Galaxy clustering out to z~1.5 from field-to-field variations of WISP galaxy number counts

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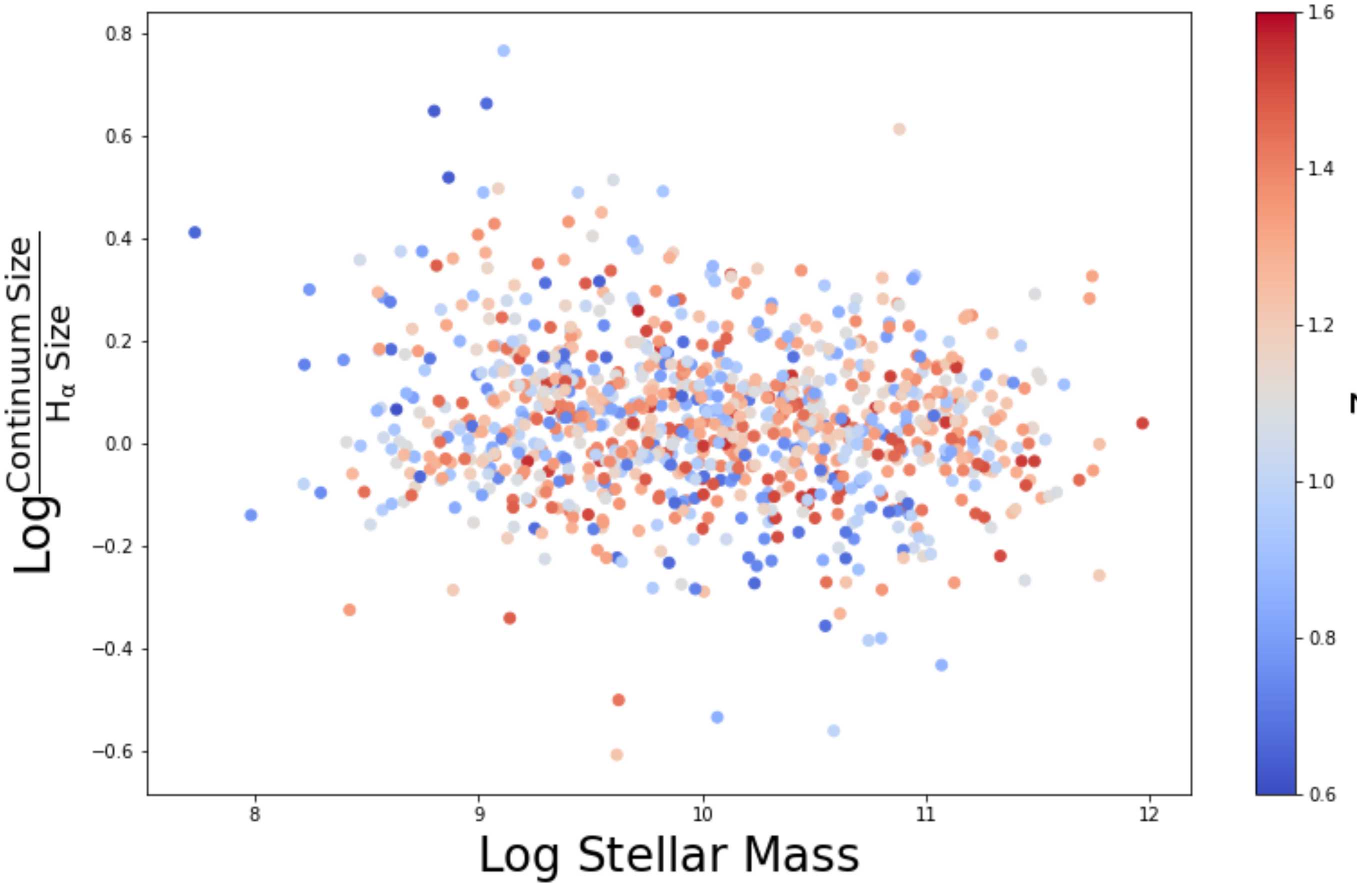
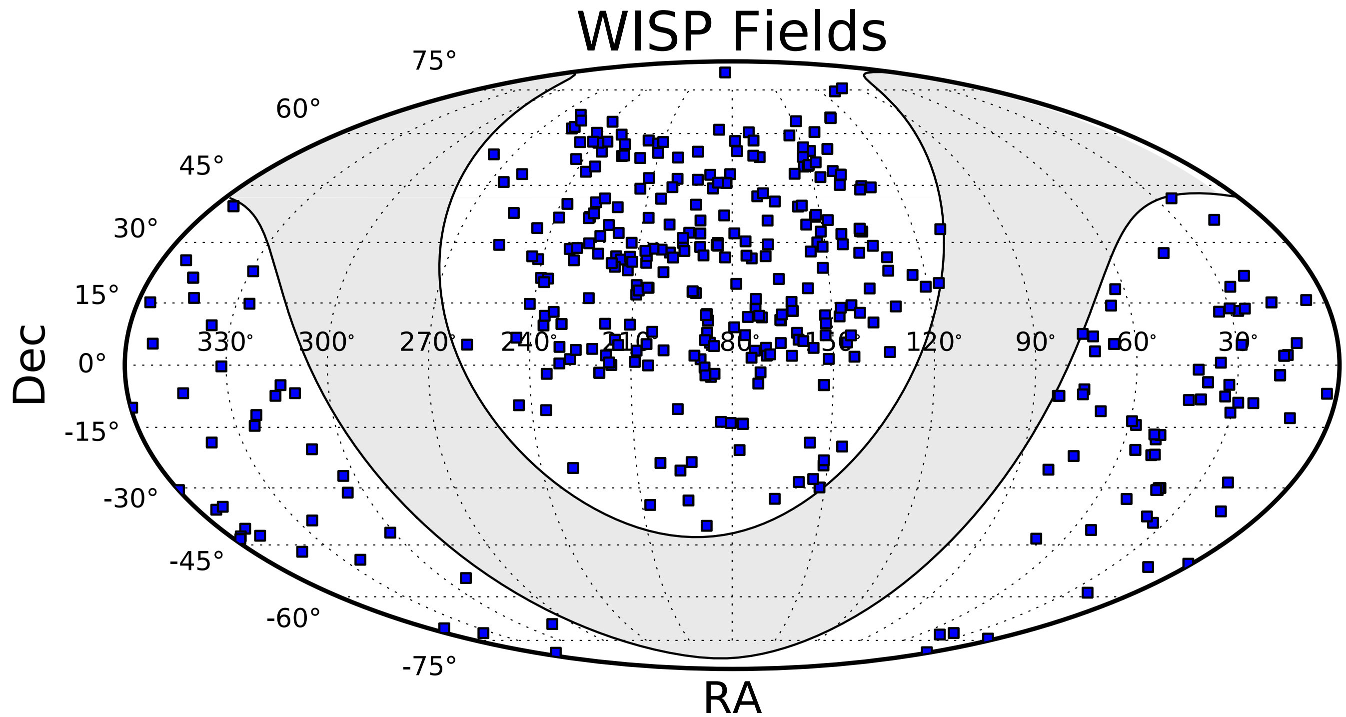
Hα EMISSION HALF-LIGHT RADII

More massive objects tend to have similar continuum / line sizes, while low mass galaxies have larger sizes in the continuum compared with Ha.



