

# CSP Observations of Stripped Core-Collapse SN

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Melina Bersten, Joe Anderson

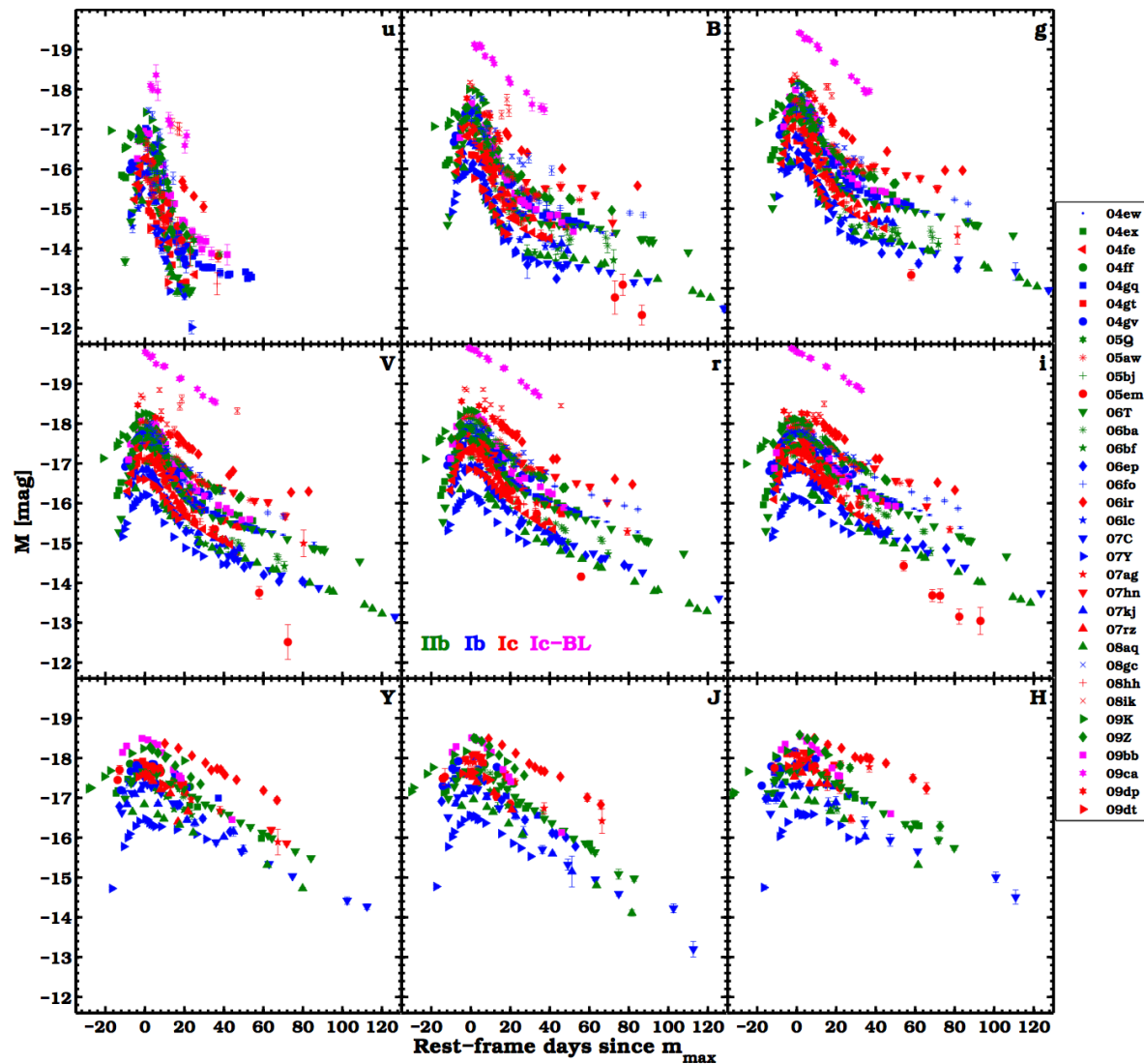


# Current Research Activities

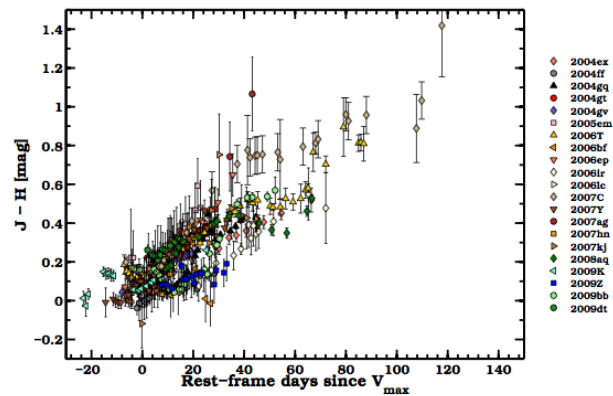
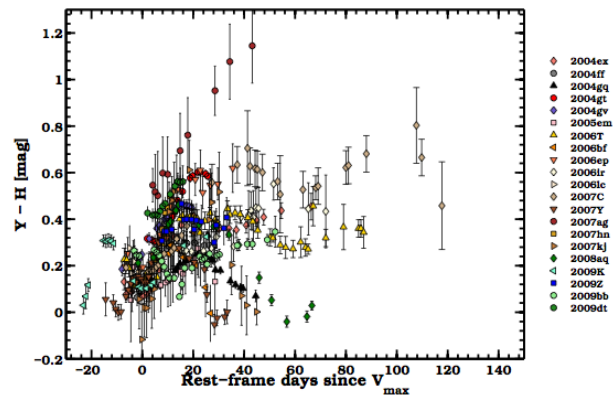
