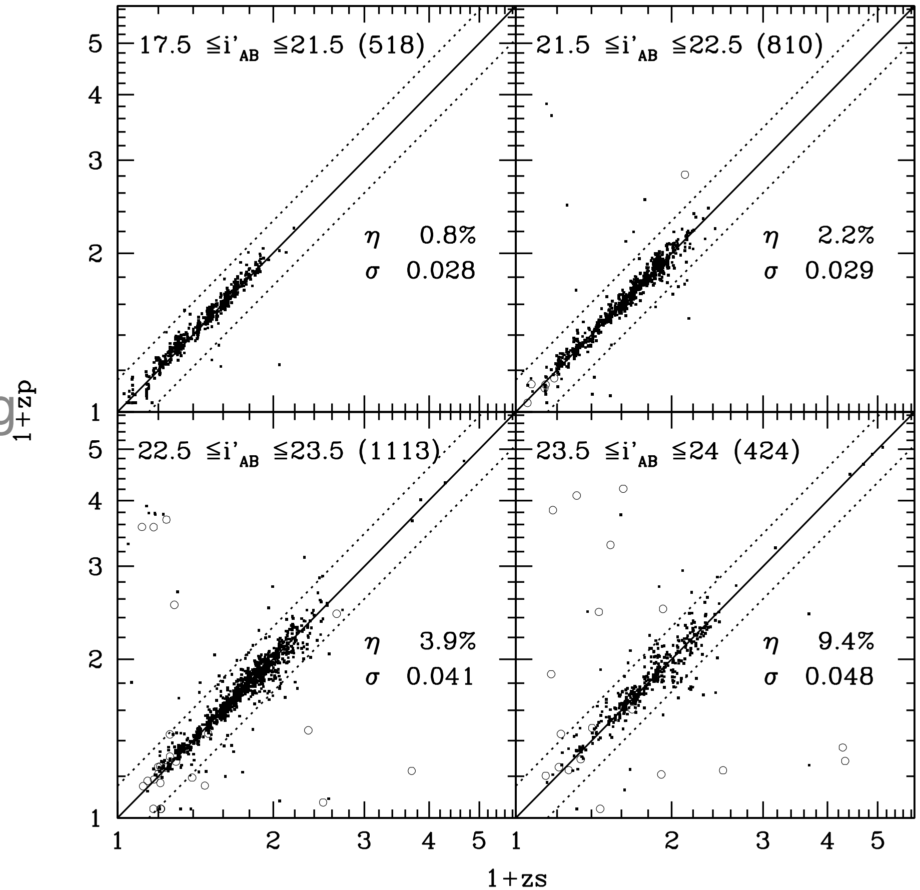
Galaxy clustering in the CFHTLS

Henry Joy McCracken
...and a cast of thousands

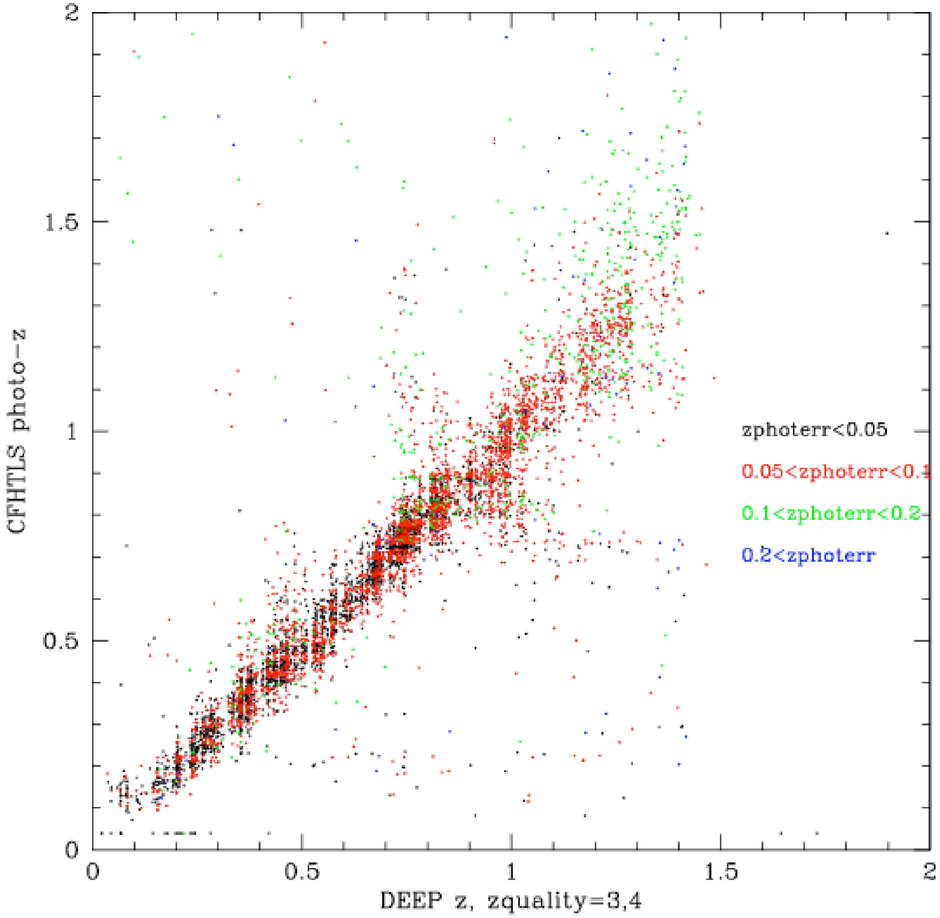
CFHTLS-T03 photometric catalogues

- We use the ‘official’ cfhtls-t03 dataset with the exception that we add some u-band data from COSMOS in the d2 field (this data will be public shortly)
- Depths reach AB 26 in all filters and all fields
- Photometric redshifts are calibrated using the 8000 redshifts from the VVDS survey
- We then use this calibration to derive photo-zeds for the other fields (d2,d3,d4)
- **Validity domain: 0.2<z<1.2 and 18<i<24.5**
- Robust measurement of cosmic variance possible thanks to the four independent cfhtls fields