Introduction



The availability of a large number of independent fields allows the study of the clustering properties of star-forming galaxies over the scale of the WFC3 field of view

Introduction

The clustering strength can be quantified with the galaxy cosmic variance

$$\sigma^2_{gal} \triangleq \frac{1}{V} \iint_V \xi_{gal}(r_{12}) dV_1 dV_2$$

volume average of the 2-point correlation function over the field volume

WISP provides many independent measurements of the number of galaxies (N) in a volume V. The relative variance of the observed number counts is not simply σ_{gal} but depends on the combination of:

— large-scale structure

— Poisson noise associated with the discrete sampling of the matter field

— observational incompleteness $N_{raw} \Rightarrow N_{CC}$

— variable depth

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Two ways:

1) Limit the analysis to a common luminosity limit

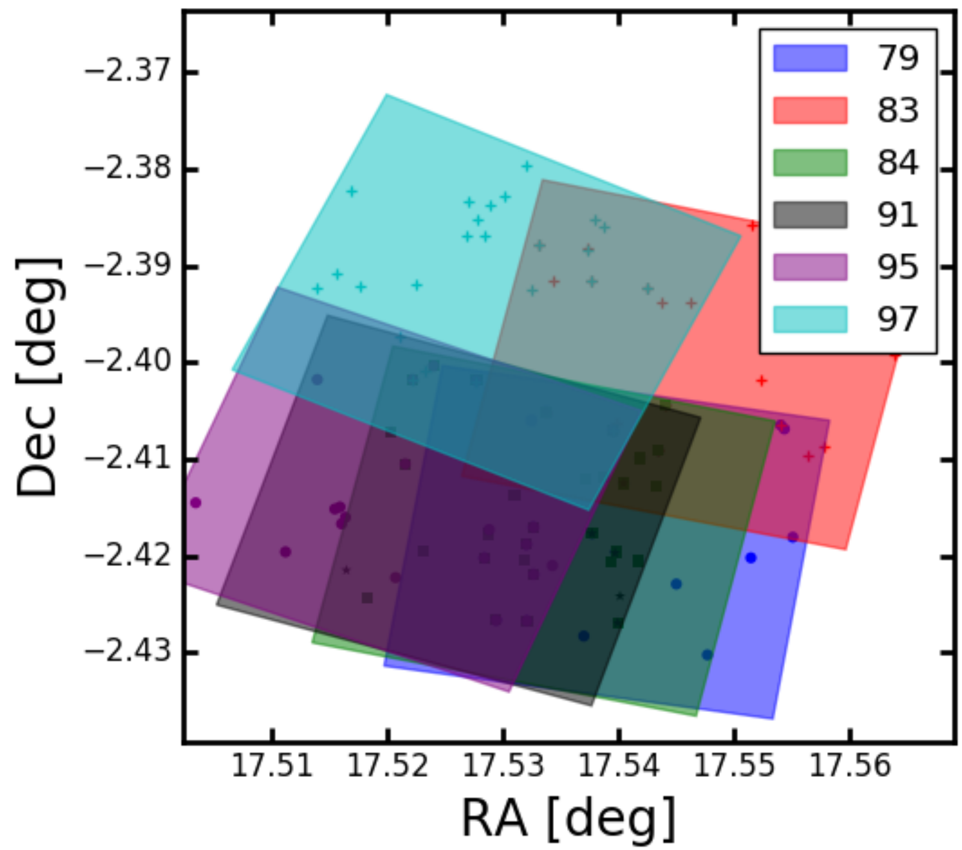
2) Correct for the additional variance

$$\sigma^2_{gal} = \frac{<(N-\mu)^2> - \mu - \sigma^2_{FL}}{\mu^2}$$

Field and galaxy selection

We start with 434 fields, and apply the following cuts:

— 37 overlapping fields

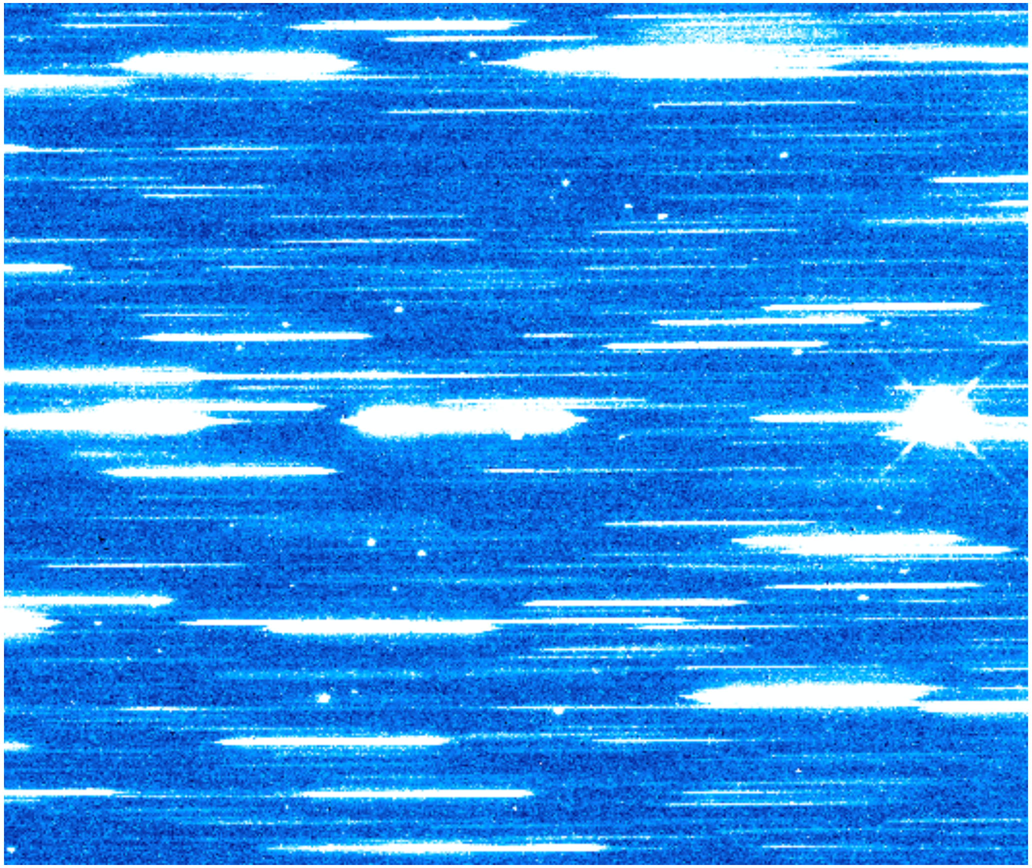


Field and galaxy selection

We start with 434 fields, and apply the following cuts:

