First look into DESI DR1

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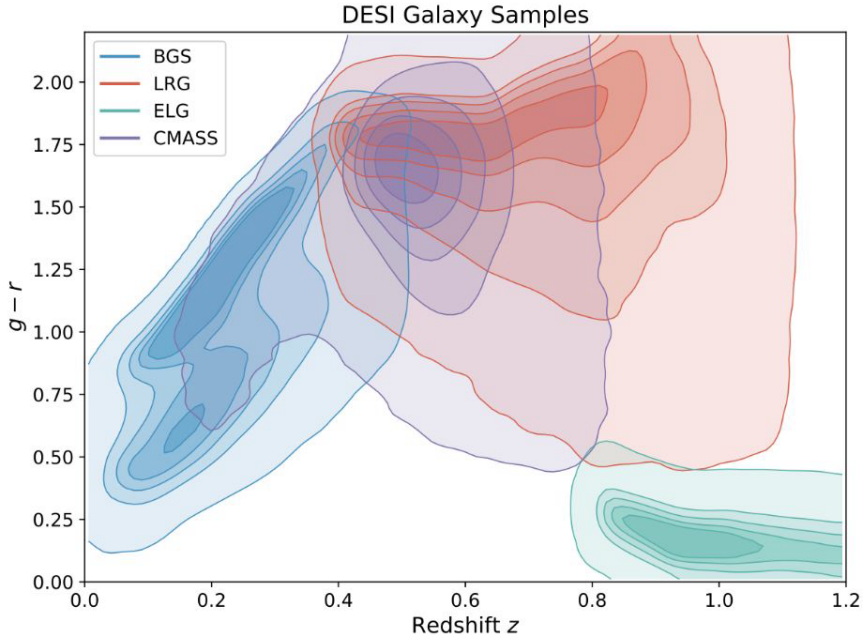
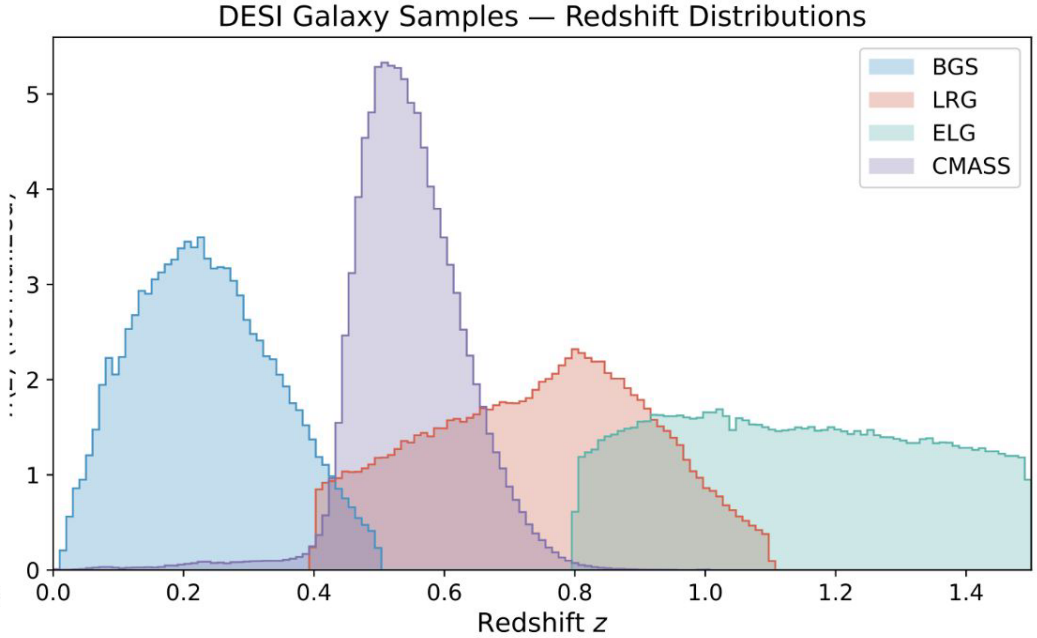
DESI DR1 data processing

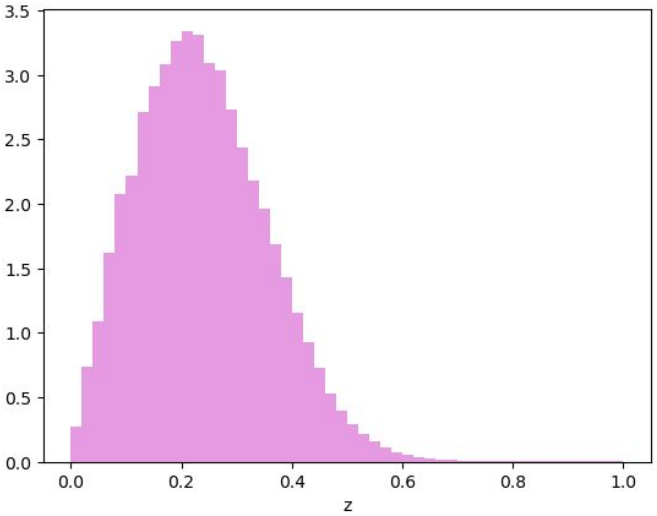

DESI Galaxy Samples
BGS
LRG
ELG
CMASS
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
$g - r$
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Redshift z

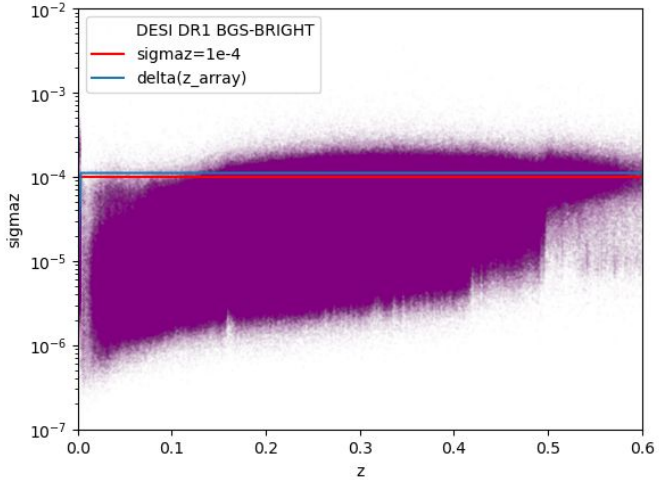

DESI Galaxy Samples — Redshift Distributions
BGS
LRG
ELG
CMASS
5
4
3
2
1
0
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
Redshift z

DESI DR1 BGS-BRIGHT

- Bright Galaxy Survey samples
- ~ 6.5 M galaxies
- 0.02<z<0.6
- 14,000 deg2

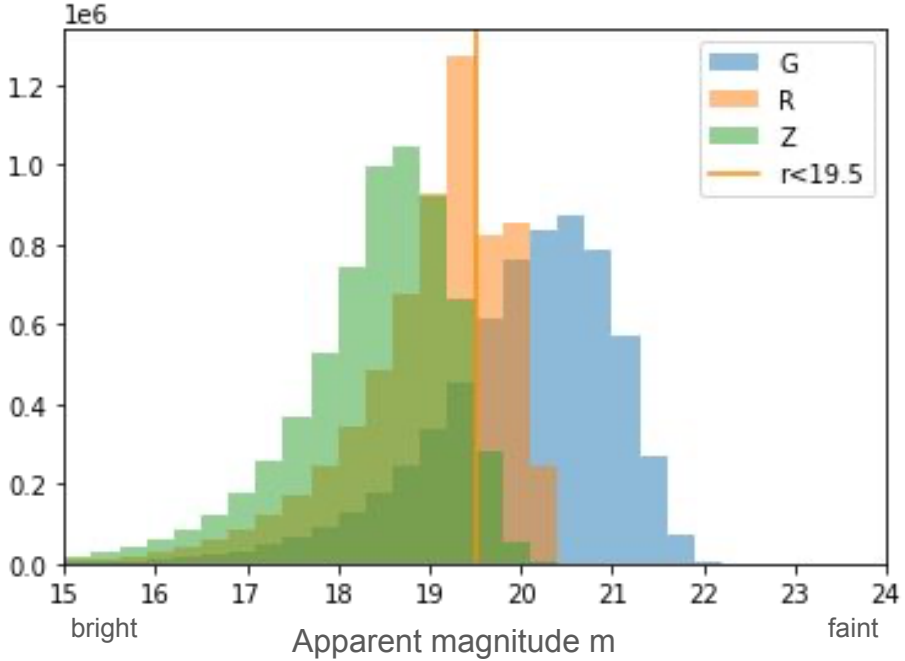
- grz bands (+others)
- r<19.5 absolute magnitude limited
- spec-z errors