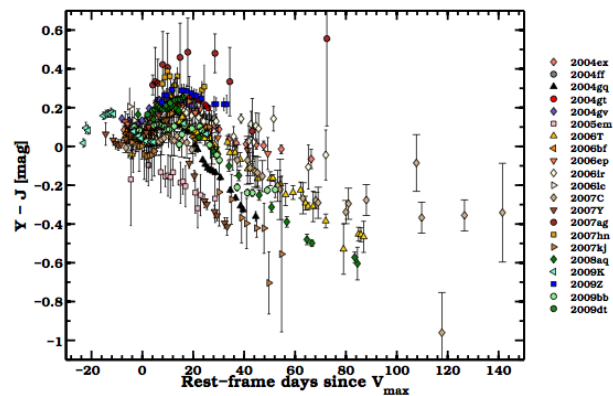
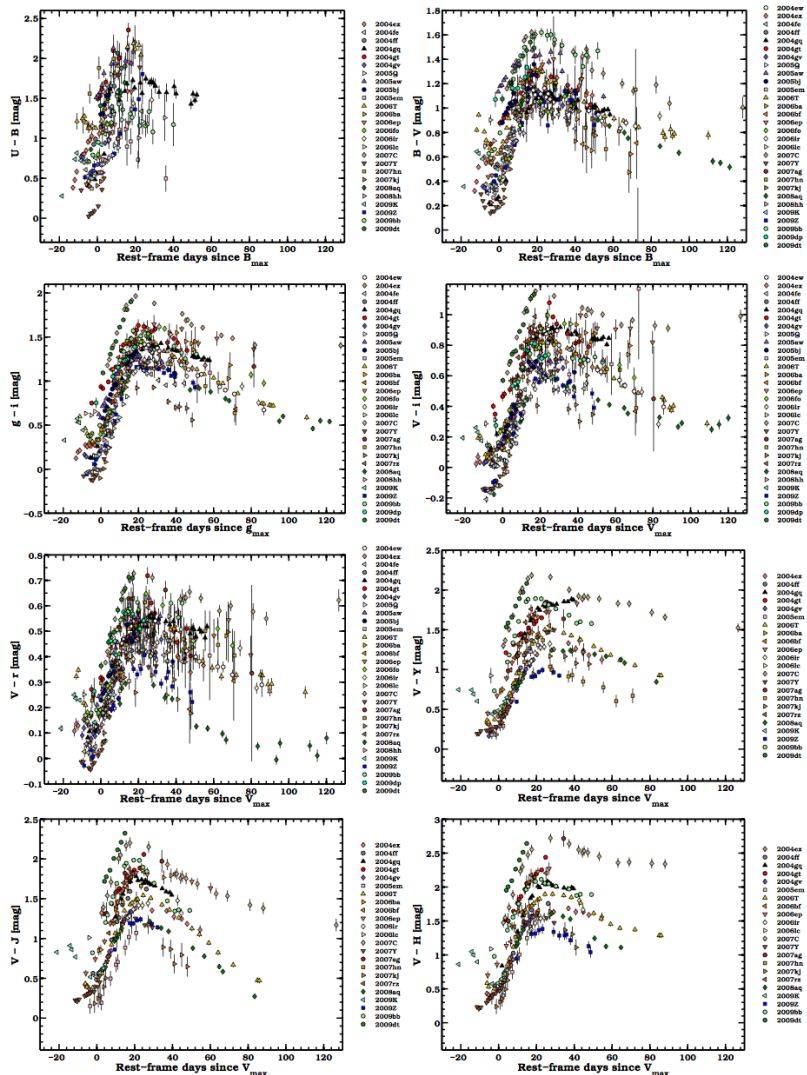
- CSP I & II SN Ib/c samples and methods
- SN IaX optical and NIR studies of growing sample of  $\sim 6$
- SN IIn CSP II, e.g., SN 2013L
- SNLS CSP II, e.g., CSP15aah
- SN Ia CSP II, e.g. 2013gy...????
- NGC7552-OT

