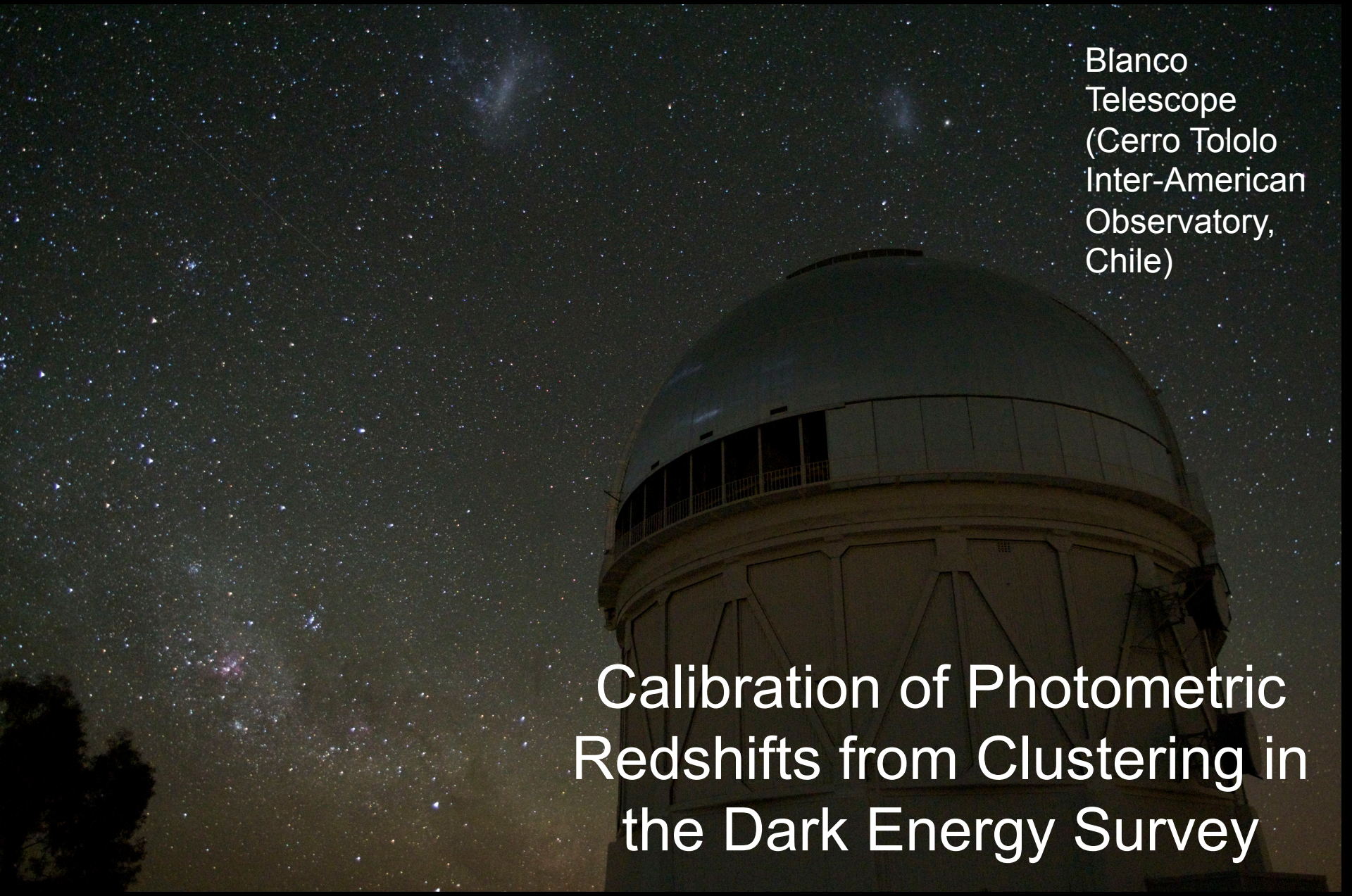


Blanco Telescope (Cerro Tololo Inter-American Observatory, Chile)

