SN Ia analyses with the Nearby Supernova Factory spectrophotometric data

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CONTENTS

- **Observational cosmology with SNe Ia**
- **The Nearby Supernova Factory project**
- **Some SNfactory results**
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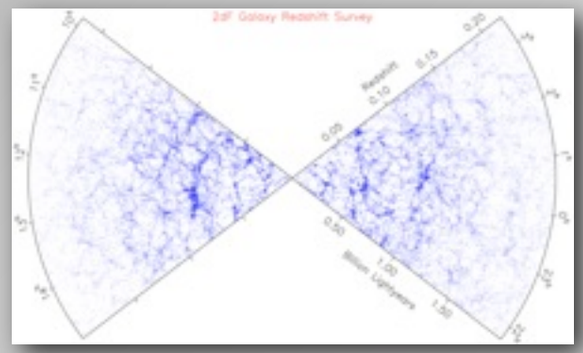
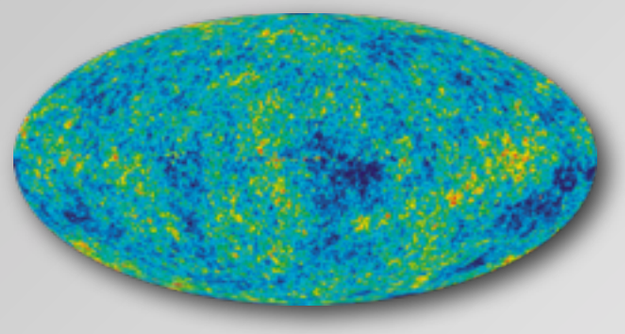
Concordance cosmology: Three principal probes

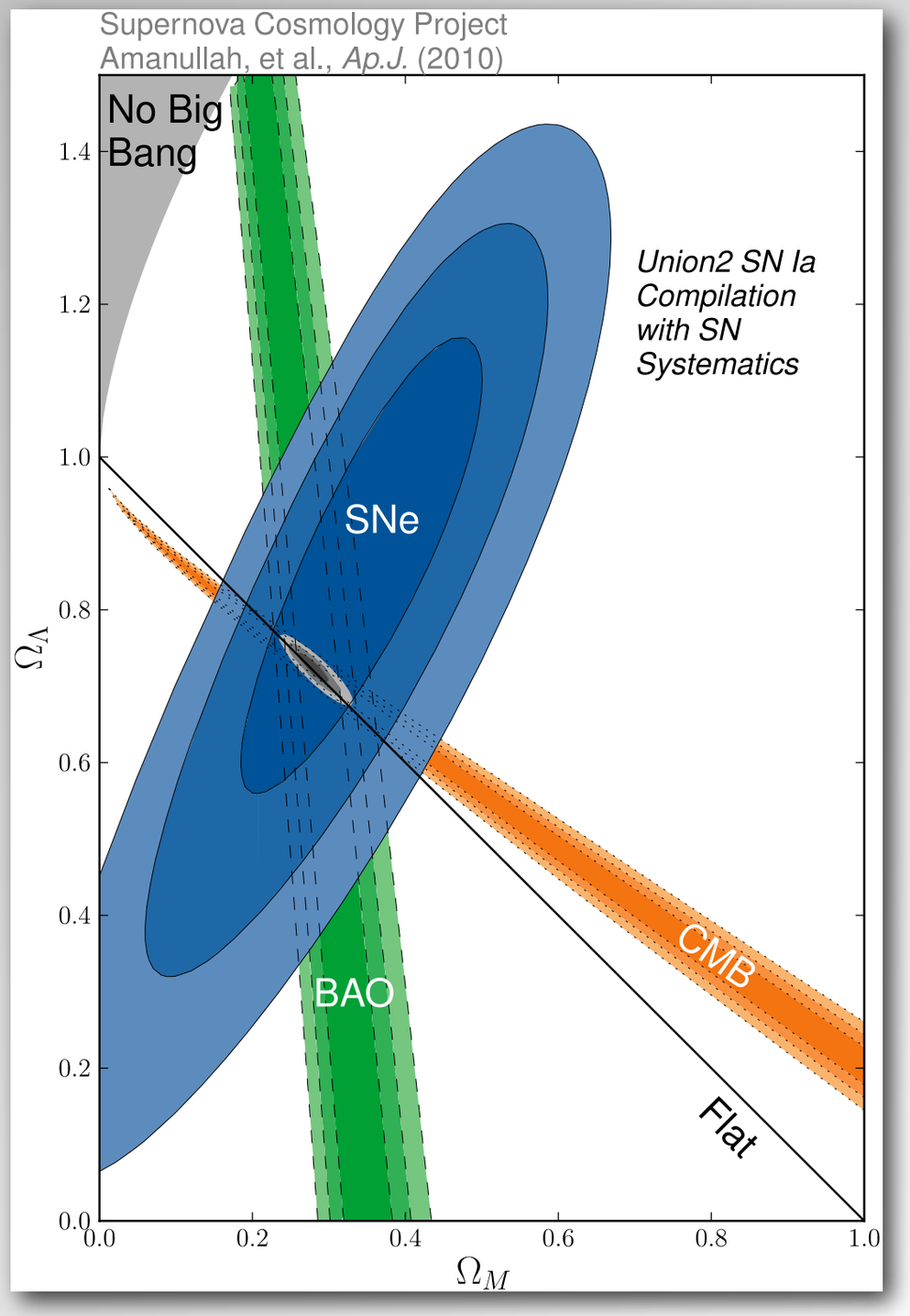
Standard candles (SNe Ia)
(Nearby and distant surveys)

Large scale structures
(**BAO**, Weak lensing, Clusters)

