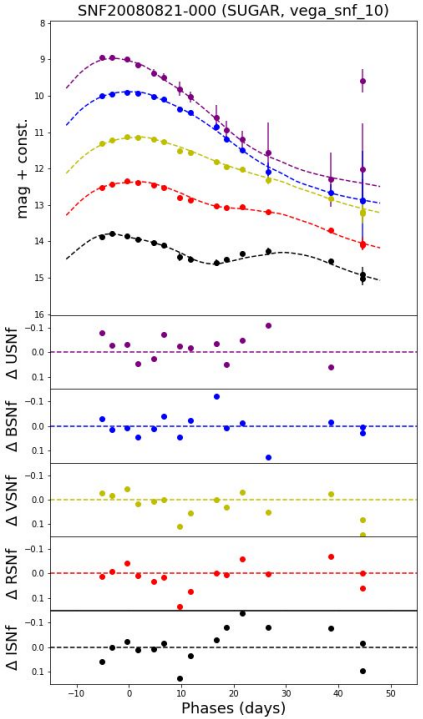
Estimate light curves parameters with SUGAR

Florian Mondon
Ph.D avisor : Emmanuel Gangler

SUGAR parameters fitting using spectra or light curves

Light curves fitting :



SUGAR standardisation :

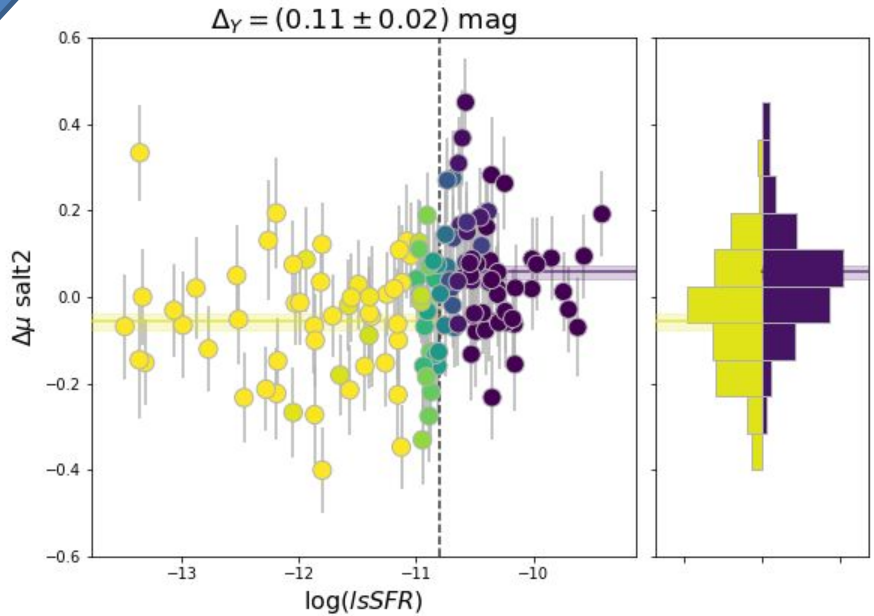
$$\mu_{sugar} = m_B^* - M_B - \sum_{i=1}^{3} \alpha_i q_i - \beta A_v$$

	BVR	UBVRI	UBVR	BVRI	Spectro
σ_{int} SUGAR	0,125	0,123	0,127	0,125	0,117
wrms SUGAR	0,135±0, 010	0,132±0, 010	0,135±0, 010	0,134±0, 010	0,125±0, 010
σ_{int} SALT2	0,130	0,125	0,118	0,138	
wrms SALT2	0,142±0, 010	0,136±0, 010	0,131±0, 010	0,148±0, 010	