# Absolute Magnitudes

34 objects (24 with NIR photometry)



# Colors

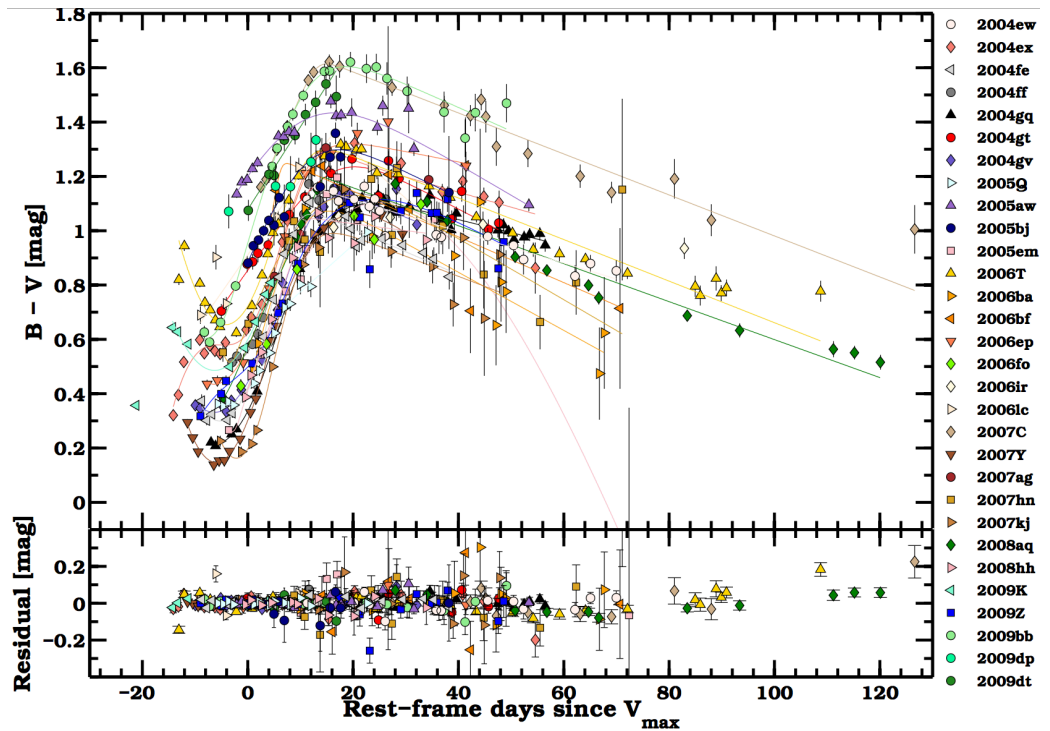
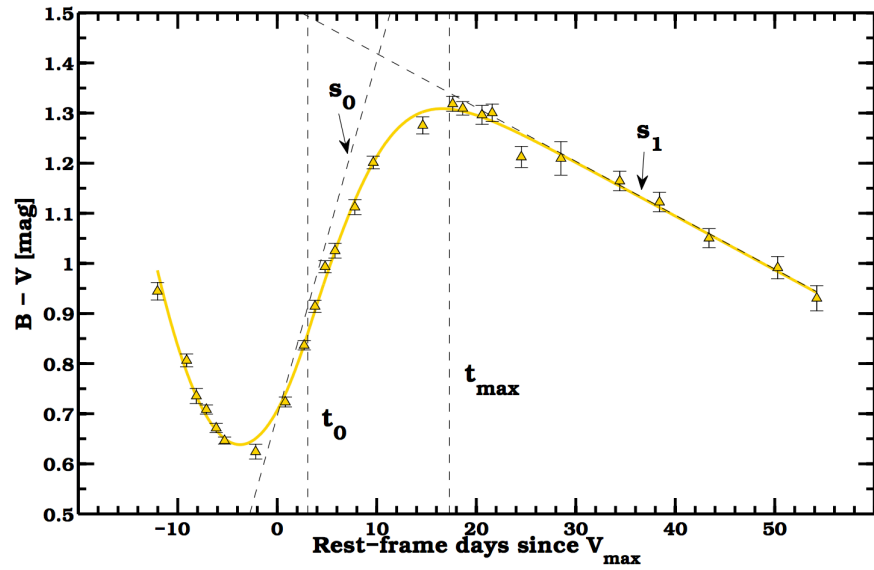