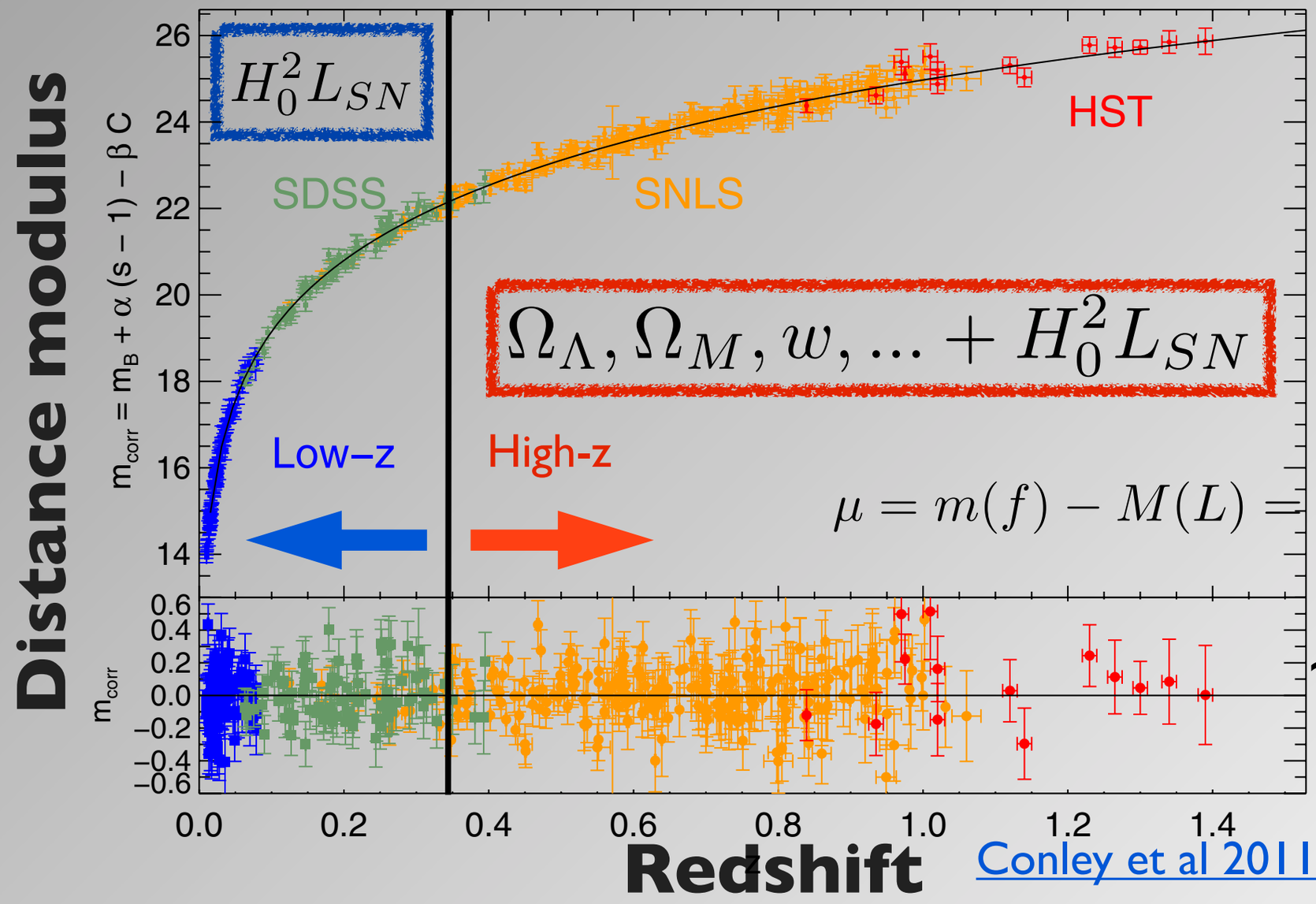


CMB
(COBE, WMAP, PLANCK)