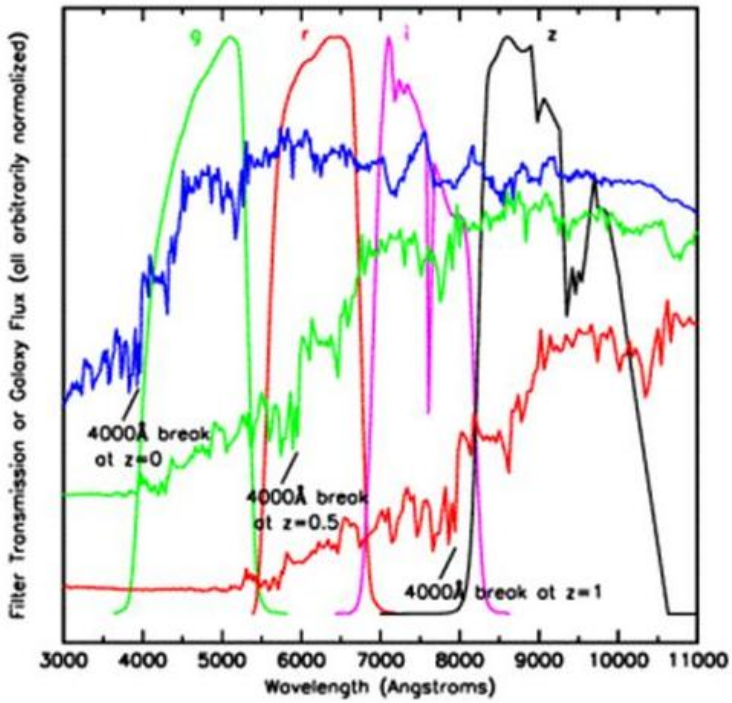
Calibration of Photometric Redshifts from Clustering in the Dark Energy Survey

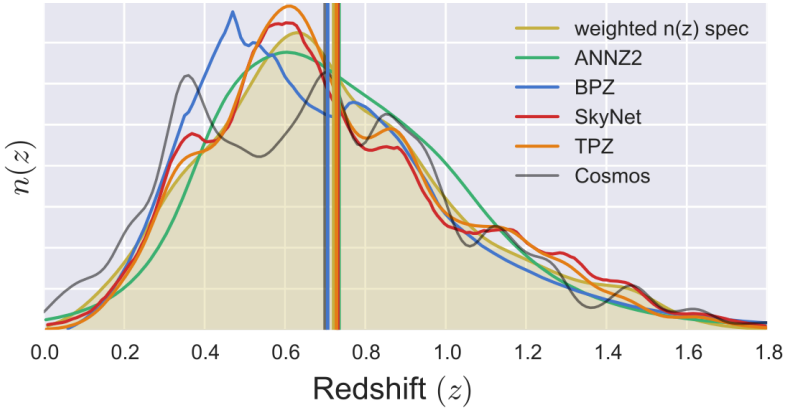
Ross Cawthon (UChicago/KICP)

DES: A Large Photometric Cosmological and Astrophysical Survey

DARK ENERGY SURVEY

- 5 year (525 night) survey over 1/8th of the sky (5000 deg^2)
- Many year 1 cosmological analyses to be out Summer 2017
- Cosmology: grav lensing, large scale structure, clusters, type Ia supernovae, cross correlations w/CMB, more…
- Photometric bands (g,r,i,z,y)
- Photometric redshifts (pros & cons):
  - 300 M galaxies expected
  - Photo-z (redshift) errors far larger than spectroscopy
  - Photo-z algorithms often give different predictions

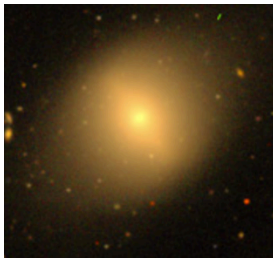




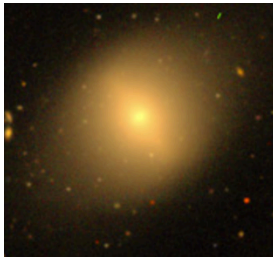
Clustering Redshifts

DARK ENERGY SURVEY

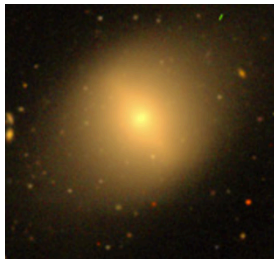
- Independent (of photometry) technique of estimating redshifts
- Takes advantage of the clustering of galaxies (galaxies more likely than random to be close to each other)



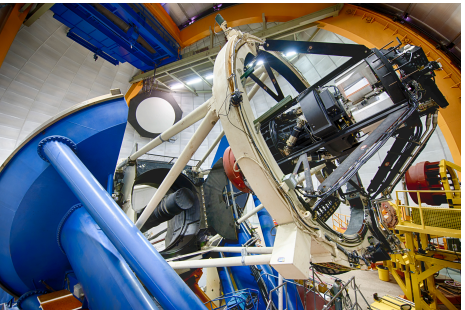
Z=0.7?



