



Light Curve Analysis of Type II SNe KSP-ZN7090

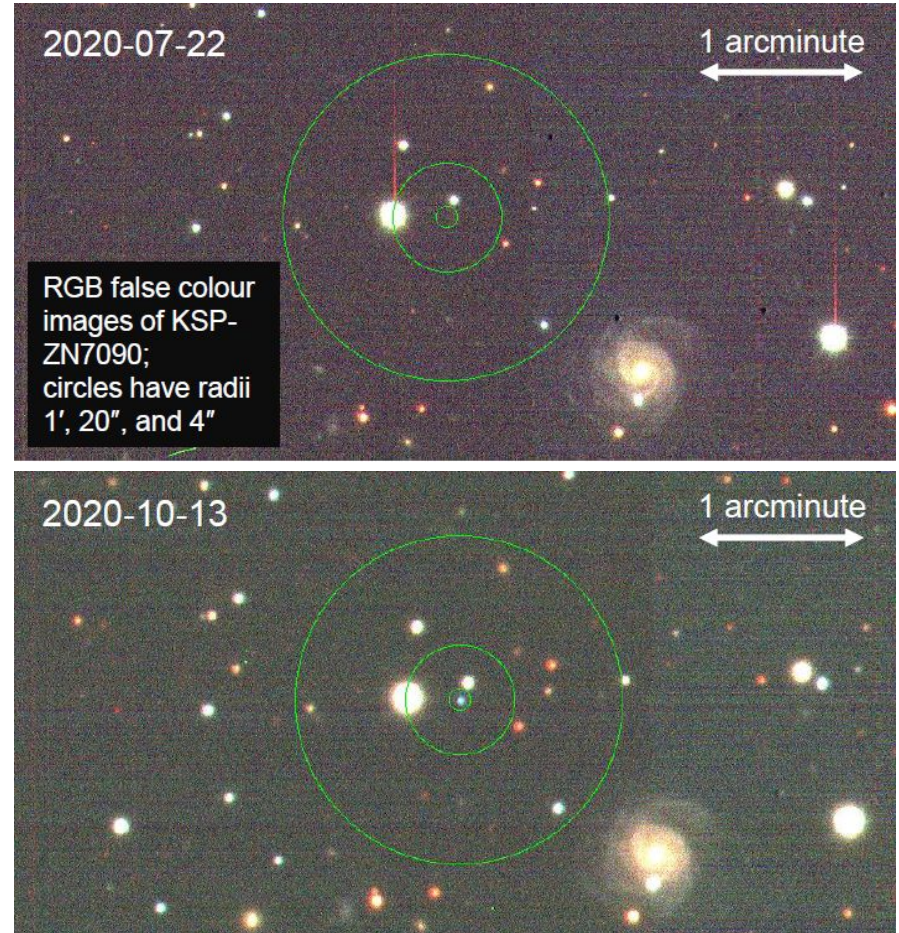
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First Detection

- First detected by KMTNet on 2020-10-12 14:44 UTC
- Young Type II SN detected within 1 day after explosion
- Multiband observation (BVi)

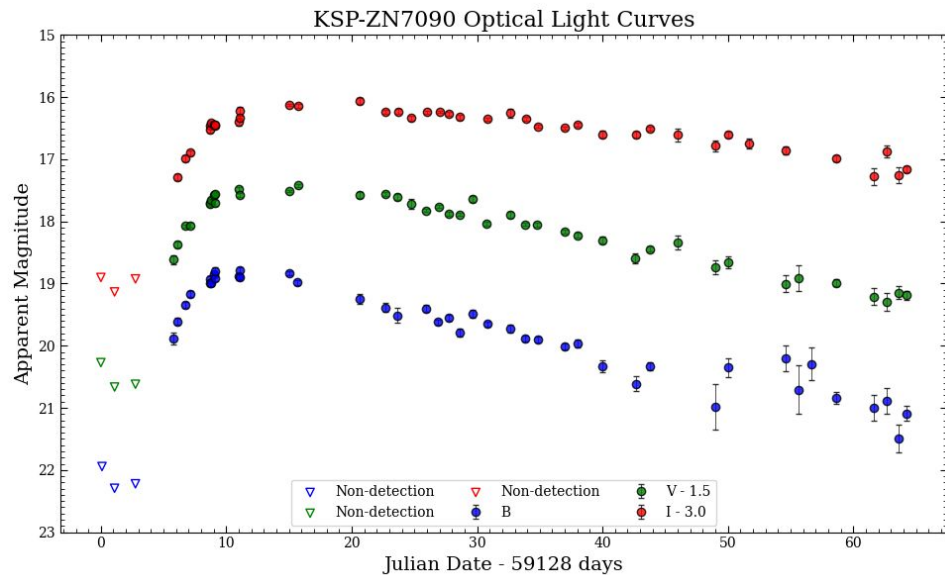


Mathew Leung

Photometry Work



- Image Subtraction
- PSF Photometry
- Light Curve Binning & Image Stacking
- Colour Corrections
- Extinction Correction





