SNe Ia Photometric Techniques

S-Corrections

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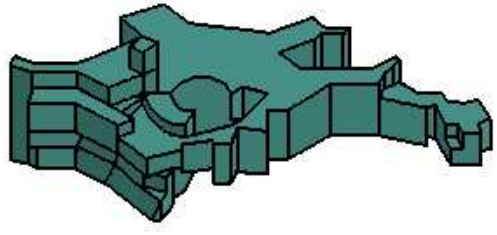
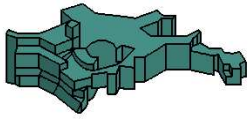
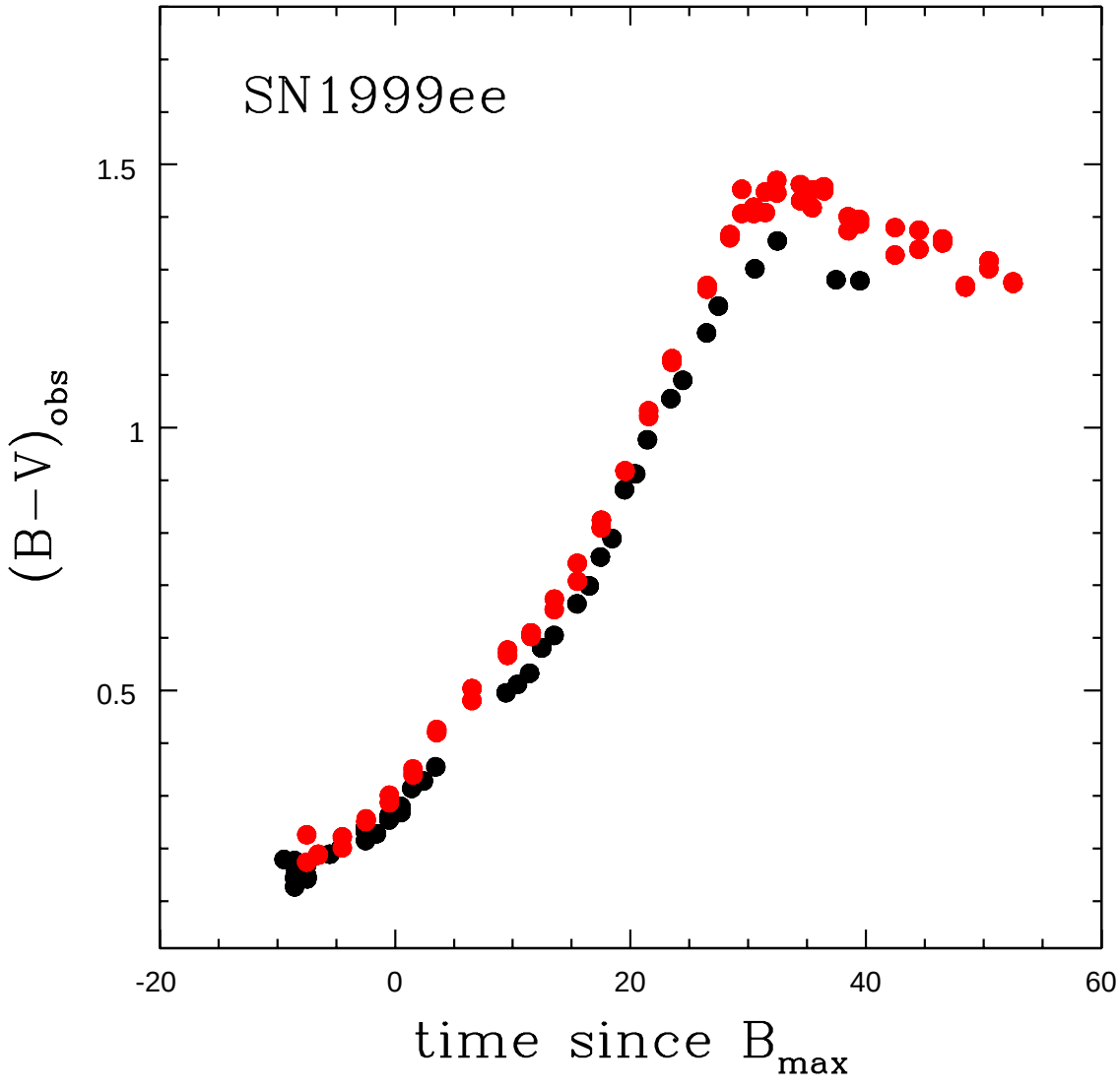


Outline

- S-corrections
  - motivation
  - implementation
- An example: SN 1999ee
  - optical
  - near-infrared
- Spectrophotometry of Landolt Standards useful for $UBVRIz$-band S-corrections
- summary



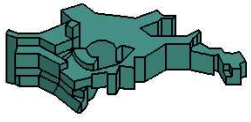
Motivation



Motivation

- color terms do not place photometry on "standard" system...
- systematic shift of 0.02 mag in $B - V$ color

  $\longrightarrow$ 0.08 mag error in extinction corrected peak M_B
  $\longrightarrow$ biased cosmological parameters
- with spectrophotometry of a SN: computed S-corrections can place photometry on the $standard$ system