Z=0.5?



Z=0.3?



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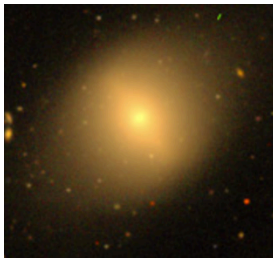
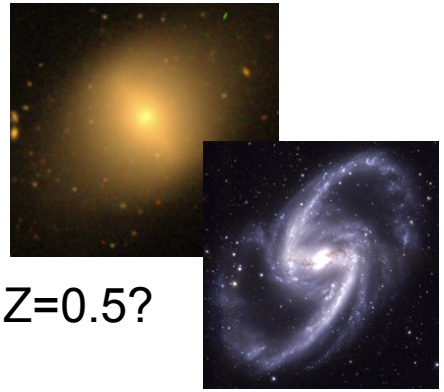


Z=0.7?



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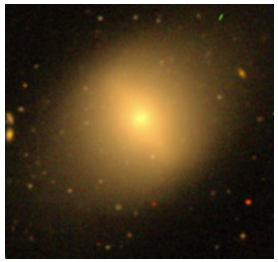
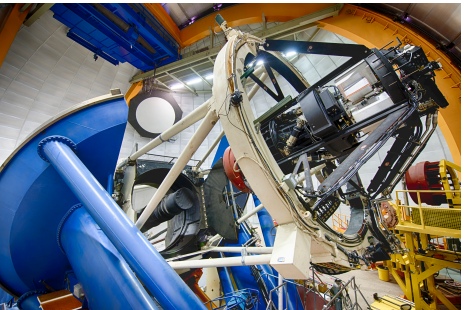


Z=0.3?

Z_{spec}=0.501

(Known Redshift)