Creating Bolometric Light Curve for KSP-ZN7090

Bolometric light curves can be thought as the light curves that account for all E&M radiation emitted at all wavelengths

Bolometric Corrections
Method

- Apply bolometric corrections from well studied SNe
- We must properly classify and understand powering mechanism of ZN7090

Stage 1: Preliminary Analysis on Light Curves



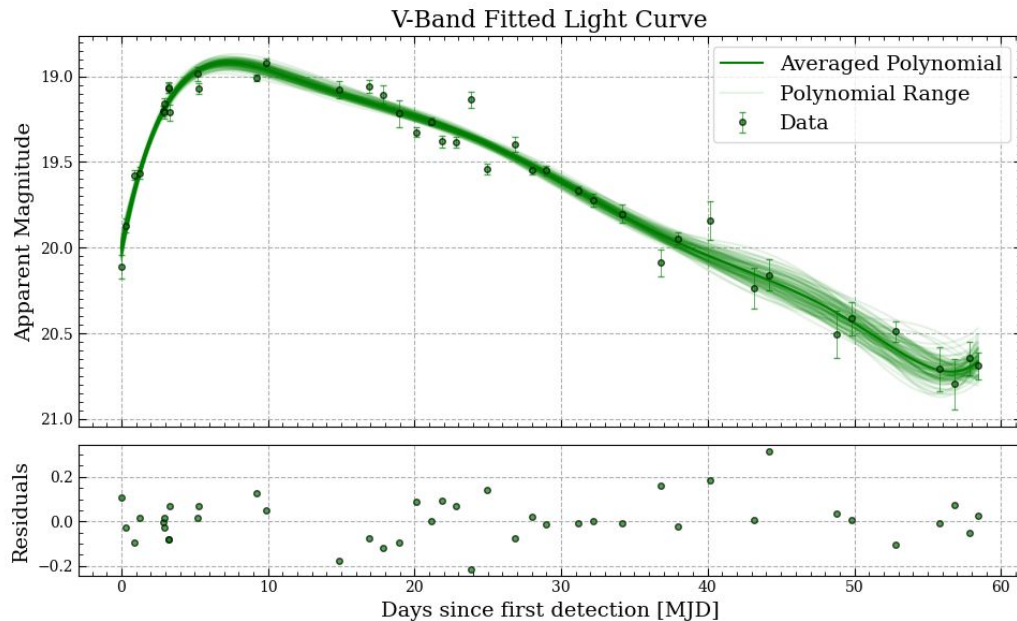
Classifying ZN7090

- A rough inspection on the host galaxy's spectrum indicated P-Cygni profile for H-alpha (Hint towards Type II SNe)
- Subdivision within Type II SNe
 - Type II-P
 - Type II-L
- Difference between division lies on the morphology of light curve
- Type II-L
 - Linear decline post peak
 - Decline rate is greater than 0.01 mag/day
- Type II-P
 - Plateau phase post peak
 - Attributed to hydrogen recombination on the ejecta

Estimating Peak Magnitude Epoch

- Fitted a polynomials of degree 7 for light curves
- Date: 2020-10-19 20:52
- V-band decline rate is consistent with other Type II-L SNe

$$\Delta m = 3.84 \pm 0.01 \frac{\text{mag}}{100 \text{ day}}$$



Epoch of First Light & Rise Times



- Two main mechanisms could dominate the rise of a CCSNe
 - Shock breakout
 - Radioactive decay
- Mechanisms vary the rise time

Constrain Epoch of First Light

- Perform simultaneous power fitting on early light curve

$$f(t) = C_{\lambda}(t - t_0)^n$$

First Light Dates:

1. 2020-10-12 09:09
2. 2020-10-12 05:56

Table 2: Light curve rise times for power fits in different scenarios

KMTNet Band	2 Day Model (Days)	3 Day Model (Days)
B-Band	5.4 ± 0.3	5.5 ± 0.3
V-Band	7.5 ± 0.3	7.6 ± 0.3
I-Band	9.5 ± 0.3	9.6 ± 0.3