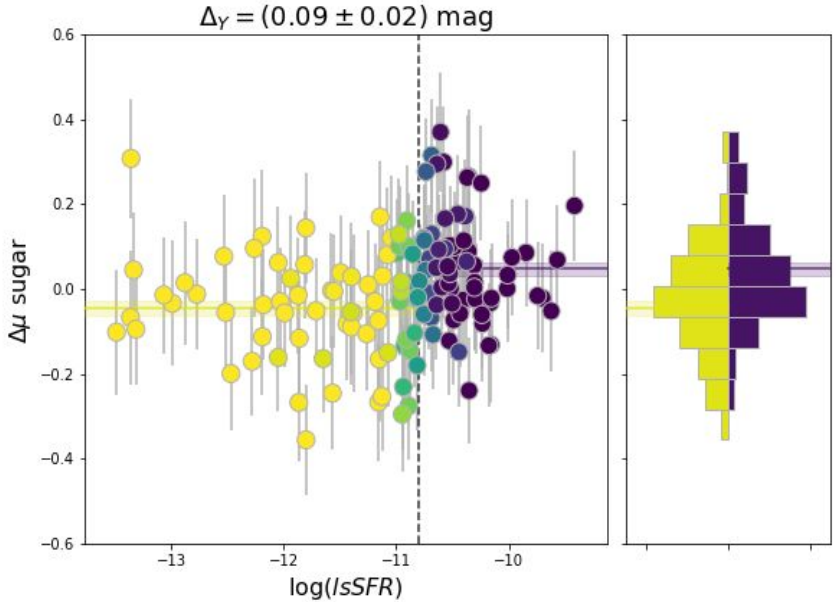
Table 1: Compared performances of SUGAR and SALT2 on the values of Hubble diagram wrms and σ_{int}

Comparaison du LsSFR step entre une standardisation SALT2 et SUGAR

Standardisation SALT2 :



Standardisation SUGAR :



Summary of the SNe Ia Standardization

paramètres	wRMS	σ_{int}	ΔM	ΔY
salt2	0.140 ± 0.008	0.128	-	-
sugar	0.134 ± 0.008	0.124	-	-
salt2 + ΔM	0.133 ± 0.008	0.121	0.12 ± 0.03	-
sugar + ΔM	0.125 ± 0.008	0.116	0.09 ± 0.03	-
salt2 + ΔY	0.128 ± 0.008	0.116	-	0.15 ± 0.03
sugar + ΔY	0.122 ± 0.008	0.112	-	0.13 ± 0.03
salt2 + ΔM + ΔY	0.127 ± 0.008	0.115	0.05 ± 0.03	0.11 ± 0.03
sugar + ΔM + ΔY	0.121 ± 0.008	0.111	0.05 ± 0.03	0.10 ± 0.03

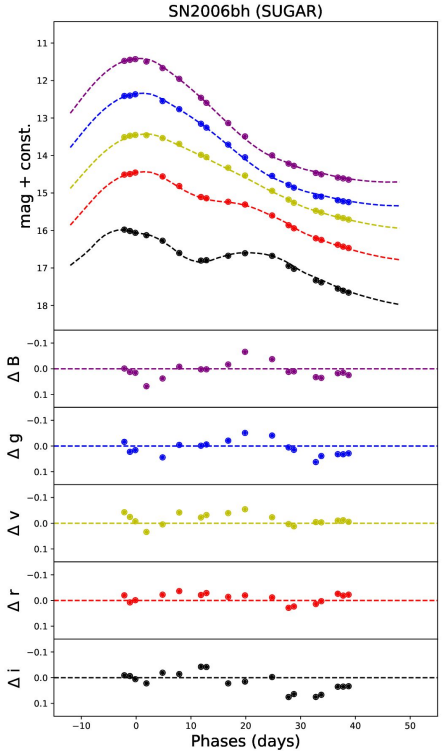
Table 1: Summary of the SNe Ia Standardization (UBVRI)

LsSFR step : $\mu_{sugar} = m_B^* - M_B - \sum_{i=1}^{3} q_i \alpha_{t,\lambda,i} - A_V \beta + p\, \Delta Y$