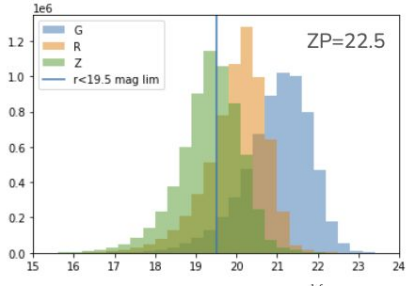




From flux to apparent magnitude

mag = ZP - 2.5*log10(flux)



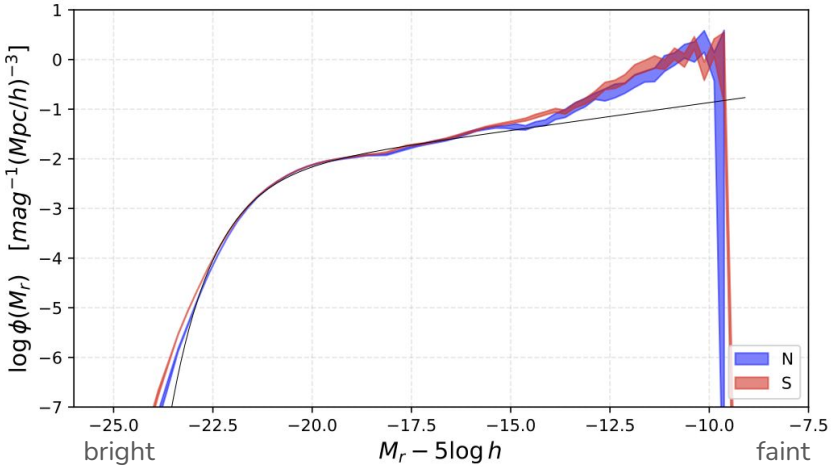


Luminosity functions

- LF derived in https://arxiv.org/pdf/2511.01803

Table 1. The Schechter parameters for the global $0.002 < z < 0.6$ LFs, used in Figs. 8 and 10 as fiducial reference curves. The meaning of the parameters are defined in Eqn. 12. We do not provide errors for these parameters as they are formally poor fits, as illustrated, for example, in Fig. C2.

	$\log_{10}\Phi^*$ $[h^{-3}\mathrm{Mpc}^3]$	$M^* - 5\log h$	α
All (South)			
g	-1.91	-19.98	-1.26
r	-2.06	-20.97	-1.28
z	-2.15	-21.88	-1.28
$w1$	-2.13	-21.78	-1.20



K-corrections

- Needed to correct for the peculiar velocities of galaxies and obtain their rest-frame magnitudes.
- K-corrections polynomials derived in https://arxiv.org/pdf/2511.01803
- Compare with polynomials already implemented in gwcosmo.
  Note that they go up to z=0.6.

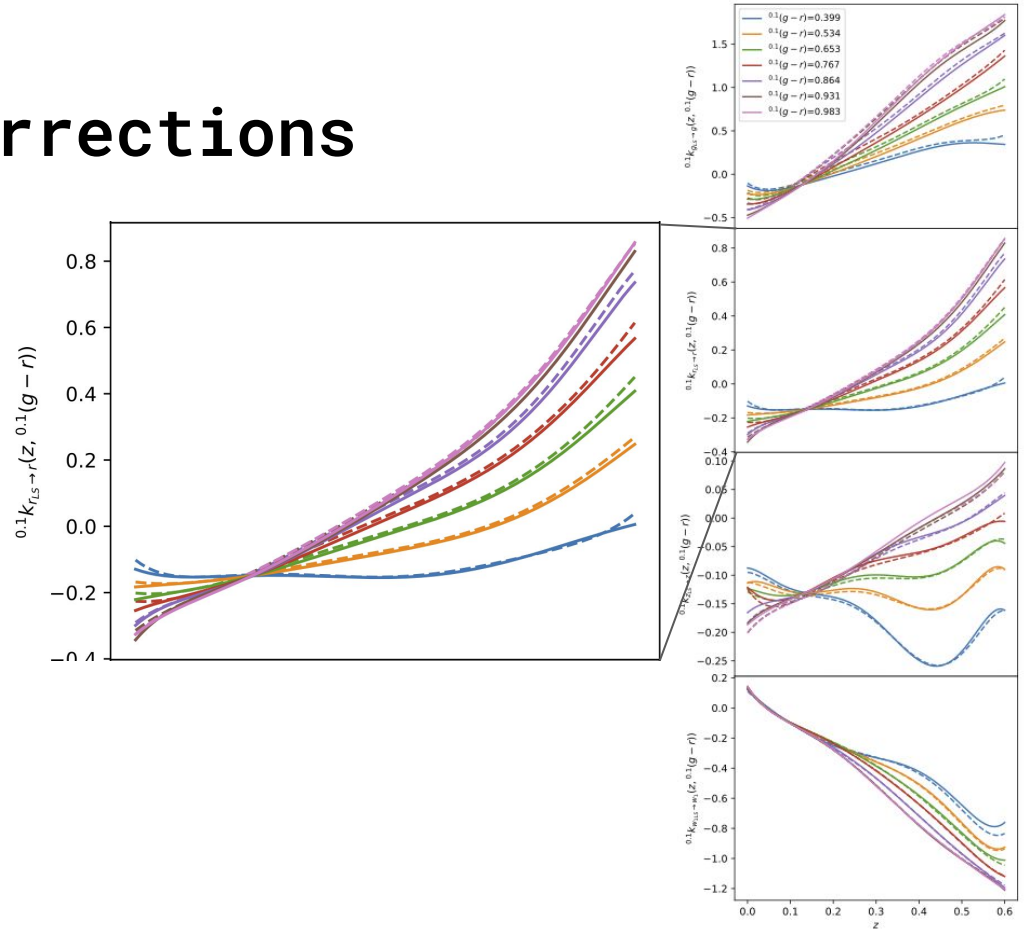
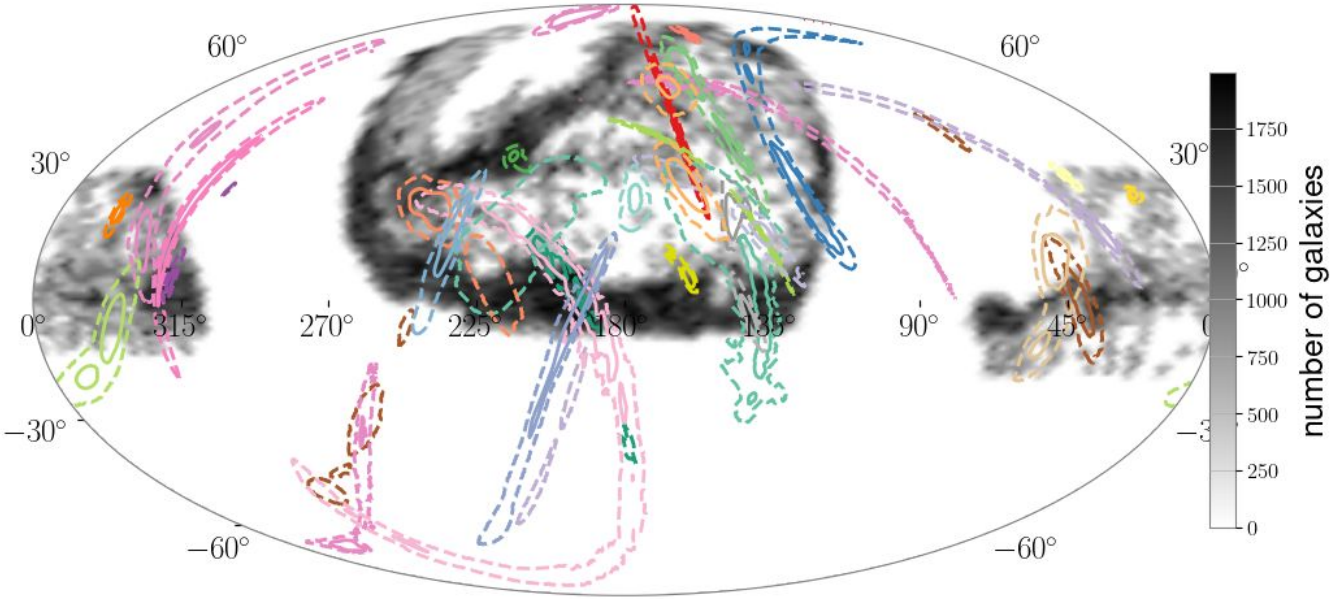


