SALT2mu

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Why SALT2mu?

- Standard SALT2 approach fits training parameters α and β simultaneously with cosmology.
- We want to
  - Decouple fit for SN properties from cosmology.
  - Decouple SN cosmology fit from light curve fitter (cosmology fit based only on the distance modulus μ)

Implementation

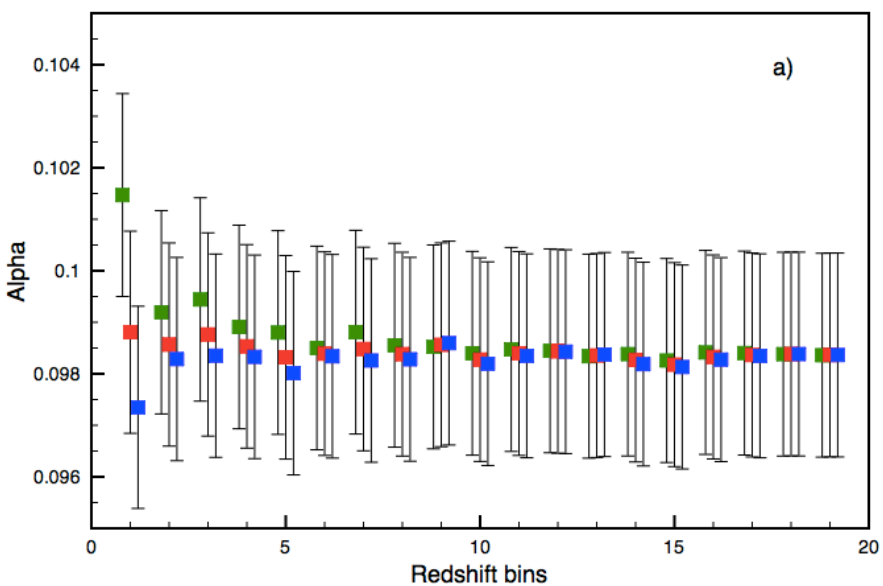
- Place data into bins of redshift and determine a by minimizing the expression

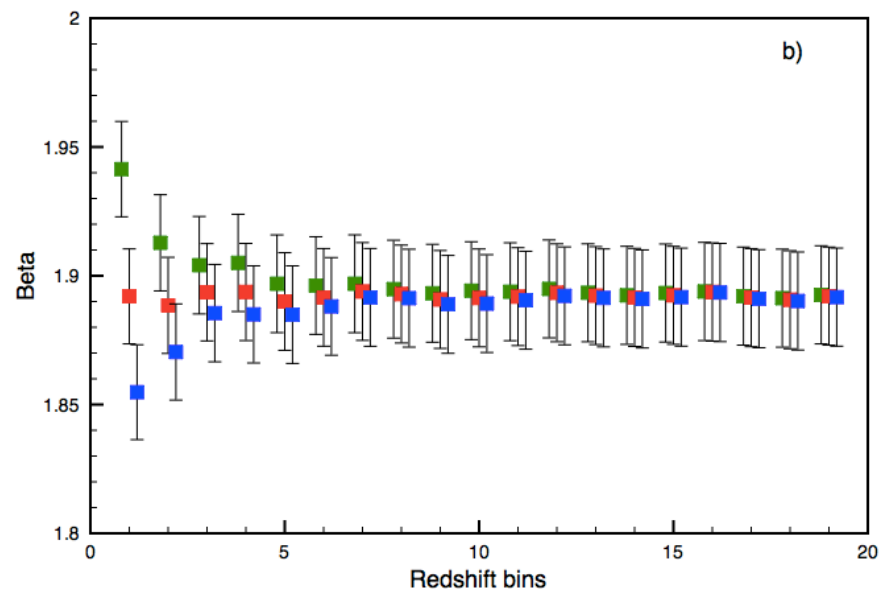
$$M_{0i} = m_x - \mu(z) + \alpha x_1 - \beta c$$
$$m_x = -2.5\log_{10}(x_0)$$

- where M_{0i} varies independently for each bin.
- The error on the residual is given by

$$\sigma^2 = \Sigma_{11} + \alpha^2\Sigma_{22} + \beta^2\Sigma_{33} + \alpha\Sigma_{12} + \beta\Sigma_{13} - \alpha\beta\Sigma_{23}$$

