The Dark Energy Survey Supernova Program

5-year results, methodology, and future directions

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What is DES?

THE DARK ENERGY SURVEY

- Started observing in 2013
- DECam on the Victor M. Blanco Telescope
  - u**griz**Y filters
- Six years (758 nights)
  - 3 year preliminary SN results
  - 5 year final SN results
- Multi-probe survey
  - **Supernovae**
  - Gravitational Lensing
  - Galaxy Clusters
  - Baryon Acoustic Oscillations

Supernova Cosmology in Brief

Type Ia Supernovae (Observations)

$$\mu_{SN} = m - M + \Delta\mu$$

What cosmological parameters make these equal?

Cosmological Prediction (Theory)

$$E(z) = (\Omega_R(1+z)^4 + \Omega_M(1+z)^3 + \Omega_K(1+z)^2 + \Omega_\Lambda(1+z)^{3(1+w)})^{0.5}$$

$$D_L = (1 + z)\, c / H_0 \int_0^z E^{-1}(z)dz$$

$$\mu_{Cosmo} = 5 \log_{10}(D_L / 10[pc])$$

Calculated | Observable | Unknown

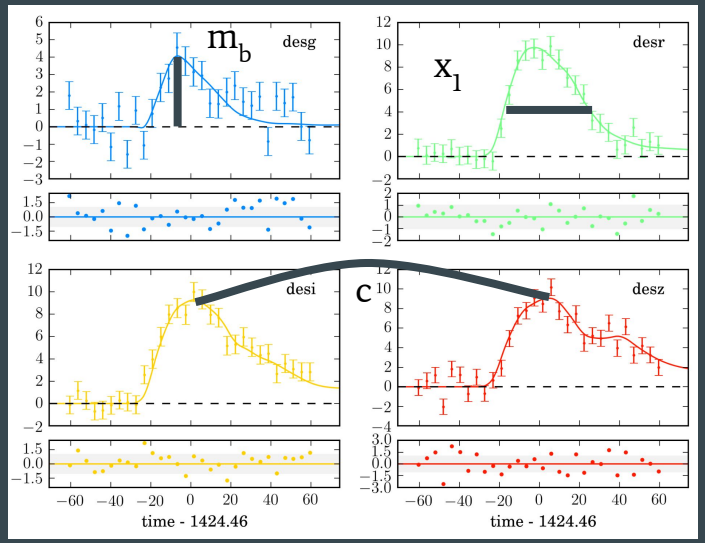
Tripp (1998)

Standardising Type Ia Lightcurves

SALT Lightcurve Fit

Contamination and Bias correction

$$\mu_{SN} = m_B + \alpha x_1 - \beta c - M + \Delta\mu_{bias}$$



Nuisance Parameter

Calculated | Observable | Unknown

Pippin - From lightcurves to cosmological parameter estimates

Designed by Sam Hinton
Developed and maintained by me

	3 year	5 year
Prepare & Simulate Data Prepare & simulate lightcurves for analysis	Difference Imaging	Scene Modelling Photometry
Lightcurve Fitting Fit SALT parameters to data and simulations using SNANA	SALT2	SALT3
Classification Photometrically classify lightcurves with SuperNNova or Scone	Spectroscopic	Photometric
Contamination and Bias Correction Correct for contamination and bias using BEAMS with Bias Correction (BBC)	G10 Dust Model	P21 Dust Model
Systematic Covariance Matrix Compute a systematic covariance matrix, account for many systematic uncertainties		
Cosmological Fitting Perform cosmological parameter inference with Bayesian methods like COSMOSIS or WFIT	CosmoMC	Cosmosis

A Comparison of Results and Uncertainties

- Order of magnitude more supernovae
- Uncertainty ~1/2
- Systematics not yet dominant
  - SALT and dust majority