NaCl : Nouveaux algorithmes de Courbes de lumière

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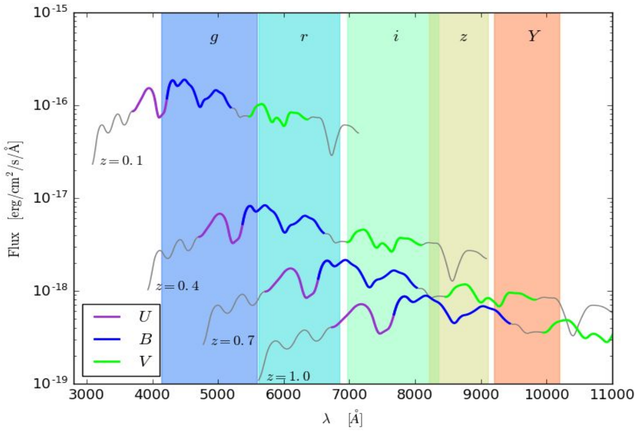
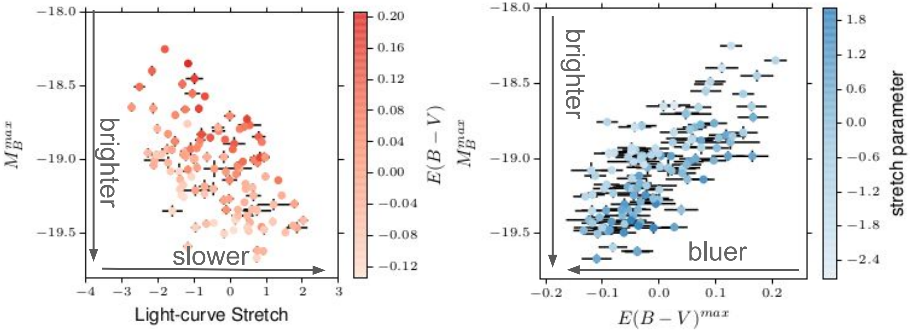
Light curve fitter

- To construct a Hubble Diagram, every magnitude must be expressed in the same restframe band : band B (by convention) at peak : $m_B^\star$



- To minimize the dispersion the Hubble diagram residuals : extraction of parameter link to the stretch, x1, and color, c.

$$\mu = m_B^\star - M_B + \alpha X_1 - \beta c \pm 15\%$$



New generation of SALT2-like model

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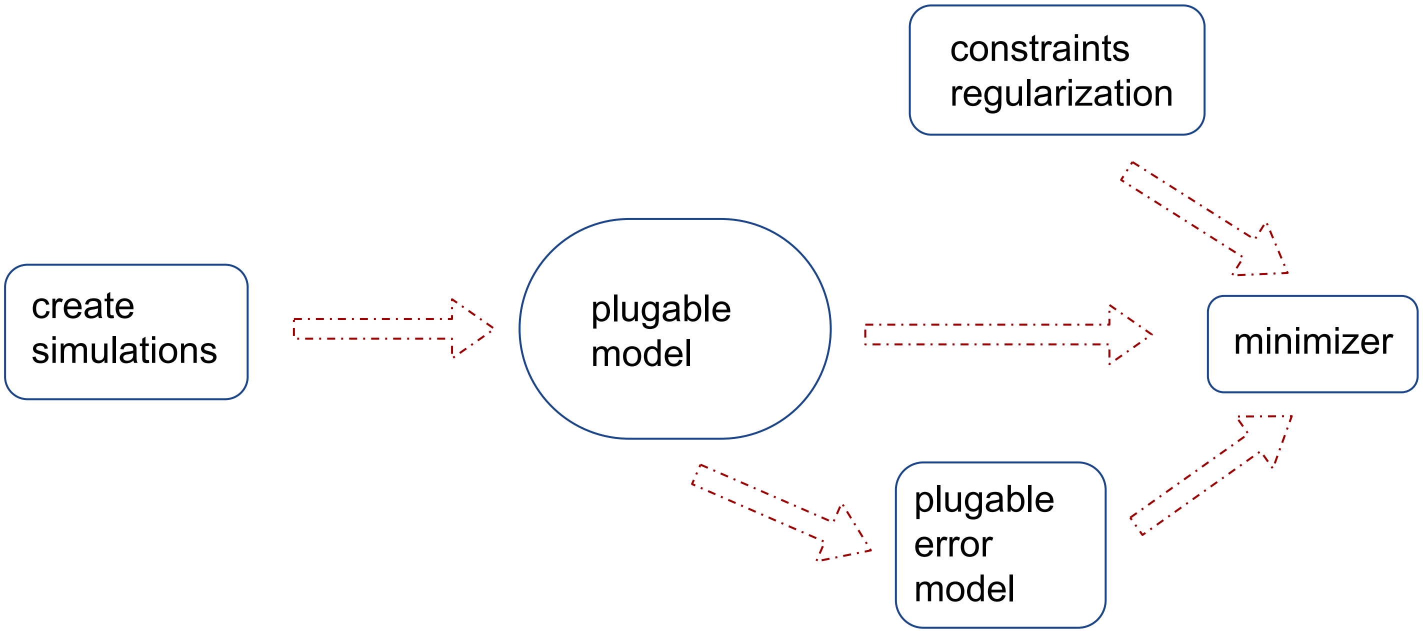
- ➢ Why a new generation ?
  - Number of SN is much higher :
    - scaling code
    - fast training procedure
  - Clear propagation of systematics :
    - Propagate the systematics on the time of maximum
    - Propagate the calibration uncertainties
  - Construction of a flexible pipeline in order to test new modelization
  - Study of model bias