Dependence on Redshift Binning



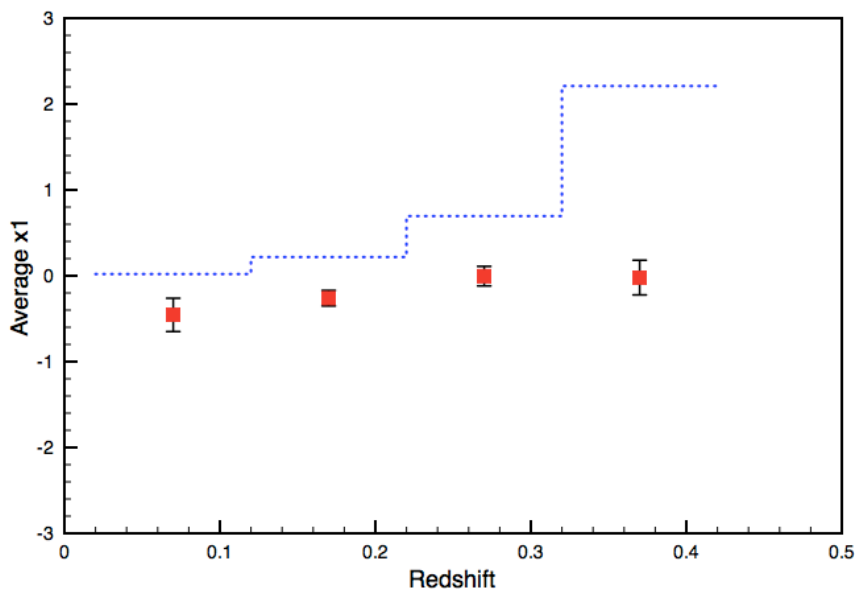


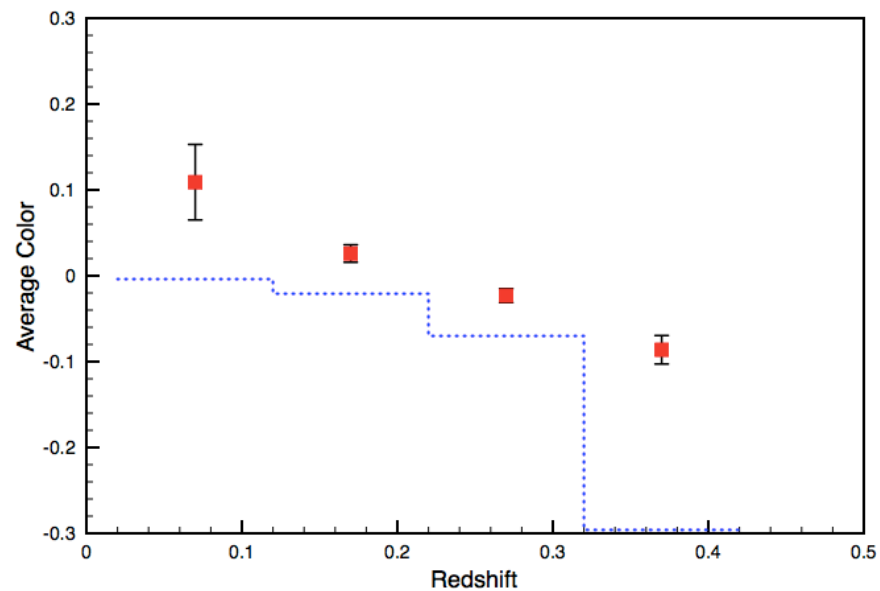
Dependence on the Form of the Intrinsic Error

Intrinsic Error	χ^2	α	$\Delta\alpha$	β	$\Delta\beta$
$\delta_0=\delta_1=\delta_c=0$	1305	0.1891	0.0064	2.820	0.050
$\delta_0=0.14$, $\delta_1=\delta_c=0$	350	0.1465	0.0098	2.650	0.078
$\delta_1=0.70$, $\delta_0=\delta_c=0$	330	0.3002	0.0200	2.405	0.116
$\delta_c=0.05$, $\delta_1=\delta_c=0$	333	0.1330	0.0110	3.208	0.102

SDSS 3-year spectroscopic sample with selection criteria either approximately or exactly the cosmology sample.

Does it Matter?





