Redshift Calibration of DELVE Galaxy Survey

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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 $g_1$, $g_2$ can help describe dark matter evolution through the following equation:

$$\bar{w}_{g_1, g_2}(\theta) = \int_0^\infty n_{g_1}(z)n_{g_2}(z)b_{g_1}(z)b_{g_2}(z)\bar{w}_{mm}(\theta, z)\, dz$$

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:

$$n_{u,j}(z_j) = \frac{\bar{w}_{ur}}{\sqrt{\bar{w}_{rr}} (1 + z_j)^{\gamma}}$$

where $u, r$ represent the photometric and spectroscopic surveys, respectively.
- Correlations (denoted $\bar{w}_{g_1, g_2}$) 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

DELVE Data Results

Data release 1:
- Little overlap with existing spectra (WiggleZ)
- More data is needed to reduce noise

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