Hubble diagram



$$\mu = m(f) - M(L) = 5\log\left(\frac{d_L(z,\omega)}{10\mathrm{pc}}\right)$$

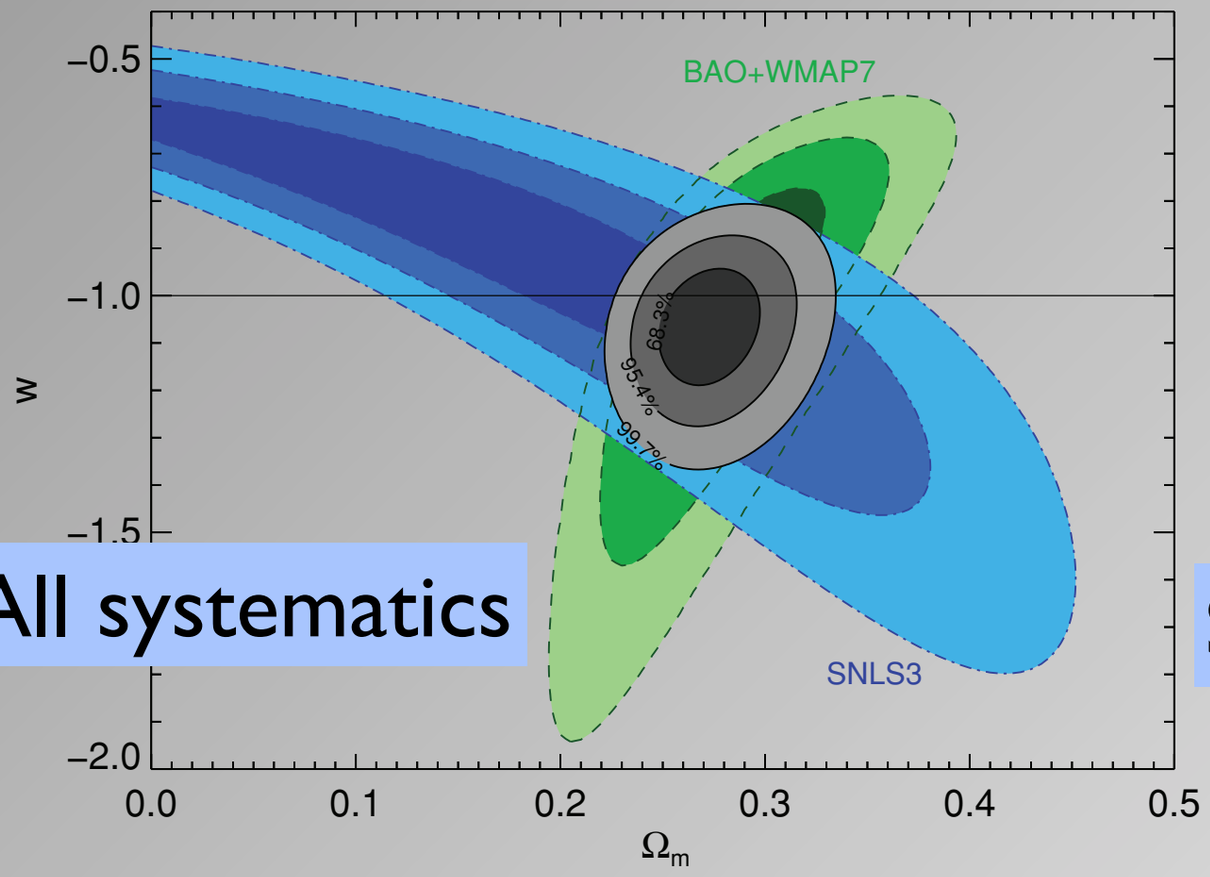
~0.15 magnitude dispersion

Conley et al 2011

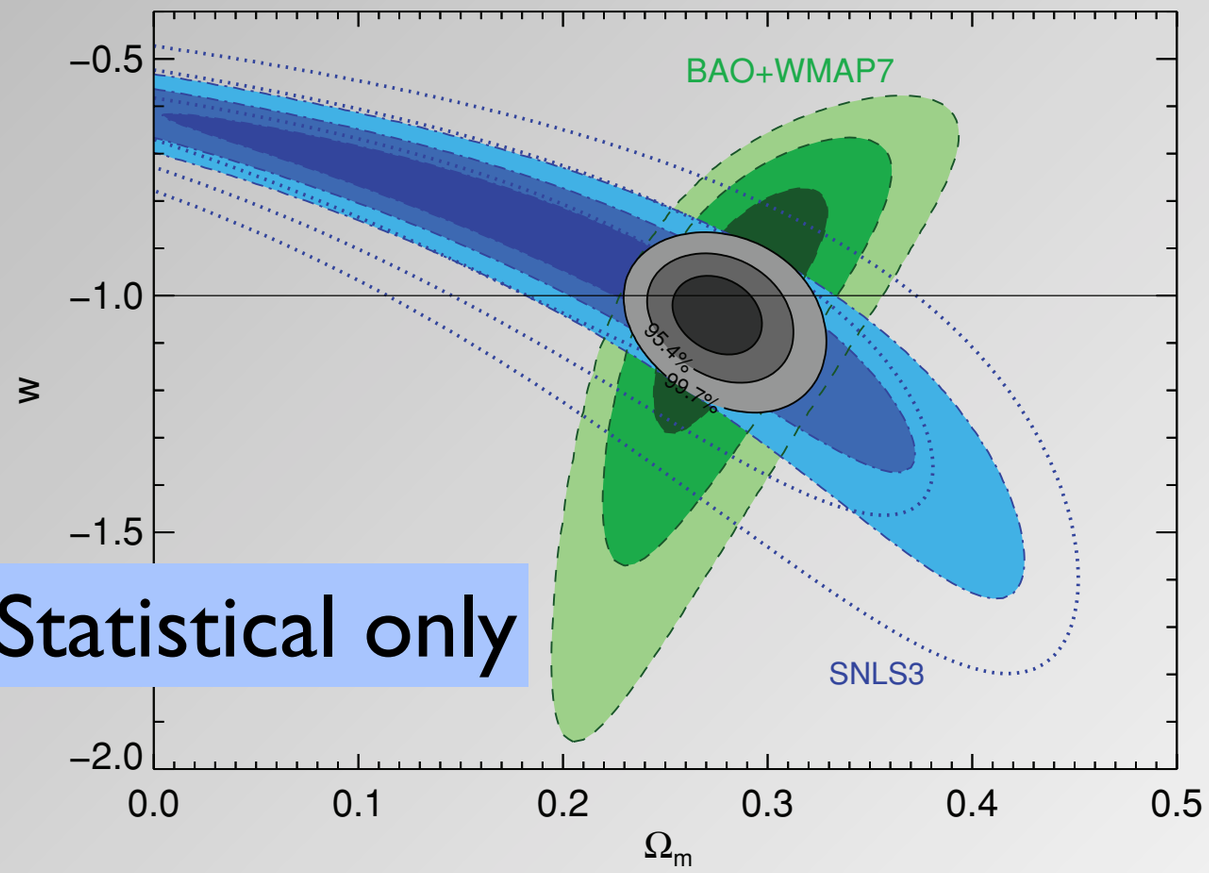
- **High-z SNe:** cosmological parameters + $H_0^2 L$
- **Nearby SNe:** constrain the degeneracy between cosmology and SNe Ia luminosity

Uncertainties

SNLS3: Sullivan et al. 2011



All systematics



Statistical only

Systematics: Dominated by calibration uncertainties

High quality data of low redshift SNe Ia needed to reduce systematics: SNfactory

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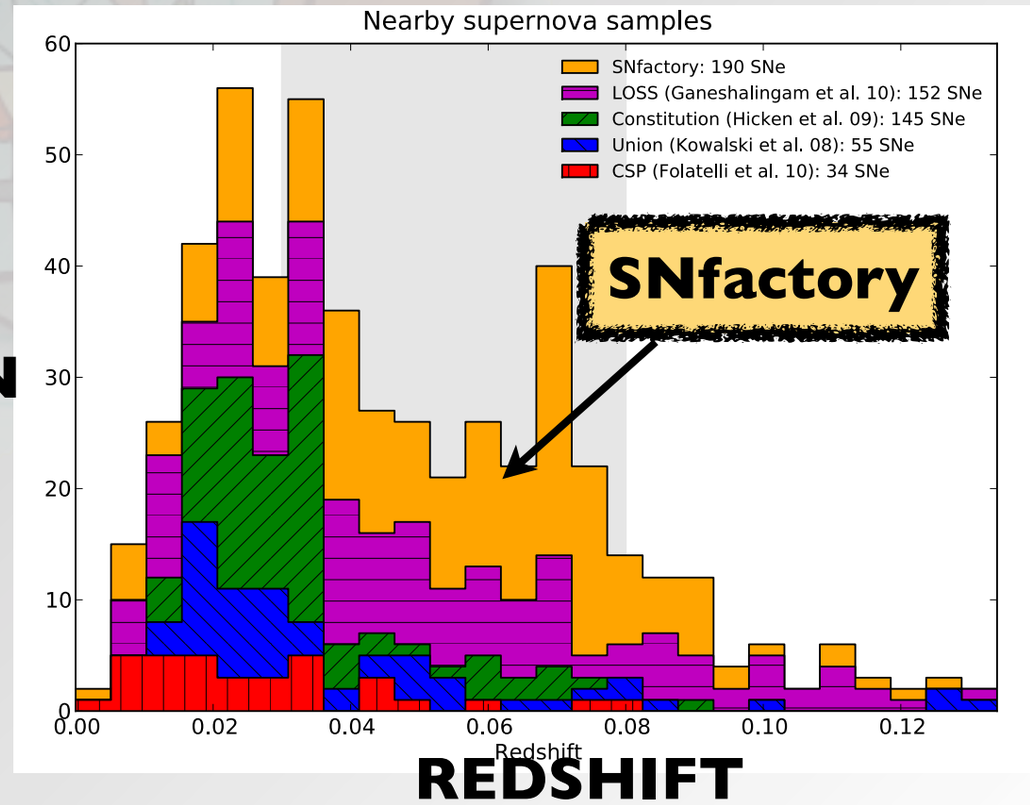
The Nearby Supernovae Factory

A unique data set of spectrophotometric Type Ia supernovae spectral time series

- **Main Goals**
  - Anchor the Hubble diagram: control of systematics
  - Spectrophotometric time series of Nearby SNe Ia
  - **Standardization**
  - **SNe Ia physics:** spectral properties, extinction, etc.

- **Data sample**
  - **~220 SNe** with more than 5 spectra
  - **~3000 spectra** [-15;+40] days wrt max
  - 0.01 < redshift < 0.1
  - median phase of 1st spec: -4 days
  - mean cadence of observation: ~3 days
  - spectral coverage 3200 - 9000 Å



SNfactory: Observations

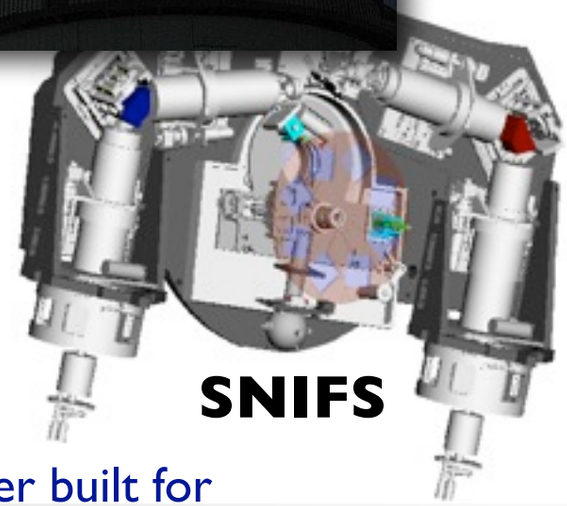
1. Search

Dedicated search until 2008. **Public sources** and **PTF and LSQ** after.