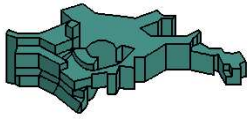
S-corrections I

- synthetic magnitude

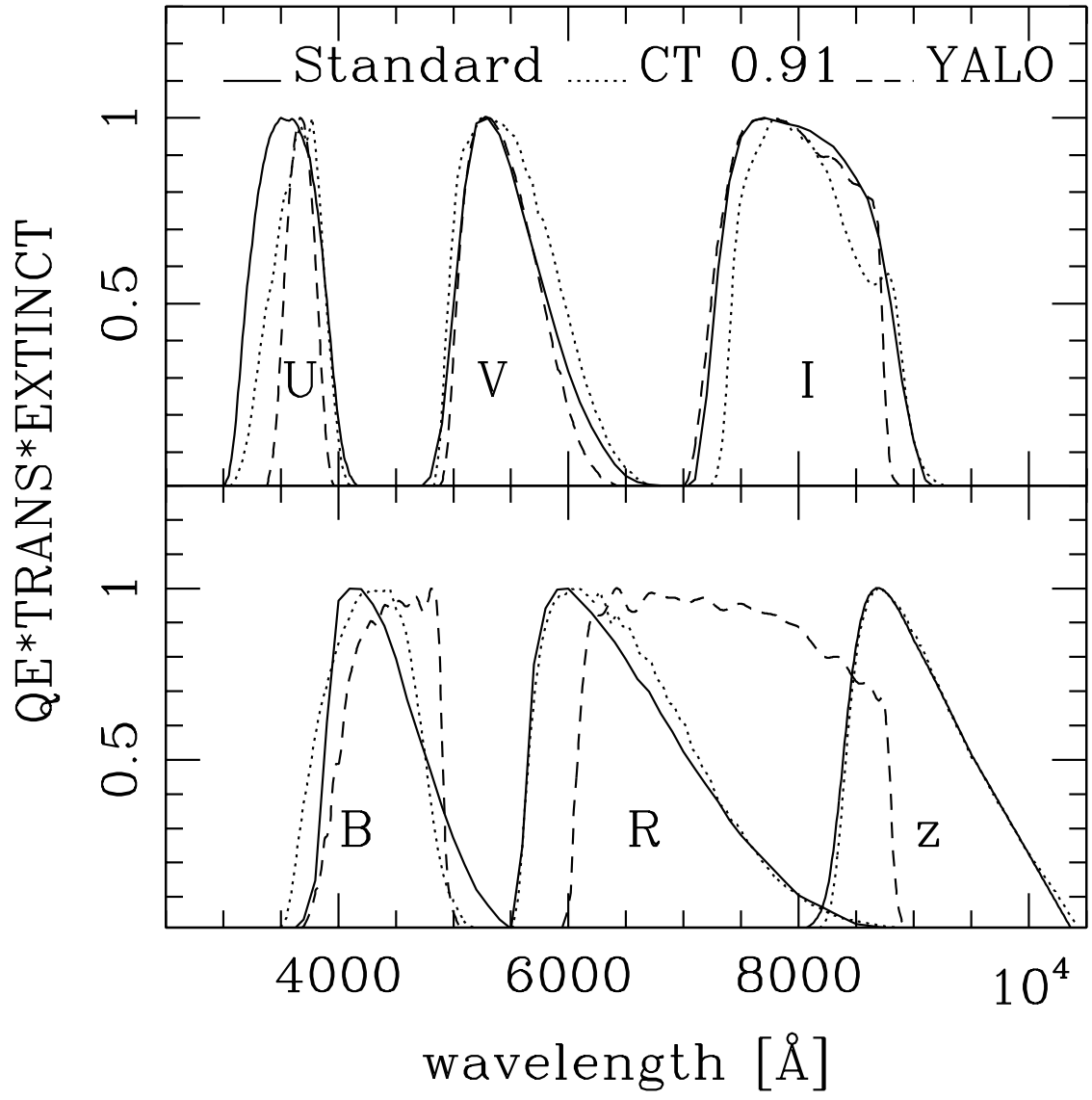
$$\mathrm{mag}_{\mathrm{syn}} = -2.5 \log_{10} \int N_\lambda \, S(\lambda) \, d\lambda \; + \; ZP \qquad \text{Eq. (1)}$$

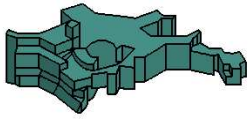
- **important** to construct modeled passbands with as much detail as possible
  e.g. filter transmissivities, QE, atm. transparency & absorption, mirror reflectivities, optical elements etc....
- necessary to characterize modeled passbands via spectrophotometric standards

  $\Longrightarrow$ do they match the instrumental passbands used at the telescope?



Standard and Modeled Passbands





S-corrections II

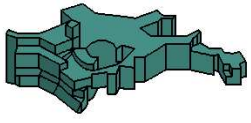
- S-correction:

