ZTF SNIa projects

for proposal outlines

How do we present the need for a ZTF SNIa program?

Failure of empirical model

1. SNIa a key component of Stage IV cosmology, if nothing else since a complementary probe with immediate interpretation will be required.
2. Stage IV use prohibited by empirical model on two levels:
    a. Psychological - “do we trust a poorly understood thing to <1%?”
    b. Astrophysical - “evolution with z must exist at some level”
3. Requires physical, or at least “predictive”, model rather than empirical

[“Predictive” model : a model we trust for *correction* for evolutionary effects.]

Astrophysical model?

What dependencies are a priori expected based on current astronomical understanding?

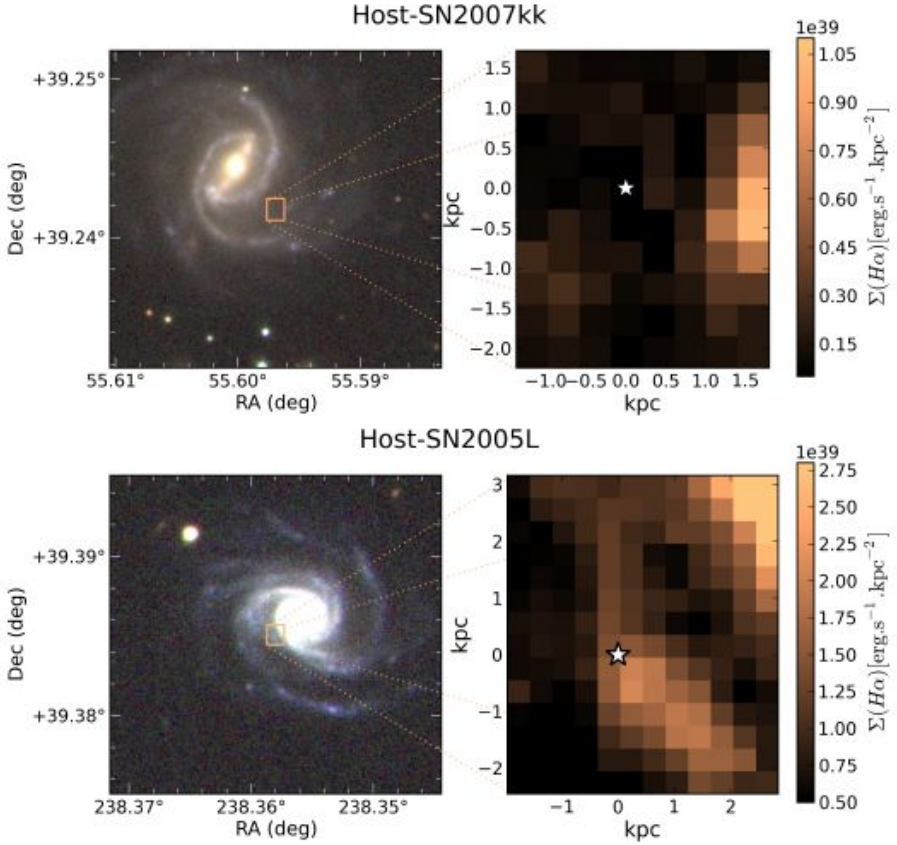
- Three spectroscopic (intrinsic) subtypes of normal SNe Ia.
- Five different galaxy environments:
  - Global old + metal rich
  - Local young + metal poor
  - Local young + metal rich
  - Local old + metal poor
  - Local old + metal rich
- Extinction law different between galaxies, and from SN to SN

Requirements

1. We have 3x5=15 potential astrophysical populations, with possible different evolution.

2. If reddening and SN magnitude can be constrained in each, we can claim an astrophysical understanding of SNe Ia.

3. Not necessary final “truth”, but enough to proceed beyond stepwise empirical model.



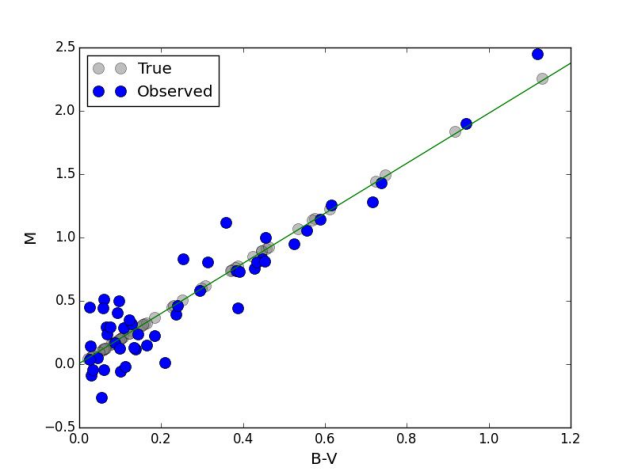
Why current samples fail:

Two decades of intense SN searching has created a sample suitable for current cosmological tests. Still, the lack of reddened SNe and missing information of the local host environment in globally active galaxies prevents a comprehensive and predictive understanding.