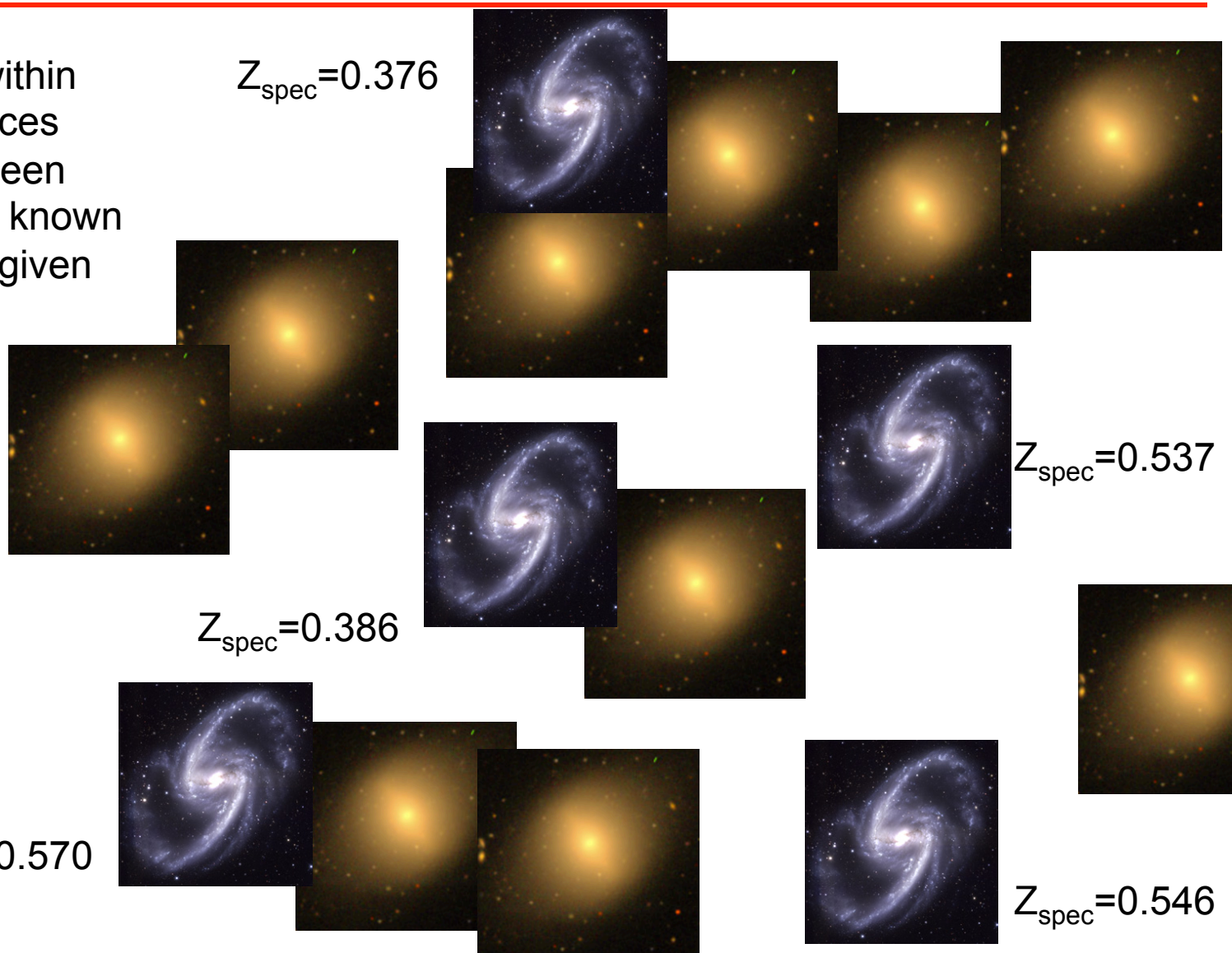


Statistically more likely the galaxy is around Z=0.5 (but may not be)

Clustering Redshifts (a statistical measurement)

DARK ENERGY SURVEY

Count pairs within certain distances (angles) between unknown and known samples of a given redshift bin



Data Available

DARK ENERGY SURVEY

(Regular) Galaxies

-Δz_{phot}~0.05(1+z)
-i.e. 30M weak lensing source galaxies in Y1 (z=0.2-1.3)
-Large number, poor redshifts

Redmapper (clusters) Redmagic (large red galaxies)

-Δz_{phot}~0.02(1+z)
- ~700k redmagic in Y1
-Up to z~0.9
-Moderate number, moderate redshifts

Spectroscopic Galaxies

-Δz_{spec}~0.0001
-None from DES
-Largest sample: 23k from SDSS in S82, few k from other surveys
-Mostly z<1
-Small number, excellent redshifts

Data Available

DARK ENERGY SURVEY

(Regular) Galaxies

Gatti et al., Davis et al. (in prep)

-Δz_{phot}~0.05(1
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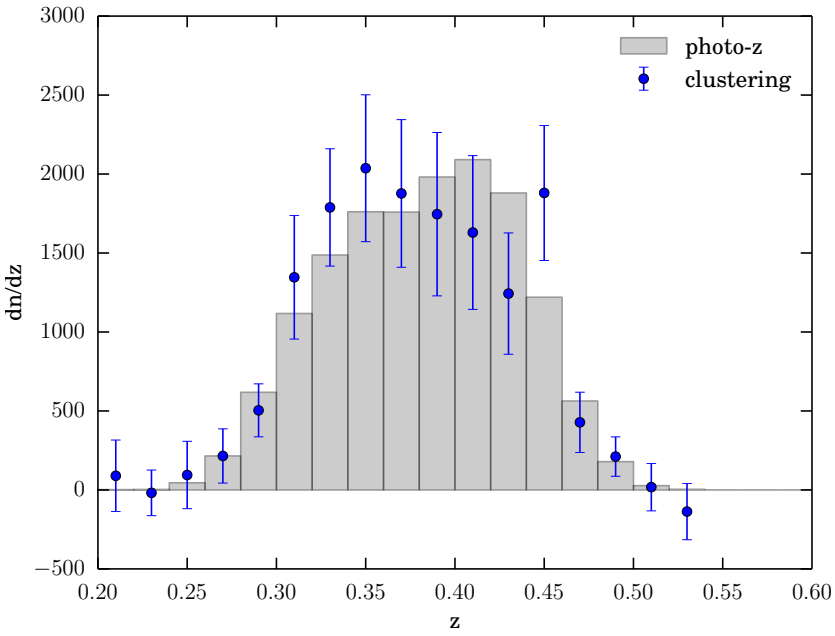
Procedure for Calibrating Redshifts

DARK ENERGY SURVEY

- 1. Compute pair-counting statistic, (~W(θ)) between unknown & known samples
  - Choose distance weighting, scales, method, errors (jackknives)
- 2. Correct for intrinsic galaxy clustering amplitude? (Galaxy Bias)
- 3. Cut low amplitude regions ('tails')
- 4. Calculate mean clustering redshift
- 5. Find single shift parameter of photometric redshift to fit clustering mean
- Future work may change procedure.