= ~10^{-7} of the surface observed each night

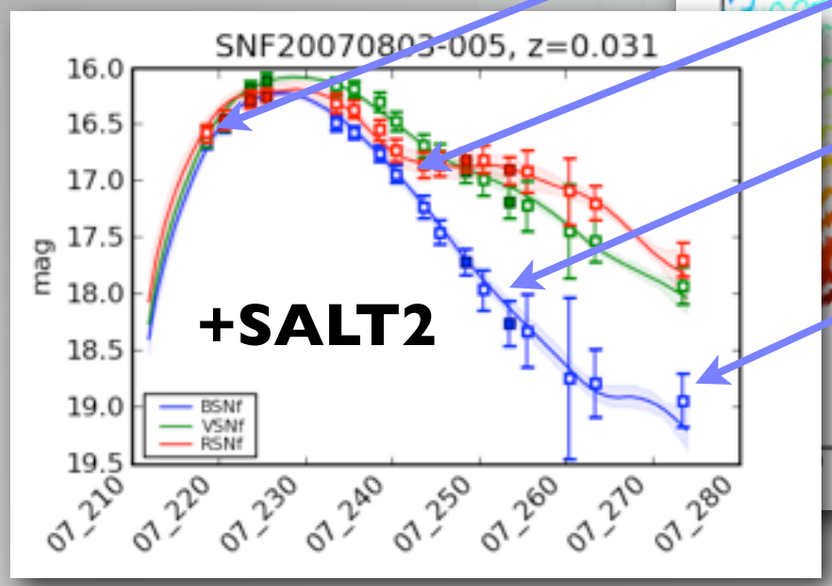
2. Observation

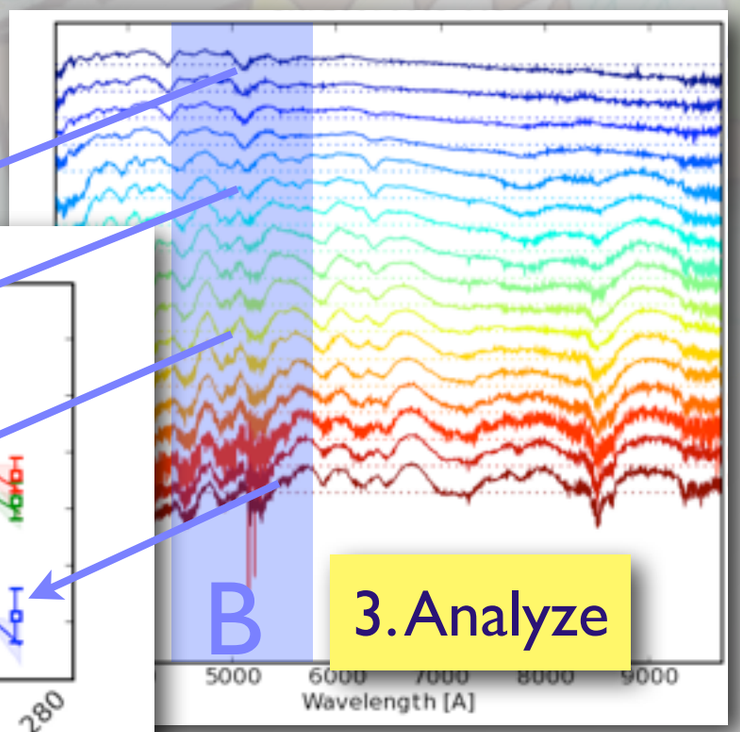
Follow up



Spectrometer built for nearby SNe Ia observations

- synthetic light curve in **any filter**
- **spectral details**





3. Analyze

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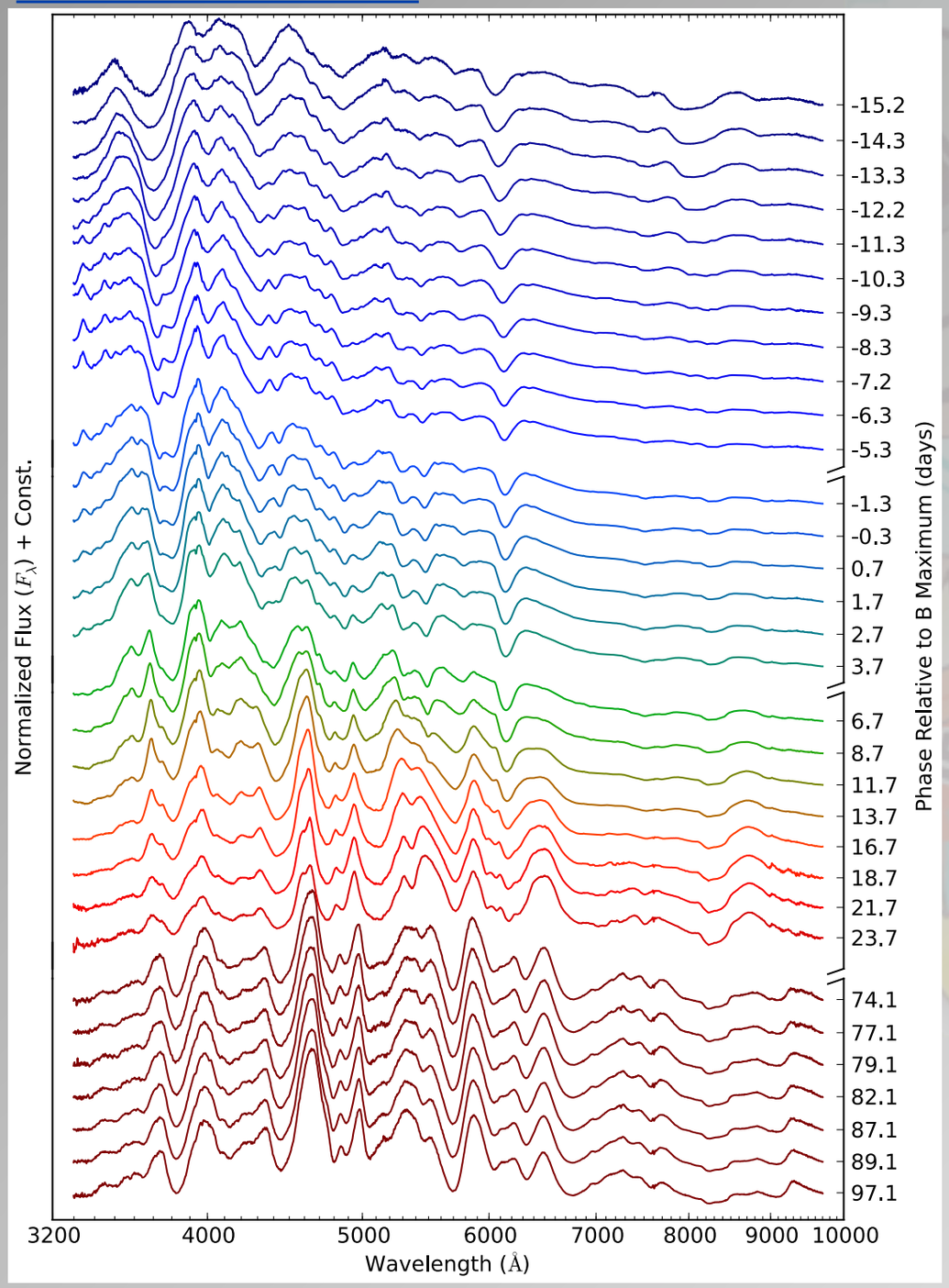
