

JLA: training SALT2 with synthetic data

Jen Mosher

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Why are we doing this?

- **Goal 2:** Study systematics of SALT2 training using SED models to simulate both photometric light curves and spectra.
 - ▶ Study impact of data gaps, poor S/N, galaxy contamination in spectra, etc ...

Building the Machinery

Tasks

- Simulation
- Training set creation
- Training
- Post-train testing

Intermediate Goal

- Using **ideal** SED training set
 - ▶ get reasonable DM's
 - ▶ get reasonable cosmology

Where we are now

Tasks

- Simulation
- Training set creation
- **Training**
- Post-train testing

Training Parameters to Choose

- training set
 - ▶ redshift, phase
 - ▶ filters
 - ▶ SNR, Cadence
- SALT2 model parameters
 - ▶ training surface type, size, and spline coverage
 - ▶ lots more..

Where we are now

Tasks

- Simulation
- Training set creation
- Training
- **Post-train testing**

Post-Train Testing Schematic

- Training creates SALT2 model
- SALT2 model used to fit lightcurves
 - ▶ output SN variables include: stretch ($x1$), color ($S2c$)
 - ▶ no cosmology yet
- cosmology fitter used to extract DM, cosmology
 - ▶ SNANA SALT2mu.exe
 - ▶ $m(z, cosmo) = M + \alpha x1 + \beta c + DM(z, cosmo)$
 - ▶ outputs model parameters α, β, M , cosmology
 - ▶ output SN variables include: DM

Where we are now

Tasks

- Simulation
- Training set creation
- Training
- **Post-train testing**

Post-train Diagnostics

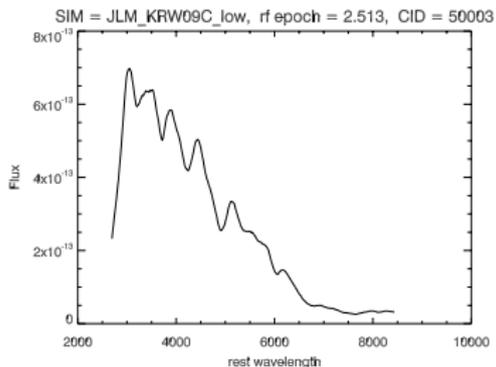
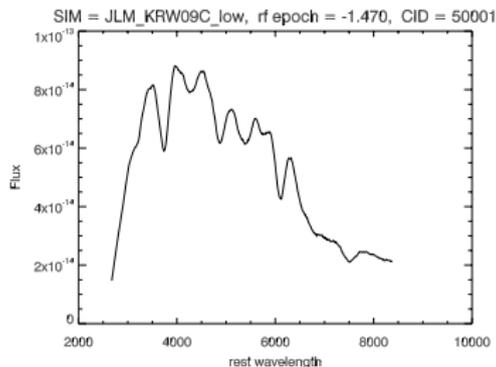
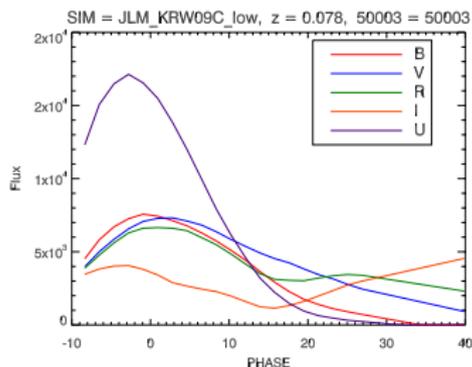
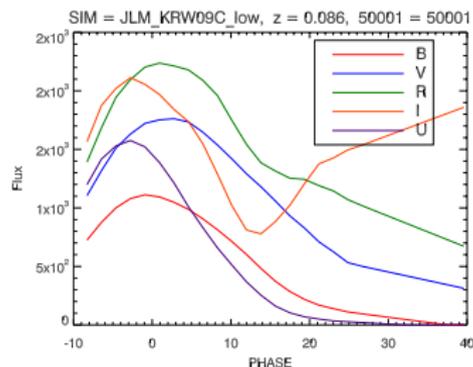
- Color Law
- DM residuals
- Cosmology
- Surfaces