How many SNe to know a population?

Simple test of fitting peak magnitude and β for given color distribution and photometric uncertainty

Assume intrinsic properties, test which sample size and photometric quality needed to achieve some target magnitude and reddening uncertainties.



Target population constraint: σ_M=0.03, σ_β=0.1

How many SNe to know a population?

Simple test of fitting peak magnitude and β for given color distribution and photometric uncertainty

Max color:

	0.4	1.0	2.0
σ_{phot}=0.01, σ_{int}=0.14,	250	**50**	50
σ_{phot}=0.03, σ_{int}=0.14,	1000	100	100
σ_{phot}=0.01, σ_{int}=0.1	250	50	50

Minimal SN # needed for: σ_{Mabs}=0.03, σ_{β}=0.1

ZTF to the rescue!

ZTF has unique potential to fill the grid:

	Early type	Old + mrich	Old + mpoor	Young+rich	Young+poor
Broad SNIa	X	X			
Core			X	...	
Shallow		X			

Straightforward methodology:

- For each bin, need 50 SNe in hubble flow extending to E(B-V)~1 with 1% photometry.
- Sufficient spectroscopy for subclassification
- Ensure that red objects followed in all subclasses

magerr 0.01
intdisp 0.14

dM_target 0.03
dRv_target 0.1

Color-disp

Objects	0.1	0.15	0.3	0.5	1
10	0 / 0	0 / 0	0 / 0	0 / 0	0 / 1
25	0 / 0	0 / 0	0 / 0	0 / 1	0 / 1
50	1 / 0	1 / 0	1 / 1	1 / 1	1 / 1
100	1 / 0	1 / 1			
250	1 / 1				

dM_target 0.01
dRv_target 0.05

Color-disp

Objects \ c	0.1	0.15	0.3	0.5	1
10	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
25	0 / 0	0 / 0	0 / 0	0 / 1	0 / 1
50	0 / 0	0 / 0	0 / 0	0 / 1	0 / 1
100	0 / 0	0 / 0	0 / 1	0 / 1	0 / 1
250	0 / 0	0 / 0	0 / 1	0 / 1	0 / 1
1000	1 / 1	1 / 1	1 / 1	1 / 1	1 / 1

dM_target 0.03
dRv_target 0.25

Color-disp

Objects \ c	0.1	0.15	0.3	0.5	1
10	0 / 0	0 / 0	0 / 1	0 / 1	0 / 1
25	0 / 0	0 / 1	0 / 1	0 / 1	0 / 1
50	1 / 1	1 / 1	1 / 1	1 / 1	1 / 1
100	1 / 1	1 / 1			
250	1 / 1				

dM_target 0.05
dRv_target 0.1

Color-disp

Objects \ c	0.1	0.15	0.3	0.5	1
10	0 / 0	0 / 0	0 / 0	0 / 0	0 / 1
25	1 / 0	1 / 0	1 / 0	1 / 1	1 / 1
50	1 / 1	1 / 1	1 / 1	1 / 1	1 / 1
100	1 / 1	1 / 1			
250	1 / 1				

magerr 0.01
intdisp 0.1

dM_target 0.03
dRv_target 0.1

Objects \ c	0.1	0.15	0.3	0.5	1
10	0 / 0	0 / 0	0 / 0	0 / 1	0 / 1
25	0 / 0	0 / 0	0 / 1	0 / 1	0 / 1
50	1 / 0	1 / 0	1 / 1	1 / 1	1 / 1
100	1 / 0	1 / 1			
250	1 / 1				

tau	0.1	0.15	0.3	0.5	1
~Maxc	0.4	0.6	1	2	3

Conclusions:
- Need colors at least up to 1 to significantly fit "Rv/beta"
- With default target values and 0.01 photometry errors, each subset requires ~50 objects extending to c~1
- A smaller intrinsic dispersion helps, but not drastically so
- Magerr 0.02 instead of 0.01 roughly doubles the required number of SNe

magerr 0.02
intdisp 0.14

dM_target 0.03
dRv_target 0.1

Objects \ c	0.1	0.15	0.3	0.5	1
10	0 / 0	0 / 0	0 / 0	0 / 0	0 / 1
25	0 / 0	0 / 0	0 / 0	0 / 1	0 / 1
50	0 / 0	0 / 0	0 / 1	0 / 1	0 / 1
100	1 / 0	1 / 0	1 / 1	1 / 1	1 / 1
250	1 / 1	1 / 1	1 / 1	1 / 1	1 / 1

magerr 0.03
intdisp 0.14

dM_target 0.03
dRv_target 0.1

Objects \ c	0.1	0.15	0.3	0.5	1
10	0 / 0	0 / 0	0 / 0	0 / 0	0 / 1
25	0 / 0	0 / 0	0 / 0	0 / 1	0 / 1
50	0 / 0	0 / 0	0 / 1	0 / 1	0 / 1
100	1 / 0	1 / 0	1 / 1	1 / 1	1 / 1