# Redshift Calibration of DELVE Galaxy Survey

FERMILAB-POSTER-21-092-PPD-STUDENT

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## DELVE Cosmology Analysis

Background:

At large scales, galaxies can be used to trace dark matter distribution in the universe. The large scale structure formed by galaxies is crucial in tracing dark matter.

- Galaxy redshift distances are used to determine structure
- DELVE does not have spectra to calculate redshifts
- Redshifts are estimated from DELVE photometric data
- Photometric redshifts are a major source of systematic uncertainty in photometric surveys like DELVE

Objective:

- Calibrate photometric redshifts from DELVE galaxy survey in order to reduce systematic uncertainty
- Determine large scale structure to assess dark matter distribution and evolution

## Calibrating Photometric Redshift Estimates to Find True Redshifts

Approach:

Two-point statistics between galaxy surveys $g1, g2$ can help describe dark matter evolution through the following equation:

$$\underbrace{\overline{w}_{g1,g2}(\theta)}_{\text{observation}} = \int_0^\infty \underbrace{n_{g1}(z)n_{g2}(z)b_{g1}(z)b_{g2}(z)}_{\text{calibrate}}\underbrace{\overline{w}_{mm}(z,\theta)}_{\text{dark matter parameter}}\,dz$$

We focus on calibrating this $n(z)$ parameter using clustering redshifts with a two-parameter fit. The $n(z)$ in some small redshift bin $j$ is defined as:

$$n_{u,j}(z_j) = \frac{\overline{w}_{ur}}{\sqrt{\overline{w}_{rr}}\underbrace{(1+z_j)^\gamma}_{\text{power law approximation for } \sqrt{\overline{w}_{uu,spec}}}}$$

where $u, r$ represent the photometric and spectroscopic surveys, respectively.

- Correlations (denoted $\overline{w}_{g1,g2}$) with external spectra used to estimate true redshifts
- Reference spectra used to calibrate photo-z distribution
- 2-parameter fit to shift and stretch photo-z distribution to clustering results

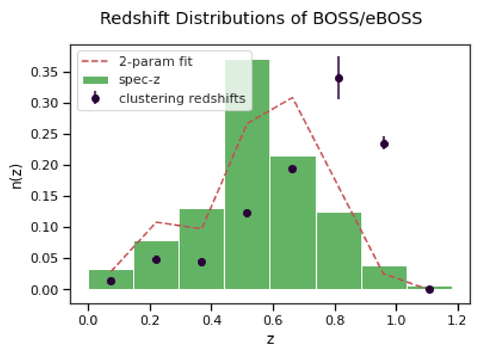
## Testing Clustering Redshifts and 2-Parameter Fitting

SDSS spectra test:

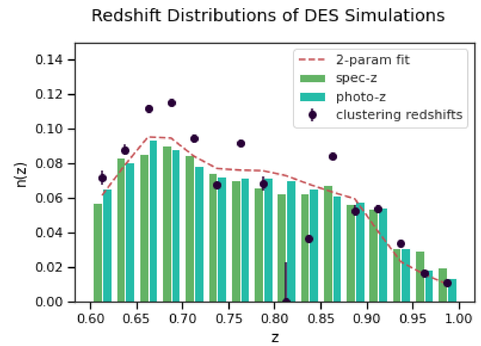
- Use spectroscopic redshifts to calibrate true redshifts (i.e.. data calibrating itself)
- Accuracy lost at higher redshifts where galaxy coverage is sparse

DES simulation test:

- Calibrate the photo-z distribution to the spec-z distribution of the same galaxies
- Increased noise with thinner binning




Test with SDSS LSS spectra catalogs (BOSS/eBOSSS)

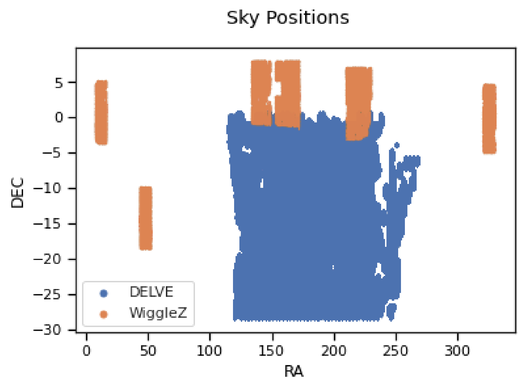



Test with DES Y1 BAO Simulations

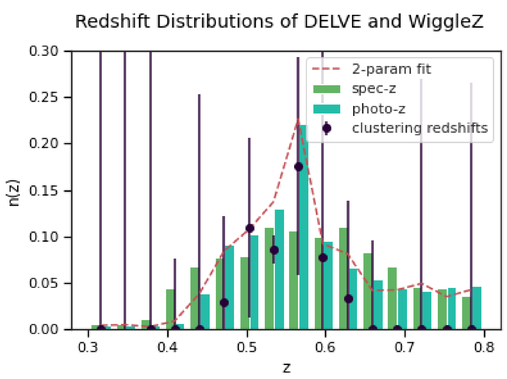
## DELVE Data Results

Data release 1:

- Little overlap with existing spectra (WiggleZ)
- More data is needed to reduce noise




DR1 and WiggleZ Footprint Overlap




DR1 and WiggleZ Results

## Conclusions and Future Work

- Clustering method appears to accurately calibrate photometric redshifts
- More data is needed to find true redshifts of DELVE galaxies
- True redshift distributions can provide insight on dark matter

This manuscript has been authored by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy, Office of Science, Office of High Energy Physics.