Ilbert et al 2006

photo-zed comparison with DEEP2



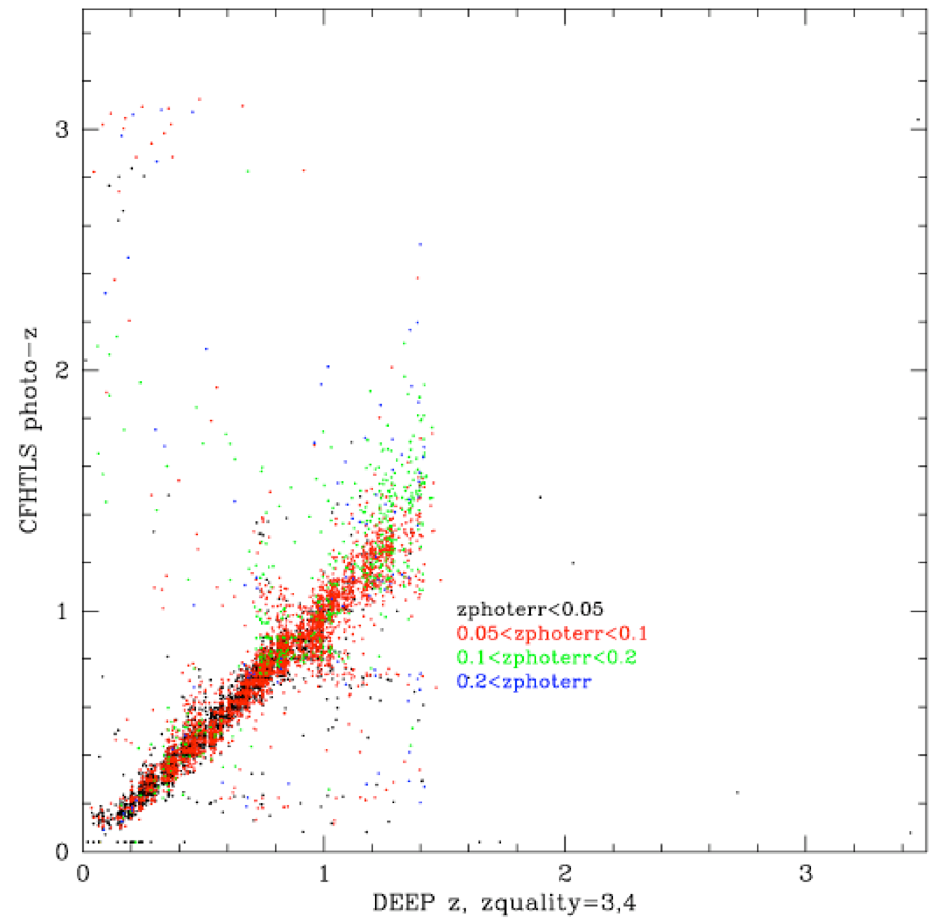
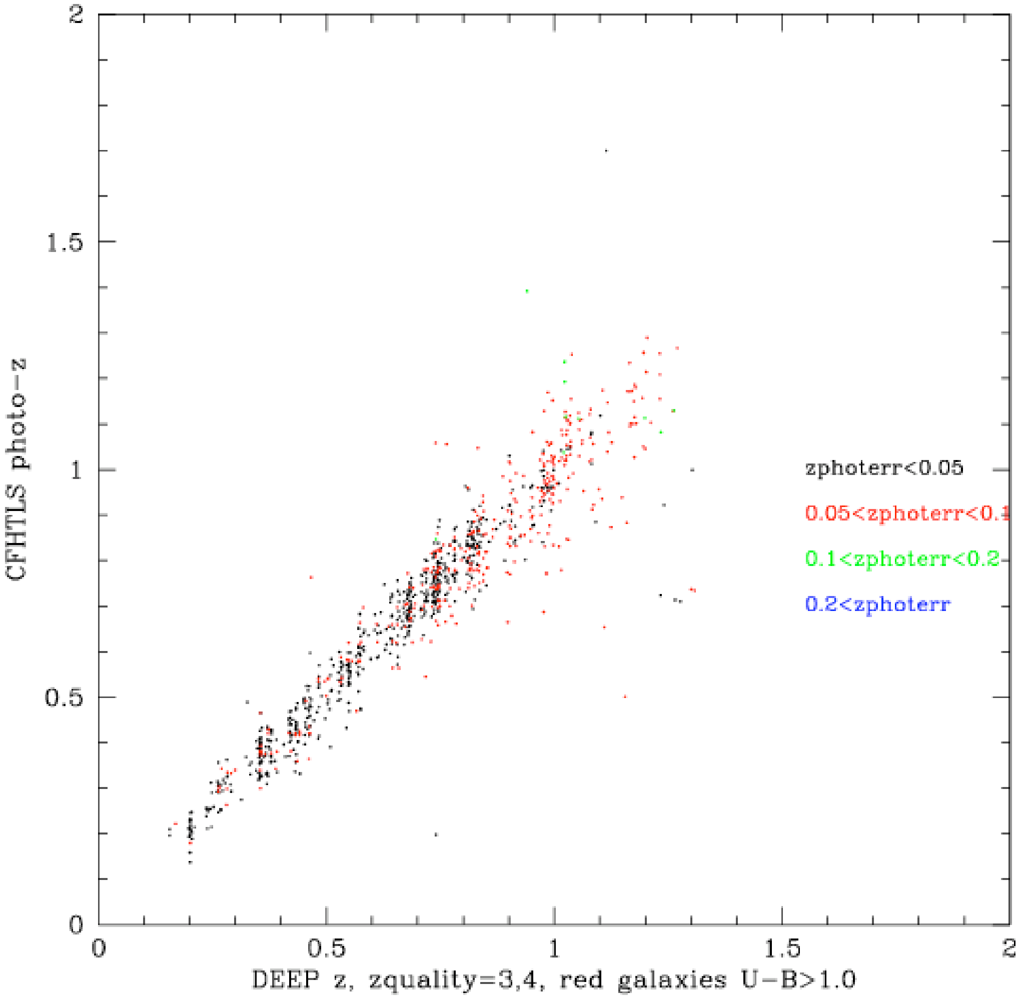