Stage 2: Applying Bolometric Corrections



Bolometric Corrections

- Bolometric corrections are energy corrections that are applied to the magnitude system in order to account for the emitted radiation in all wavelengths
- The methods for finding these correction vary between literature

$$BC_x = \sum_{k=0}^n c_k (m_x - m_y)^k$$

Color 

$$BC_x = m_{bol} - m_x$$

Bolometric Corrections Used

Martinez et al. [2022](#) , Colors: (B-V)

Layman et al. [2014](#), Colors: (B - V)

Layman et al. [2016](#), Colors: (B - i) (V-i)

Table 4. Coefficients of the polynomial fits to the BC versus different colours.

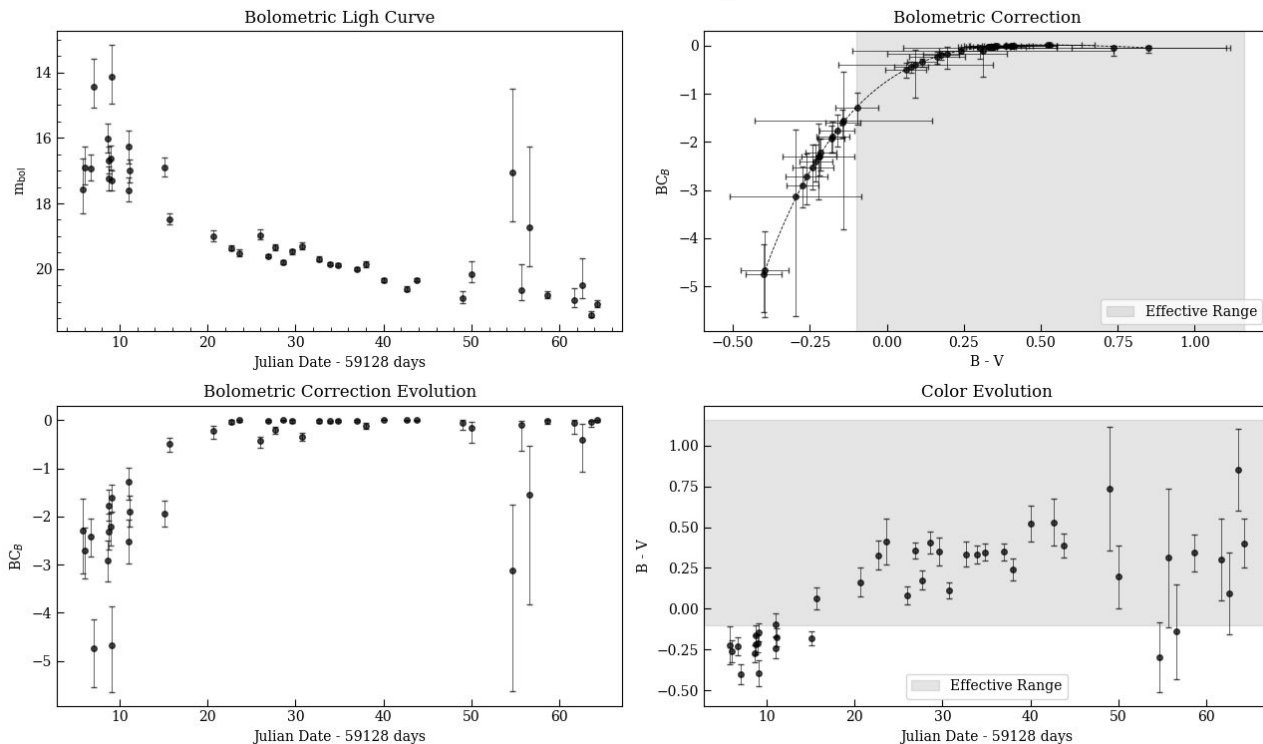
Colour	Phase	Range	c_0	c_1	c_2	c_3	c_4	σ
$B - V$	Cooling	(-0.10, 1.16)	-0.740	4.472	-9.637	9.075	-3.290	0.12
	Plateau	(0.07, 1.98)	-0.384	1.692	-2.370	1.524	-0.476	0.19
	Tail	(0.46, 1.78)	-2.696	11.532	-18.805	13.040	-3.315	0.21
$g - r$	Cooling	(-0.26, 1.09)	-0.352	1.753	-4.078	1.961	—	0.11
	Plateau	(0.01, 2.17)	-0.219	0.813	-2.194	1.205	-0.305	0.14
	Tail	(0.78, 2.07)	-9.994	21.507	-15.343	3.273	—	0.22
$g - i$	Cooling	(-0.50, 1.15)	-0.214	0.789	-2.357	1.097	—	0.11
	Plateau	(-0.10, 2.79)	-0.140	0.292	-1.224	0.522	-0.090	0.07
	Tail	(0.86, 2.43)	-0.263	-0.154	-0.256	—	—	0.08