A quick overview of KRW09 model

- 2-D model allows for explosion asymmetry
- model parameters:
 - ▶ IGNITION
 - ▶ DETONATION
 - ▶ VIEWING ANGLE (“COS”)
 - ▶ S2c - added by RK



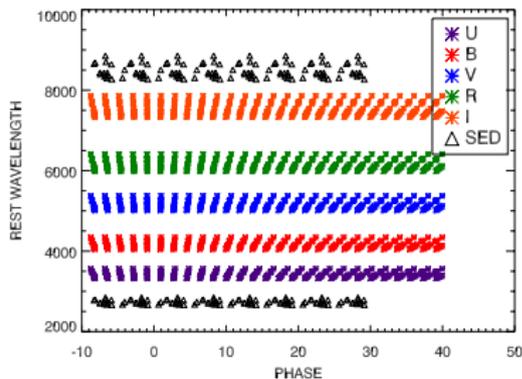
KRW09 - some pictures



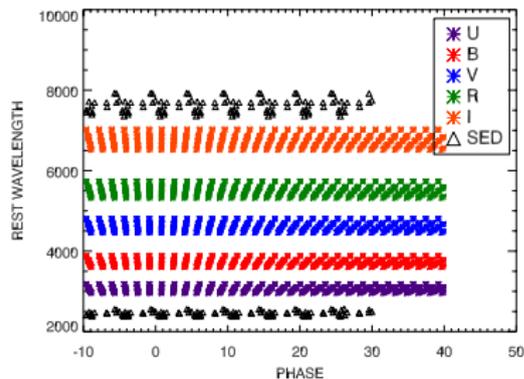
IGNIT: 1, DETON: 1
COS: -0.33, S2c: 0.4

IGNIT: 6, DETON: 2
COS: -0.70, S2c: -0.1

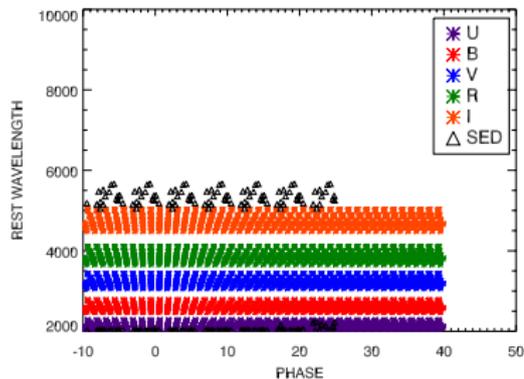
KRW09 training sets



LOW: $z \leq 0.1$ (3)