Photo-zed comparison with DEEP2 II



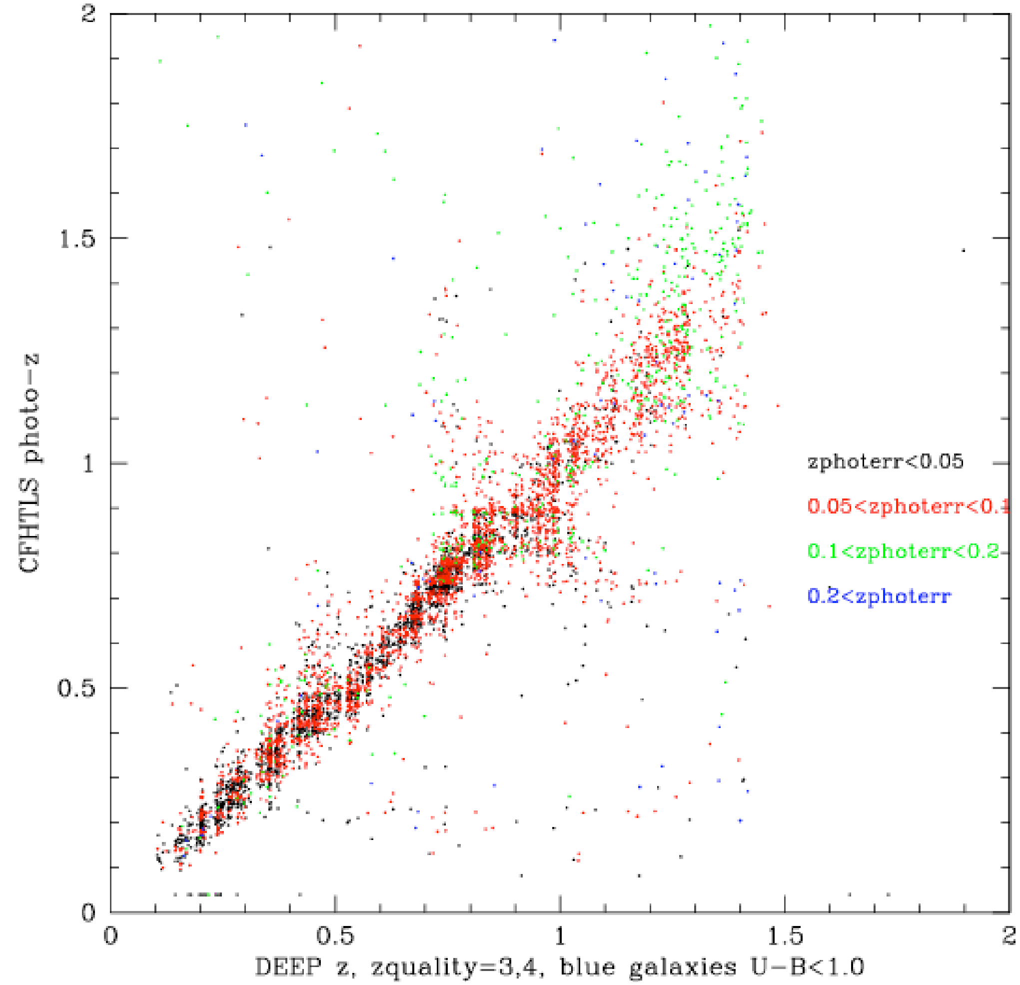
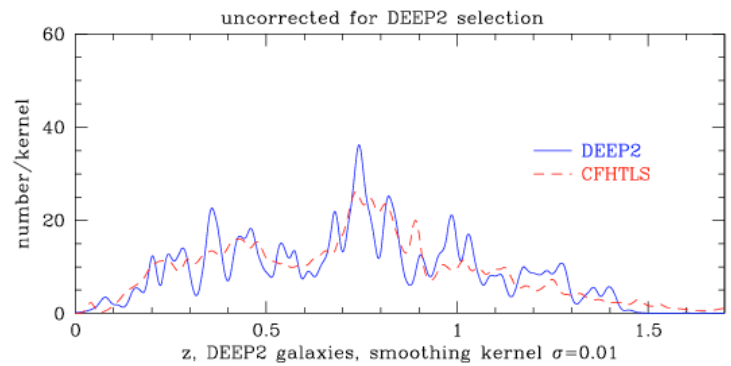
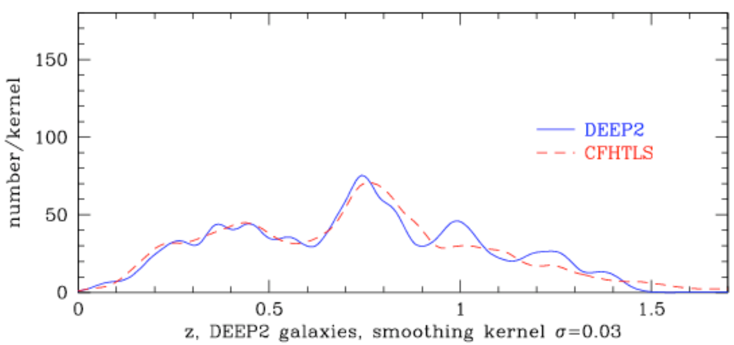
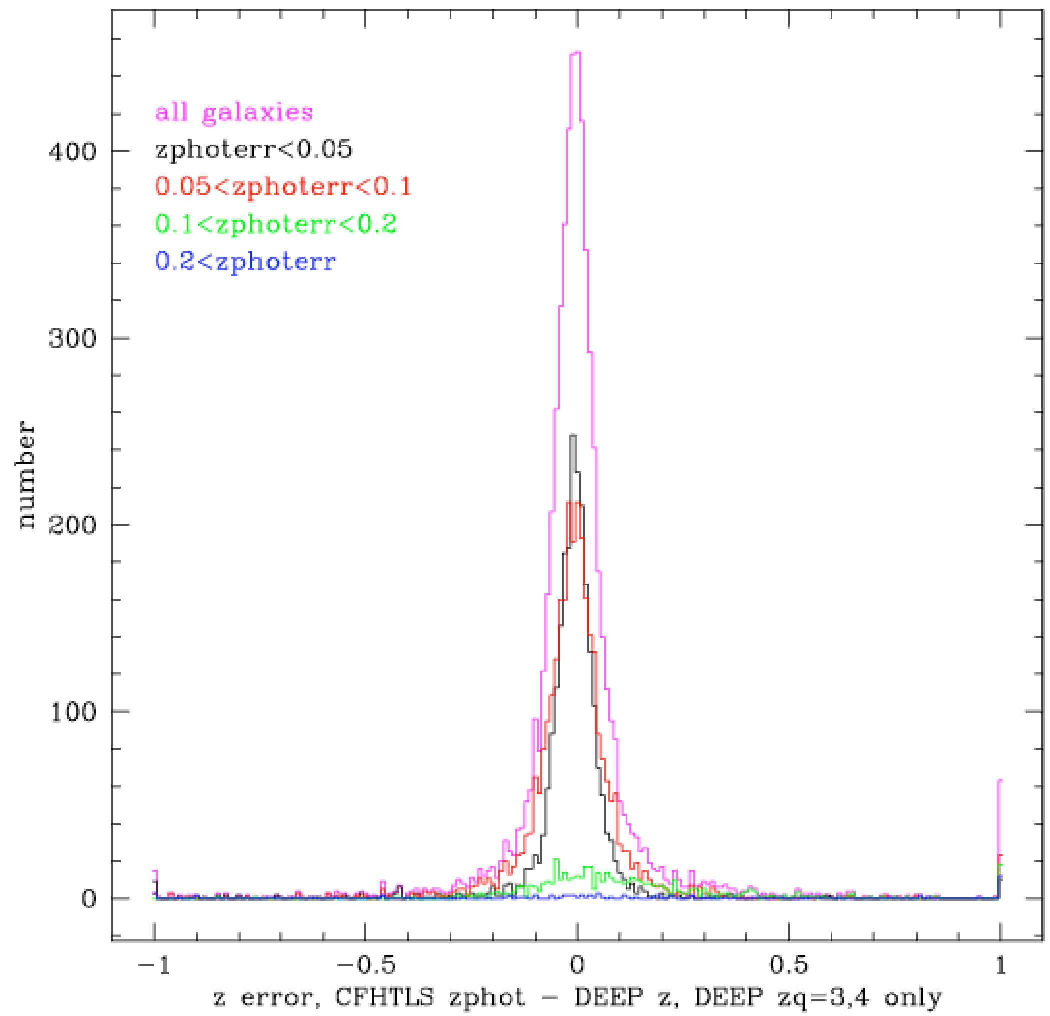


Photo-zed comparison with DEEP2 III







Computing the comoving correlation length-I

$$\omega(\theta) = \frac{H_0 H_\gamma}{c}\, \theta^{1-\gamma}\, \frac{\int_0^\infty N^2(z)\, r_0^\gamma(z)\, [x(z)]^{1-\gamma}\, E(z)\, F(z)\, dz}{[\int_0^\infty N(z)\, dz]^2}$$

Relativistic limber equation

$$\omega(\theta) = A_\omega \theta^{-\delta}$$

Assuming w(θ) is a power law…

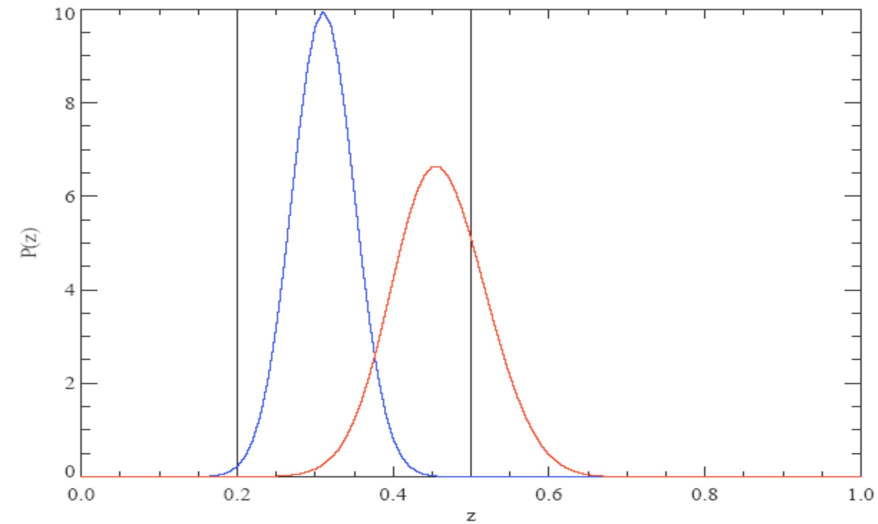
$$r_0^\gamma(z_{\rm eff}) = A_\omega \left[\frac{H_0 H_\gamma}{c}\, \frac{\int_{z_1}^{z_2} N^2(z)\, [x(z)]^{1-\gamma}\, E(z)\, dz}{[\int_{z_1}^{z_2} N(z)\, dz]^2} \right]^{-1}$$