— 37 overlapping fields

— 48 crowded, or contaminated by bright sources



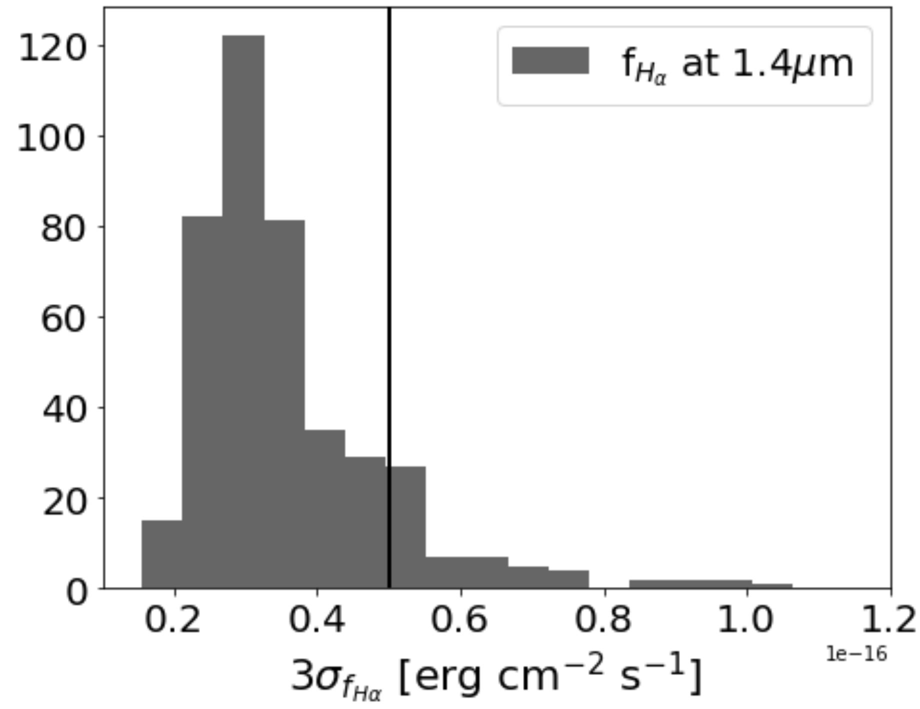
Field and galaxy selection

We start with 434 fields, and apply the following cuts:

— 37 overlapping fields

— 48 crowded, or contaminated by bright sources

— 32 with much shallower depth



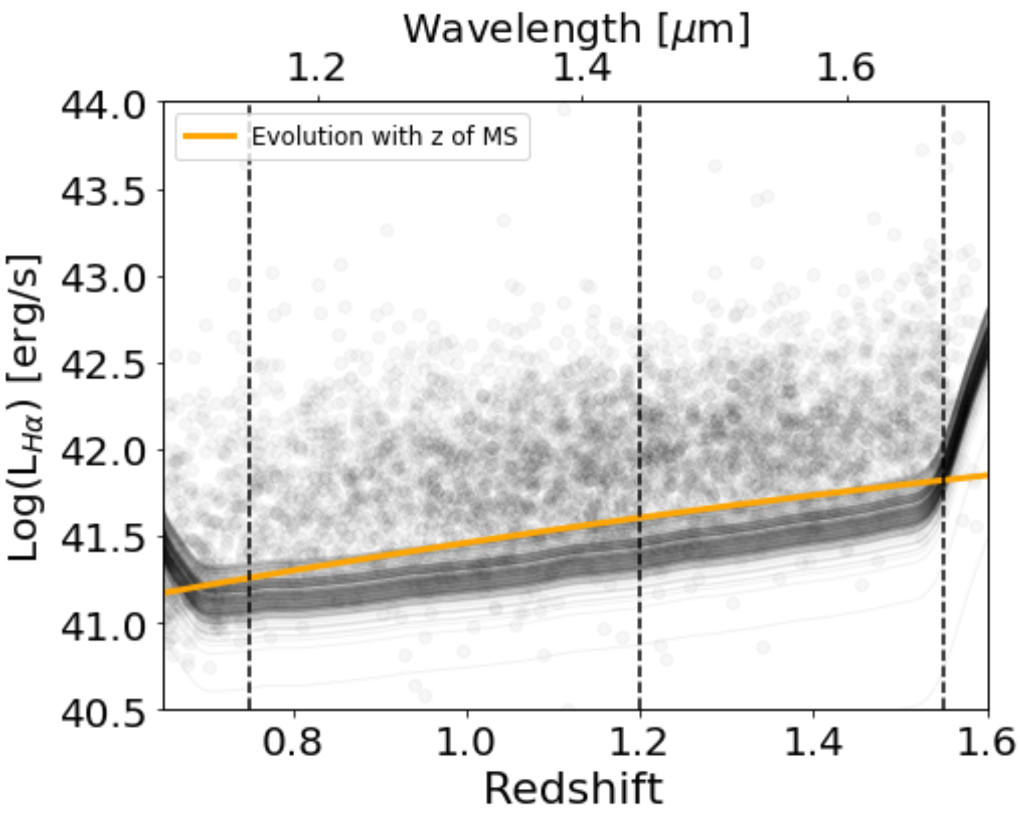
317 fields (186 with both grisms and 147 with red grism only)

Field and galaxy selection

We consider all Hα galaxies in the 0.75 — 1.55 redshift range (~3500 objects).

We split in redshift, at z=1.2, to ensure the same volume in the two redshift ranges.

At each redshift we include galaxies above a redshift dependent luminosity limit.



Field and galaxy selection

The SFR — Mass relation evolves with redshift, mainly in its normalization.