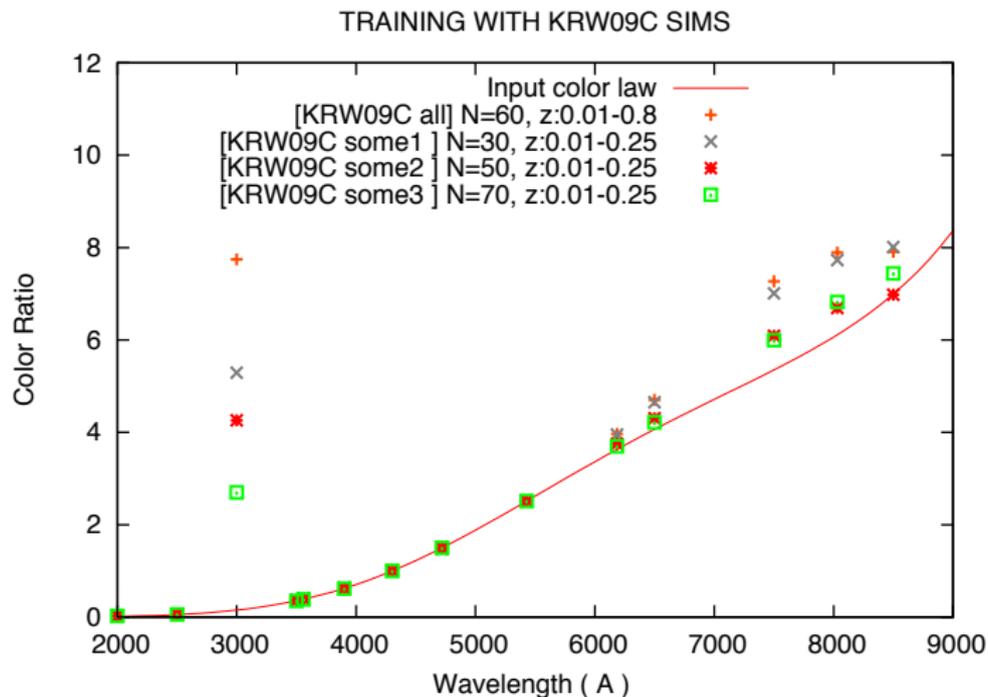


INT: $z \in [0.1, 0.25]$ (2)



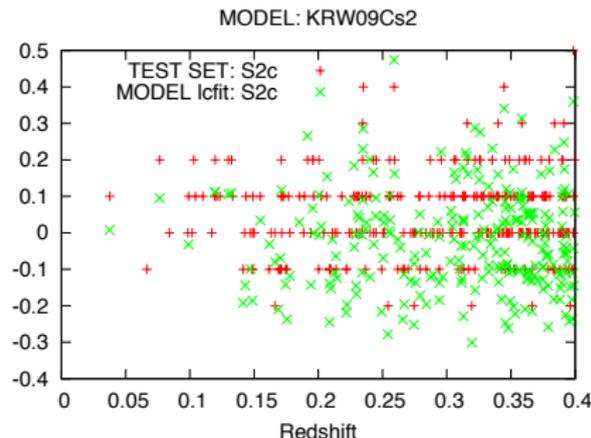
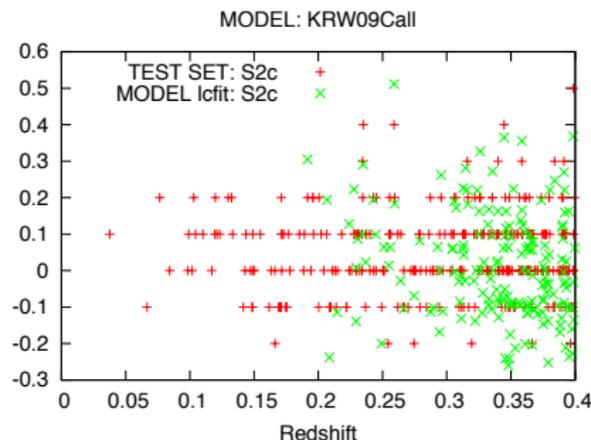
HIGH: $z \in [0.6, 0.8]$ (1)

KRW09 Trained Color Laws



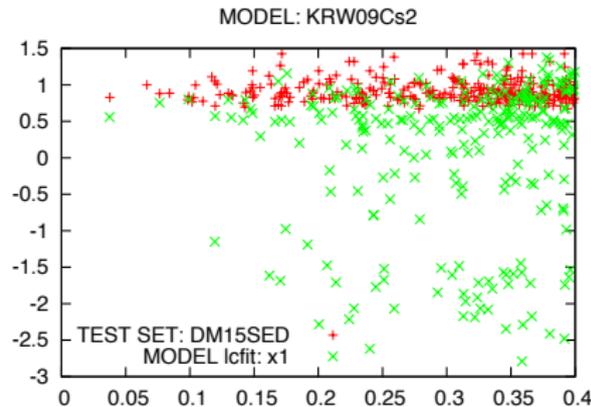
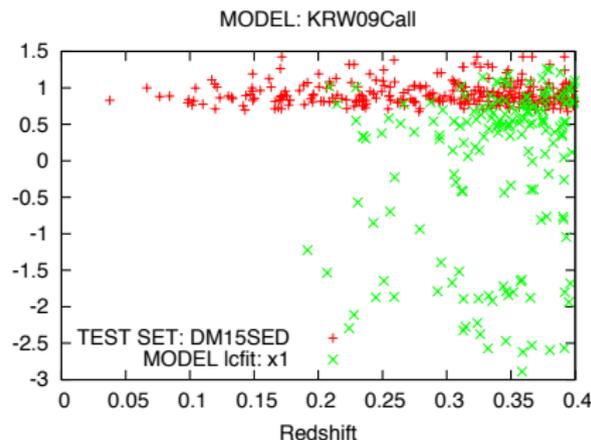
KRW09 fit vs sim: Color