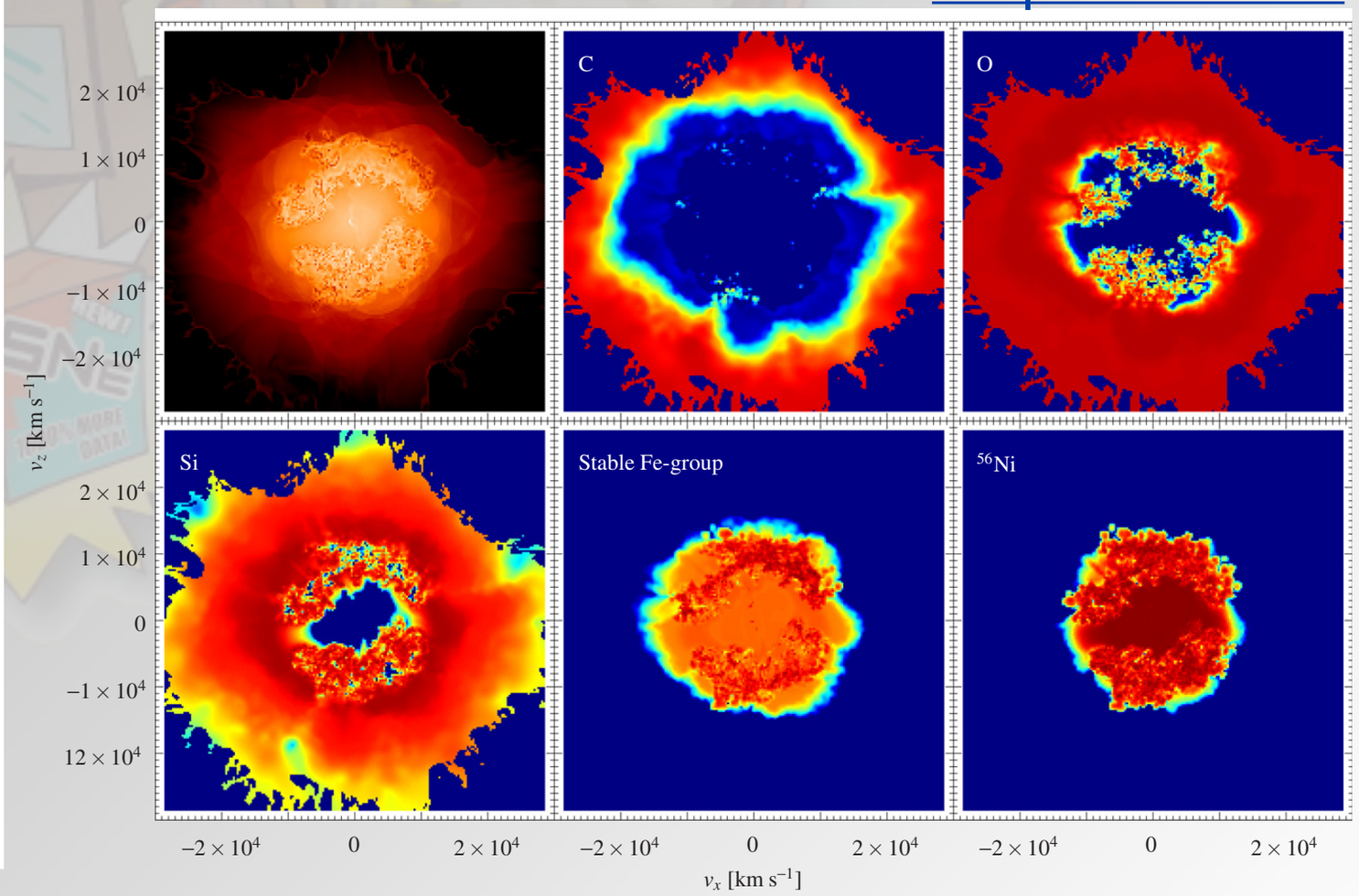
SN2011fe

Pereira et al. 2013



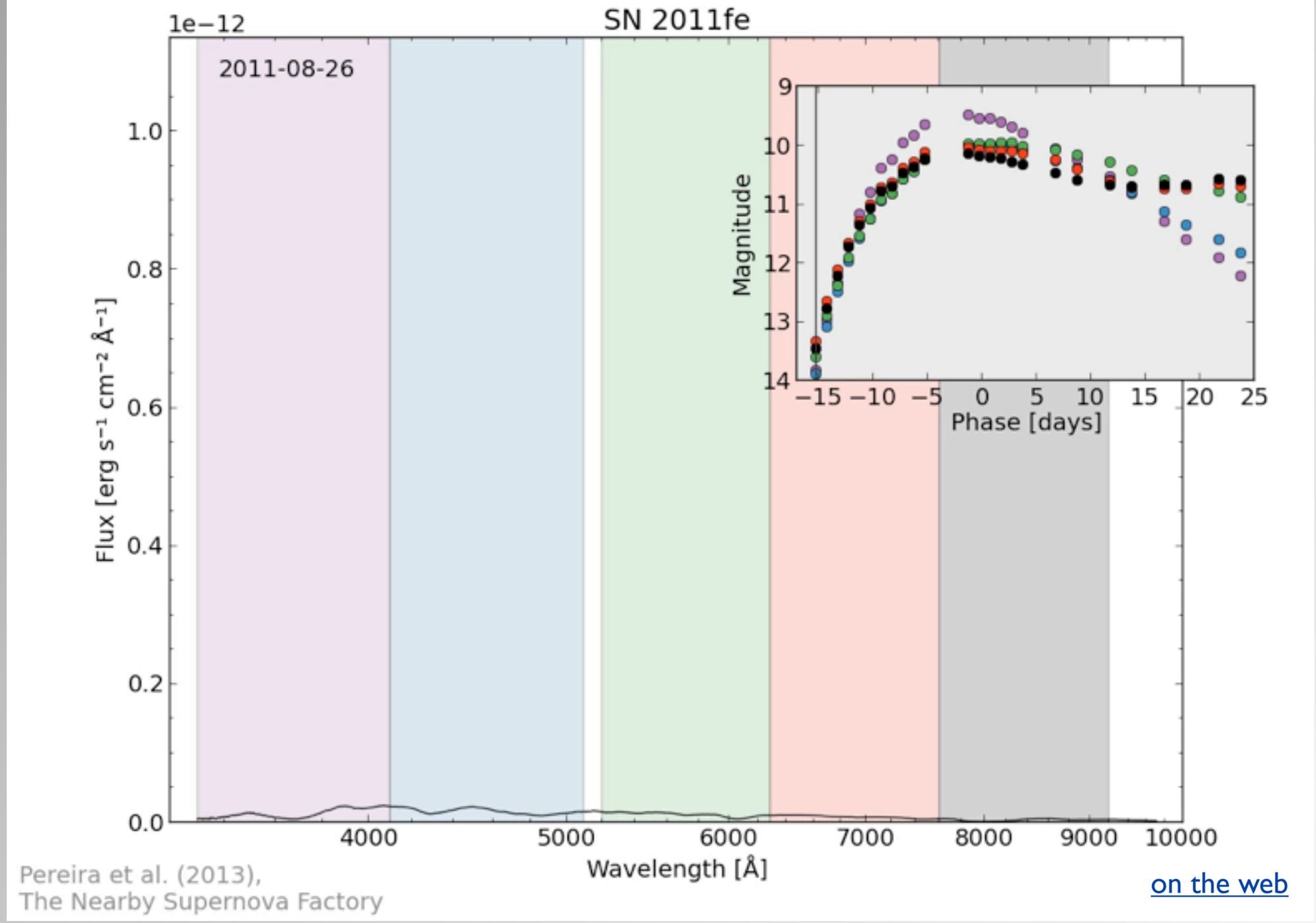
- "normal" SN Ia observed in the galaxy M101
- Closest and brightest SN Ia observed
- Very little evidence for reddening in its host galaxy
- Ideal data set for SN Ia physic studies