Figure 4. The k-correction polynomials to the SDSS g, r, z and WISE $w1$ bands with $z_{\rm ref} = 0.1$ from the respective observer frame DECaLS band (South, solid line), BASS/MzLS band (North, dashed line) and WISE bands. The r, z and $w1$-band k-corrections are direct fits to the FSF data. For the g band, the r-band polynomials are transformed to the g band using Eqn. 3 and the figure shows polynomial fits to the resulting g-band k-correction.

Footprint and overlap with GWTC-6

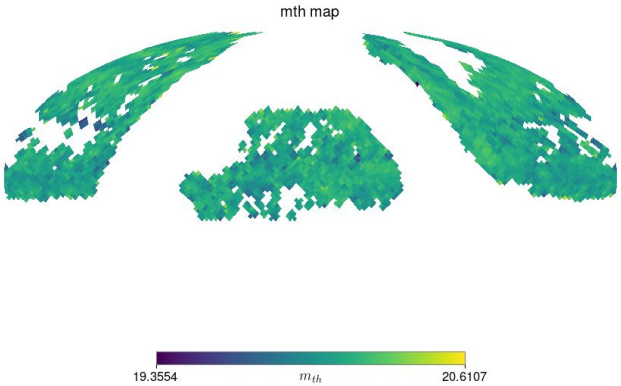


GW170608_020116	GW200202_154313	GW240629_145256	GW250114_082203	GW250727_180329
GW170818_022509	GW230627_015337	GW240916_184352	GW250119_190238	GW250813_021200
GW190412_053044	GW240413_022019	GW240921_201835	GW241230_233618	GW250904_102207
GW191216_213338	GW240512_024139	GW240923_204006	GW250205_103541	GW251031_185915
GW200115_042309	GW240520_213616	GW241009_084816	GW250211_043543	GW251105_125919
GW200129_065458	GW240622_004008	GW241130_034908	GW250331_013448	