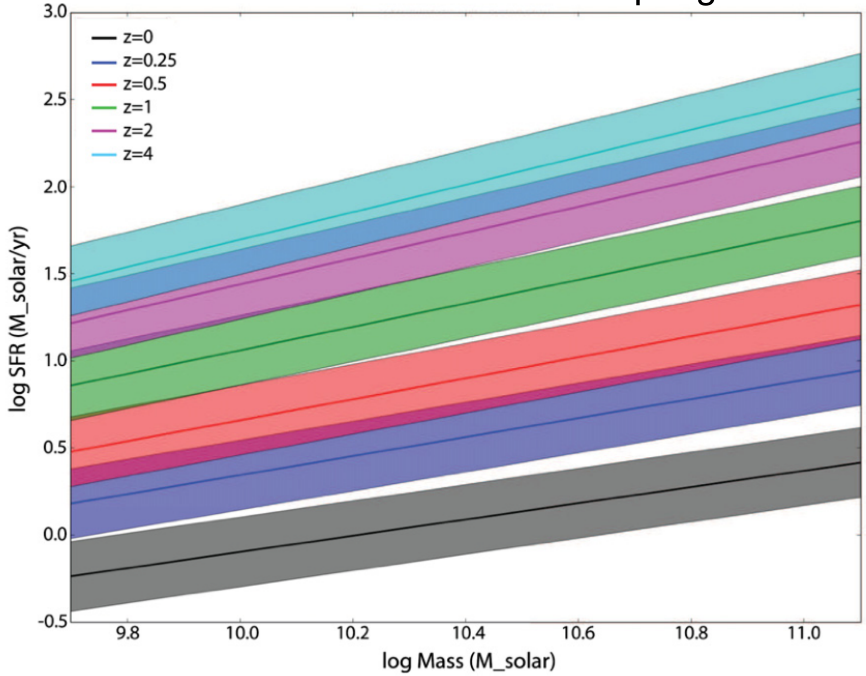
$\log(SFR(z)) \propto \beta(z)$

$\beta(z) \sim 1.14z - 0.19z^2$ Whitaker et al. 2012

$\log(SFR) \propto \log(L_{H\alpha}) \Rightarrow$

$\log(L_{H\alpha}) \propto \beta(z) \sim 1.14z - 0.19z^2$

Speagle+2014

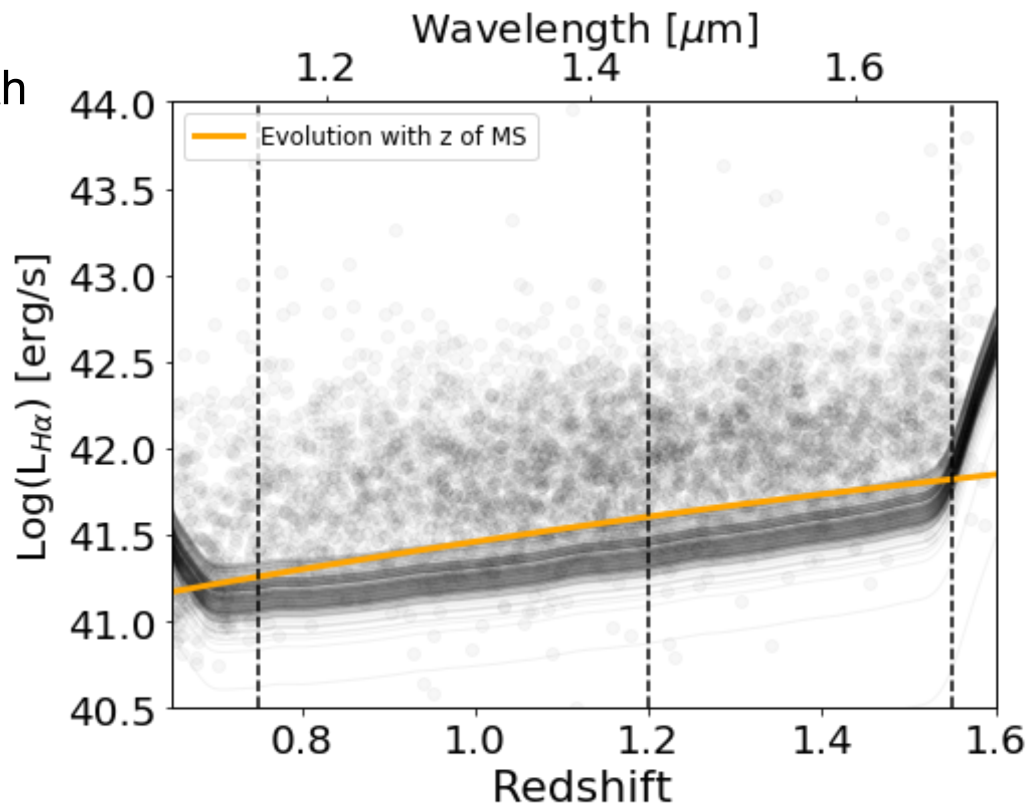


Field and galaxy selection

The SFR — Mass relation evolves with redshift, mainly in its normalization.

$\log(L_{H\alpha}) > 40.55 + 1.14z - 0.19z^2$

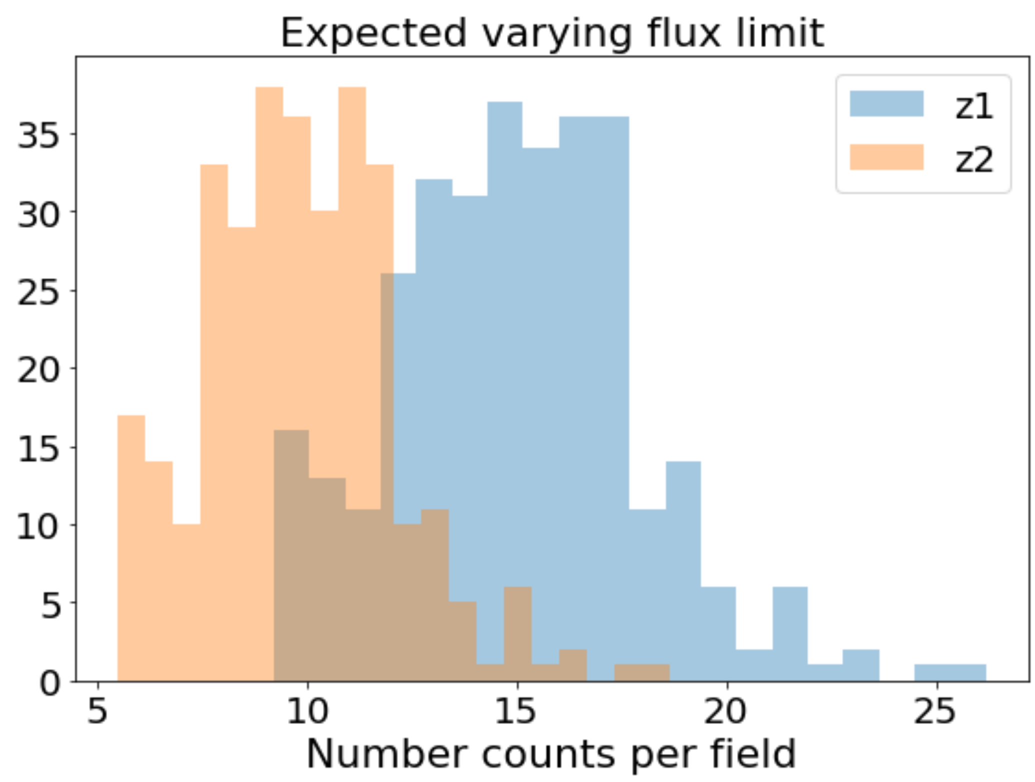
$L_{H\alpha}$ limit corresponds to $0.7L^*_{H\alpha}$ at $z=0.75$



Field and galaxy selection

We can estimate σ_{FL} looking at the dispersion in the number counts predicted by integrating the Hα luminosity function(*) down to the flux limits of each of the 317 fields

A correction of 5% to the variance



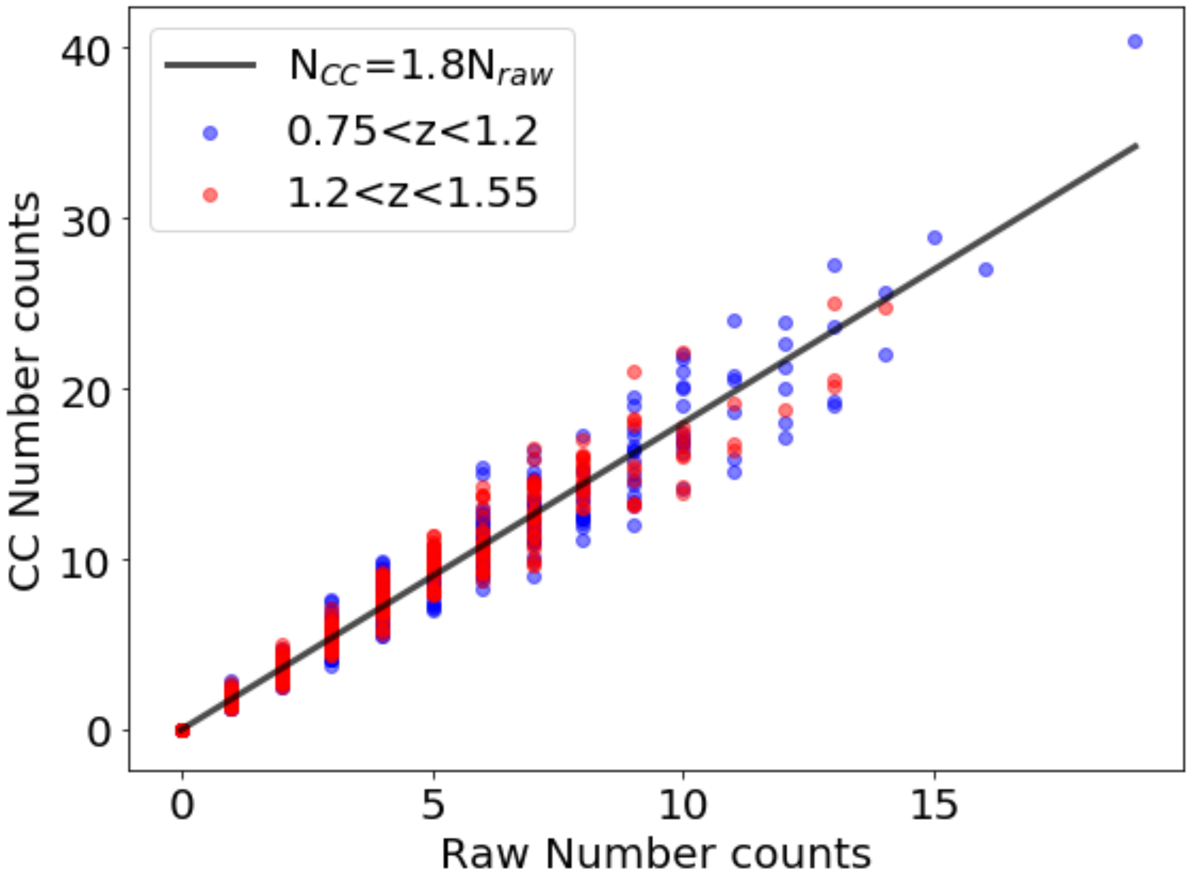
(*) We used the Colbert et al.(2013) Hα luminosity function with the Sobral et al. parameterization for the redshift evolution.