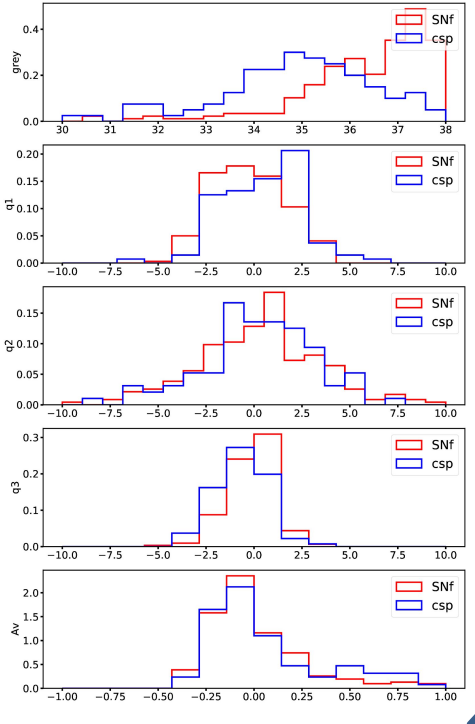
Mass step : $\mu_{sugar} = m_B^* - M_B - \sum_{i=1}^{3} q_i \alpha_{t,\lambda,i} - A_V \beta + p\, \Delta M$

Light curve fitting with external data set

Light curve fitting example :

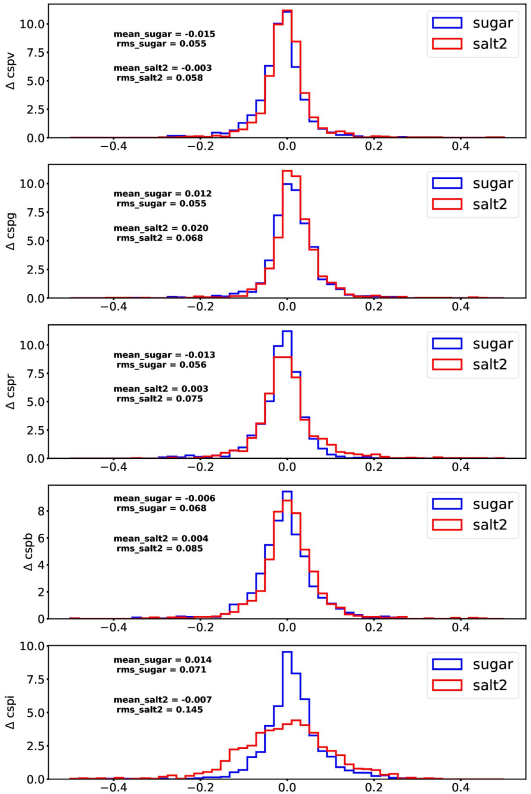


SUGAR parameters distribution CSP compare to SNf :