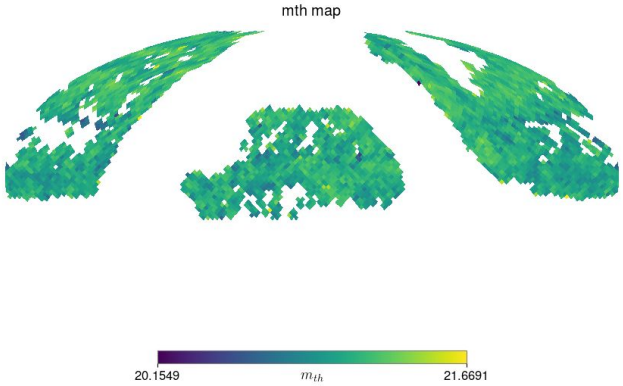
Computing selection effects

Magnitude threshold maps

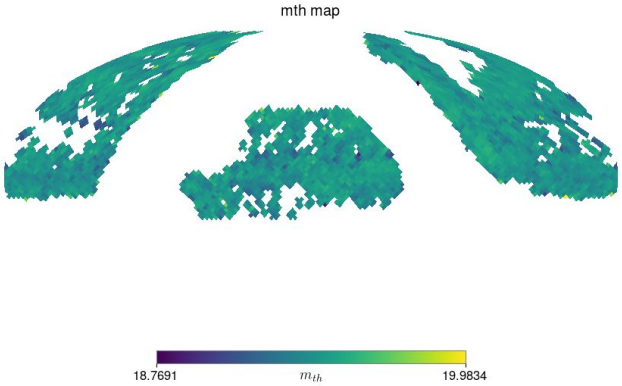
r-band



g-band



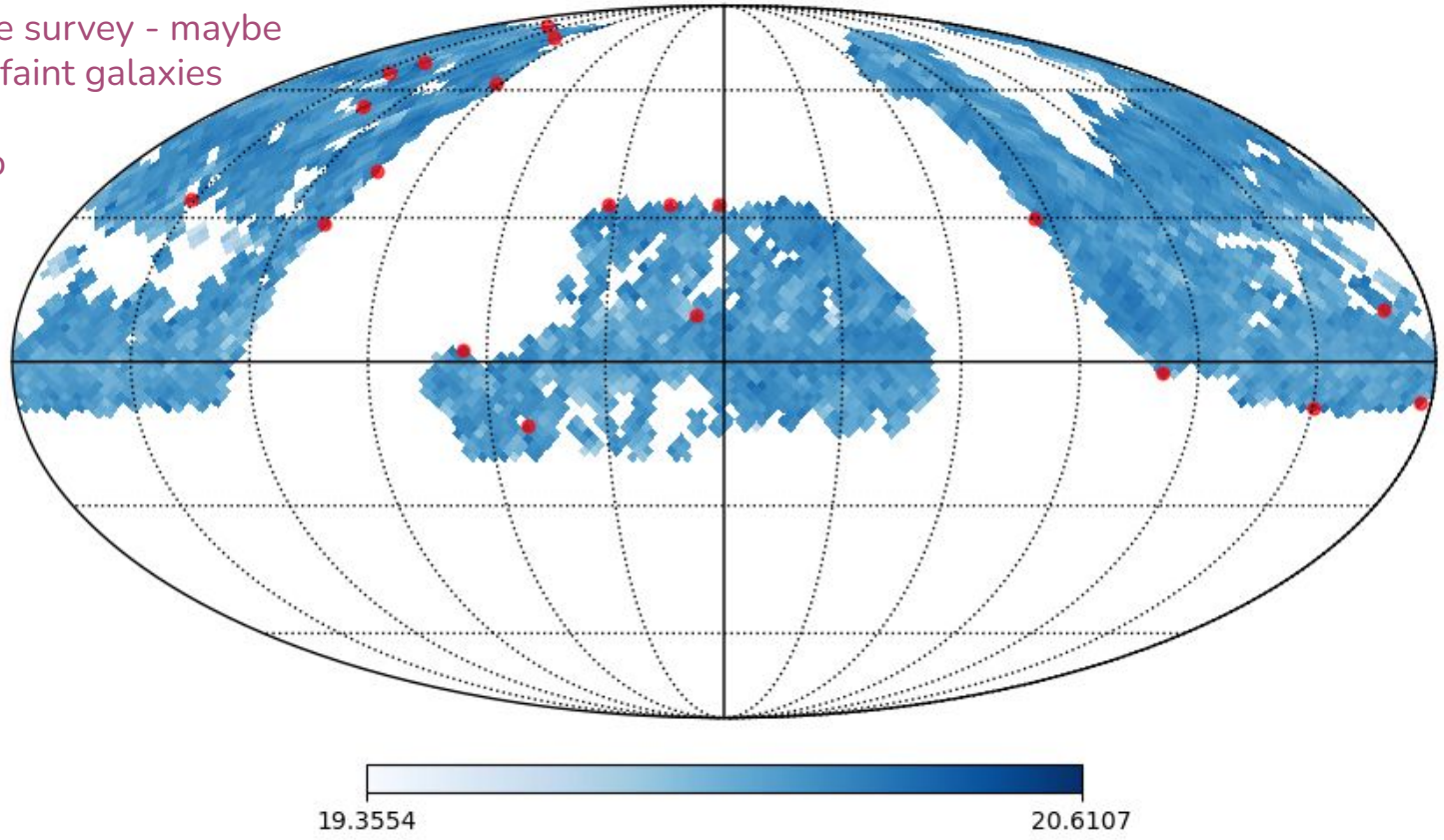
z-band



Difference between bands
Uniformity
Consistency/comparison with magnitude limit
Why is it not enough to compute selection effects here?

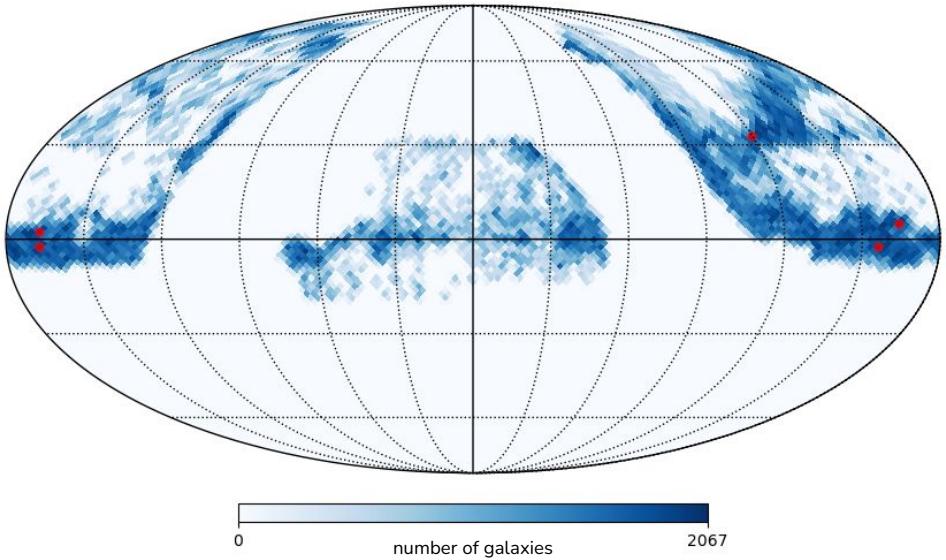
Where are the most complete pixels?

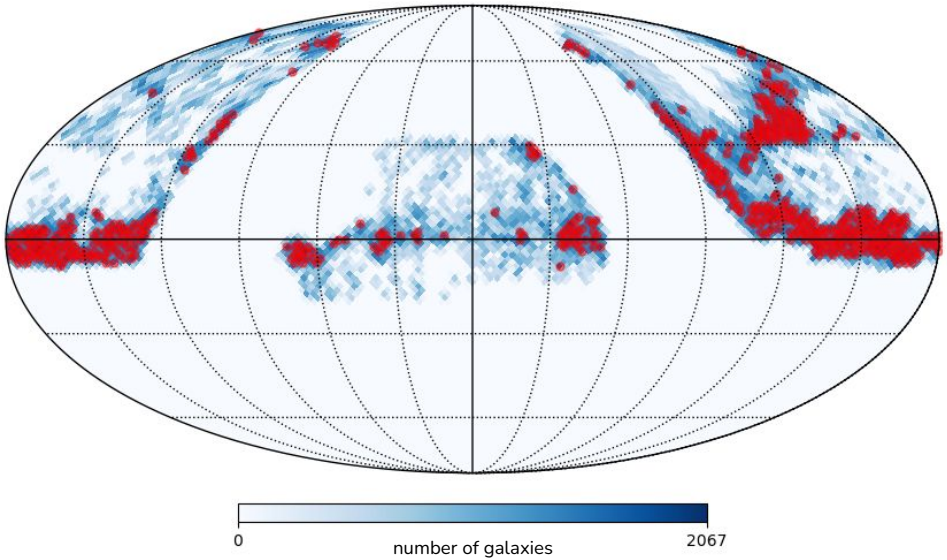
All at the boundaries of the survey - maybe there are just not so many faint galaxies in these pixels
Use the normalisation map instead!



Where are the most complete pixels?

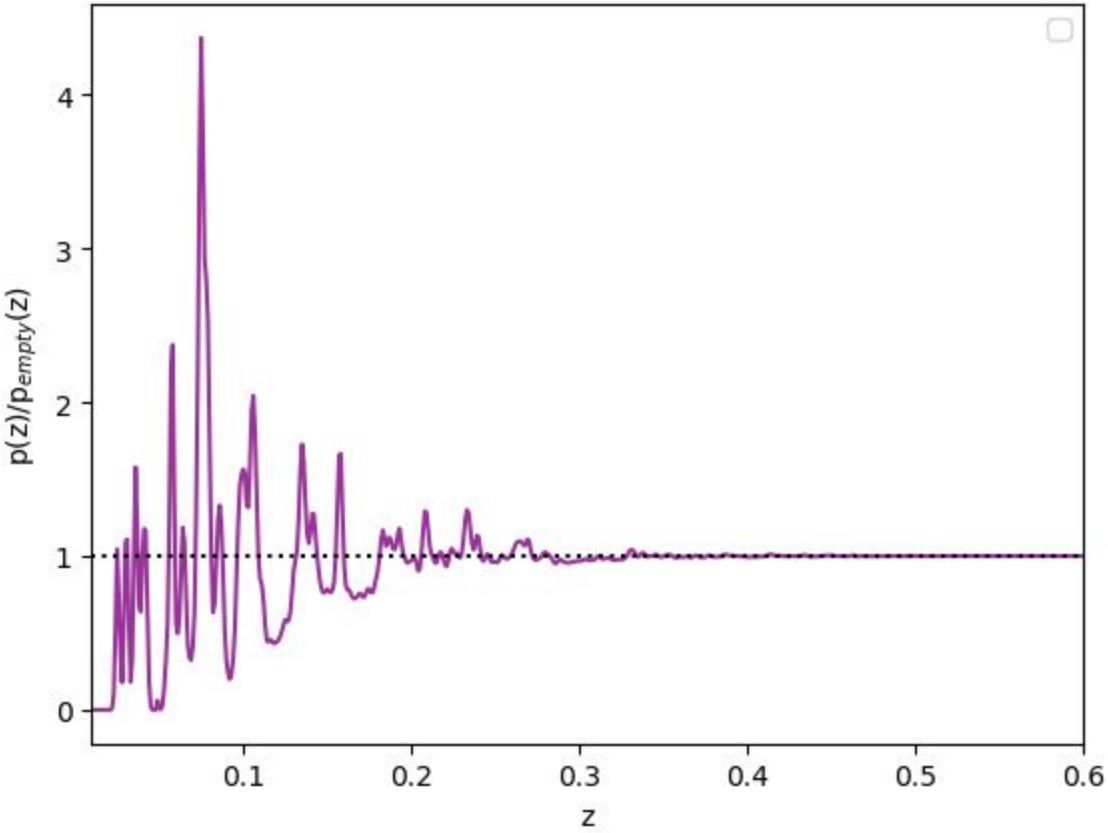
Only 5 pixels with more than 2000 galaxies → ~600 with >1500