Field and galaxy selection

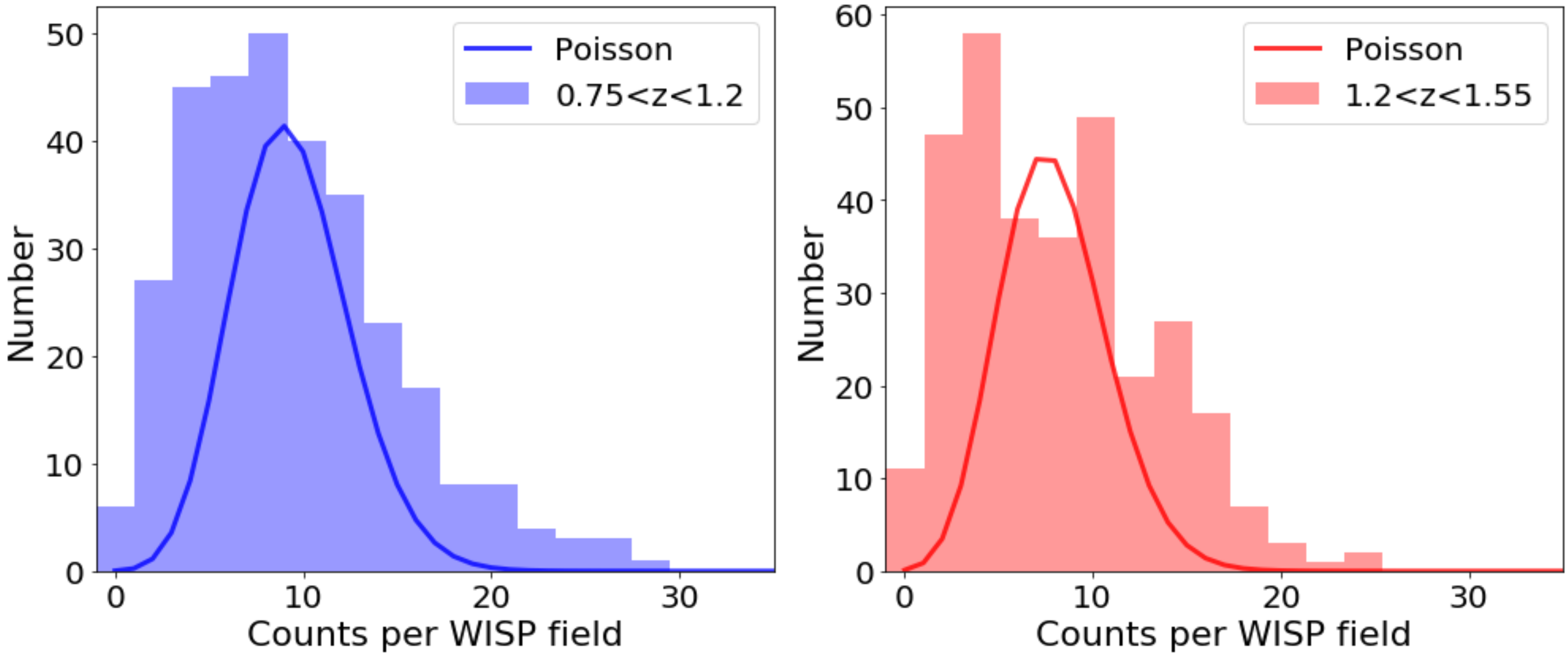
The number of galaxies above the evolving $L_{H\alpha}$ limit is used to compute the completeness-corrected number counts per field as:

$$N_{CC}=\sum_i 1/C_i(f_{H\alpha},EW_{H\alpha})$$

Number of Galaxies in Z1 = 1667
Number of Galaxies in Z2 = 1389



Counts in Cells results

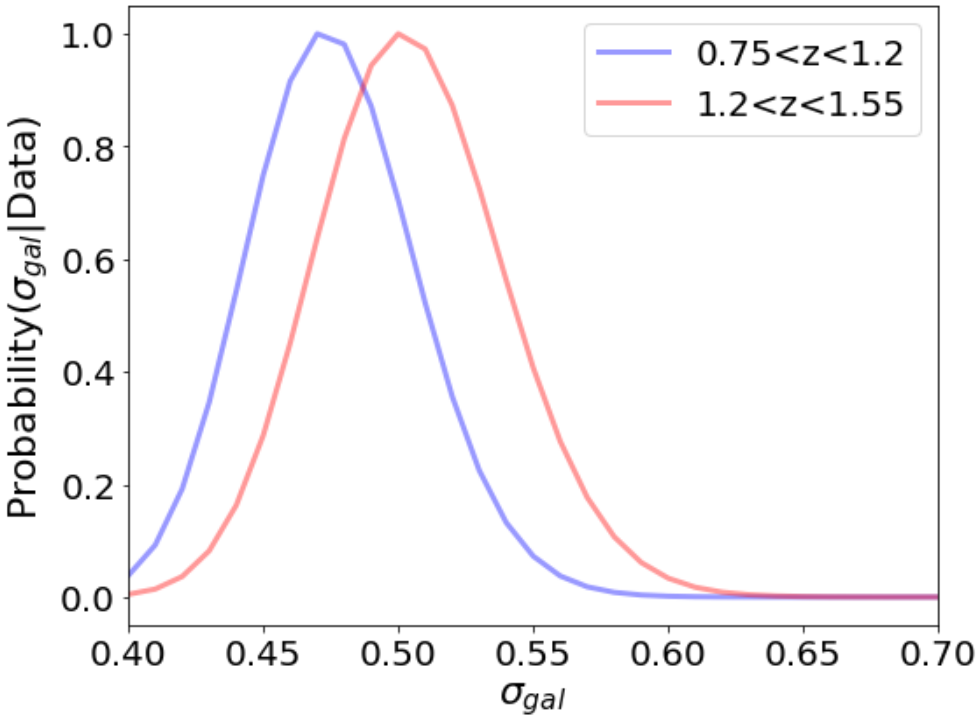


Poisson distributions with the same means are clearly narrower than data, cosmic variance is contributing to the observed spread.

Counts in Cells results

To compute σ_{gal} from the observed counts in cells, we assume that number counts are the result of Poisson sampling of the underlying matter density fluctuation field (δ_{gal}).