$$\Delta V = V - v + CT_V(b - v) + ZP_V \qquad \text{Eq. (2)}$$

V is the SN syn. mag. computed with Bessell function

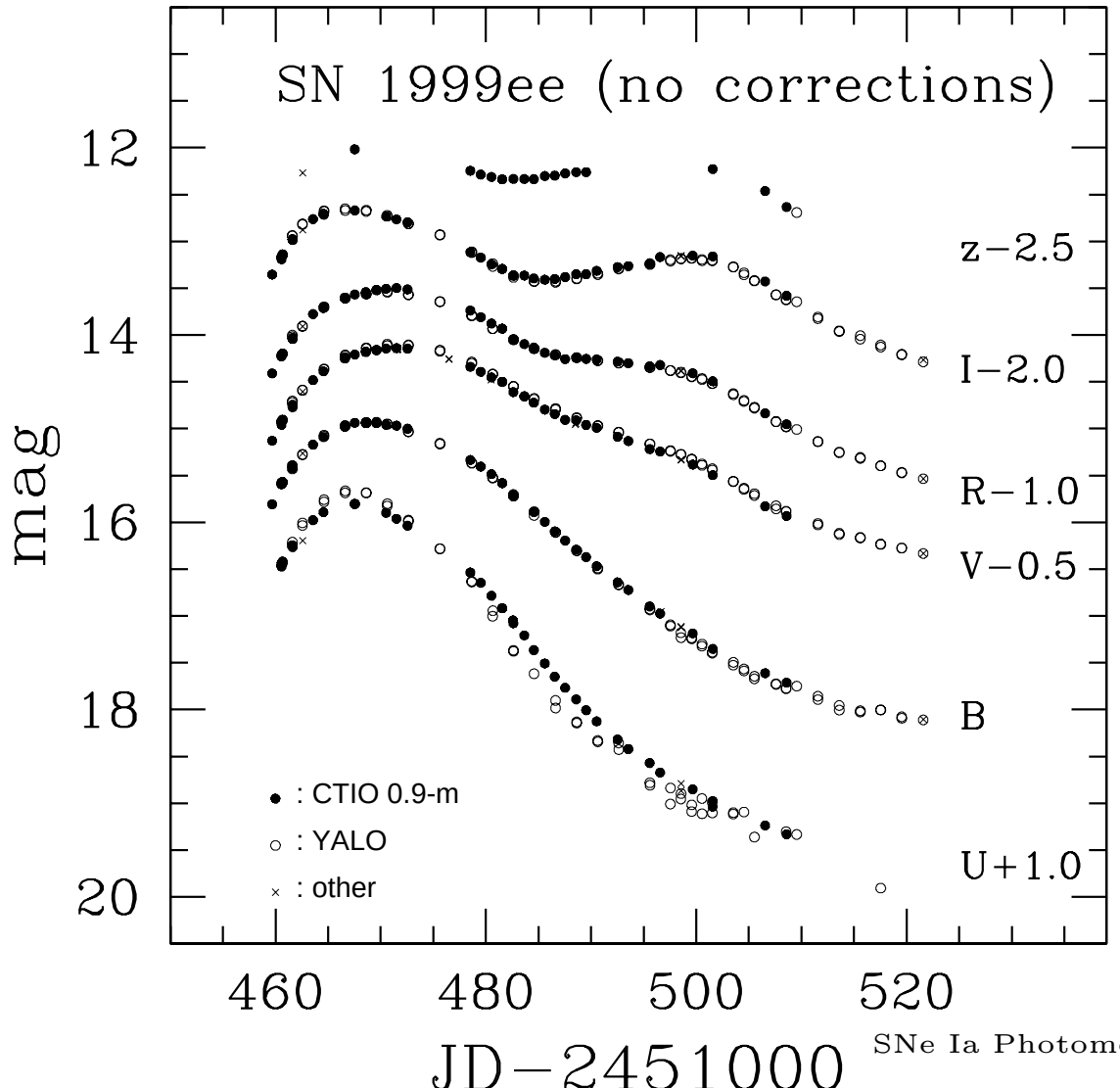
v & b are the SN syn. mag. computed with instrumental passbands

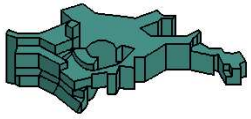
- SPECTROPHOTOMETRY OF STANDARDS!!!
  - flux-calibration of spectra
  - calculating zero-points to within $\sim$ 0.01 mag.
  - accurately characterize instrumental passbands