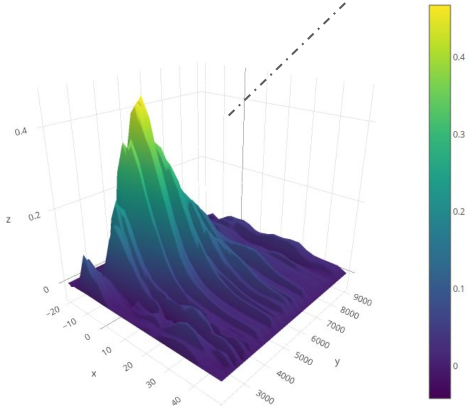
NaCl framework

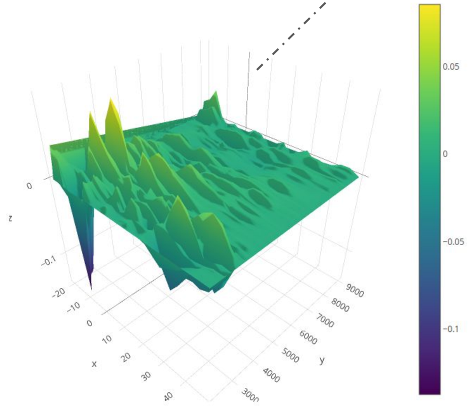


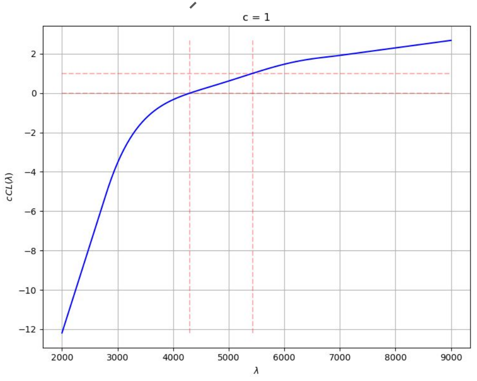
- Globals parameters
- X0, tmax, X1 and c

NaCl : Spectrophotometric model

$$S^{SN}(\lambda, p) = \left[M_0\,(p,\lambda) + X_1 M_1\,(p,\lambda)\right] e^{c\,CL(\lambda)}$$