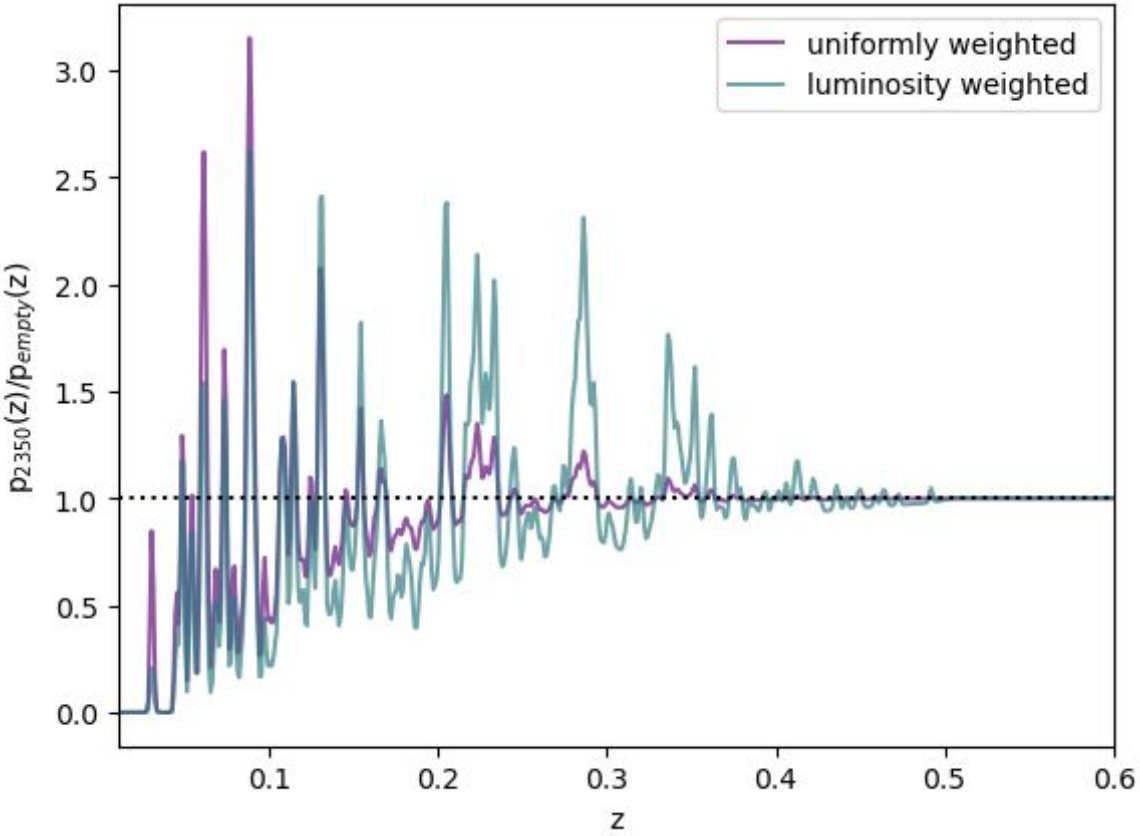


Line-of-sight redshift prior

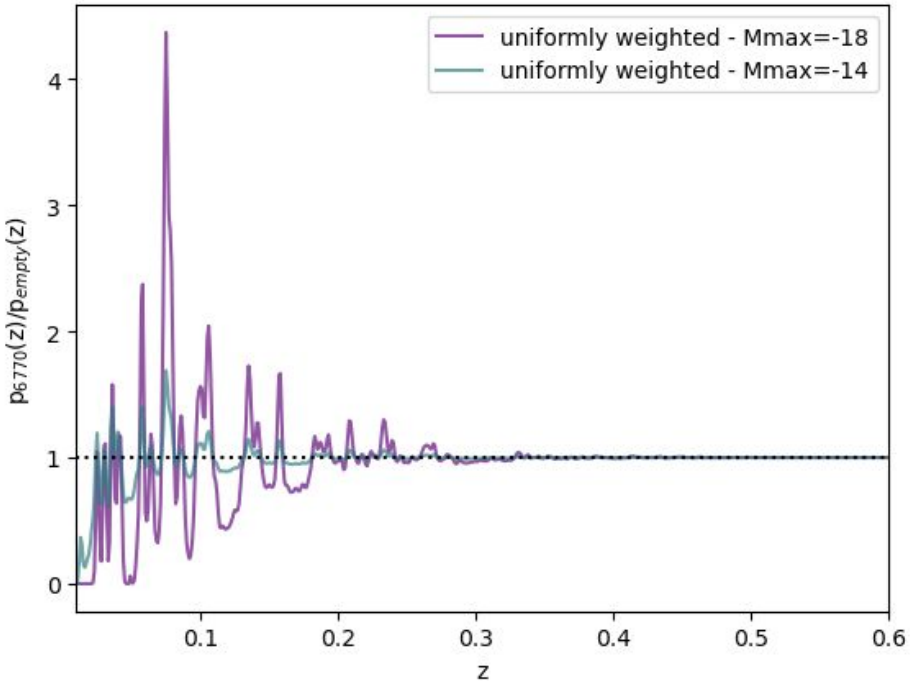
Line-of-sight >2000 gal

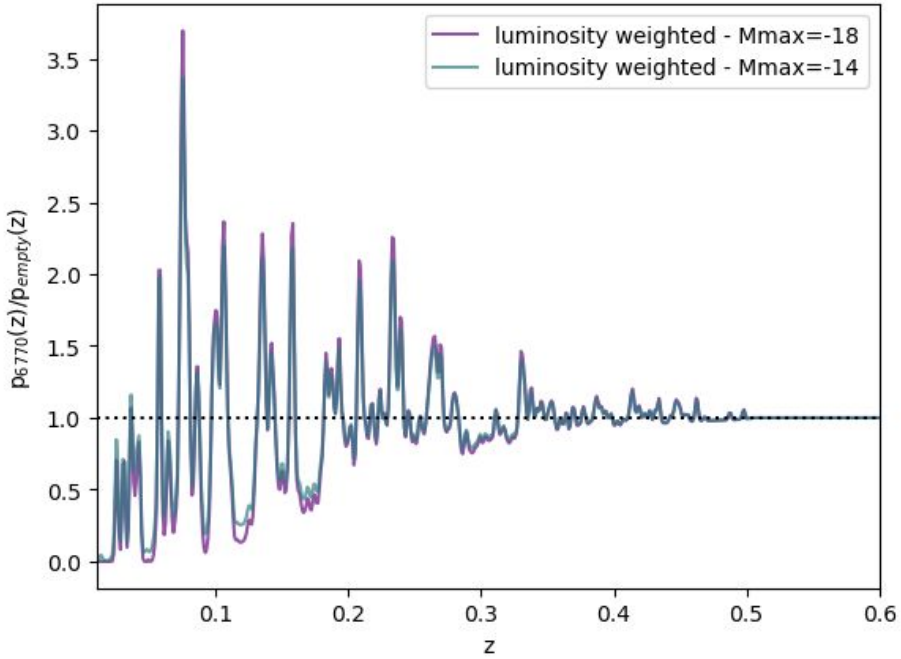


Impact of weighting method