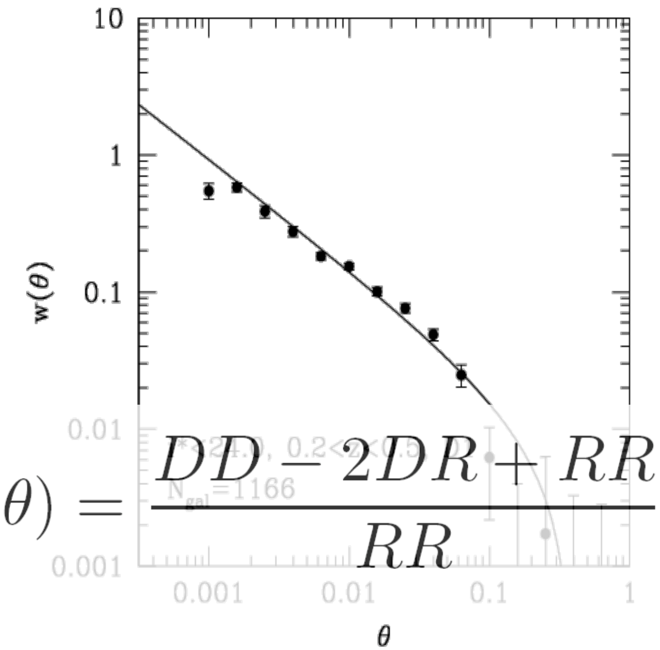
$$\omega(\theta) = \frac{DD - 2DR + RR}{RR},$$

Which you get from computing pair counts on your catalogue….

Computing the comoving correlation length

- For each galaxy in each redshift slice we compute the area under that galaxy's probability distribution function
- These areas are used as weights in the correlation function measurement
- This ensures that **all** information about the reliability of each photometric redshift is used
- The resulting measurements are then fitted with a power law with the appropriate finite-volume correction.



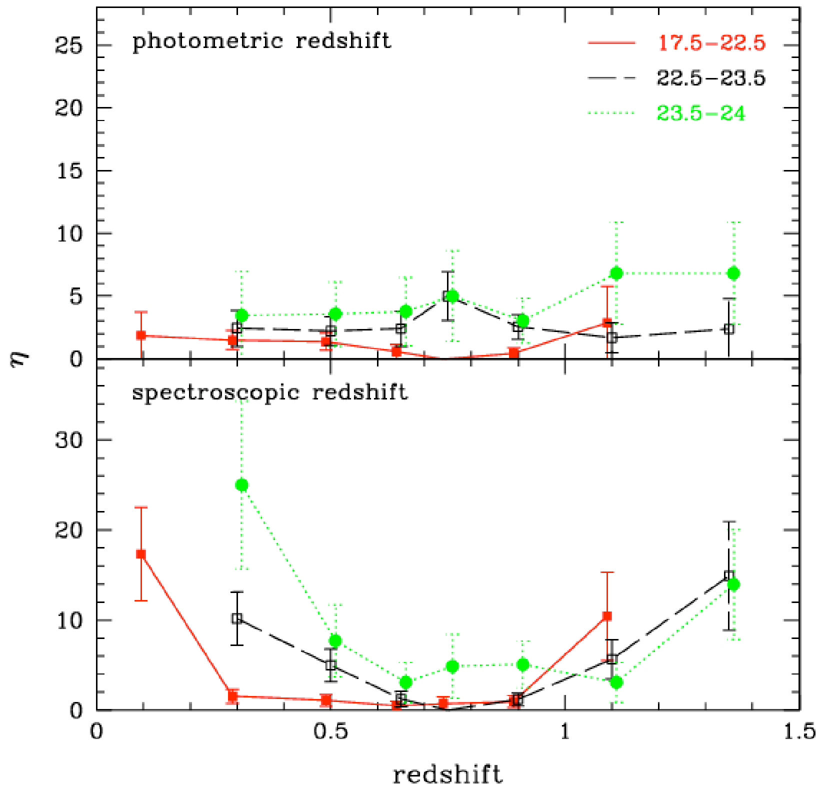


$$\omega(\theta) = \frac{DD - 2DR + RR}{RR},$$

Computing the co-moving correlation length...

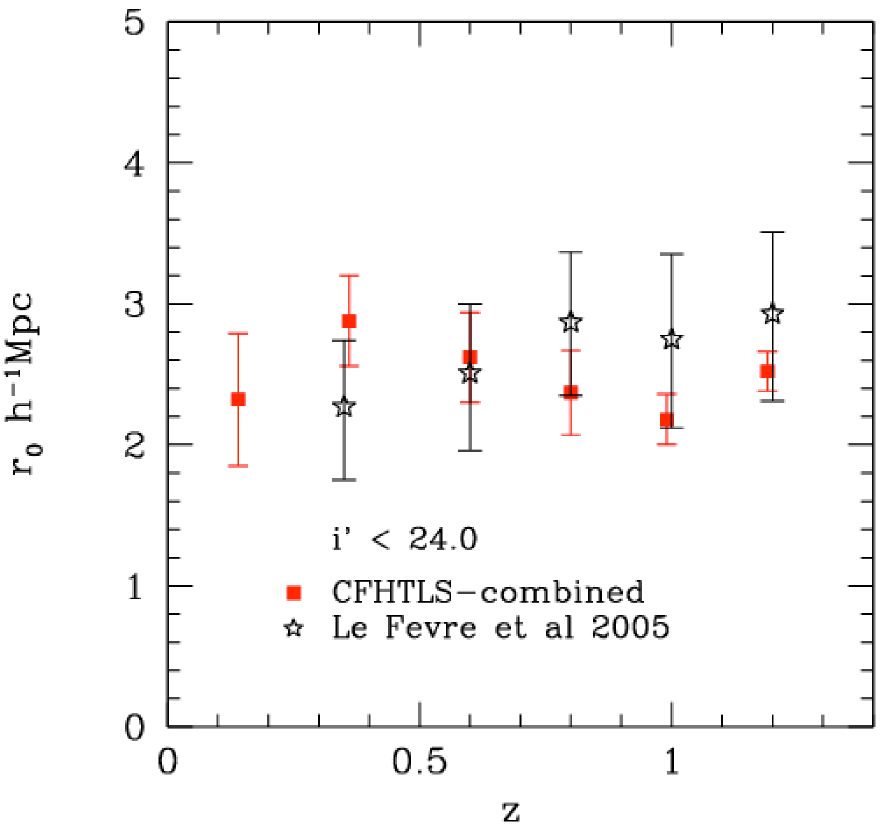
- We compute the projected correlation function w(theta) in each field using the same selection criteria
- Galaxies are selected in the redshift ranges where our photometric redshifts are most reliable, based on comparisons with VVDS spectroscopy
- Error bars presented in this work are ‘true’ cosmic variance error bars, based on independent measurements on the four cfhtls fields