- KRW09s2 model fits low z SNe better than KRW09all model
- SIM Sc2 values are discrete, model is not
- Can't compare to default SALT2: most SNe failed fitcuts



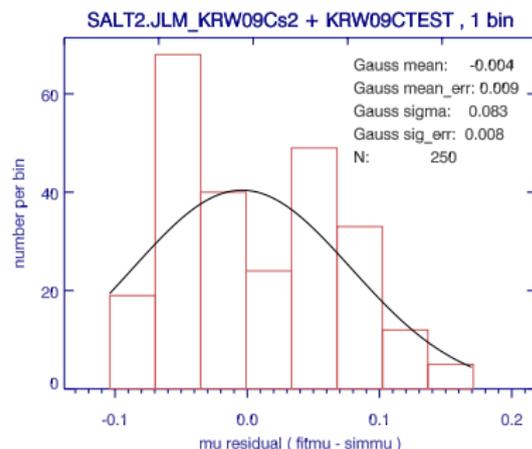
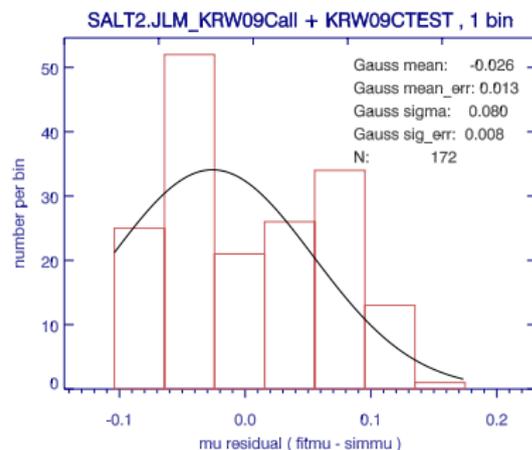
KRW09 fit vs sim: Width-Lum par

- Width-Luminosity is not a KRW09 model parameter
- SIM outputs DM15SED, SALT2
lcfits outputs x1
- fit has long tail in this parameter, at all z

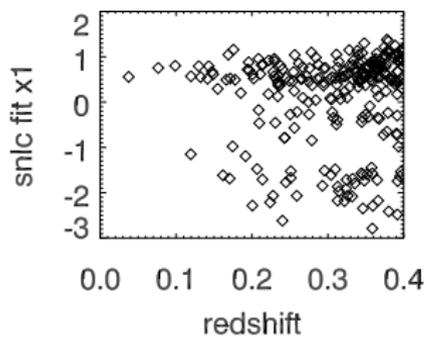
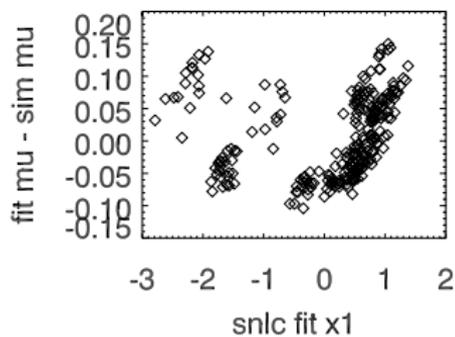
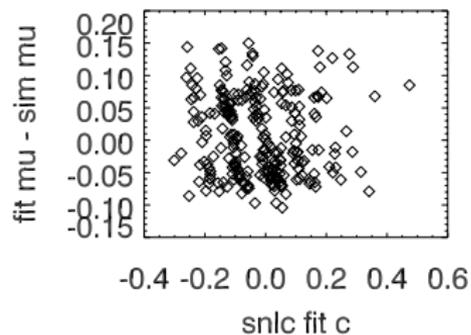
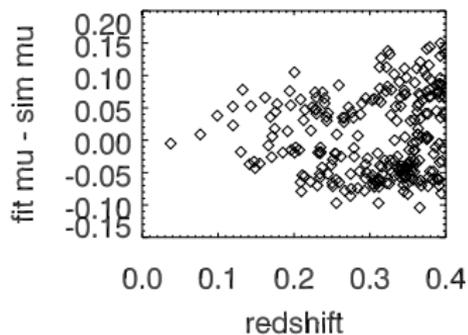