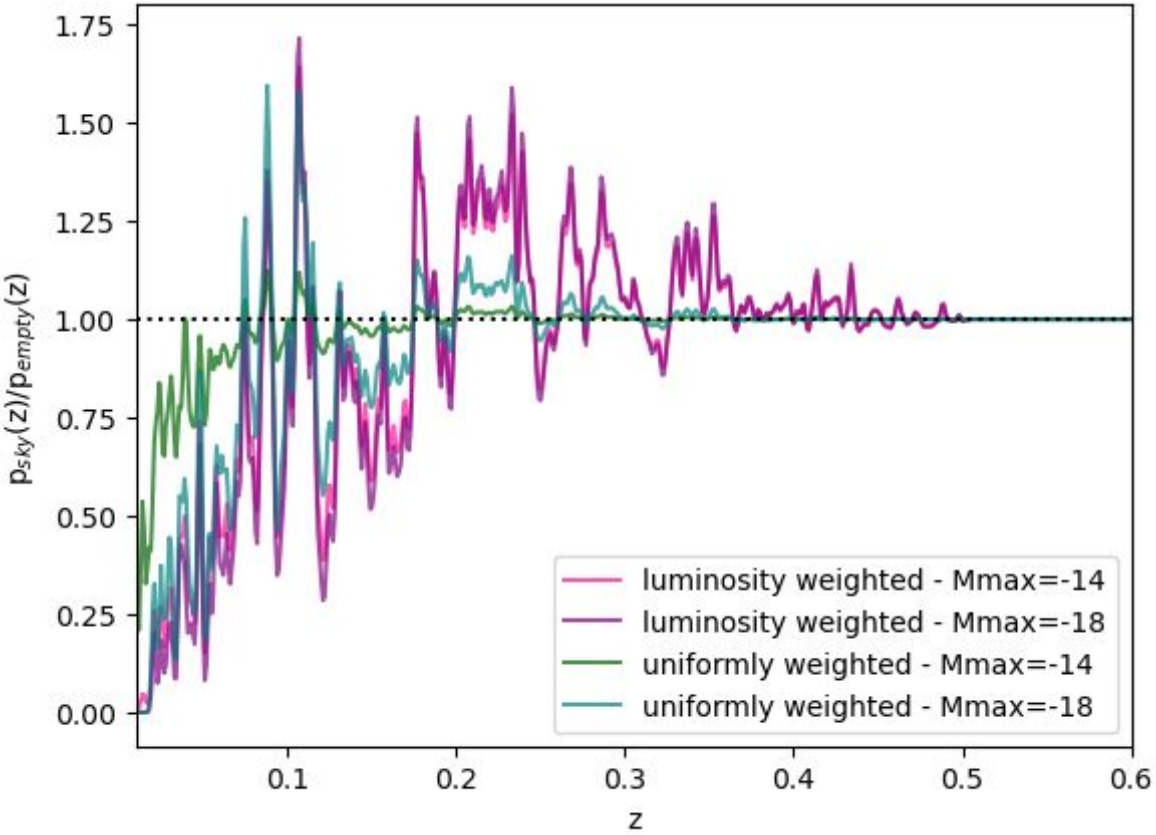
Impact of LF faint end



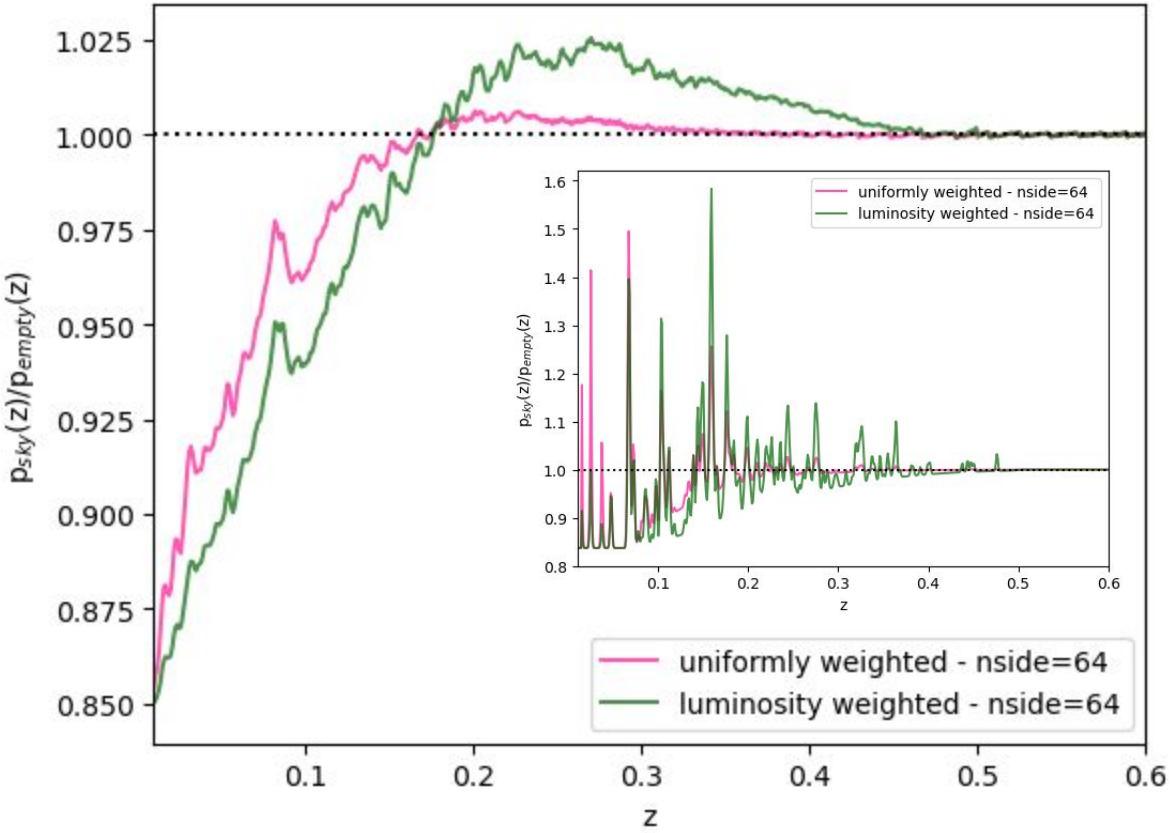


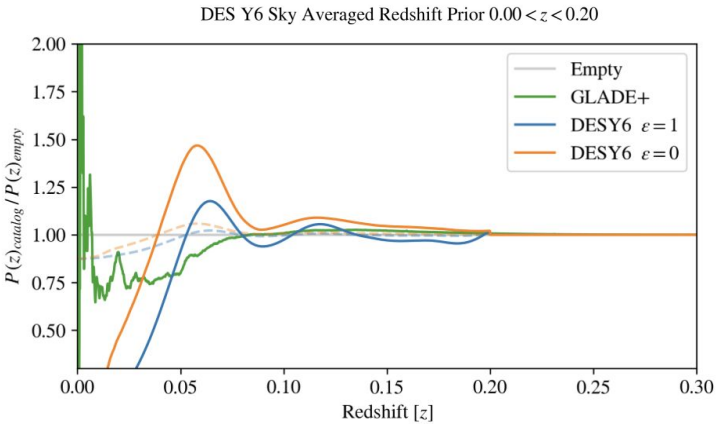
Difference is much more significant in the uniformly weighted case.