Roepke et al. 2012



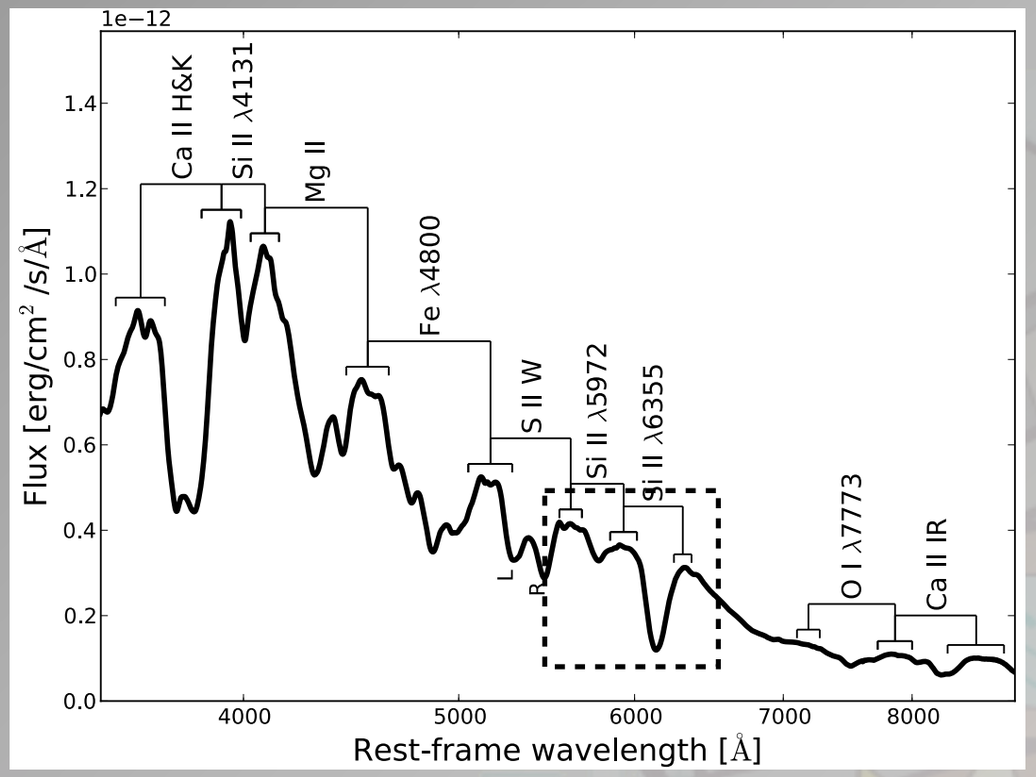
SN2011fe

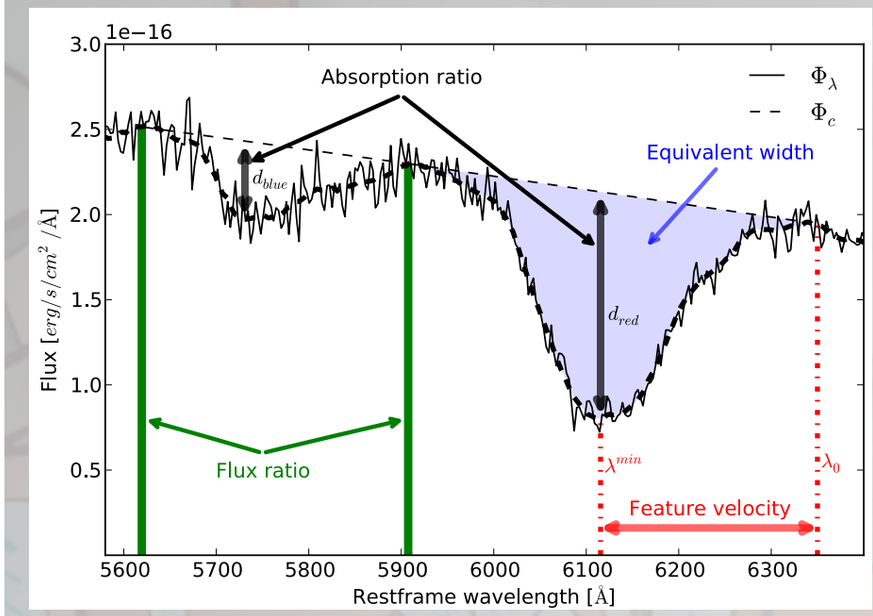
[Pereira et al. 2013]



[on the web]

Spectroscopic standardization



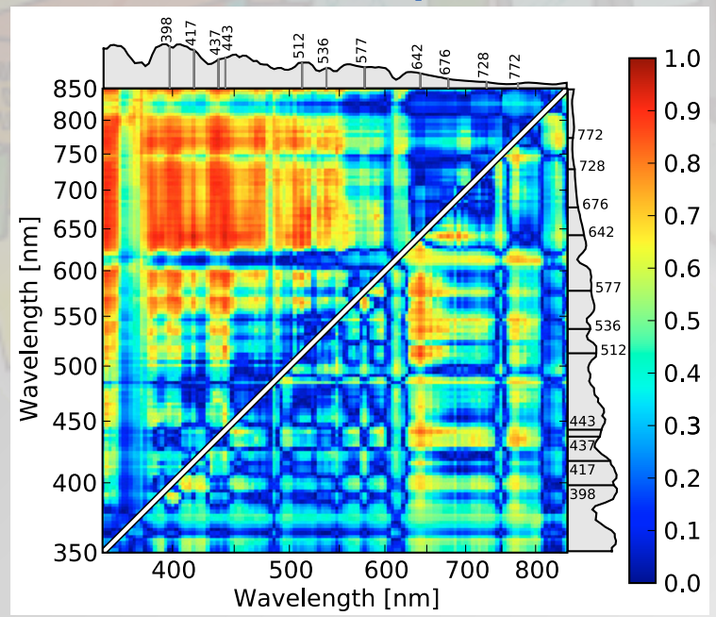


- Equivalent width
- Absorption ratio
- Flux ratio
- Feature velocities
- Etc.