KRW09 DM residuals

- DM obtained from lcfits fits file via SALT2mu
- SALT2mu: single bin, fixed cosmology
- DM residuals are not gaussian (bimodal?)



KRW09Cs2 DM Residual vs lcfits params



Hsiao1c model

Based on Hsiao Template

- Modified to incorporate model parameters:
 - ▶ stretch ($\times 1$)
 - ▶ color (S2c)



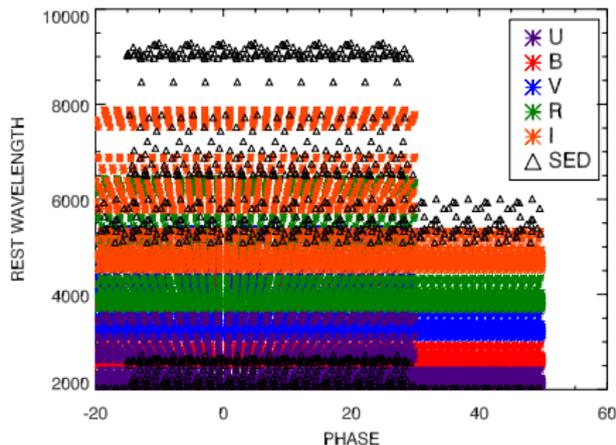
Training with Hsiao1c

- Training Set Composition

- ▶ N=60
- ▶ Use “IDEAL” training set
- ▶ UBVRI filters
- ▶ $z \in [0.01, 0.8]$
- ▶ phase map (p vs λ) shown, top right

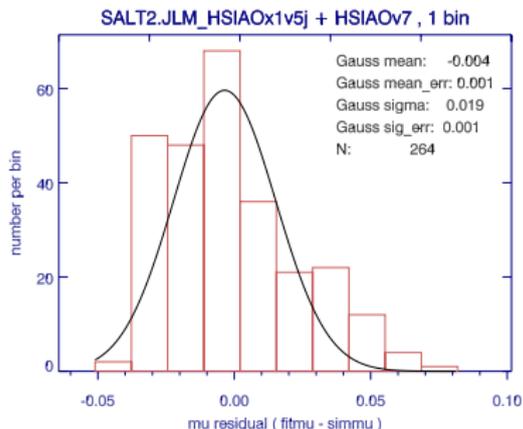
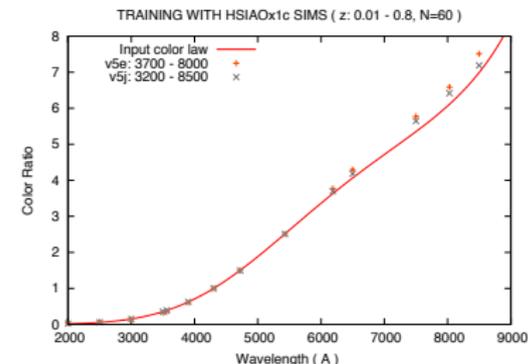
- SALT2 Model Parameters