Assuming that δ_{gal} follows the log normal PDF originally proposed by Coles and Jones (1991), then:



$$P(N \mid \mu\sigma^2_{gal}) = \int_{-1}^{\infty} P_{LN}(\delta_{gal} \mid \sigma^2_{gal})\, d\delta_{gal} \exp[-(1+\delta_{gal})\mu](1+\delta_{gal})^N \mu^N / N!$$

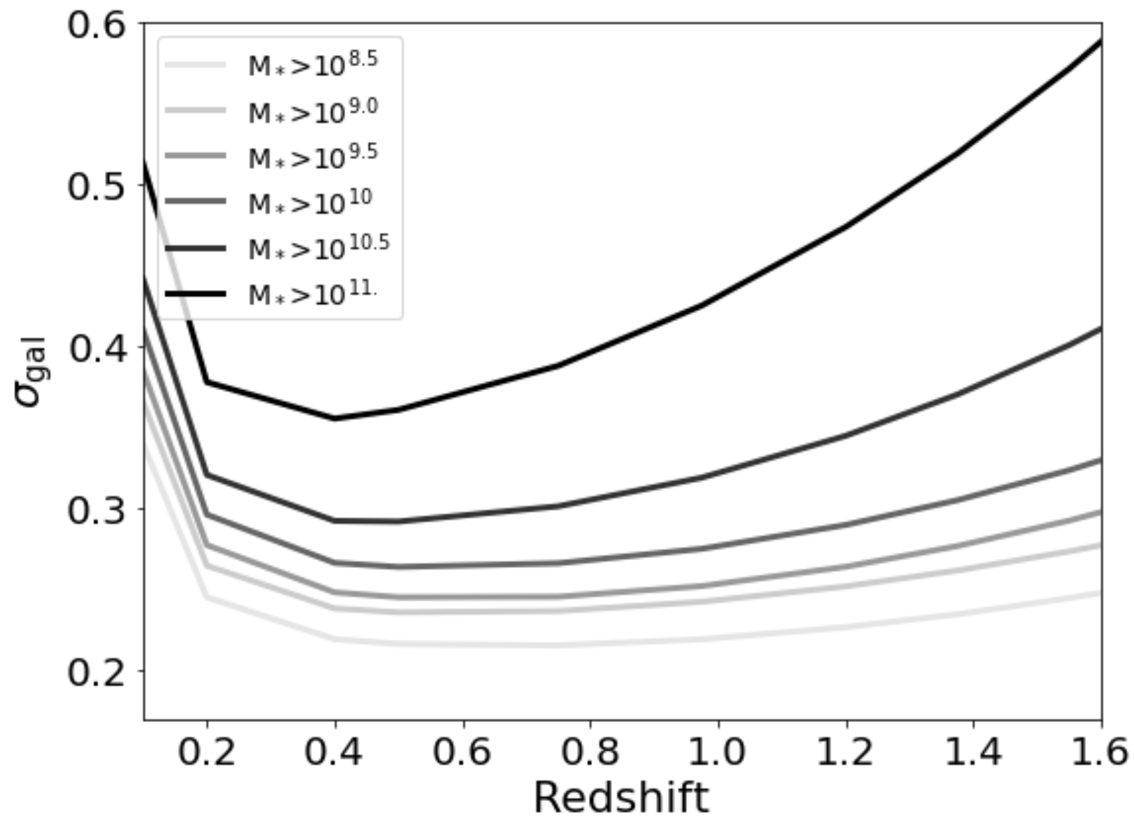
Counts in Cells results

Moster+2010 used a Halo Occupation Distribution (HOD) model to derive an empirical relationship between stellar mass and dark matter halo mass.

Together with N-body simulations they computed the galaxy bias as function of stellar mass and redshift.

$$b^2(M_*, z) \triangleq \xi_{gal} / \xi_{DM}$$

$$\rightarrow \sigma^2_{gal}(M_*, z) = b^2(M_*, z)\sigma^2_{DM}(z)$$



Predictions computed for the appropriate WISP cell volume (area and Δz)

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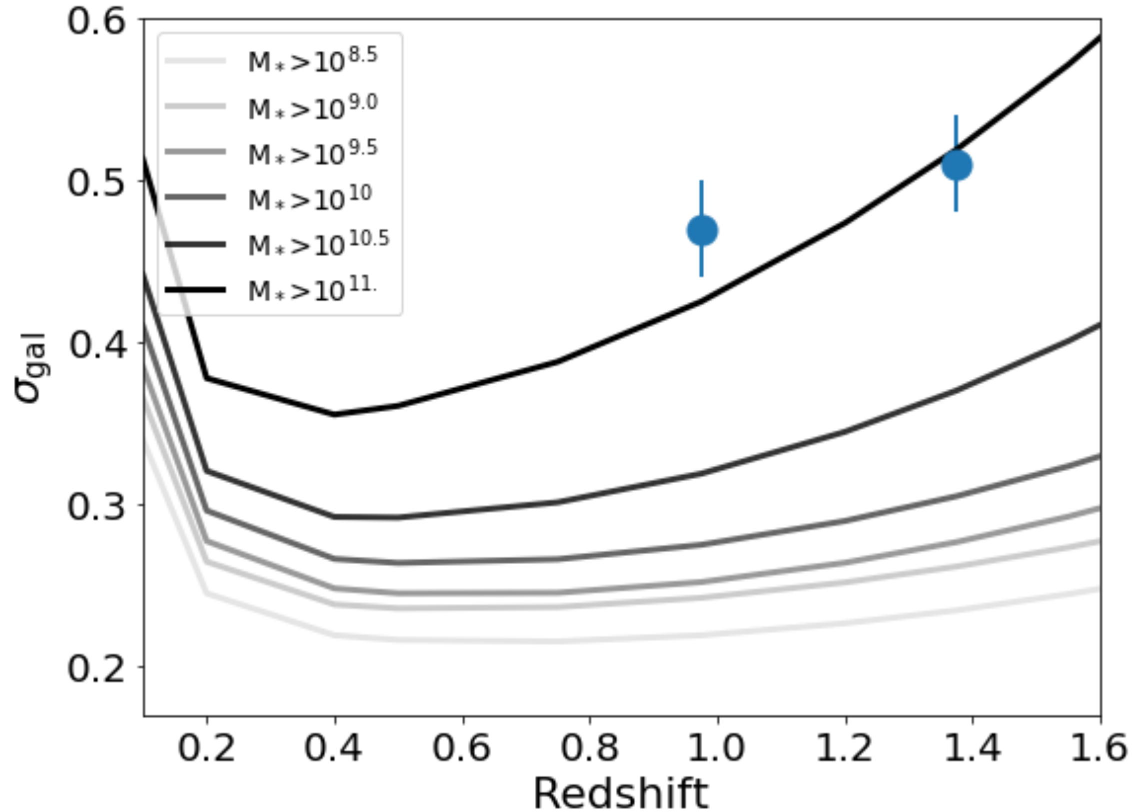
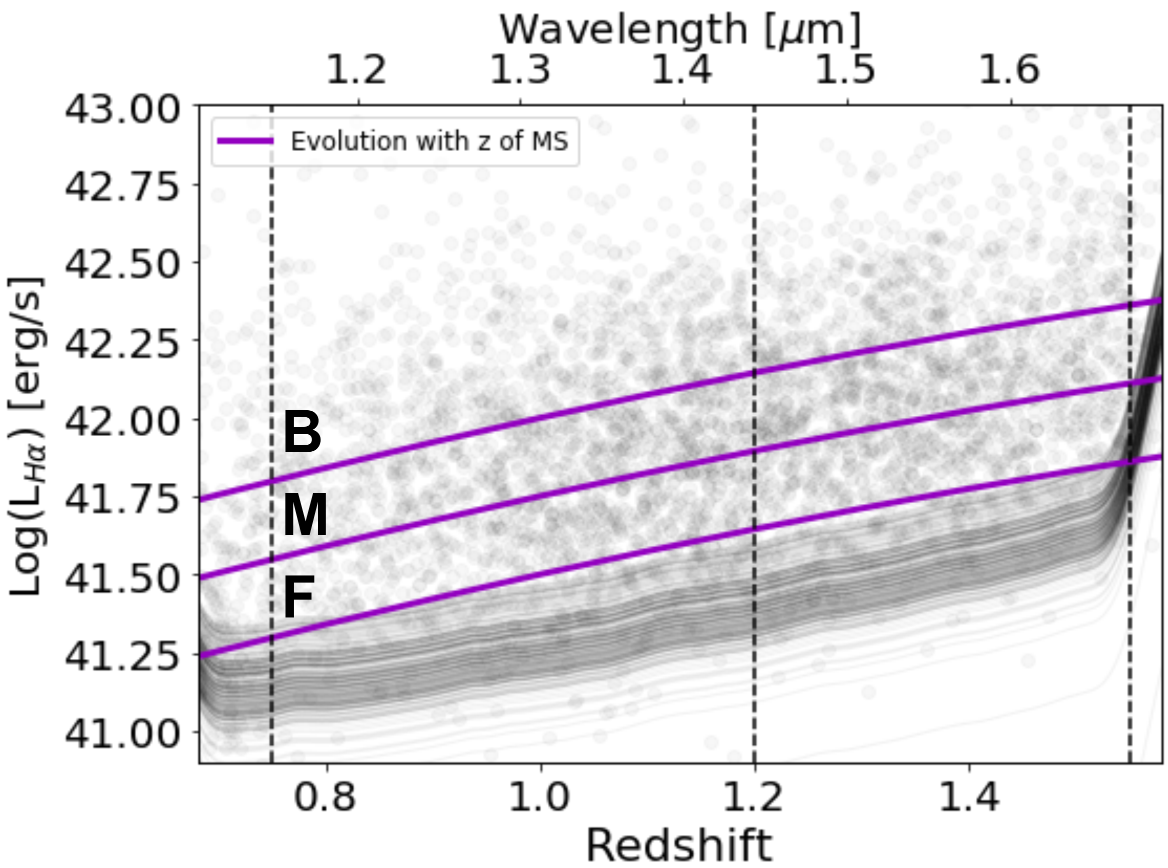
Hα selected galaxies are clustered like the most massive objects at z>1