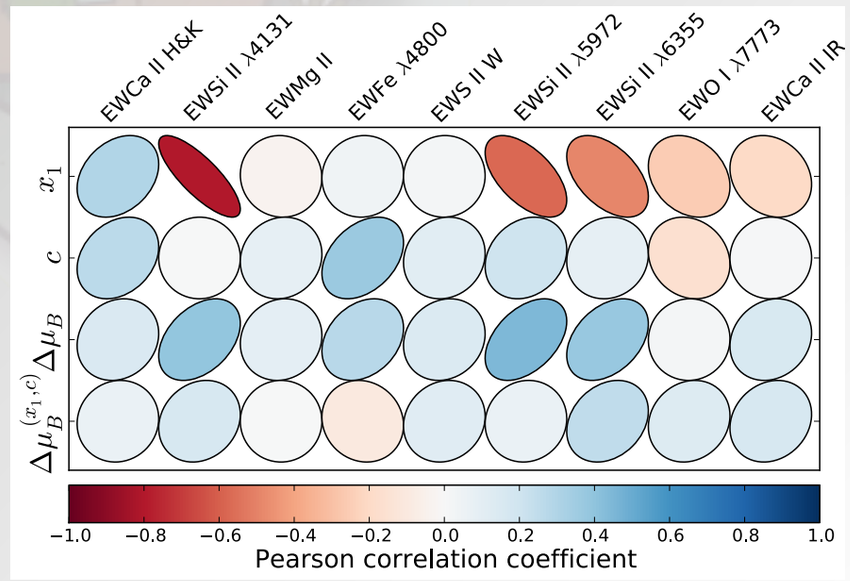
Study of their

- Correlation to the photometric parameters
- Standardization power
- Sensitivity to extinction
- Etc.

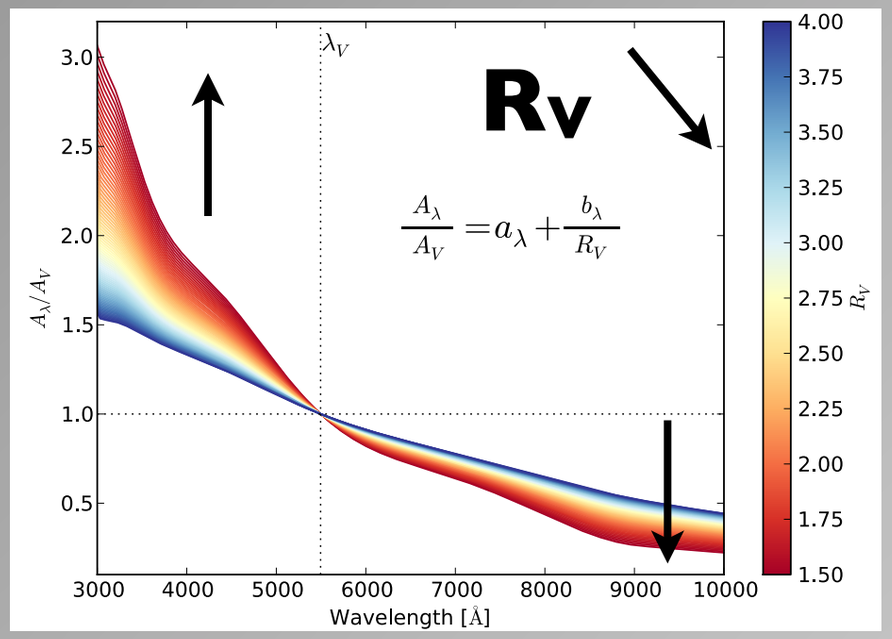
Bailey et al.2009



Chotard et al. 2013a, in prep



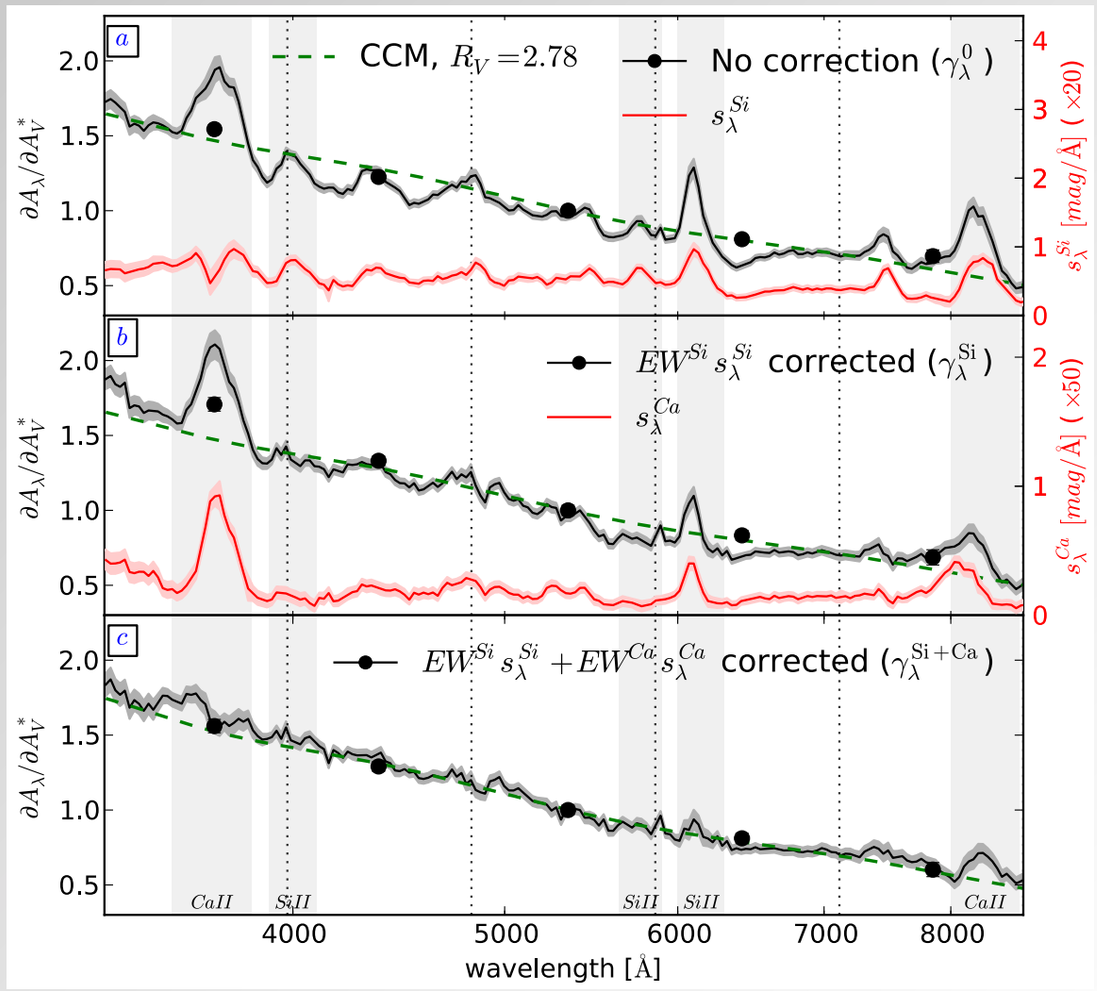
SNe Ia extinction law



Problematic

- SNe Ia dispersion dominated by extinction variability
- Recurrent issue in SNe Ia analysis: extinction law or 'Rv'?
- **Lower values** than the Milky Way one usually found & large dispersion in these values