Average of 5 best pixels



Full sky >1500 galaxies Mmax=-18 Kcorr

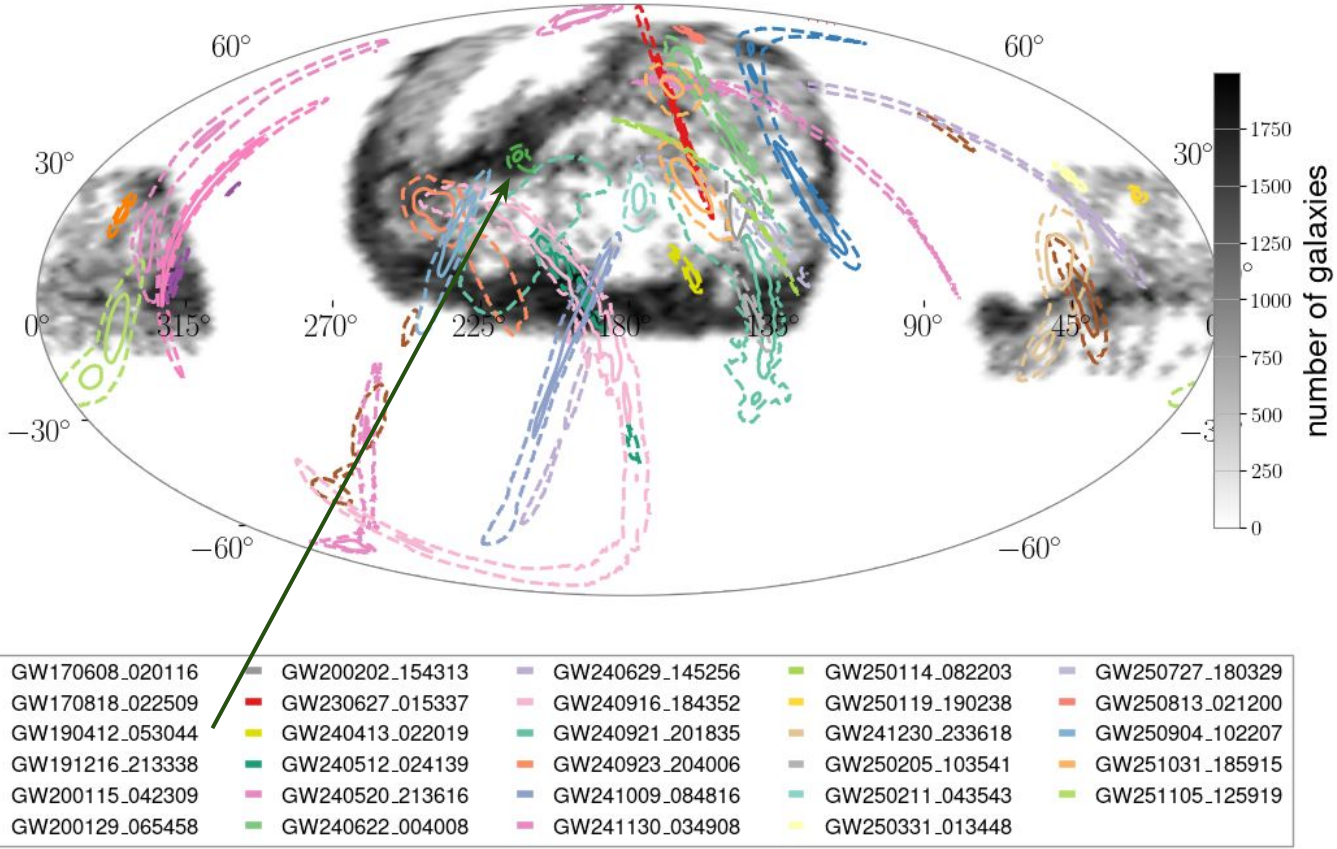




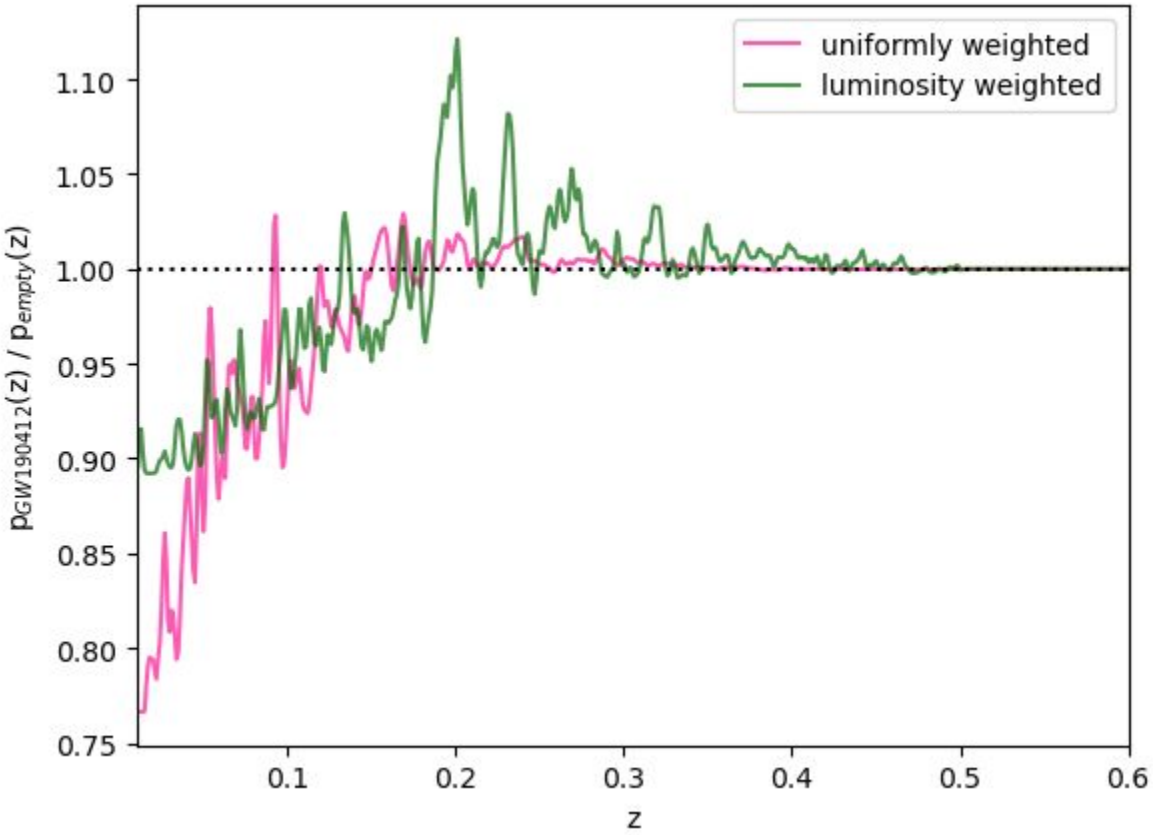
From DES O4b review page.

main panel = all pixels (DES dashed)
inset = >1500 pixels (DES solid)