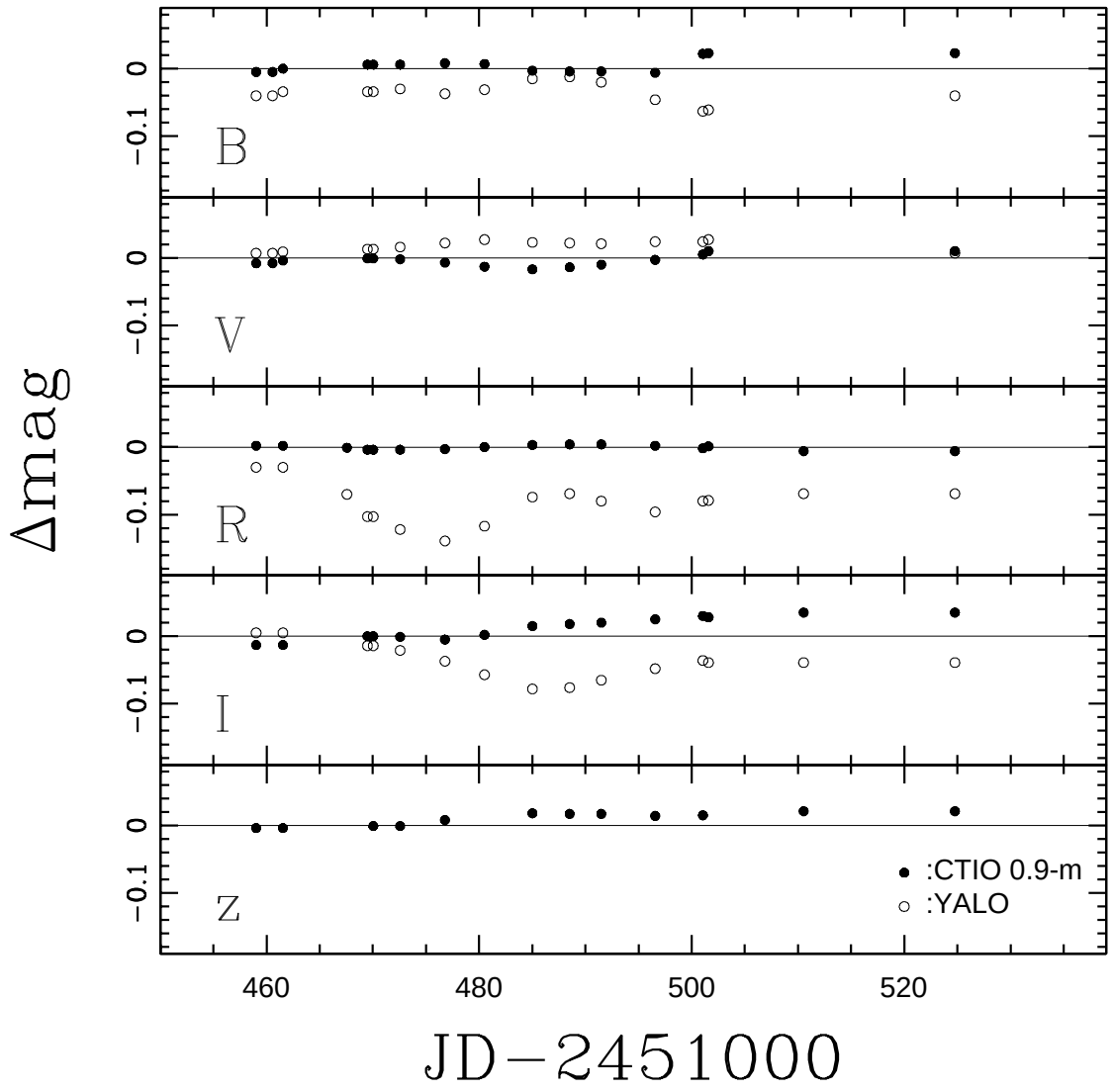
An Example

Optical Photometry of SN 1999ee

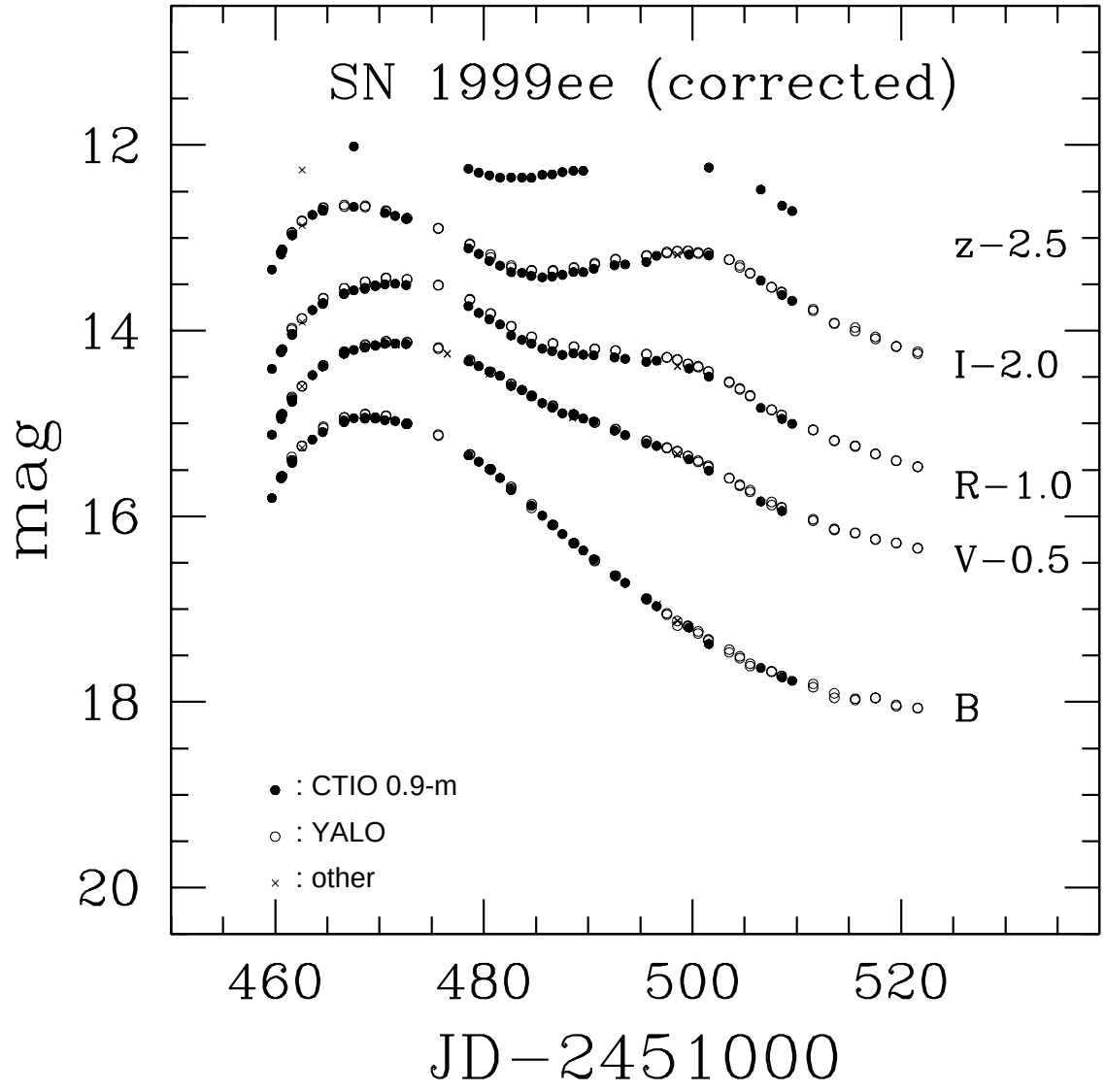


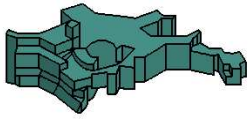


S-corrections for SN 1999ee



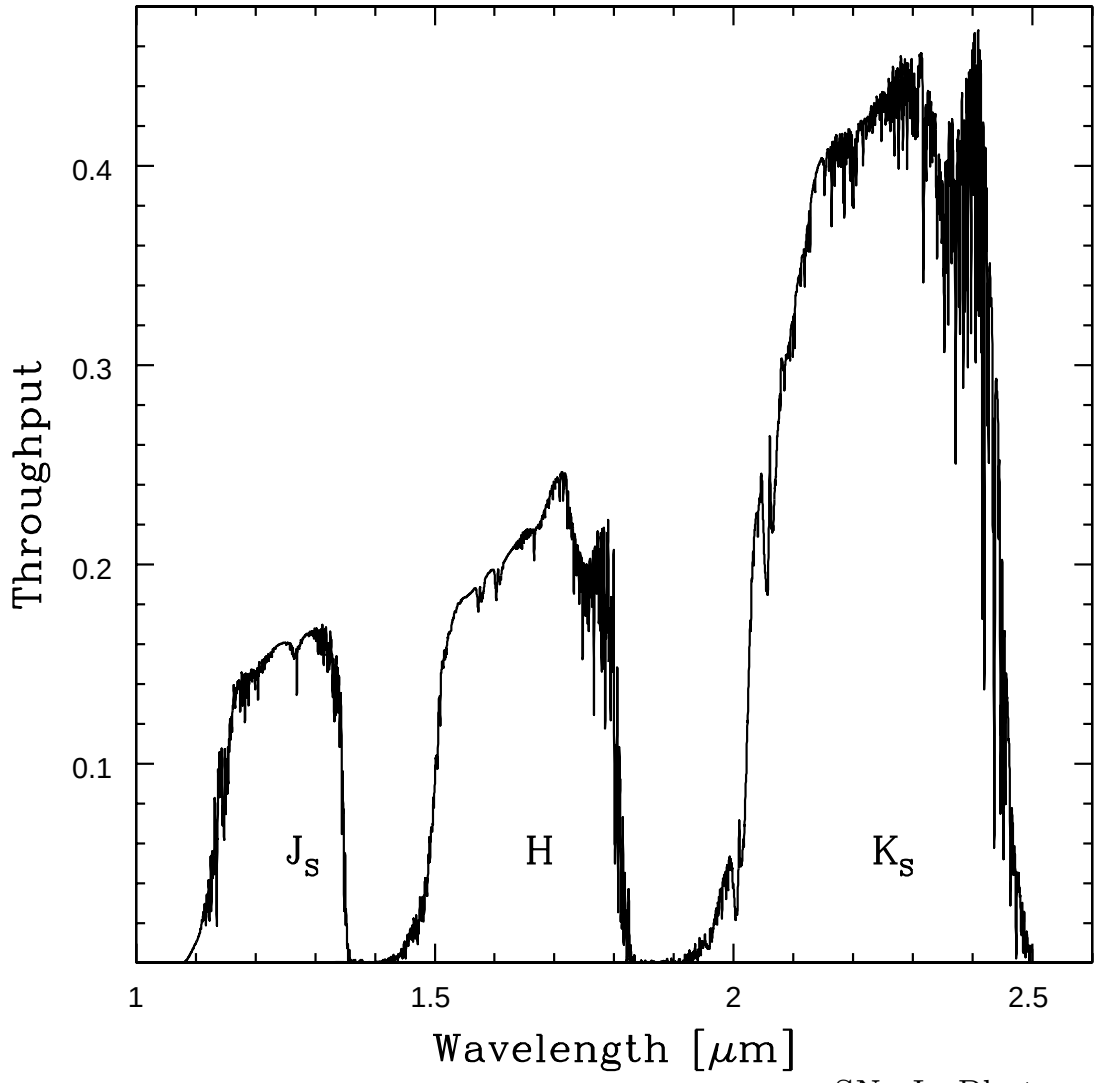
Corrections to Photometry





S-corrections in the INFRARED

JHK-band passbands in Persson system (YALO)



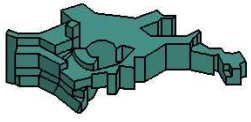
Are the modeled passbands Good?

There are no spectrophotometric standards in the infrared comparable to that in the optical!

What can we use in order to compare the synthetic color terms to the observed color terms?