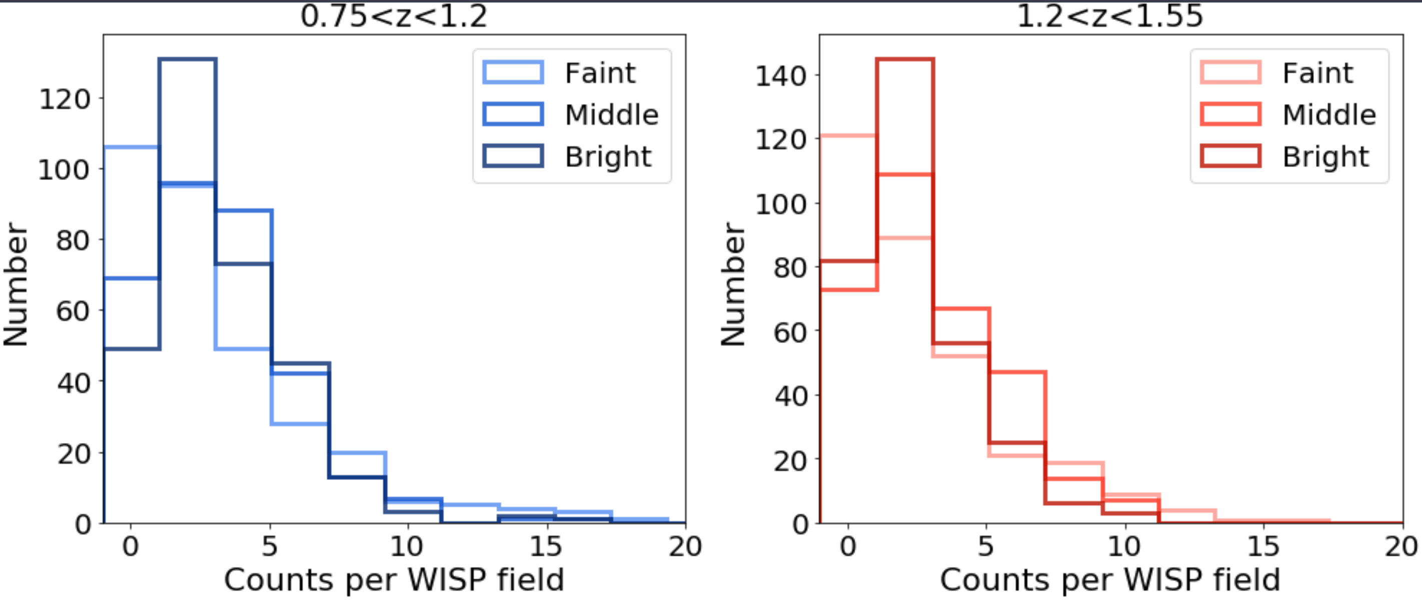


Counts in Cell results

	0.75<z<1.2	1.2<z<1.55
Faint	980	871
Middle	1004	944
Bright	1004	713

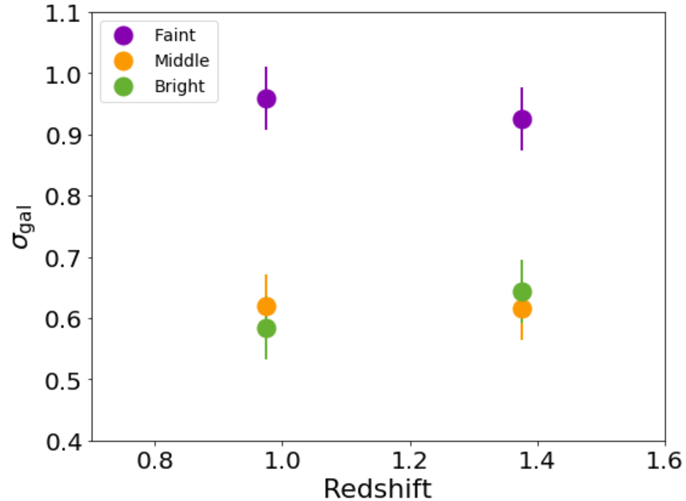


Counts in Cell analysis

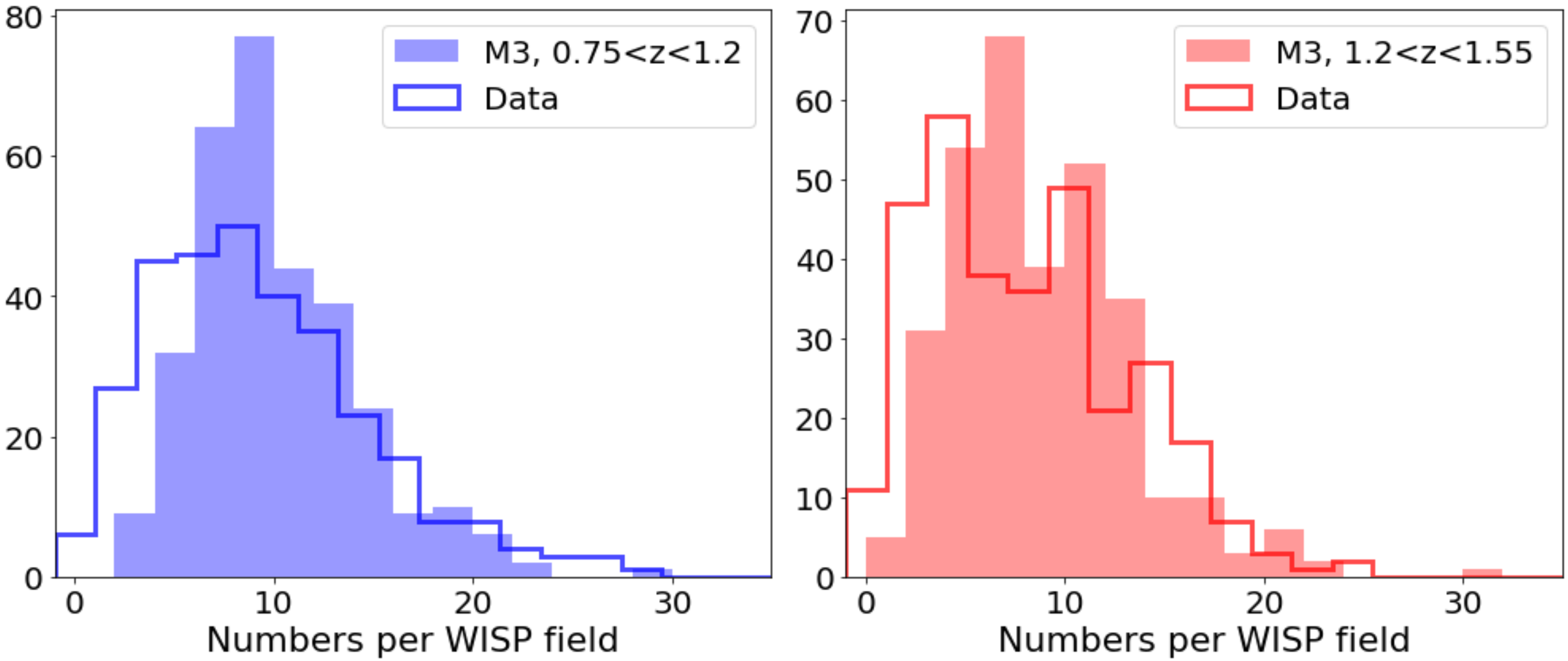


Fainter galaxies have larger cosmic variance compared to the brighter ones.

Are we preferentially selecting compact satellites of more massive objects?



Comparison with Flagship simulations



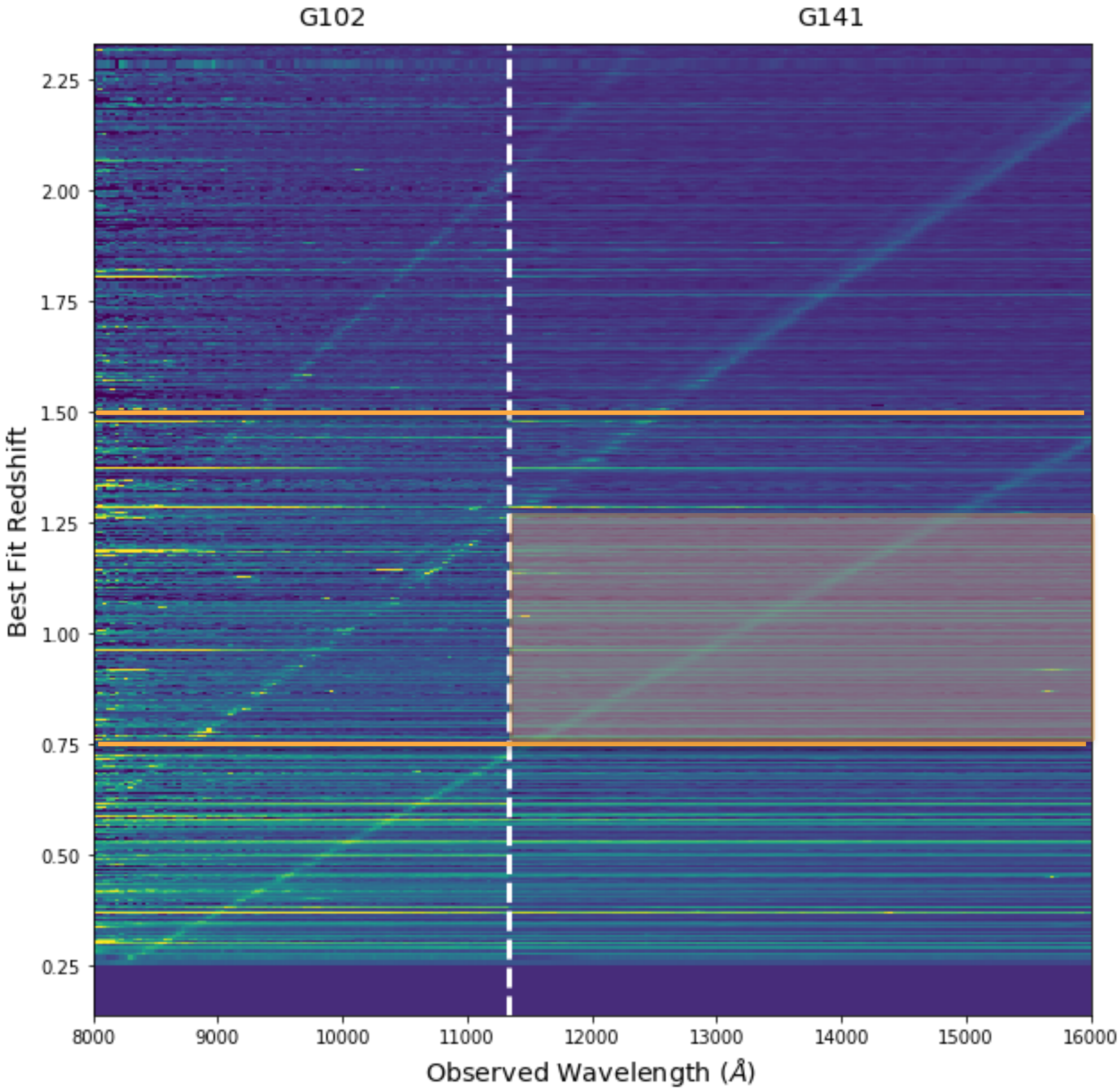
The mean number counts agree between flagship simulations and observations.
The widths of the distributions are somewhat narrower in the simulations compared to the real data, suggesting again a smaller predicted cosmic variance

Conclusions & future work

- We performed a counts in cells analysis of the Hα selected galaxies in the WISP survey in two redshift bins at 0.95±0.2 and 1.35±0.2
- We find large values of the galaxy cosmic variance, consistent with the clustering strength predicted for the most massive objects at these redshifts
- Faintest Hα galaxies have the largest cosmic variance
- The comparison with the Flagship Simulations shows that WISP galaxies are more clustered than similarly selected objects in the simulations

To do:

- check the clustering as a function of size: are most compact objects more clustered than larger ones.
- check single line emitters



Only one line in the G141-only fields.