- ▶ surface phase range: -20 - 50
- ▶ surface λ range: 2000 - 9200 Angstroms
- ▶ Color Law λ range: 3200 - 8500 Angstroms
- ▶ Bottom right: SALT2 input parameter file



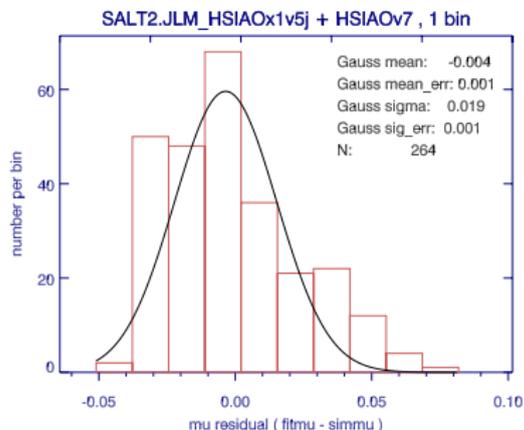
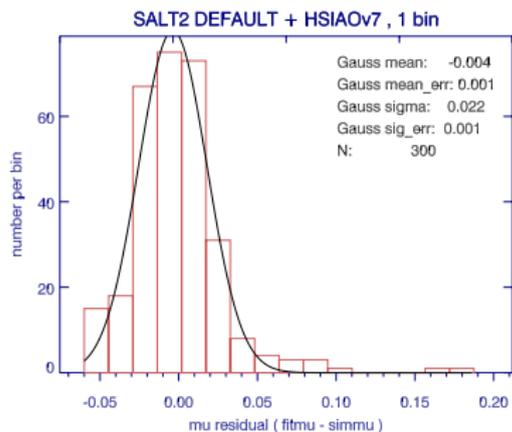
```
Example.conf
2
BSplineAdaptedBasis2
6 -20 50
30 2000 9200
BSplineAdaptedBasis2
6 -20 50
30 2000 9200
4 3200 8500
```

Compare Hsiao1c Training (v5j) with Default SALT2



- Tested on independent Hsiao1c sim
 - ▶ $N = 300$
 - ▶ $z \in [0.01, 0.4]$
- Slight discrepancies in output color law at larger wavelengths
- α, β , DM from SALT2mu fits
 - ▶ single bin
 - ▶ fixed cosmology
 - ▶ $\alpha_0 = .109 \pm .002$
 - ▶ $\beta_0 = 2.579 \pm .015$
- DM residuals non-gaussian

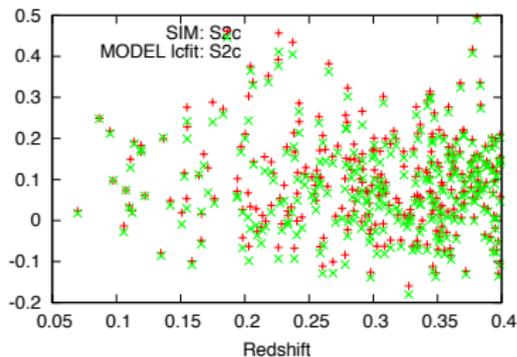
Testing Hsiox1c (v5j)



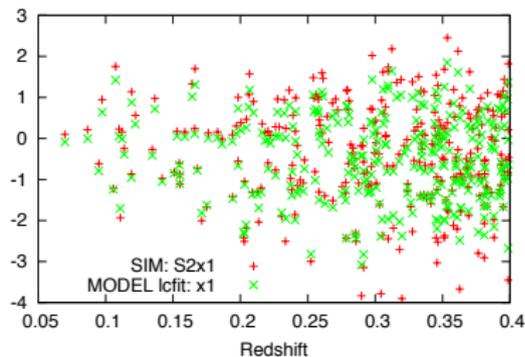
- Default SALT2 model residuals are gaussian
- SALT2mu output parameters α and m00 are inconsistent
- for SALT2 model:
 - ▶ $\alpha_0 = .154 \pm .002$
 - ▶ $\beta_0 = 2.501 \pm .017$
 - ▶ $m_{00} = -29.823 \pm 0.002$
- for HSIAOx1c v5j:
 - ▶ $\alpha_0 = .109 \pm .002$
 - ▶ $\beta_0 = 2.579 \pm .015$
 - ▶ $m_{00} = -29.507 \pm 0.002$