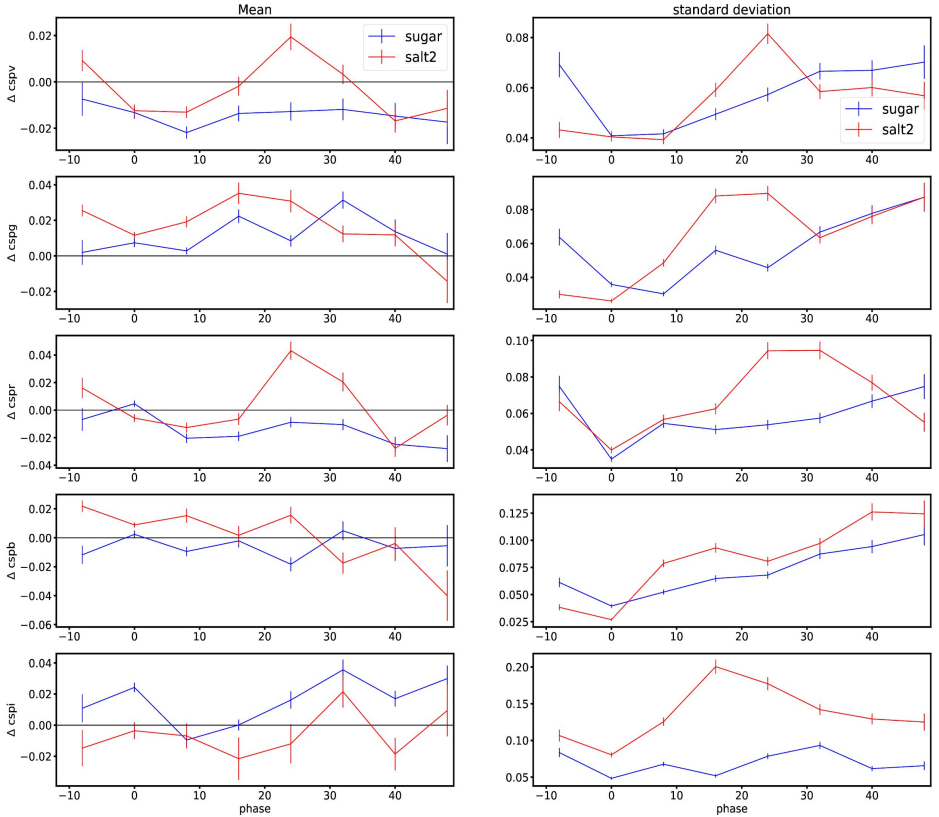


CSP Light curves residuals

Light curves residuals:

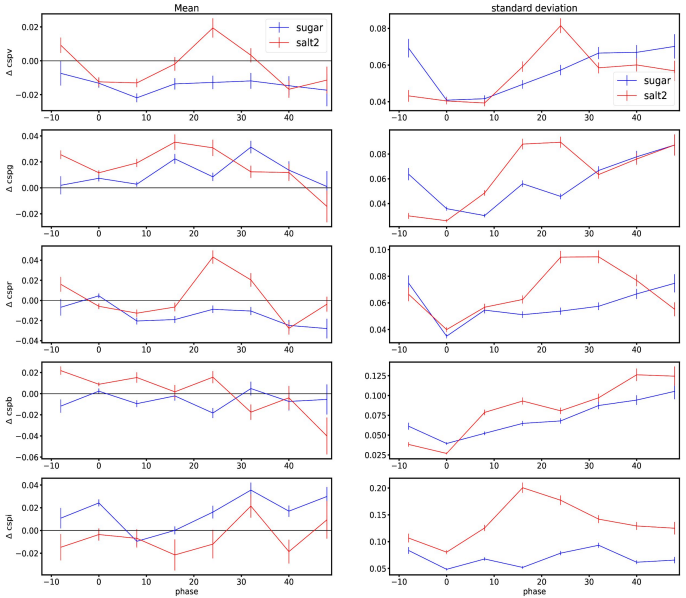


Light curves residuals sample by phase:



Build an error model for SUGAR

Light curves residuals sample by phase:



Error model:

$$\sigma^2_{residuals} = \sigma^2_{mesure} + \sigma^2_{model}$$

Build an error model for SUGAR

How to determine σ^2_{model}?

What we want :

- Complete error model in phase and wavelength

What we have :

- residuals for different phase and bands in CSP light curves

Build an error model for SUGAR

Likelihood :

$$-2\ln(L) = cst - \ln(\det(w)) + \sum \frac{residuals^2}{\sigma^2_{residuals}}$$