Notes. $BC = \sum_{k=0}^n c_k(\text{colour})^k$, where colour is taken from Column 1. σ is the standard deviation about the fit.

Bolometric Light Curve Adapting Martinez et al. 2022

Bolometric Corrections

Martinez et al. Cooling B-V



Bolometric Corrections using Layman et al. 2014 & 2016

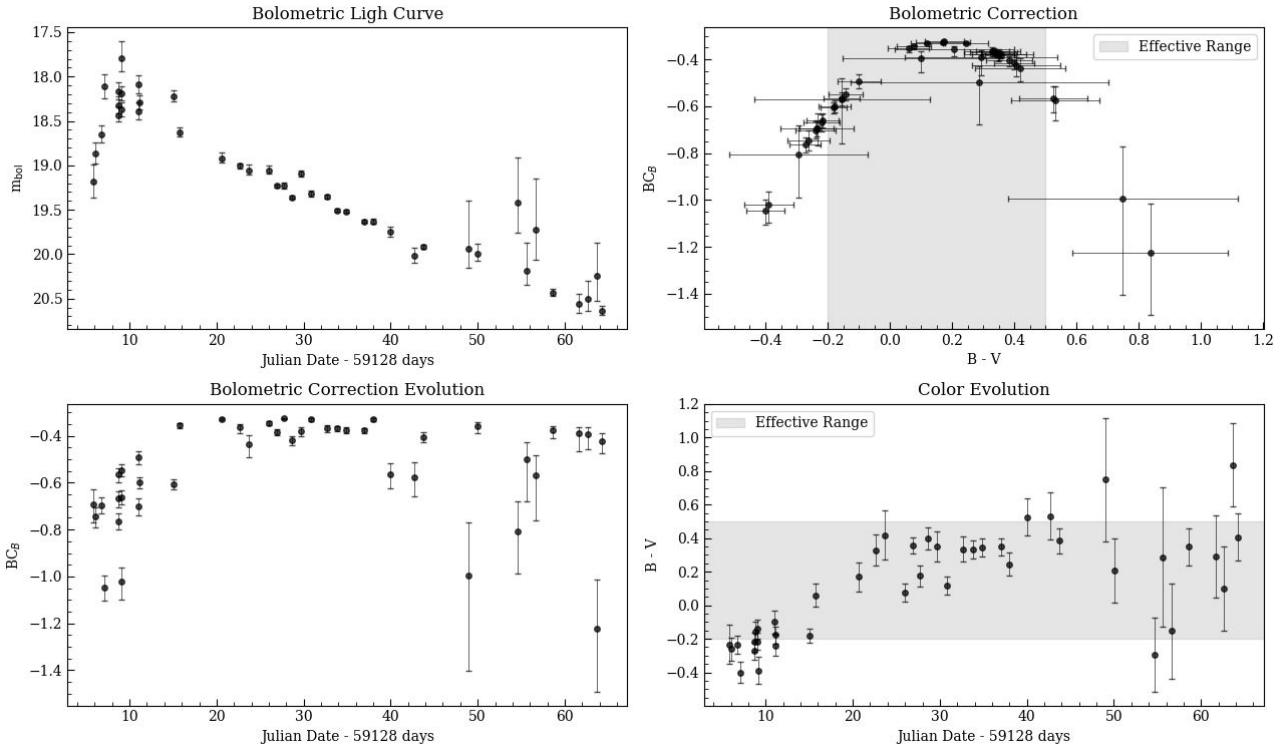
Layman provides a correction for a combination between Sloan and Johnson Cousin filters, and just Johnson magnitudes.

Table 3: Lyman, Bersier, James, Mazzali, et al. 2016b bolometric correction coefficients for polynomial of degree 2 specific to the shock cooling phase.