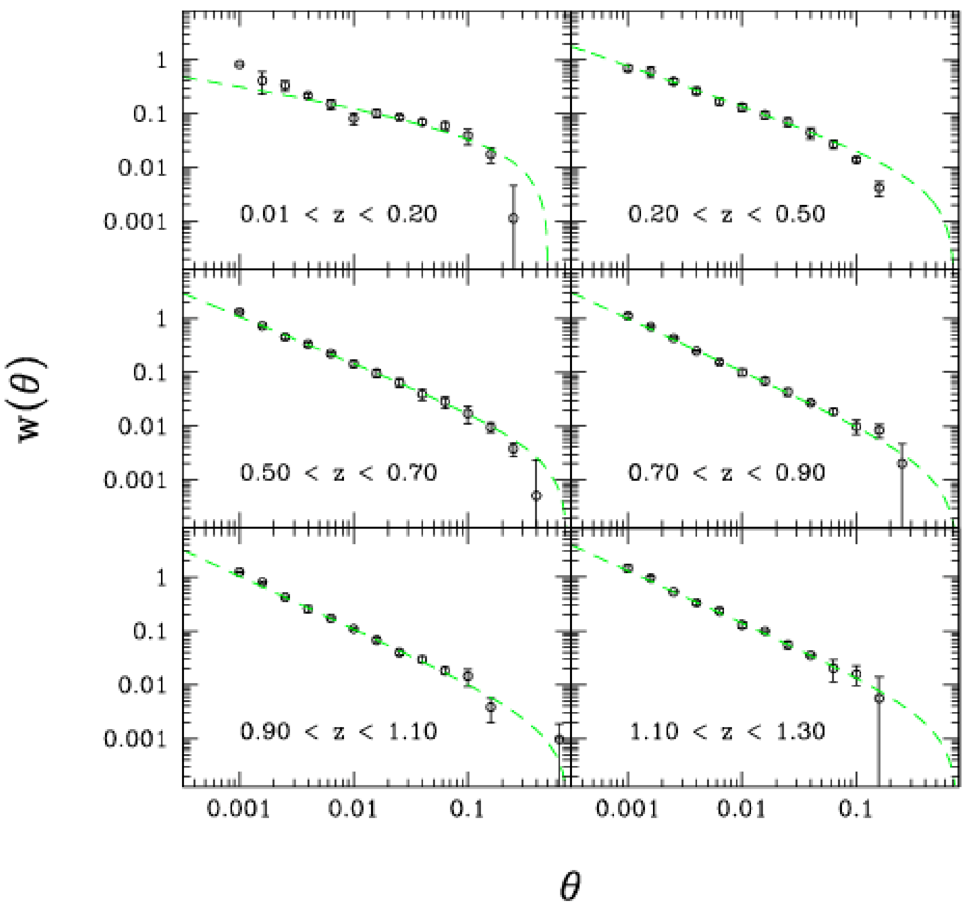
% contaminants



% incompleteness

Can photometric redshifts be used to measure galaxy clustering?

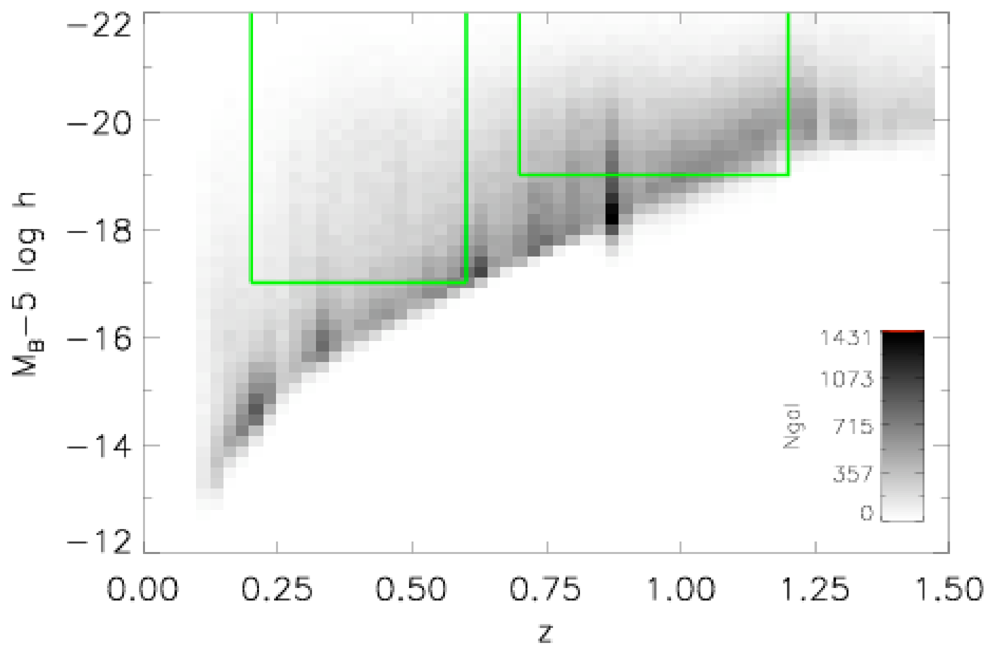


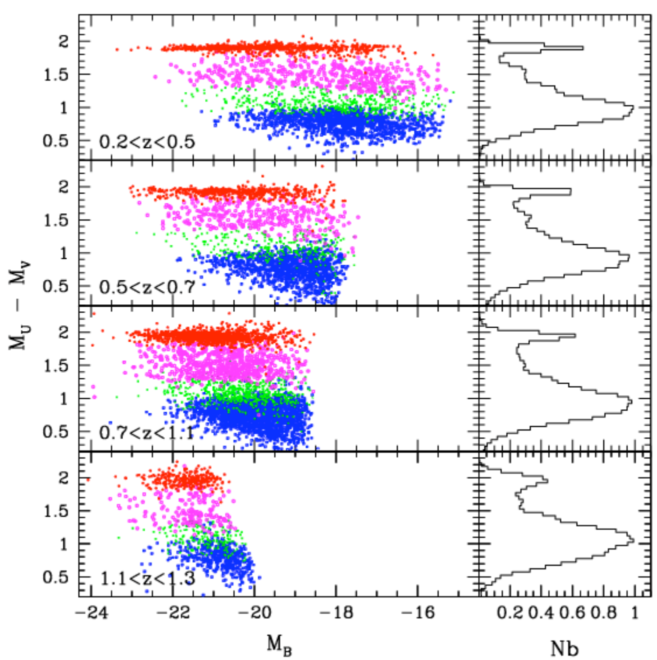


- Apply a simple magnitude-limited selection to the photometric redshifts and try to measure r0
- Excellent agreement between z-photo derived correlation and those derived with spectroscopic redshifts

Volume-limited samples

- Using the CFHTLS photo-zed we derive absolute rest-frame magnitudes for all galaxies
- We can also derive the best fitting spectral type based CWW templates

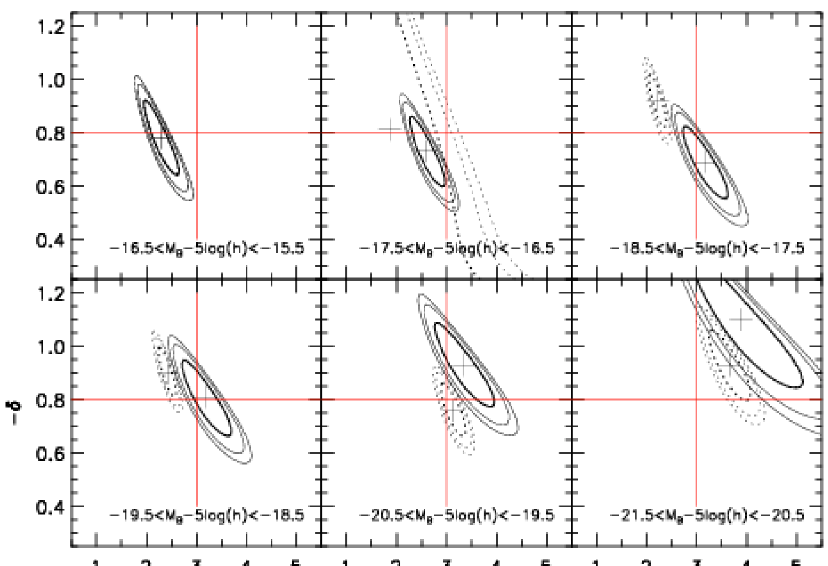




- Define two redshift ranges: $0.2<z<0.6$ and $0.7<z<1.1$; inside this range extract independent samples of different absolute luminosity
- Also define samples containing brighter galaxies in several redshift bins