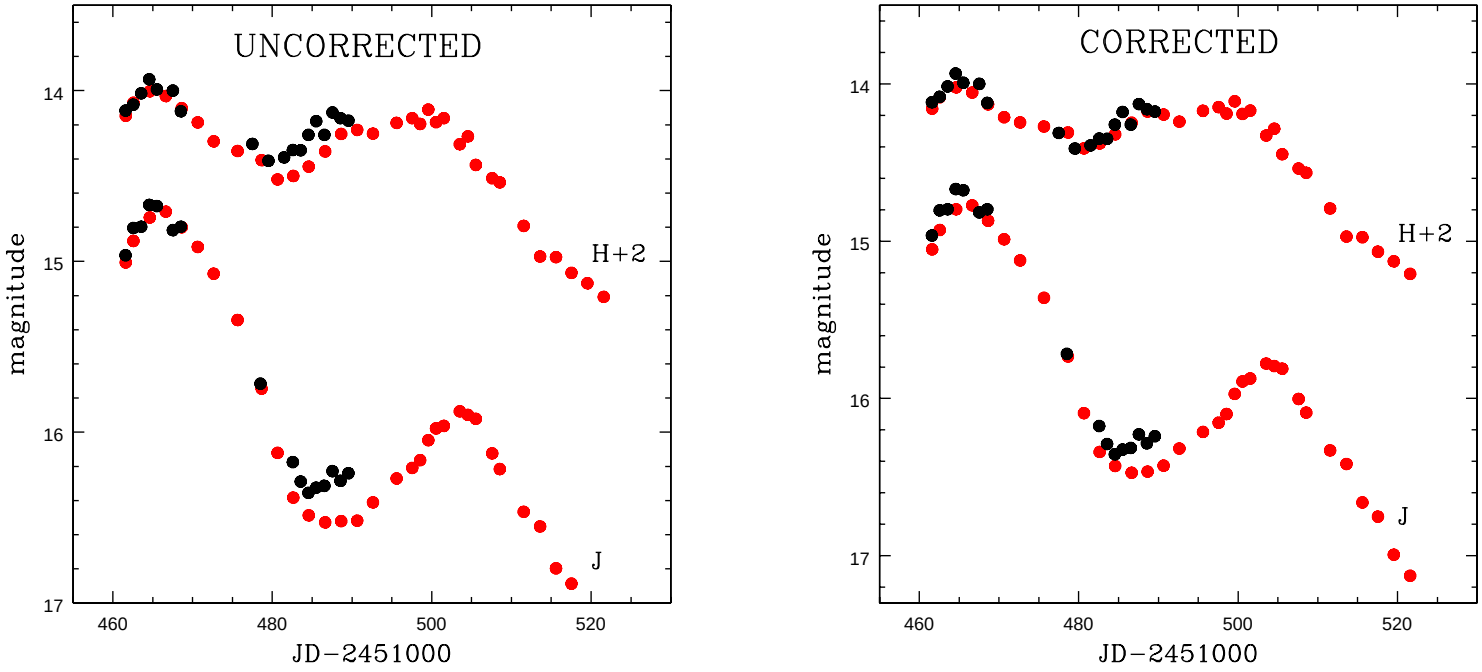
Sun, Sirius and Vega

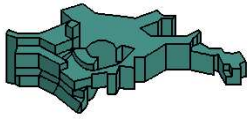
- syn. photometry $\mathrm{CT}_J = -0.037 \approx -0.043$ (photometry)
- syn. photometry $\mathrm{CT}_H = +0.020 \approx +0.015$ (photometry)



JH-band SN 1999ee

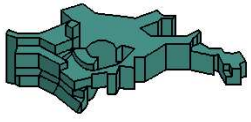
Krisciunas et al. 2004a





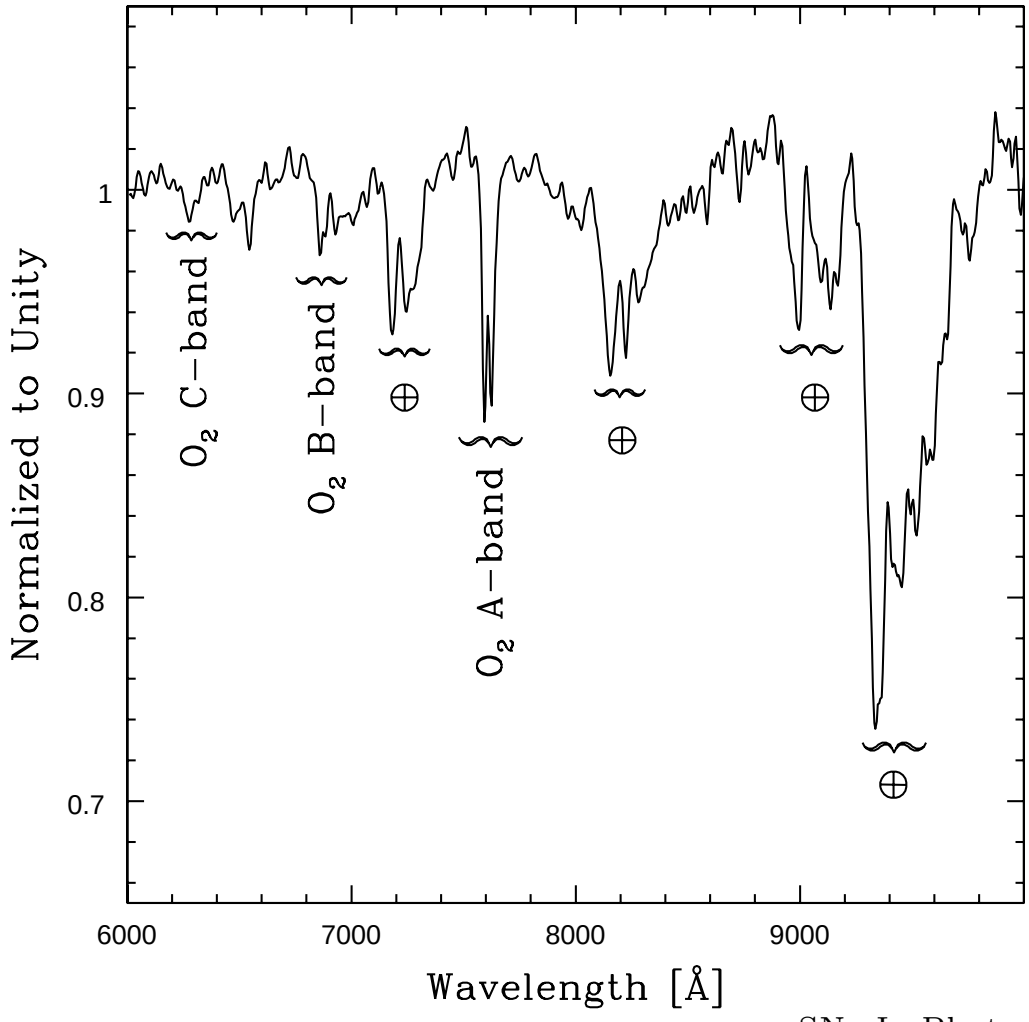
Landolt Standards Specphot.