GW190412

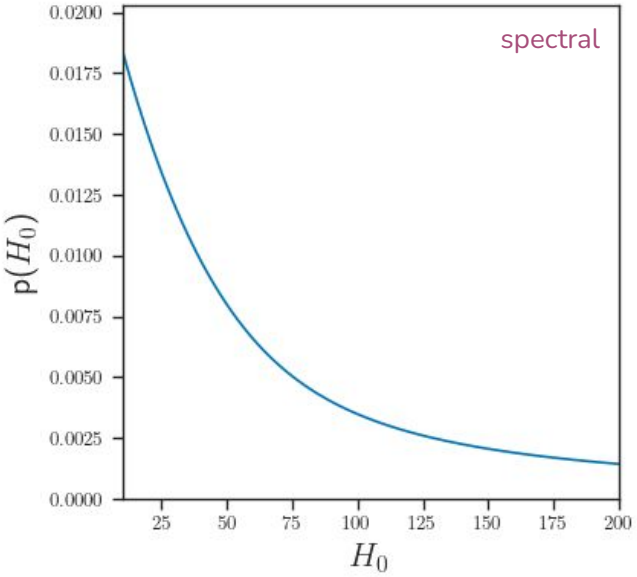

60°
30°
0°
−30°
−60°
315°
270°
225°
180°
135°
90°
45°
number of galaxies
1750
1500
1250
1000
750
500
250
0
GW170608_020116
GW170818_022509
GW190412_053044
GW191216_213338
GW200115_042309
GW200129_065458
GW200202_154313
GW230627_015337
GW240413_022019
GW240512_024139
GW240520_213616
GW240622_004008
GW240629_145256
GW240916_184352
GW240921_201835
GW240923_204006
GW241009_084816
GW241130_034908
GW250114_082203
GW250119_190238
GW241230_233618
GW250205_103541
GW250211_043543
GW250331_013448
GW250727_180329
GW250813_021200
GW250904_102207
GW251031_185915
GW251105_125919

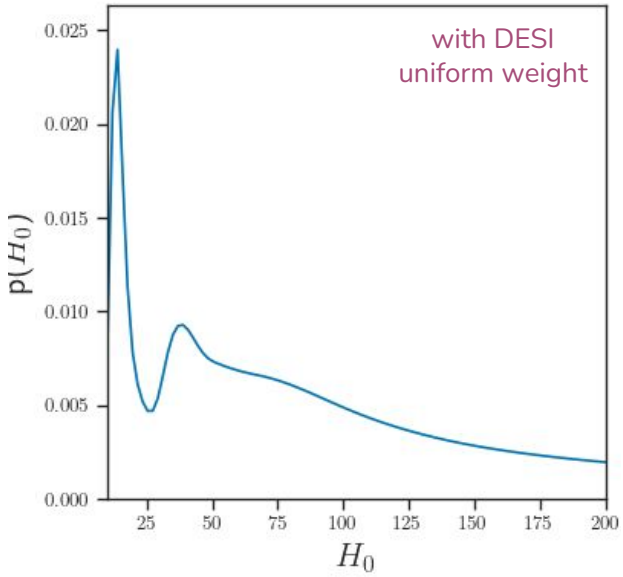
GW190412

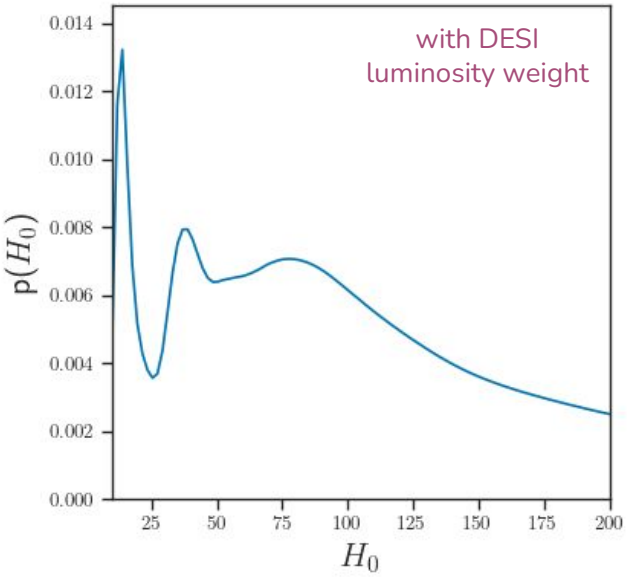

uniformly weighted
luminosity weighted
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
$p_{GW190412}(z) / p_{empty}(z)$
0.1
0.2
0.3
0.4
0.5
0.6
z

H0 posteriors

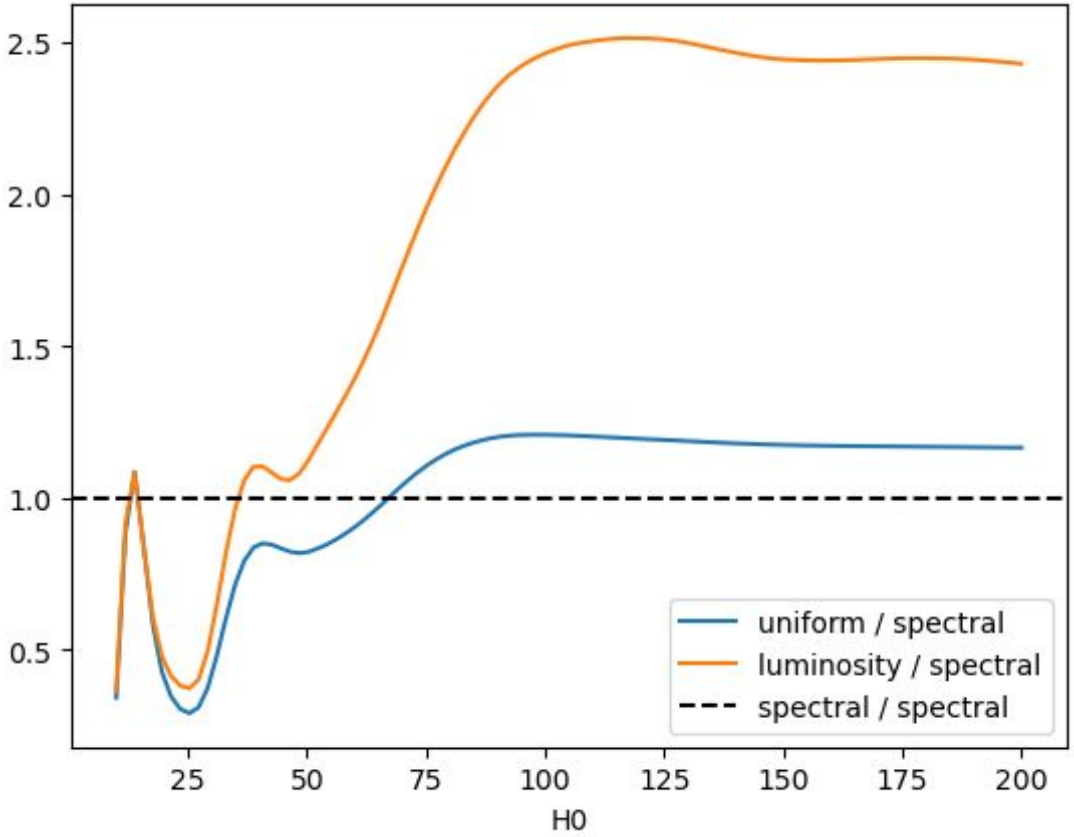
GW190412 nside=64







GW190412



- Informativeness = absolute integral between the curve and dashed line
- Luminosity weighted case is more informative, especially at high H0

Future work

- Rerun results with apparent magnitudes corrected
- Understand how to model incompleteness with a magnitude + observation limited survey
- Implement new DESI DR1 BGS k-corrections in gwcosmo
- Expend study to more LVK events
- Do a full population analysis