Simulated Data

Intrinsic Error	χ^2	α	$\Delta\alpha$	β	$\Delta\beta$
$\delta_0=\delta_1=\delta_c=0$	19500	0.2143	0.0011	3.104	0.011
$\delta_0=0.14$, $\delta_1=\delta_c=0$	4340	0.1846	0.0019	2.868	0.021
$\delta_1=0.70$, $\delta_0=\delta_c=0$	3920	0.2491	0.0027	2.875	0.026
$\delta_c=0.05$, $\delta_1=\delta_c=0$	3707	0.1842	0.0023	3.381	0.027
Computed	4111	0.1831	0.0022	3.398	0.029

Computed error matrix is

$\delta_0 = 0.069 \quad \xi_{01} = -0.119 \quad \xi_{0c} = 0.590$

$\delta_1 = 0.069 \quad \xi_{1c} = 0.362$

$\delta_c = 0.069$

Sample was generated with α=0.18 and β=3.4.

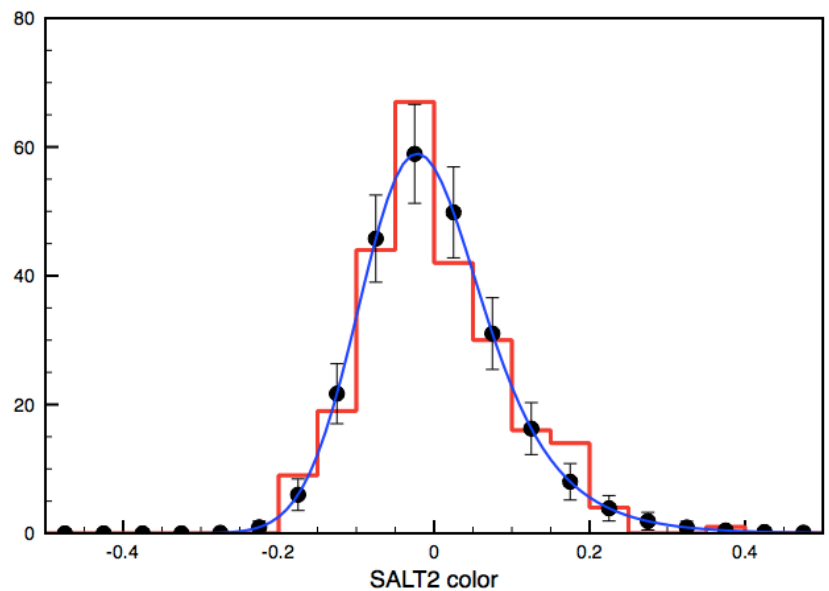
Intrinsic Color Variations

- We fit the distribution to the convolution of an exponential and a Gaussian

$$\rho(c) = \int_{c-c_0}^{\infty} \exp\left(\frac{c - c_0 - c'}{\tau}\right) \exp\left(-\frac{c'^2}{2\sigma_c^2}\right) dc'$$

- And find

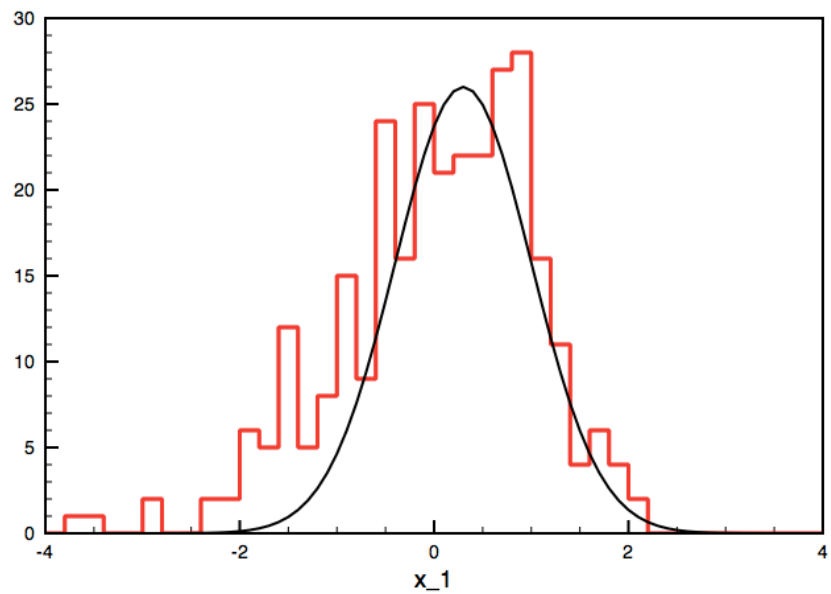
$$\sigma_c = 0.064 \pm 0.010$$
$$\tau = 0.069 \pm 0.016$$
$$c_0 = -0.068 \pm 0.015$$



☛Measurement error contributes 0.026 to σ_c so we estimate the intrinsic color scatter as 0.058.