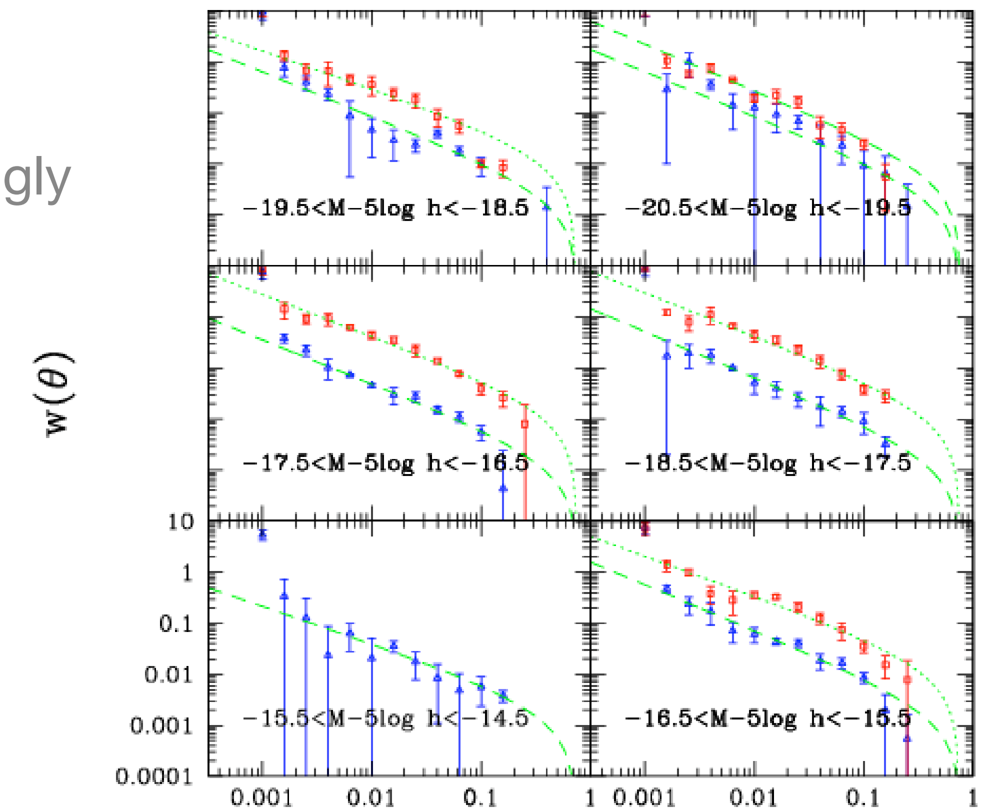
Galaxy clustering by rest-frame colour

- At any given absolute luminosity, galaxies with redder rest-frame colours are always more strongly clustered than bluer galaxies
- More luminous objects are more strongly clustered.



Galaxy clustering strength as a function of absolute luminosity and redshift

0.2<z<0.6

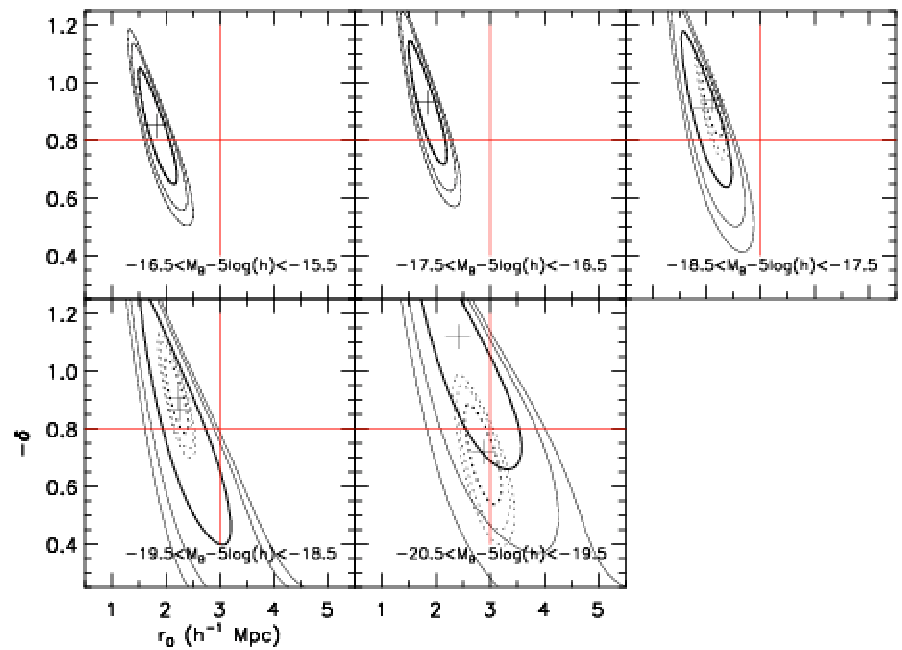


Galaxy clustering strength as a function of absolute luminosity and colour

Galaxy clustering by type, luminosity and redshift

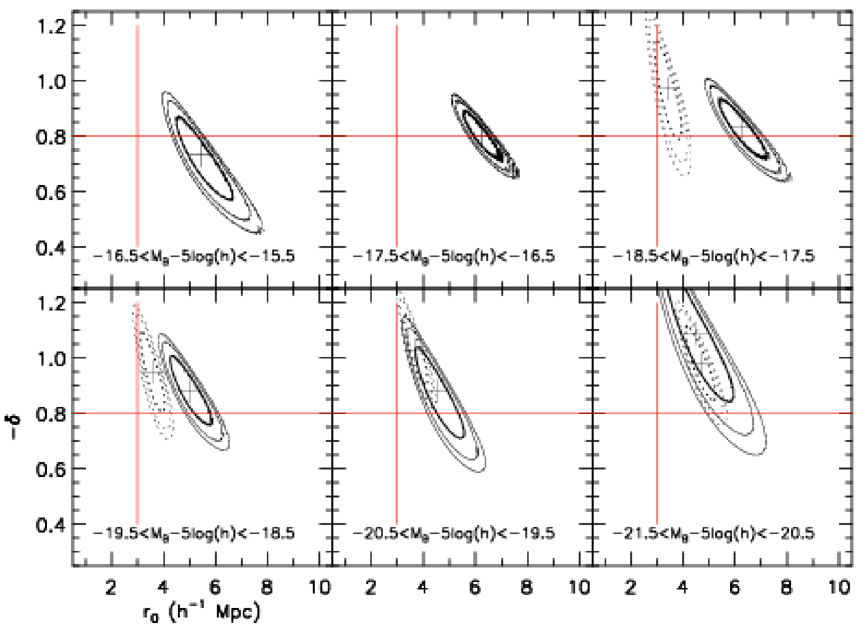
- At low redshifts, faint elliptical galaxies are strongly clustered
- Clustering amplitude of late type galaxies does not depend on luminosity in either redshift range