- ◇ 2004ex
- 2004ff
- ▲ 2004gg
- 2004gt
- ◇ 2004gv
- 2005em
- ▲ 2006t
- ◇ 2006hf
- ◇ 2006se
- ◇ 2006ir
- ◇ 2006ic
- ◇ 2007c
- ◇ 2007y
- ◇ 2007ag
- ◇ 2007hn
- ◇ 2007kj
- ◇ 2008aq
- ◇ 2009k
- ◇ 2009z
- ◇ 2009bb
- ◇ 2009dt

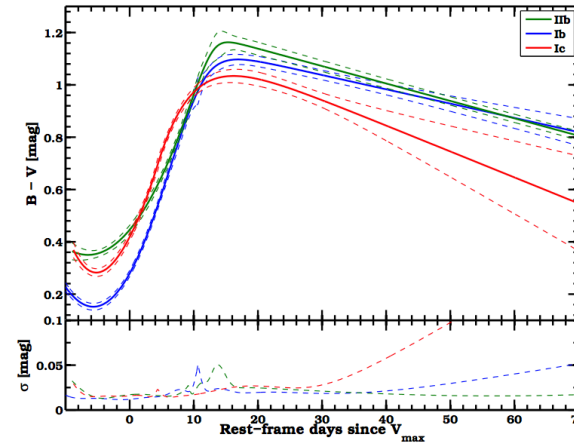