$$\sigma^2_{residuals} = \sigma^2_{mesure} + \sigma^2_{model}$$

Description of σ^2_{model} by 2D linear Spline

- Fit the nodes that describe this spline

Build an error model for SUGAR

- First fit all light curves

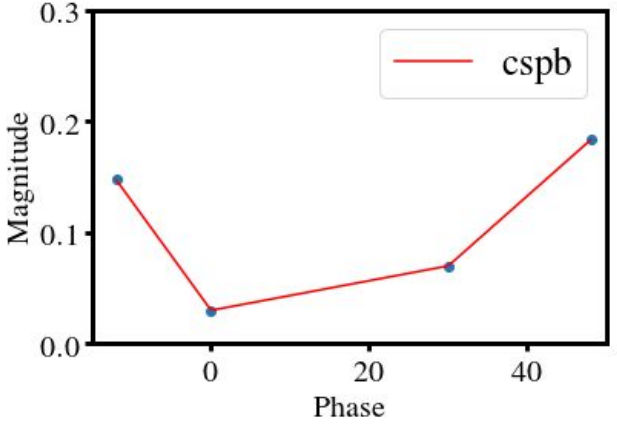
Residuals

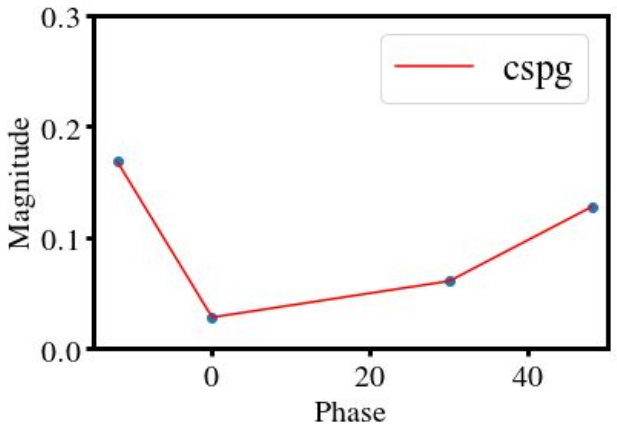
- First fit the Spline that maximise the Light curves:

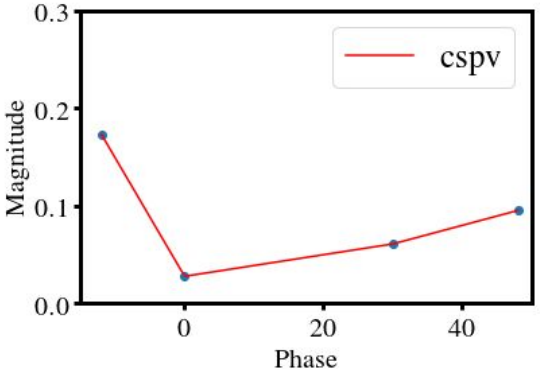
$$-2\ln(L) = cst - \ln(\det(w)) + \sum \frac{residuals^2}{\sigma^2_{residuals}}$$

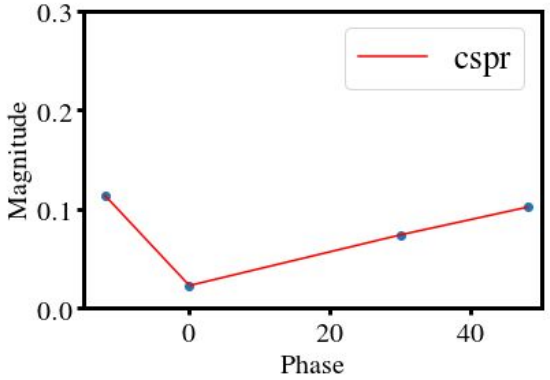
$$\sigma^2_{residuals} = \sigma^2_{mesure} + \sigma^2_{model}$$

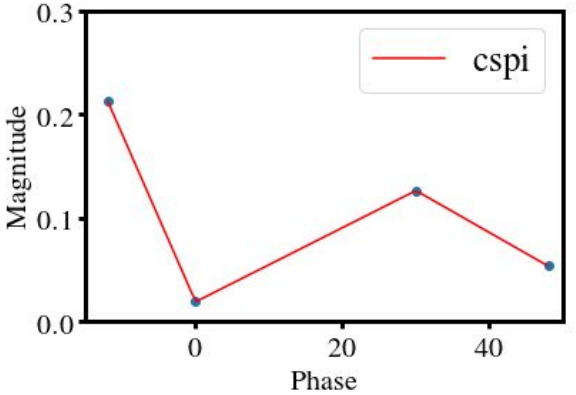
Build an error model for SUGAR











Conclusion

- SUGAR can be use with external data set
- We built a SUGAR model error
- We still have an LsSFR/Mass step with SUGAR standardisation