HSIAOx1 fit vs sim: Color and x1

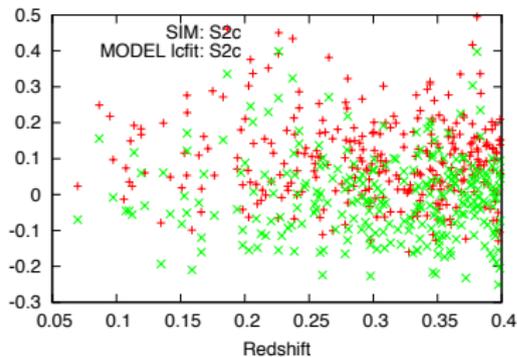
MODEL: SALT2



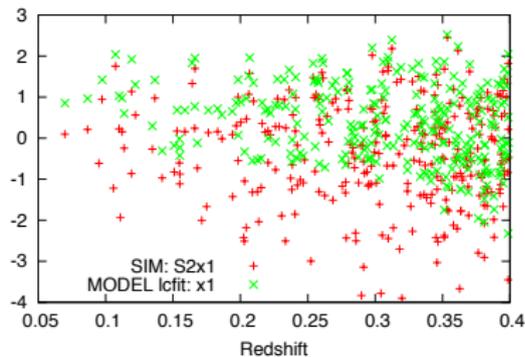
MODEL: SALT2



MODEL: HSIAOx1 v5j

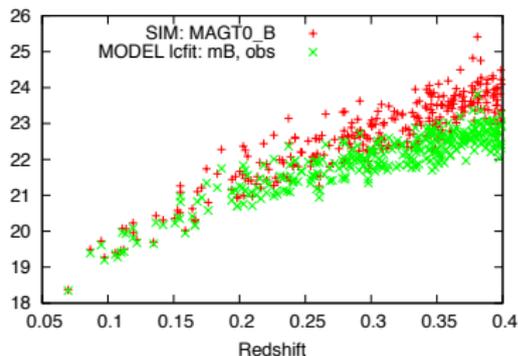


MODEL: HSIAOx1 v5j

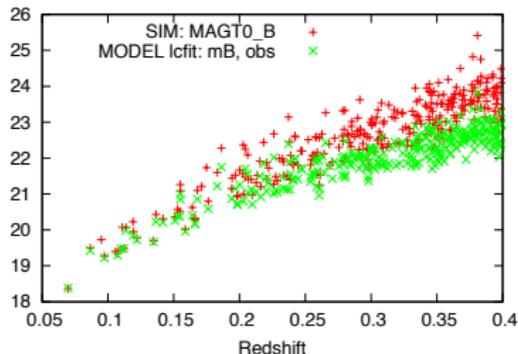


HSIAOx1 fit vs sim: mB

MODEL: SALT2



MODEL: HSIAOx1 v5j



- Compared to default, trained model
 - ▶ bluer color
 - ▶ larger stretch
- Both models underestimate mB0
- From which part of training do these differences originate?

Conclusions?

CURRENT TRAINING:

- does not reproduce color law at higher wavelengths
- results in non-gaussian DM residuals
- showing signs of degeneracy between width-lum and color

KRW09 in particular:

- suffering from discrete sim parameters?
- are 2 surfaces adequately capturing parameter space?

Next steps

- Start with Hsiox1
 - ▶ Look at differences with SALT2 (wave range, training set)
 - ▶ e.g. SALT2 trains from 2900 to 7000
- Look at surface slices
- Doublecheck understanding of SALT2mu
- Upgrade KRW09C to have continuous parameter ranges
- Consider more narrow testing to gain better understanding of effects
 - ▶ only photometry
 - ▶ only spectra
 - ▶ only 1D (narrow phase or wavelength window?)