Use just clustering redshift? Allow photometric redshift to change by multiple parameters?

Dark Energy Survey
Redmagic (z=0.3-0.45)

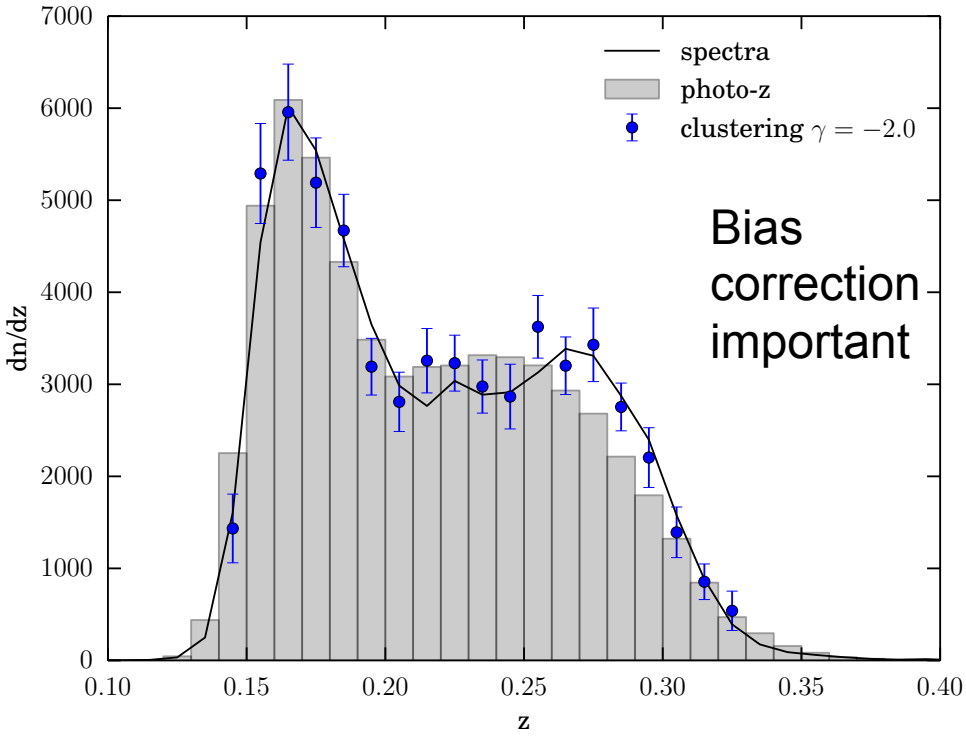


(Cawthon et al., in prep)