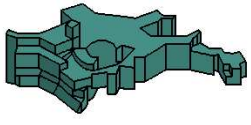
- +100 Landolt Standards ranging 7.0 $\leq$ V $\leq$ 13.0 (-0.3 $\leq$ $B-V \leq$ 1.7)
- stellar atmosphere models re-calibrated and extended flux points of secondary standards from 3100 to 10,600 Å
- derived sensitivity function produce program spectra with a wavelength range 3050 to 11,000 Å
- removed telluric and instrumental features
- mean differences between our $UBVRI$ synthetic photometry and Landolt photometry is 1% or less



Telluric Features

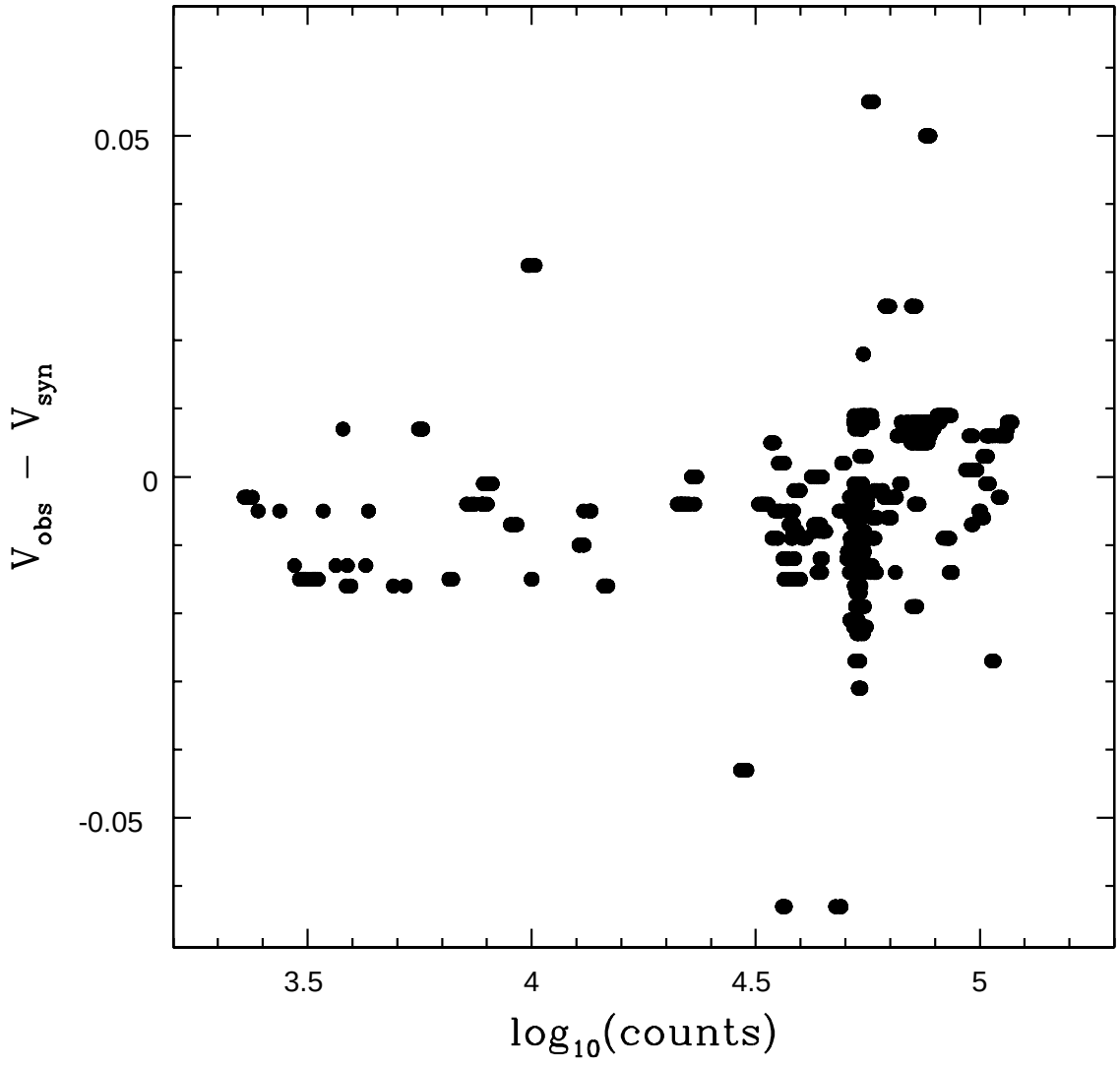
No eg131 $\rightarrow$ constructed our own spectral flats
removed fringing and telluric features