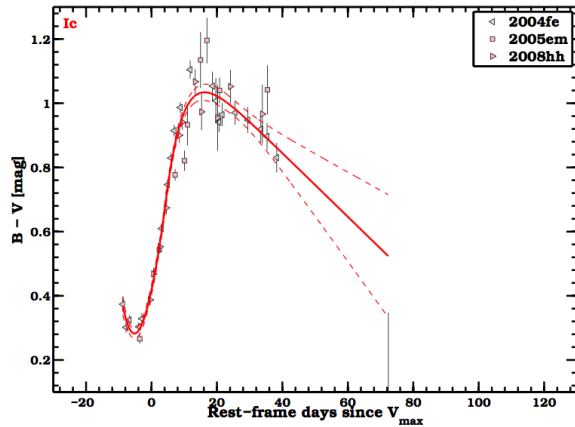
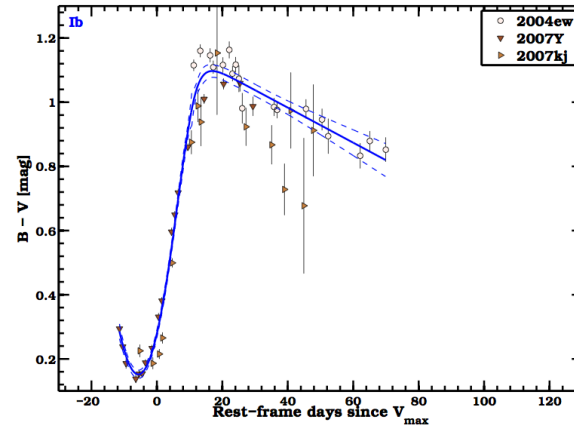
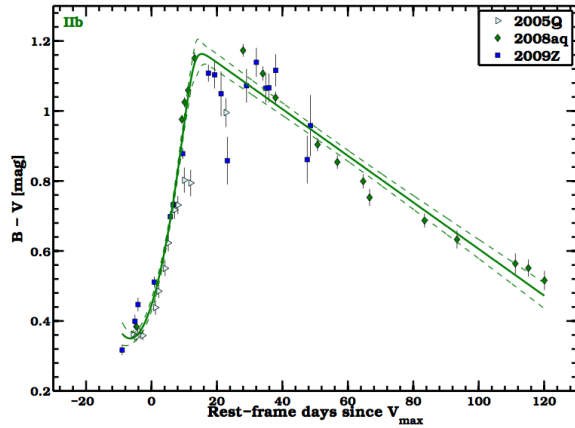
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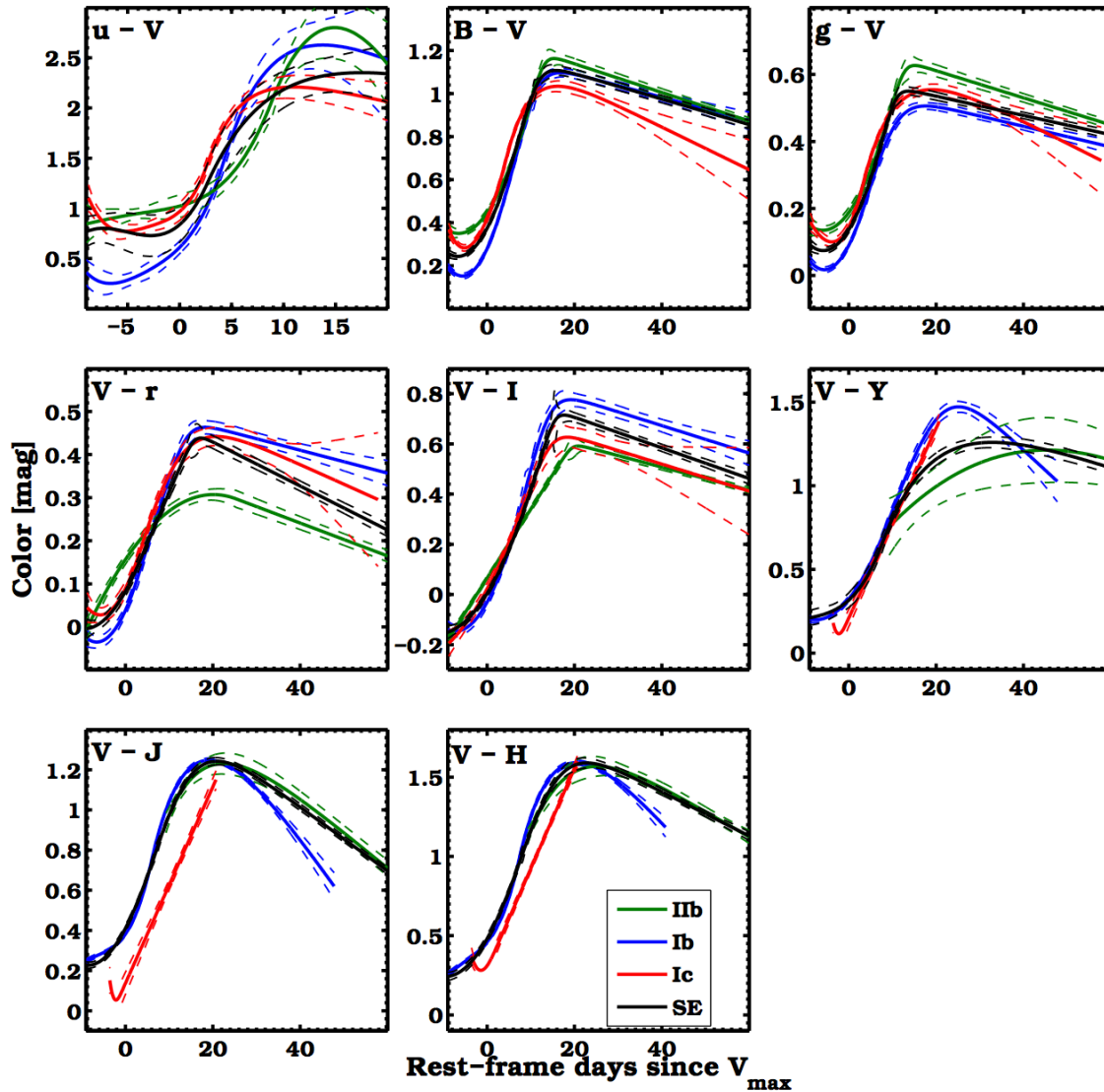
# Color fit a la