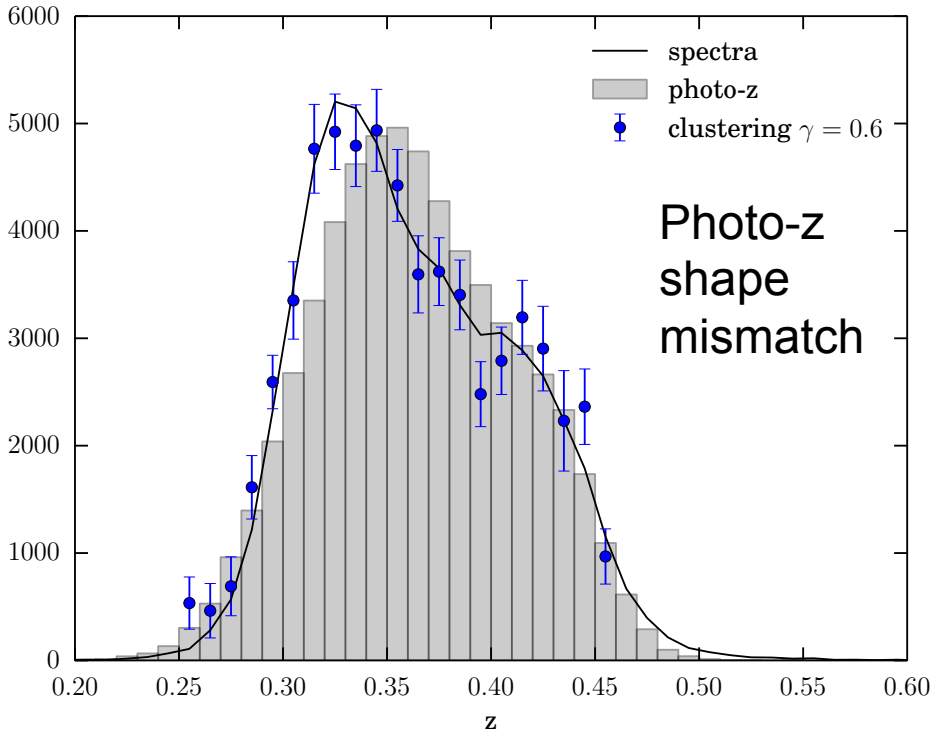
Redmagic Calibration

DARK ENERGY SURVEY

Sloan Digital Sky Survey
Redmagic (z=0.15-0.3)



Sloan Digital Sky Survey
Redmagic (z=0.3-0.45)



These plots on subsample of SDSS redmagic that has spectra itself (truth)

Overall: Z_{bias}<0.005 (SDSS), Z_{bias} <0.10 (DES, larger errors) (Cawthon et al. in prep)

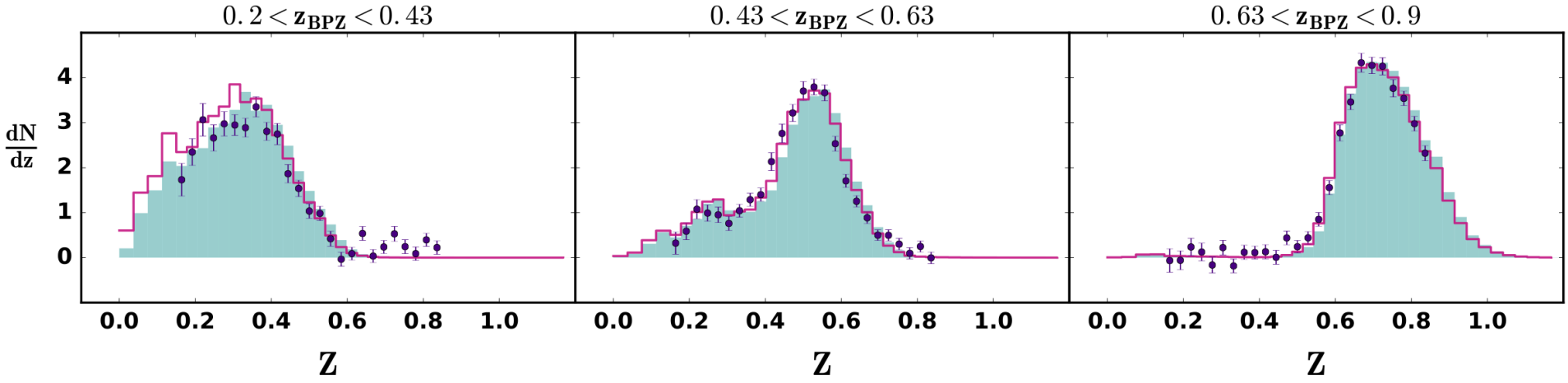
Weak Lensing Source Calibration (on sims)

DARK ENERGY SURVEY

- Simulations paper (Gatti et al., in prep) tests many steps of the procedure, estimates systematic errors
  - Bias evolution
  - Redmagic photo-z
  - Shape of source photo-z dn/dz