Color	Phase	Range	c_0	c_1	c_2	σ
B - V	Cooling	(-0.2,0.5)	-0.393	0.786	-2.124	0.089
B - i	–	(-0.392, 2.273)	-0.155	-0.450	-0.167	0.023
V - i	–	(-0.391, 0.658)	0.181	-0.212	-1.137	0.044

Bolometric Light Curve Adapting Layman et al. 2014 Bolometric Corrections

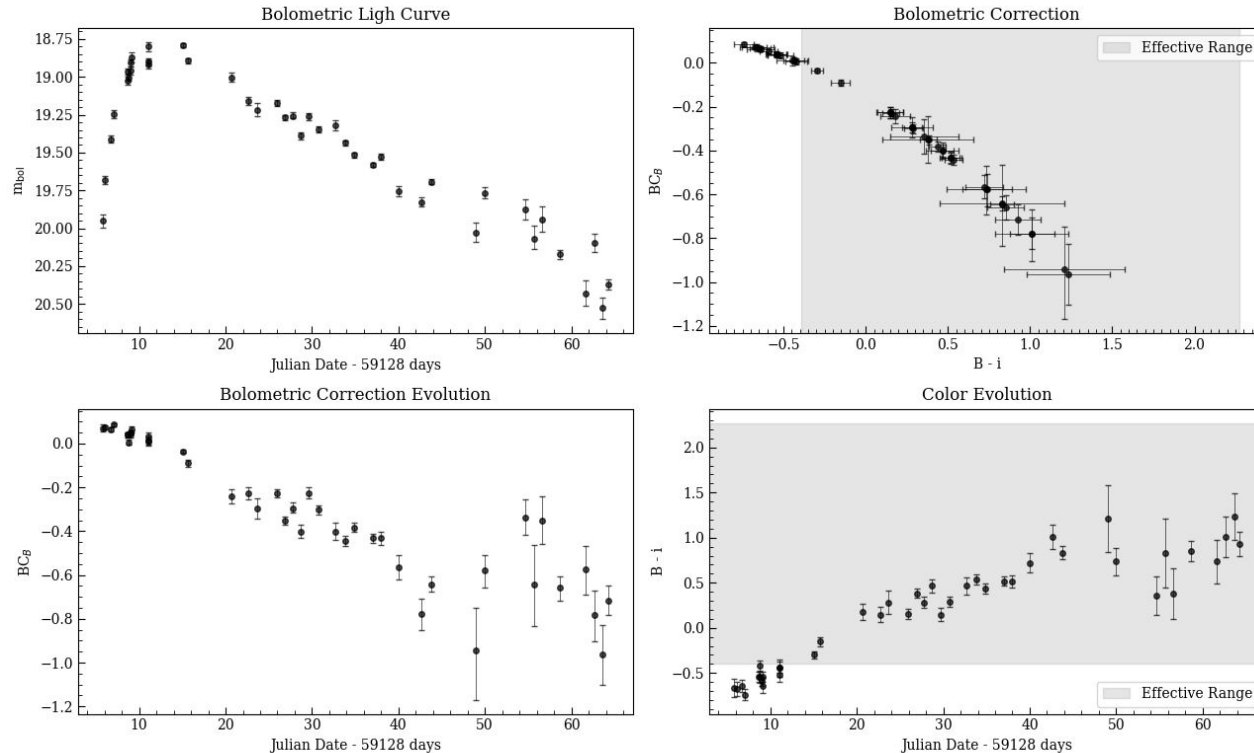
Layman et al. Cooling B-V



Bolometric Light Curve Adapting Layman et al. 2016

Bolometric Corrections

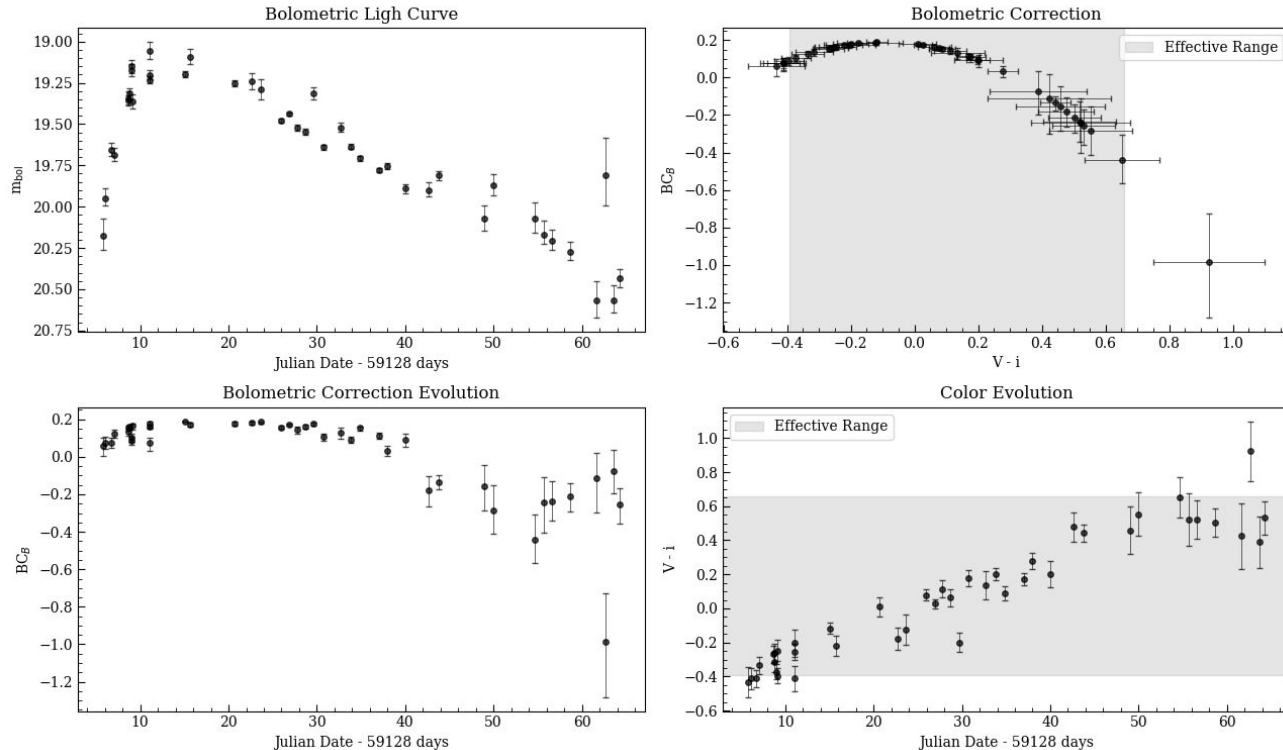
Layman et al. Type II B - i



Bolometric Light Curve Adapting Layman et al. 2016