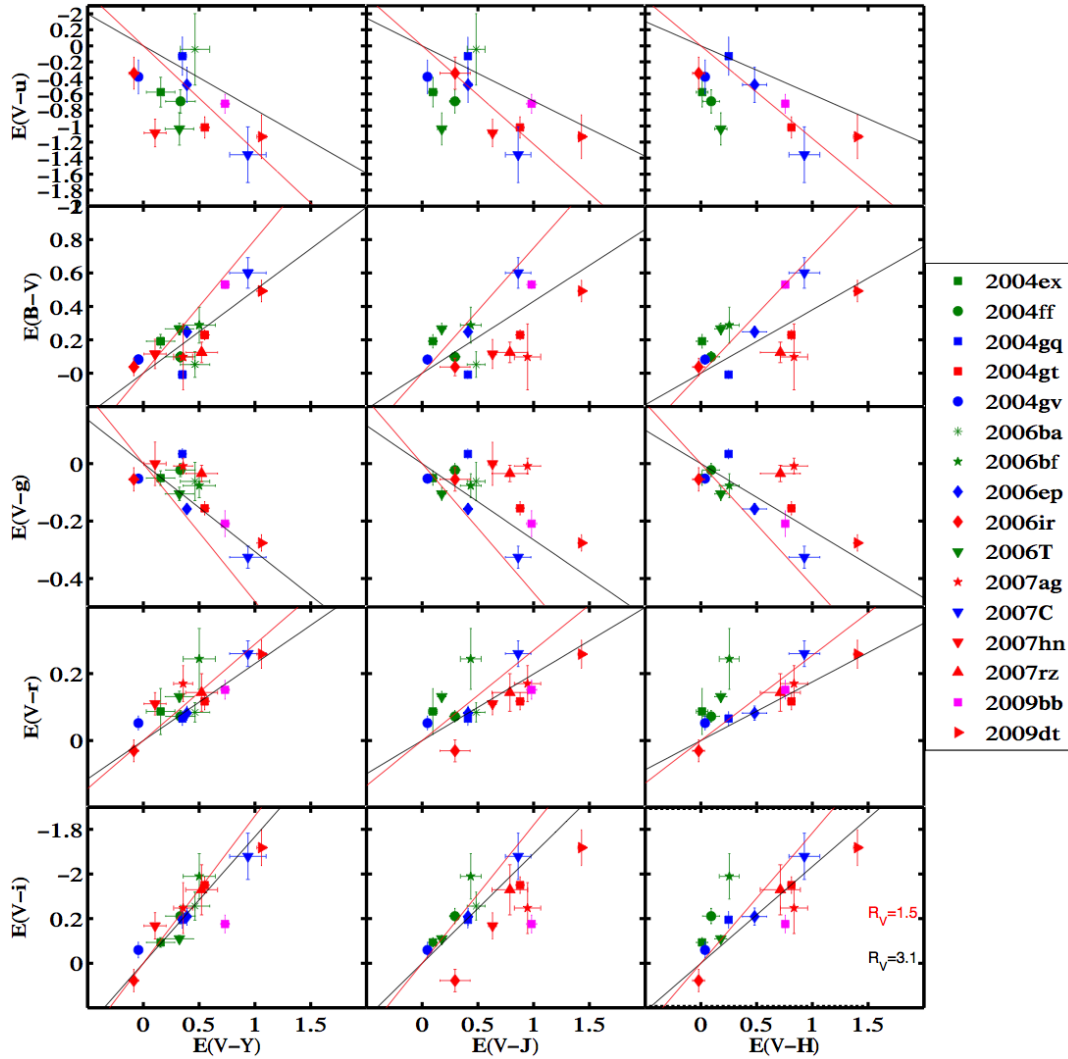
# Intrinsic color-curves templates



# Various intrinsic