Total Systematics Errors for different photo-z codes

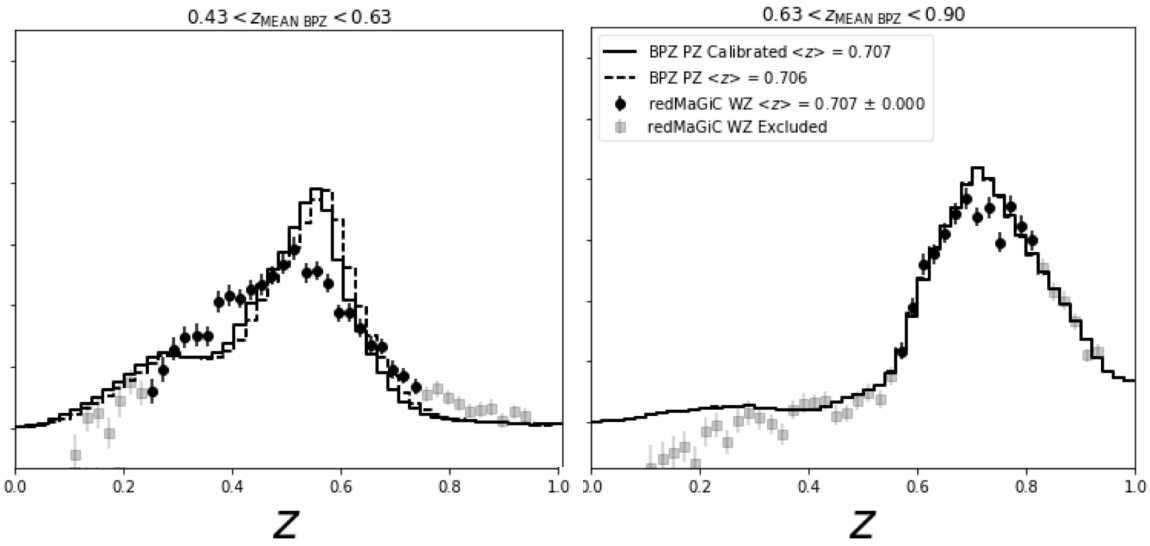
	Bin 1	Bin 2	Bin 3
BPZ	0.025 [0.029]	0.016 [0.019]	0.014 [0.016]
DNF	0.012 [0.016]	0.013 [0.016]	0.019 [0.021]
RF	0.015 [0.019]	0.013 [0.016]	0.013 [0.015]

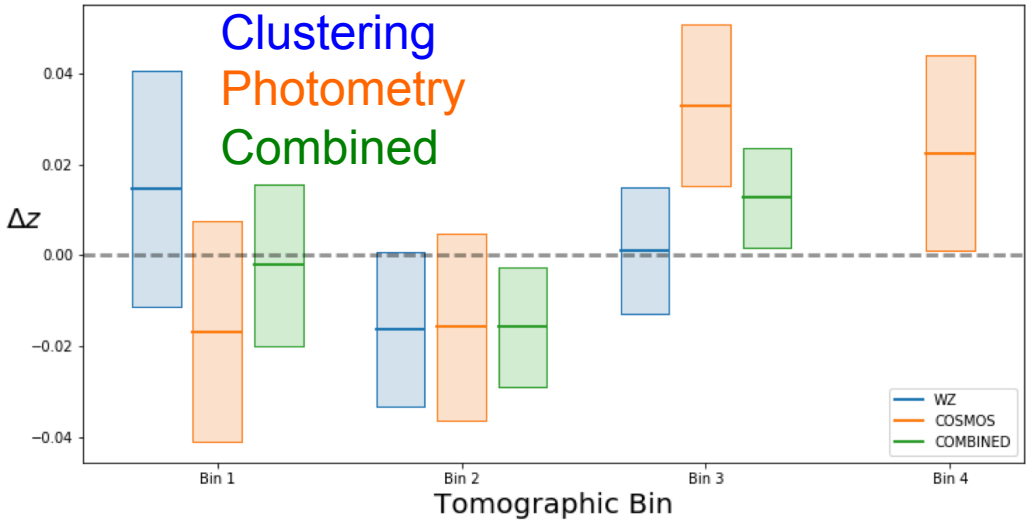


Weak Lensing Source Calibration (on data)

DARK ENERGY SURVEY

- Davis et al., in prep, applies the simulations techniques to Y1 DES data, and compares with the photometric redshift analyses
- Independent clustering and photometric redshift estimations agree within errors





DARK ENERGY SURVEY

Summary

- DES Y1 Papers expected soon (~1 month)
- These three clustering redshifts papers (Cawthon et al., Davis et al., Gatti et al.) together are one of the most expansive applications of this technique
- Much work done to show that the technique works, to understand causes of errors, and to calibrate the data
- Clustering Redshift techniques will need to continue to develop for future DES analyses, LSST (higher redshift), other surveys
- Future spectroscopic surveys can continue to aid photometric surveys with this technique