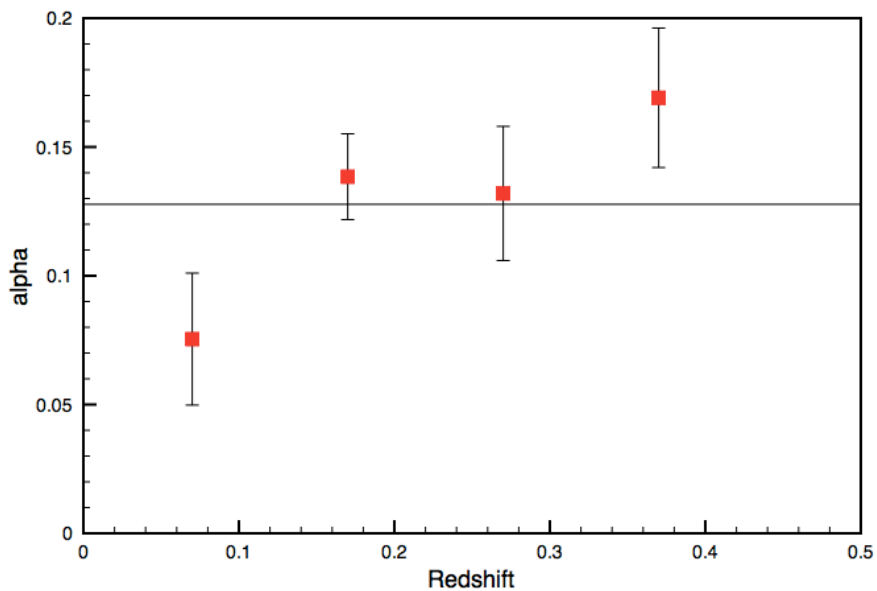
Intrinsic Shape Variations

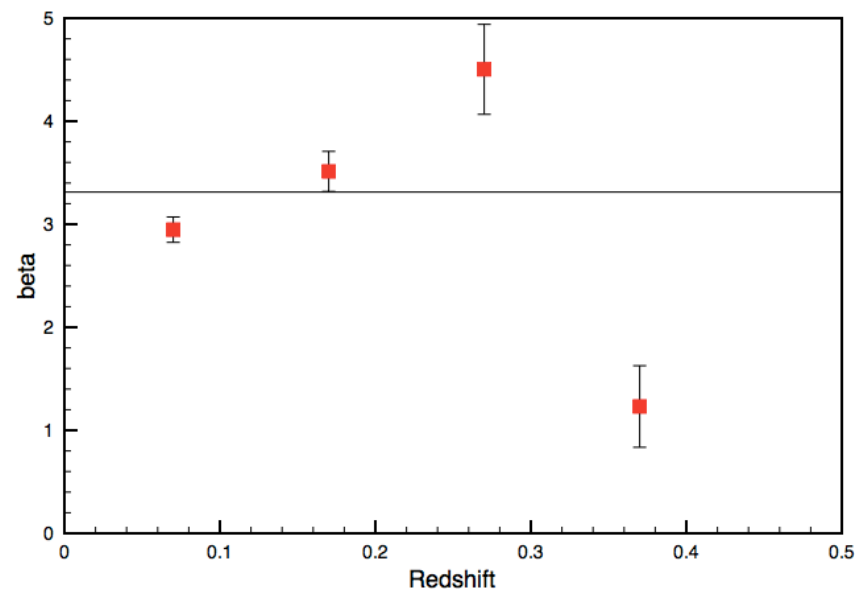
- The distribution of x_1 in star-forming galaxies is fairly narrow.
- Could intrinsic dispersion account for 0.7 of the width?



A normal Gaussian (width 1, normalized to the data), is shown for comparison.

Redshift Dependence of α and β





Conclusions

- A new method to generate distance moduli from SALT2 fits.
- The fitted parameters (and distance moduli) depend on the model for the intrinsic error.
- The method gives an unbiased result when the intrinsic error is properly included.
- We have good evidence for an intrinsic color variation of ~0.06, but information on the full matrix is limited.
- To come (?): z-dependence of α & β and non-linear dependence on x_1 and c.