color-curves templates

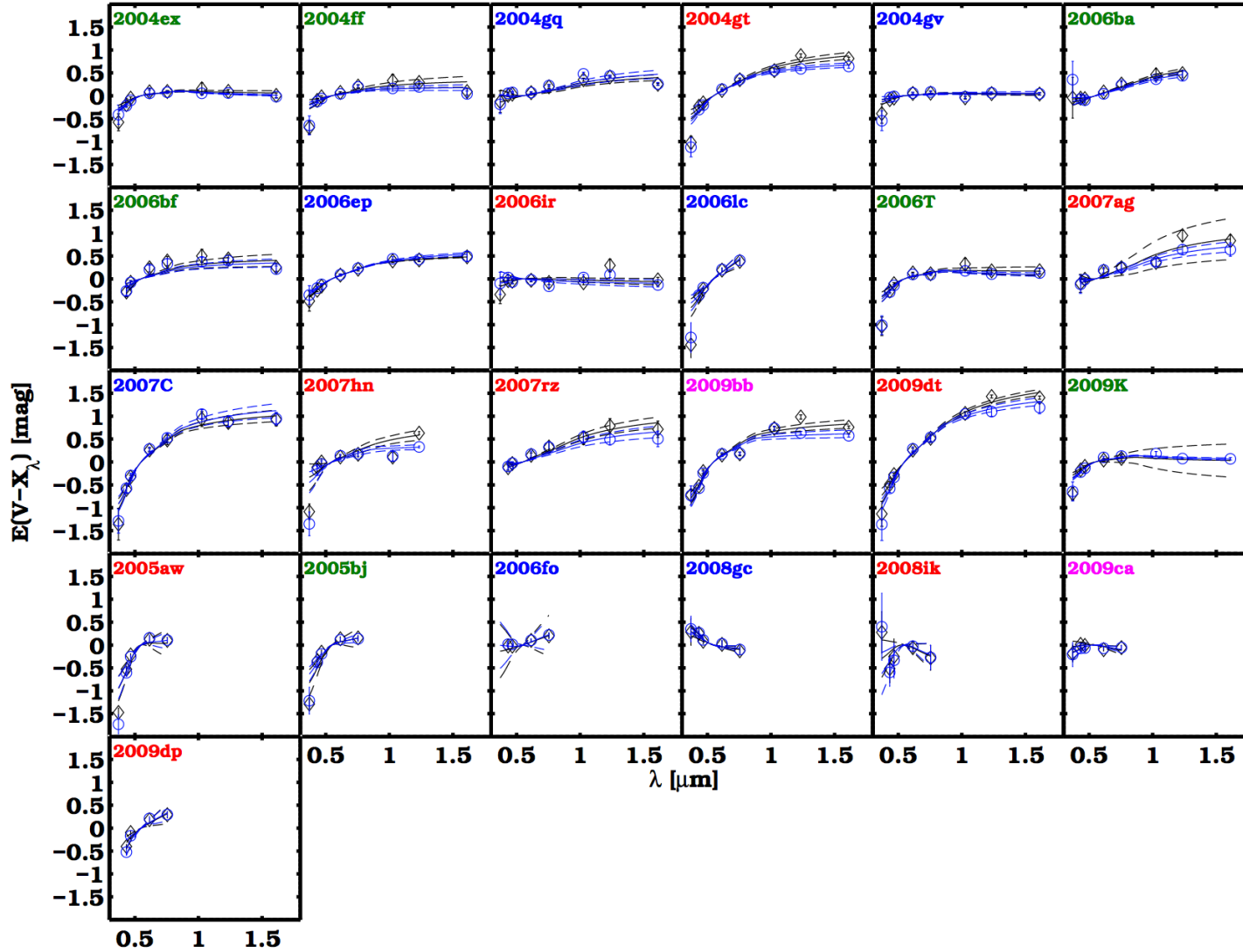


# Various color excesses