Bolometric Corrections

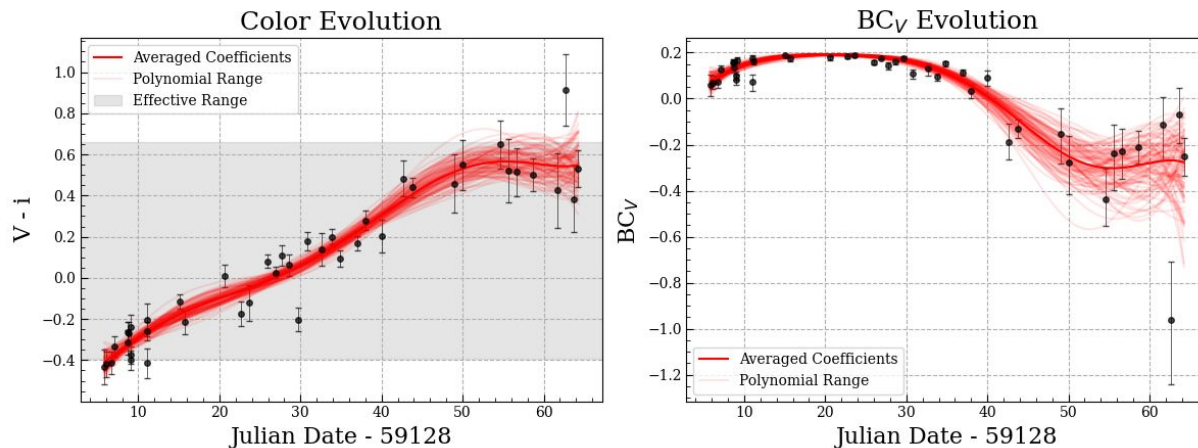
Layman et al. Type II V - i



Smooth Color Evolution

- Color is a temperature indicator for a SNe
- All color evolutions plot indicate a transition from blue to red
 - Due to the cooling of the ejecta
- We expect this cooling to be a smooth monotonic function

Gaussian Sampling on Color Evolution



Applying Simulated Color Evolution to Bolometric Correction

- Outlier bolometric magnitude in light curve has been 'corrected'