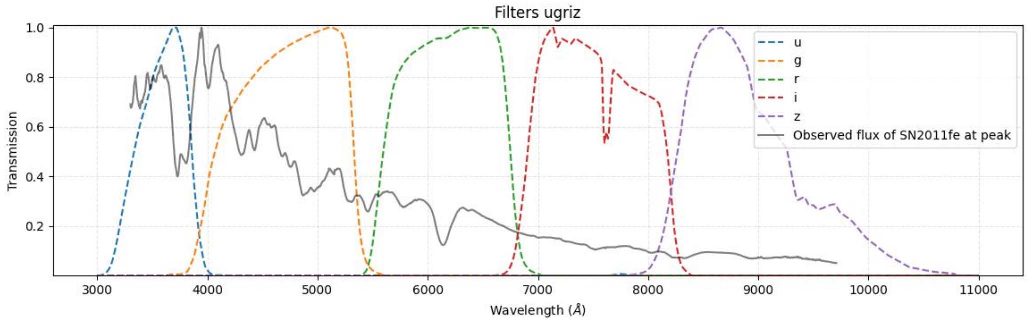




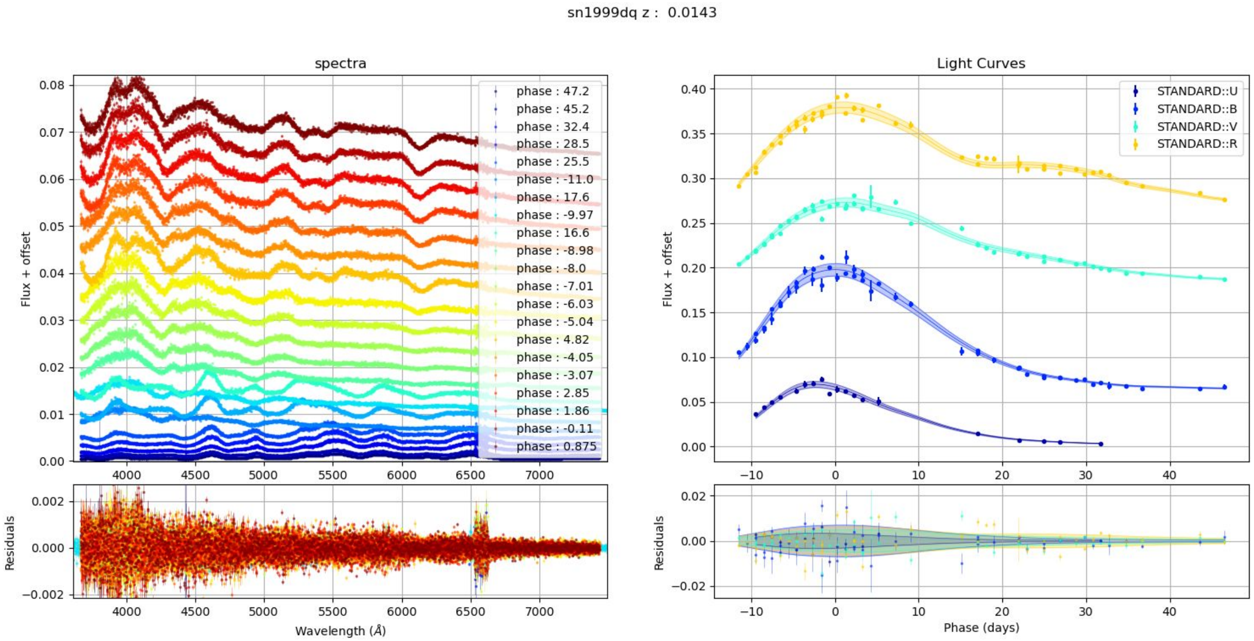


NaCl : Spectrophotometric model

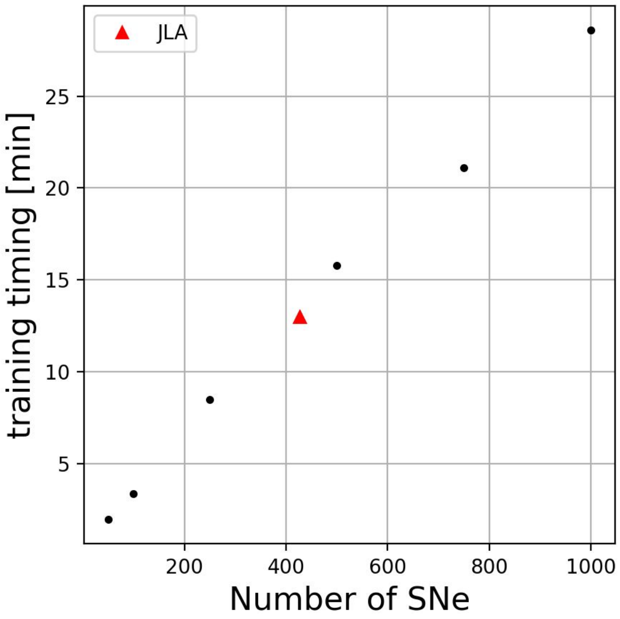
$$\phi_X^{SN}(p) = \int X_0 \, S^{SN}(\lambda, p) \, T_X\left(\frac{\lambda}{1+z}\right) \frac{\lambda}{hc} d\lambda$$