Late-type galaxies



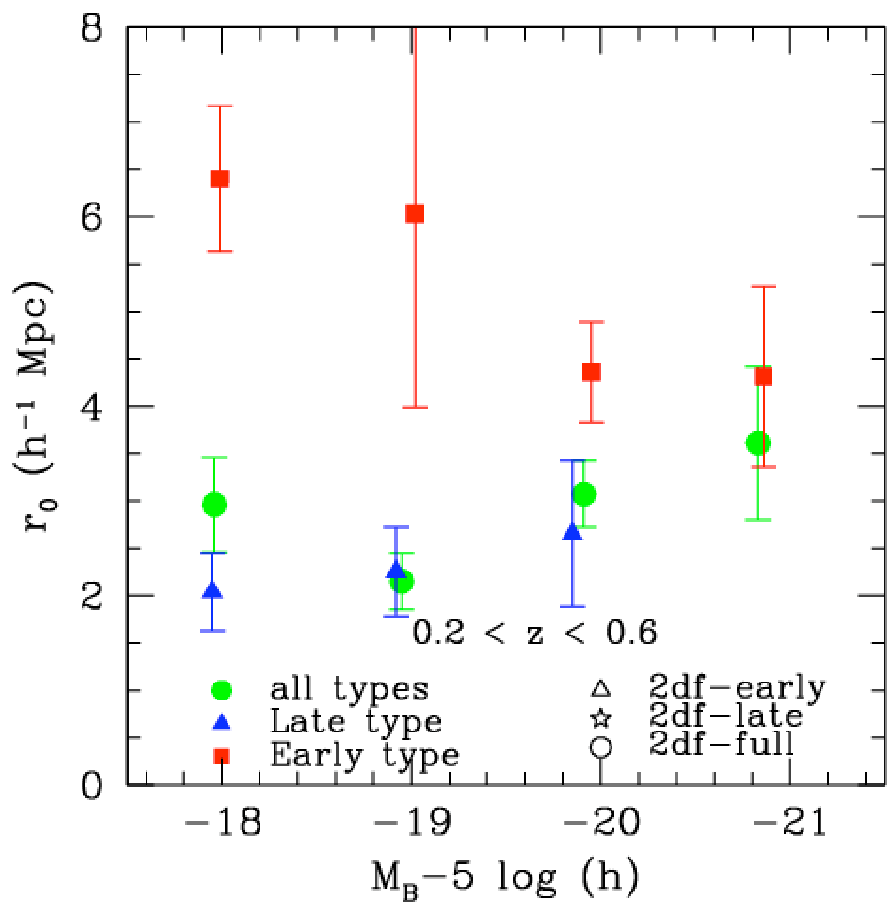
Dotted lines:high zed

Dashed lines: low zed

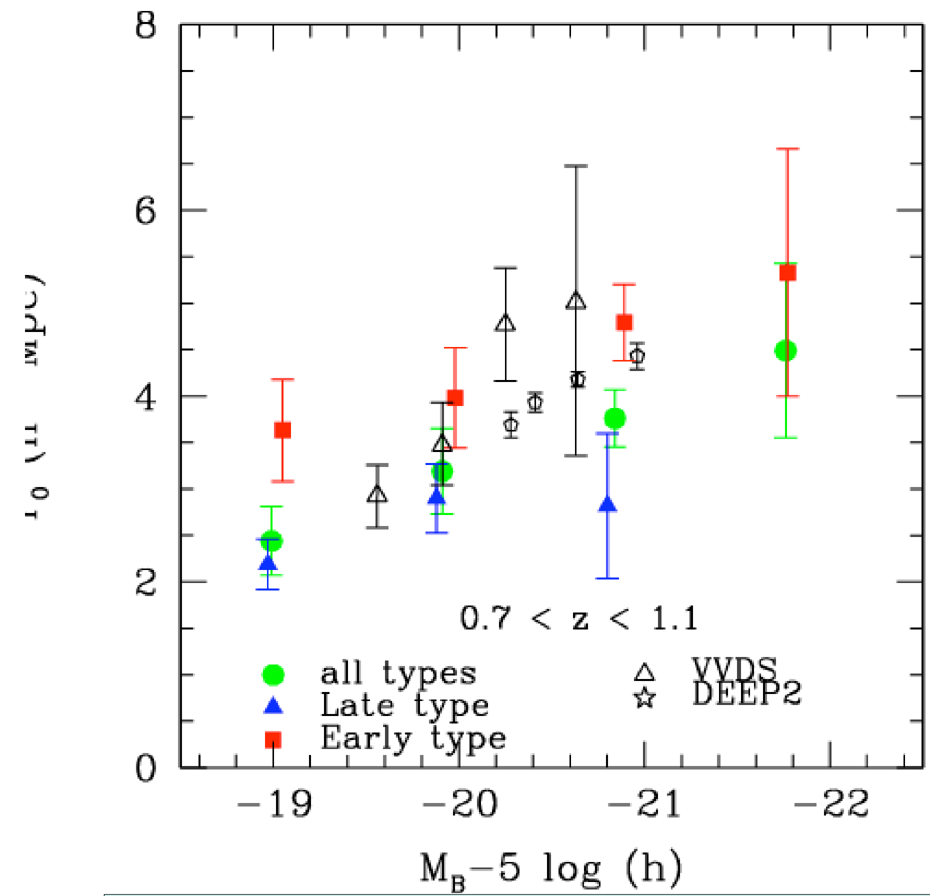


Early-type galaxies

Summary of results ...



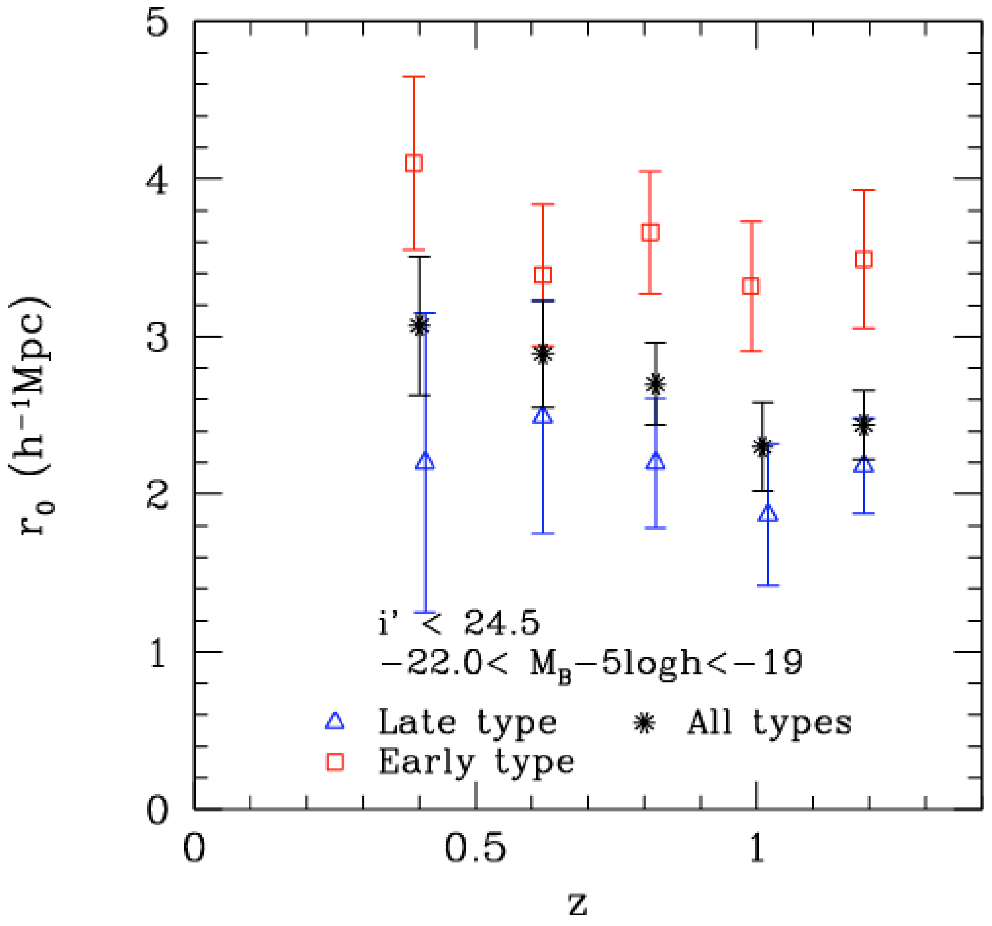
Galaxy clustering strength as a function of absolute luminosity and type at low redshift