Chotard et al. 2011



Method

- Spectral analysis of normal SNe Ia at maximum light
- Separation of their "intrinsic" and "extrinsic" components
- Construction of a mean extinction law for type Ia SNe

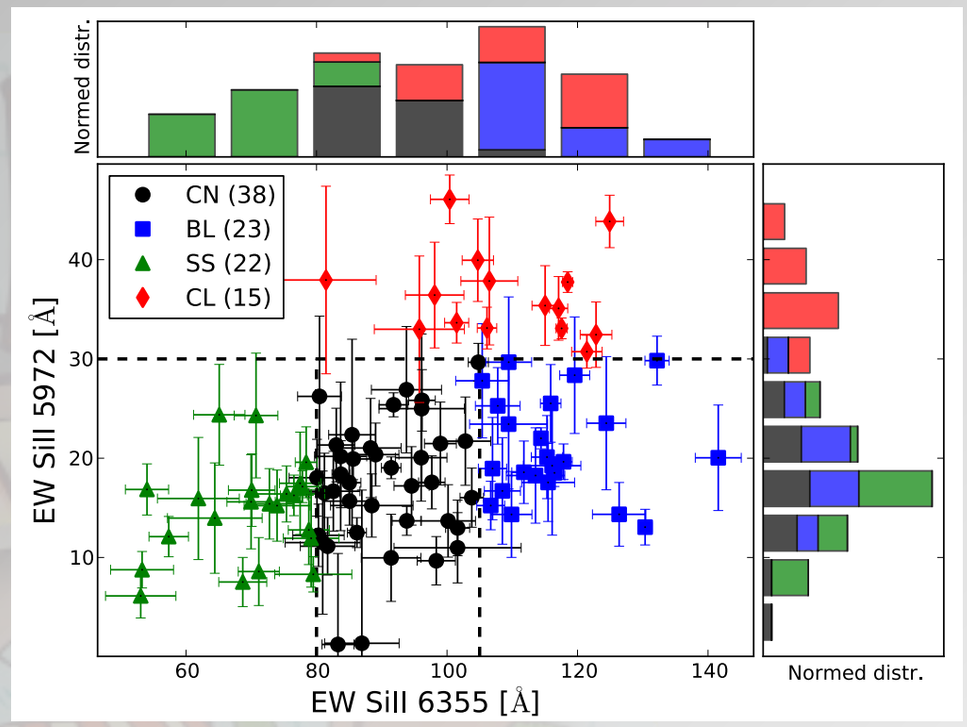
Result

- Additional **color dispersion** needed and taken into account
- **"Classical" extinction law**
- **Higher value of Rv** than in classical SN Ia analyses

Sub-classification

Presence of **SN Ia subtypes** in the main sample could introduce **biases in the cosmological analyses**:

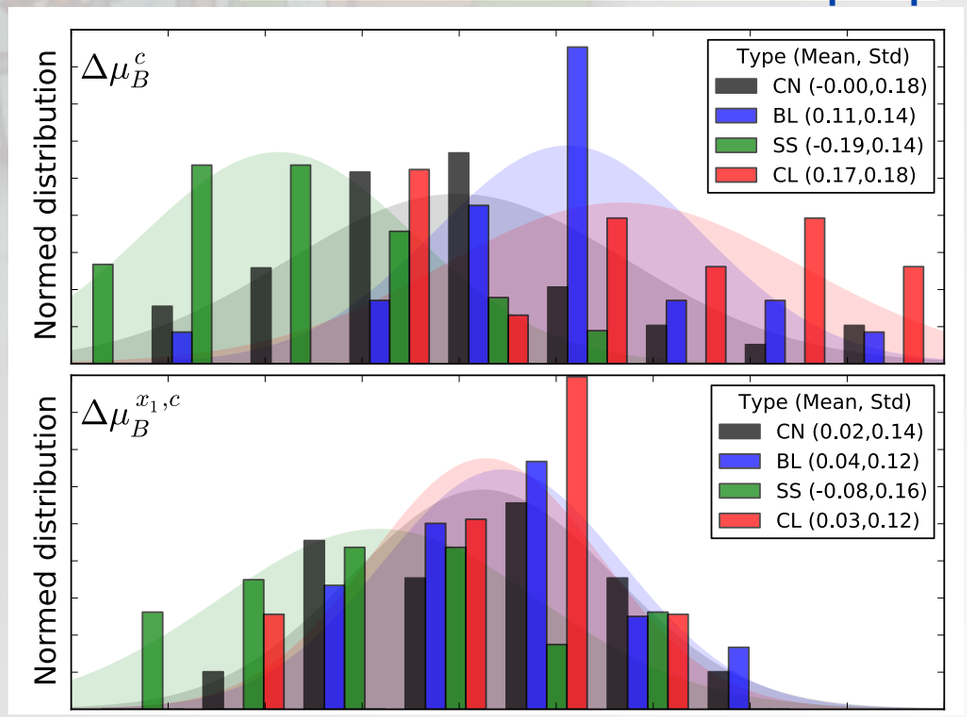
- Different mean absolute magnitude,
- Different color/magnitude relations,
- Different intrinsic variabilities,
- Evolution with redshift,
- Etc.



Chotard et al. 2013b, in prep

Intrinsic spectral indicators:

- Insensitive to host extinction/reddening
- Reflect SN Ia intrinsic variabilities
- Tools to study the sub-typing
- Etc.



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SNfactory I & II status

- **Publications**: Various analyses already published, some under publication process, and a lot of ongoing analyses, including photometry and cosmology papers.
- **Data taking**: More data taken in a regular basis to feed these analysis. Probable stop of the observation end of 2014.
- **Chinese collaboration** to SNfactory phase II since 2011
- **French (CPPM/IPNL) / Chinese (THCA) collaboration:**
  - Data transfert / Calibration process runing
  - Spectral analysis / Classification / SNe Ia velocity studies
- **SNfactory Collaboration meeting:** A few days ago in Beijing!
- Of course, SNe Ia observations and analyses in Tsinghua is not limited to SNfactory (Antartica)

THANKS!