NaCl



sn1999dq z : 0.0143
spectra
Light Curves
Flux + offset
Residuals
Wavelength (Å)
Phase (days)
STANDARD::U
STANDARD::B
STANDARD::V
STANDARD::R
phase : 47.2
phase : 45.2
phase : 32.4
phase : 28.5
phase : 25.5
phase : -11.0
phase : 17.6
phase : -9.97
phase : 16.6
phase : -8.98
phase : -8.0
phase : -7.01
phase : -6.03
phase : -5.04
phase : 4.82
phase : -4.05
phase : -3.07
phase : 2.85
phase : 1.86
phase : -0.11
phase : 0.875



JLA
training timing [min]
Number of SNe

η

Photometric calibration uncertainties in SALT2

LPNHE PARIS

- The primary flux reference.
- The transfer of the primary calibrators to the secondary standards.
- The error measurements of the CALSPEC standards.
- The transfer from the CALSPEC standards to the tertiary standard

Numerical estimation of the Jacobian of light curves parameters wrt error on ZP

Photometric calibration uncertainties matrix

$$C_{cal} = J C_\eta J^\dagger$$

- add one latent parameter per survey band;
- dispersion given the intercalibration matrix.

$$\phi_X^{SN}(p) = \int X_0 \, S^{SN}(\lambda, p) \, T_X\left(\frac{\lambda}{1+z}\right) \frac{\lambda}{hc}(1+\eta_X) d\lambda$$

Color Scatter

- broad-band colour uncertainties;
- Coherent offset between differents points of a same light curve;
- No correlation between measurements in different bandpasses.

→

- adding one latente parameter to each light curve κ
- Hold by a gaussian prior during the minimization:

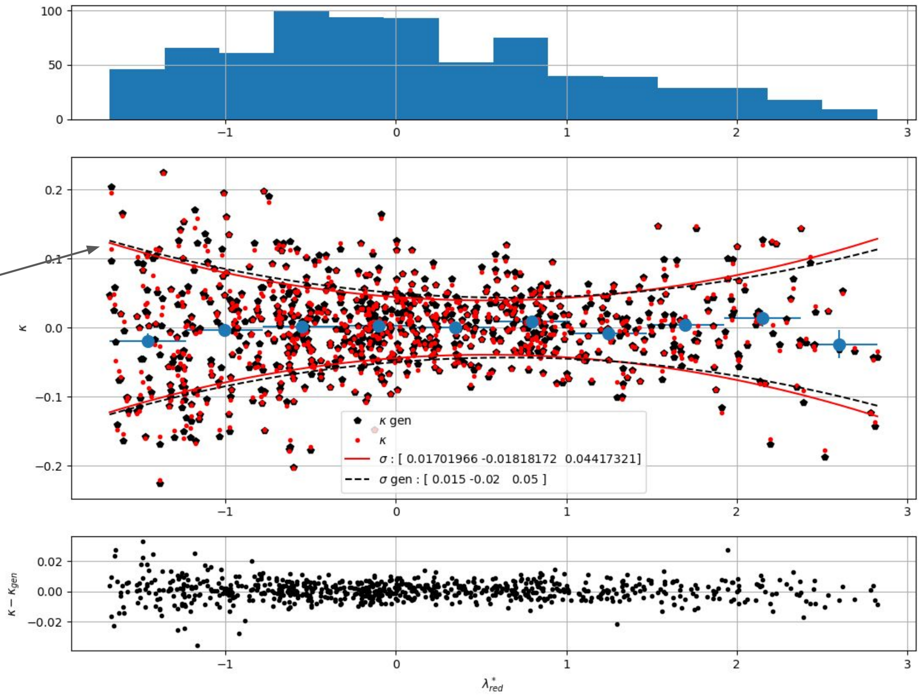
$$\kappa \sim N(0, \sigma_\kappa(\lambda))$$