Galaxy clustering strength as a function of absolute luminosity and type at high redshift

Evolution of galaxy correlation lengths in volume-limited samples

- We can also create a series of volume limited samples at fixed luminosity which we can follow from low redshift to high redshift
- In this case we are following only the brightest part of the galaxy luminosity function
- In this absolute luminosity range, clustering amplitudes change little for red and blue populations
- However, for the full galaxy sample, the increasing fraction of luminous blue starburst galaxies at high redshift causes r0 to decrease



Relative bias between blue and red galaxy samples

- Can compute the relative bias between red and blue populations. At low redshifts the different in clustering amplitudes between the red and blue population is large
- At high redshifts this difference is smaller
- The relative bias between the full galaxy population is close to 1 for bright galaxy samples (consistent with Marinoni et al. 2005)
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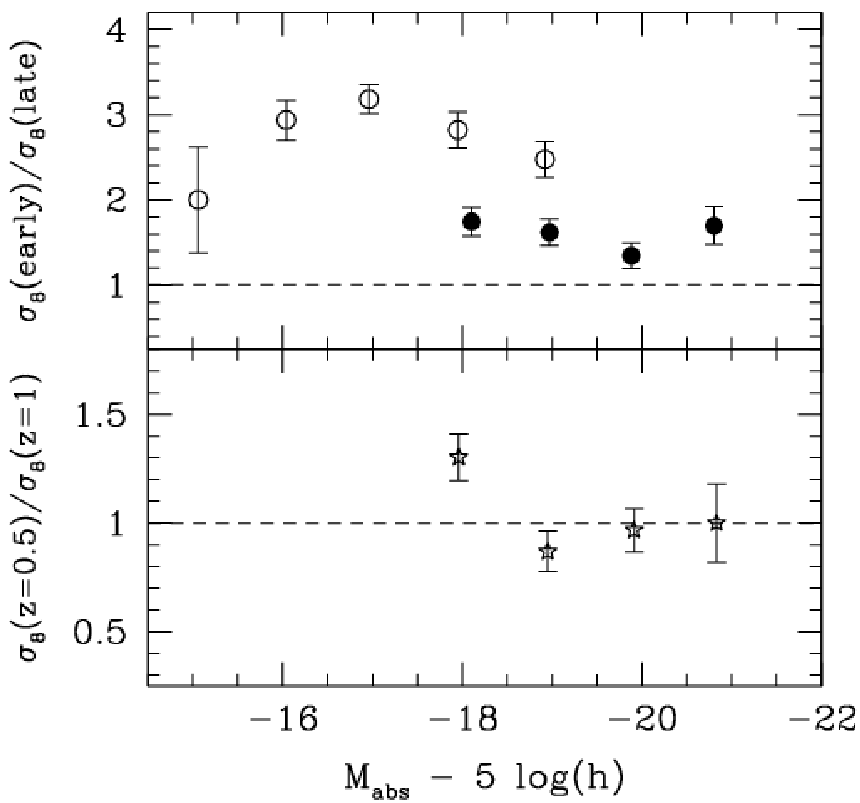
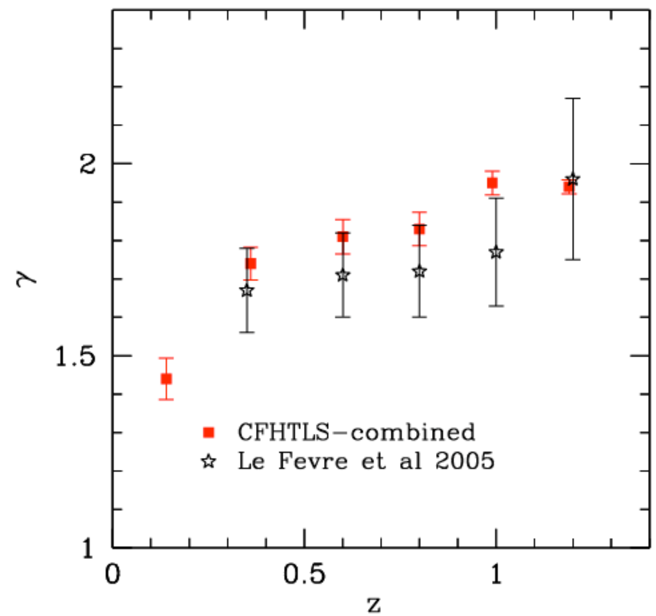
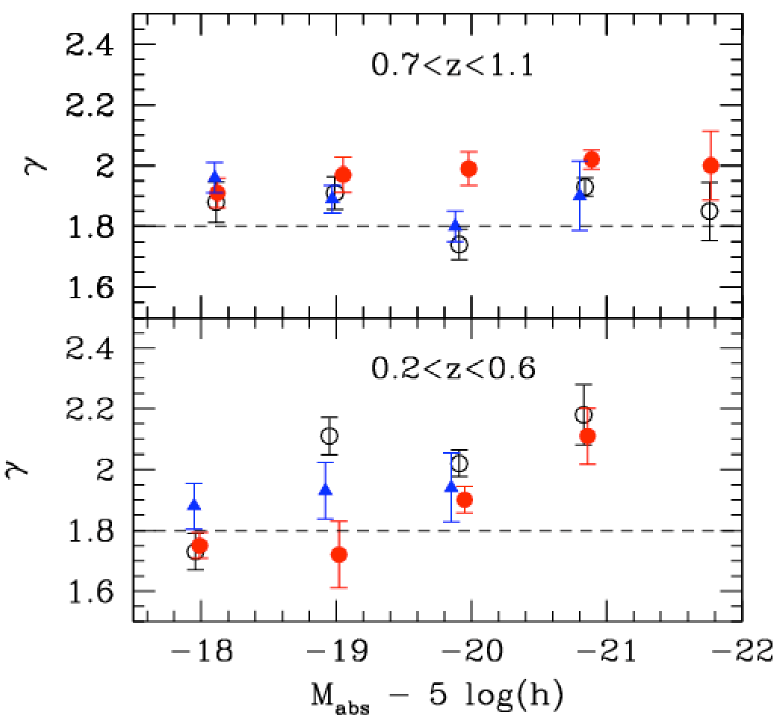


Slope of w(theta)

- Thanks to the large coverage of the CFHTLS fields we can easily measure the slope of w(theta) (in all cases we carry out simultaneous indepenent fits to amplitude and slope





- At low redshifts, more luminous ellipticals have a steeper slopes
- The slope for spiral objects is independent of absolute magnitude and redshift

Conclusions and what it all means

- For the full galaxy population, galaxy clustering amplitude depends on absolute luminosity
- Separating objects by rest frame absolute luminosity, this dependence is less pronounced
- For early type galaxies, at z~0.5, faint galaxies are strongly clustered
- For late-type galaxies, clustering strength does not depend (strongly) on absolute luminosity
- Clustering amplitude of bright spirals and ellipticals does not depend on redshift, but for the full galaxy population it decreases with redshift

- Faint elliptical galaxies inhabit dense environments
- Faint spiral galaxies inhabit low density environments
- 'Second parameter' effects are important; luminosity is not everything!