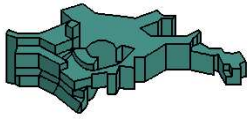




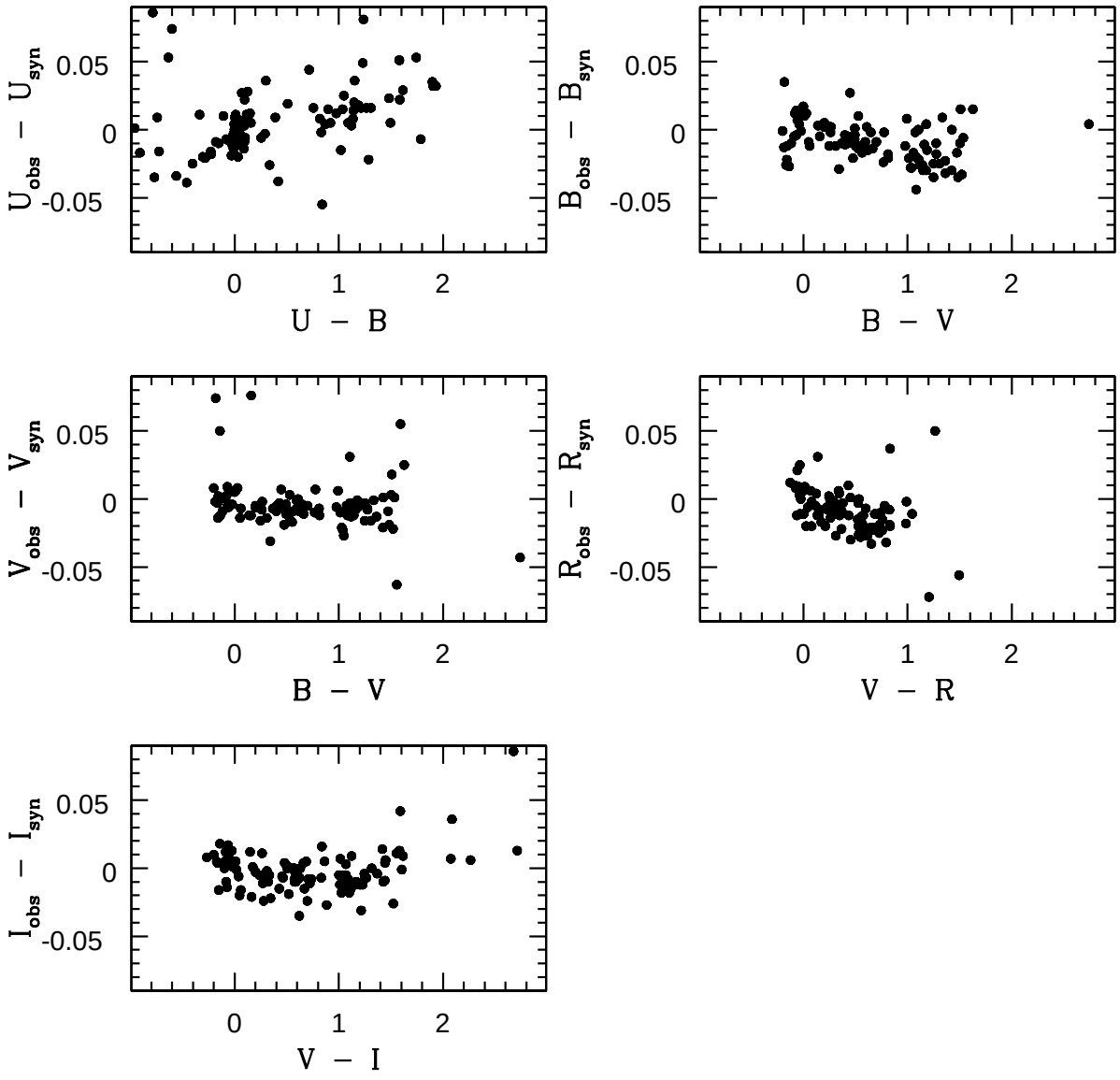
Detector linear from night to night?

Blue setup obs. for all dispersion calibrated spectra





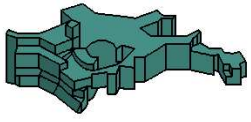
$UBVRI$ Spectrophotometry



Summary

- Photometrist should consider calculating S-corrections for data sets taken on multiple telescopes
- As of yet S-corrections have only reduced systematic errors not eliminated them!
- RTN to apply S-corrections to the infrared?
  $\longrightarrow$ a need for infrared spectrophotometric standards
- an atlas of spectrophotometric standards is now available to the public @

  www.mpa-garching.mpg.de/$\sim$stritzin/data/



Literature

- Suntzeff 2000
- Stritzinger et al. 2002 –SN 1999ee
- Jha 2002 Phd. Thesis Harvard University
- Candia et al. 2003 –SN 2002cx
- Krisciunas et al. 2003 –SN 2001el
- Krisciunas et al. 2004a,b –several in optical & IR
- Pignata, et al. 2004 –SN 2002er