- Estimation of the variance of the prior during the minimization

$$\phi_X^{SN}(p) = \int X_0 \, S^{SN}(\lambda, p) \, T_X\left(\frac{\lambda}{1+z}\right) \frac{\lambda}{hc}(1+\eta_X)(1+\kappa) d\lambda$$

Color Scatter reconstruction

$$\sigma_\kappa(\lambda_c) = \sum_{i=0}^{N_\sigma} \sigma_i \lambda^{N_\sigma - i}$$



Distances coverage

- 100 realizations
- same sampling
- same Sne parameters
- Varying Noise, calibration term, color scatter term and additional variability

- Model
- Error model
- without Color Scatter
- Propagation of calibration uncertainties

➢ We keep light curves parameters

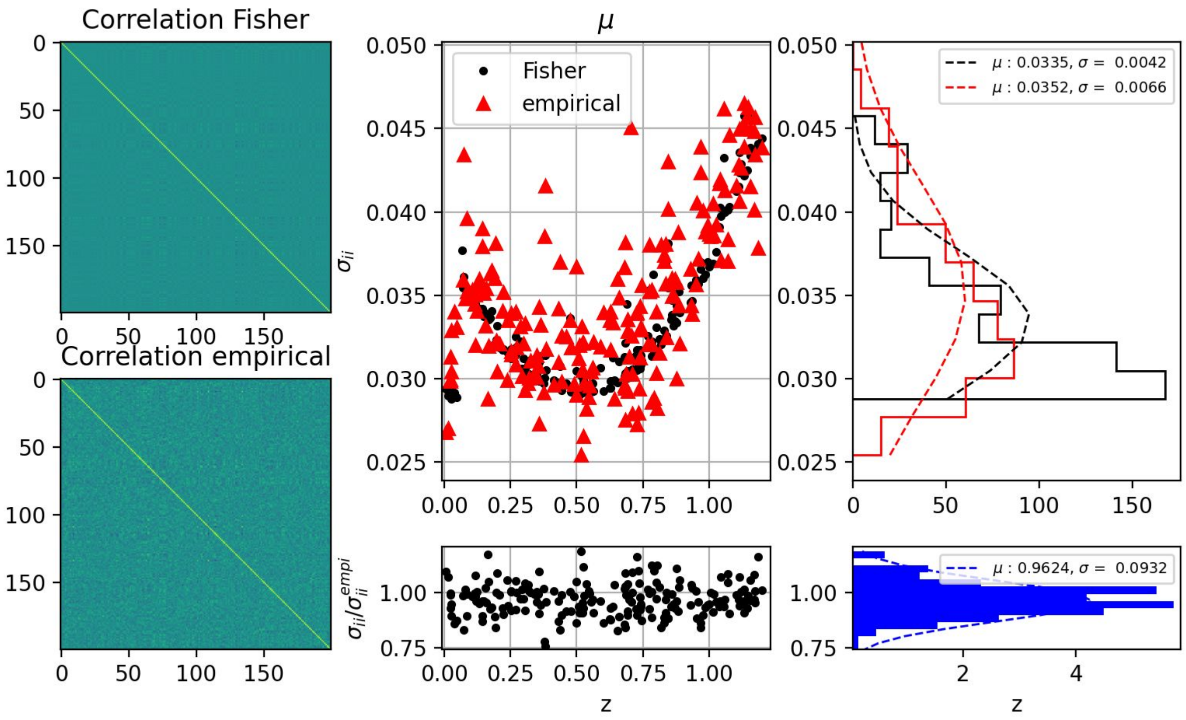
$$\mu = -2.5\log(x_0) + \alpha x_1 - \beta c - M_B$$

Uncertainties on distances

Fisher Matrix

$$Cov = \frac{\partial \mu}{\partial p} H^{-1} \frac{\partial \mu}{\partial p}^T$$

$$Cov_{empi} = \frac{(\mu - \bar{\mu})^T (\mu - \bar{\mu})}{N - 1}$$



Conclusion & roadmap

Fast full-fledged minimization procedure :

- Fit time maximum luminosity;
- SN intrinsic residuals variability model;
- Single-step comprehensive fit;
- Propagation of photometric calibration uncertainties;
- Bias study on simulations.

➢ Release of the full training code, where the model is interchangeable to investigate new standardization parameters