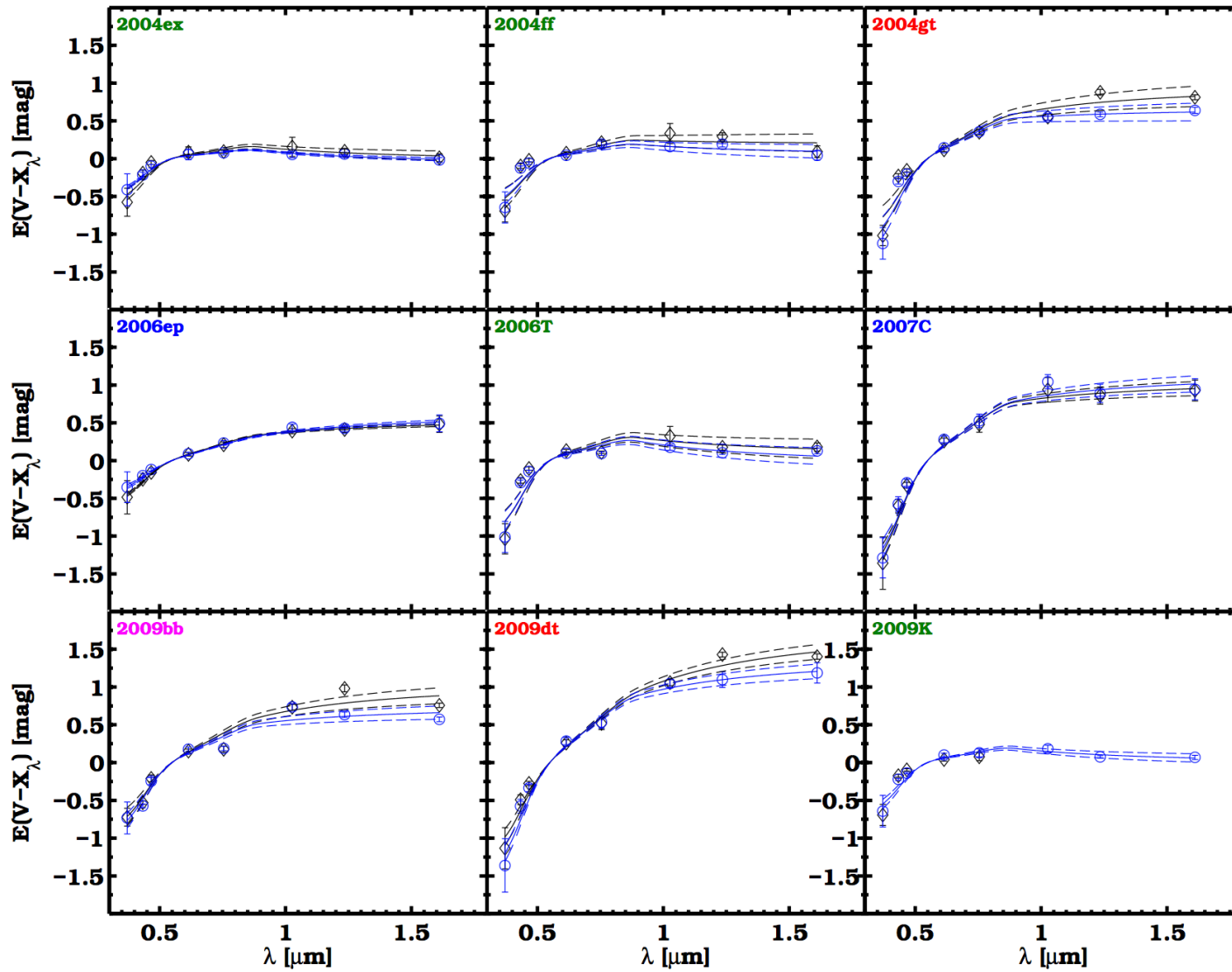




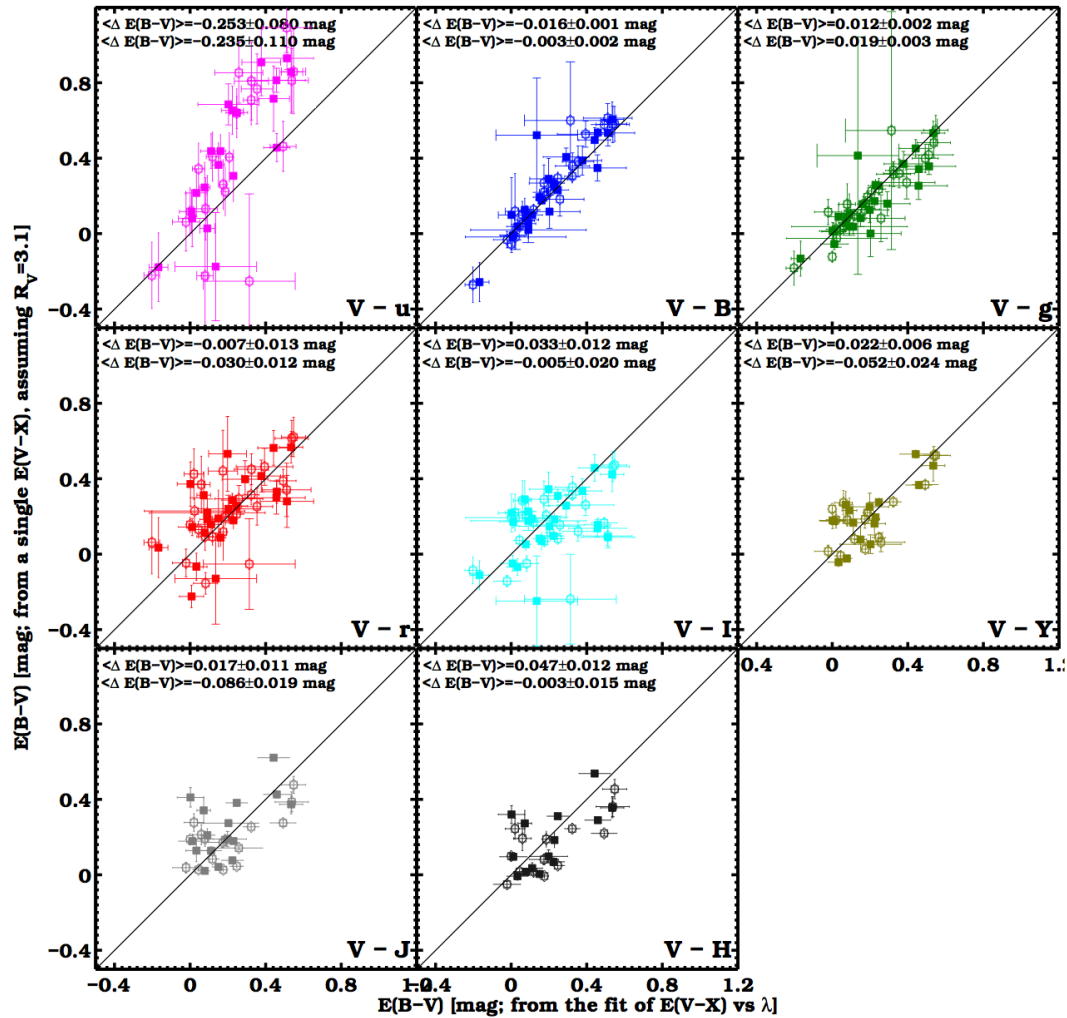
Now relax  $R_V = 3.1$  assumption



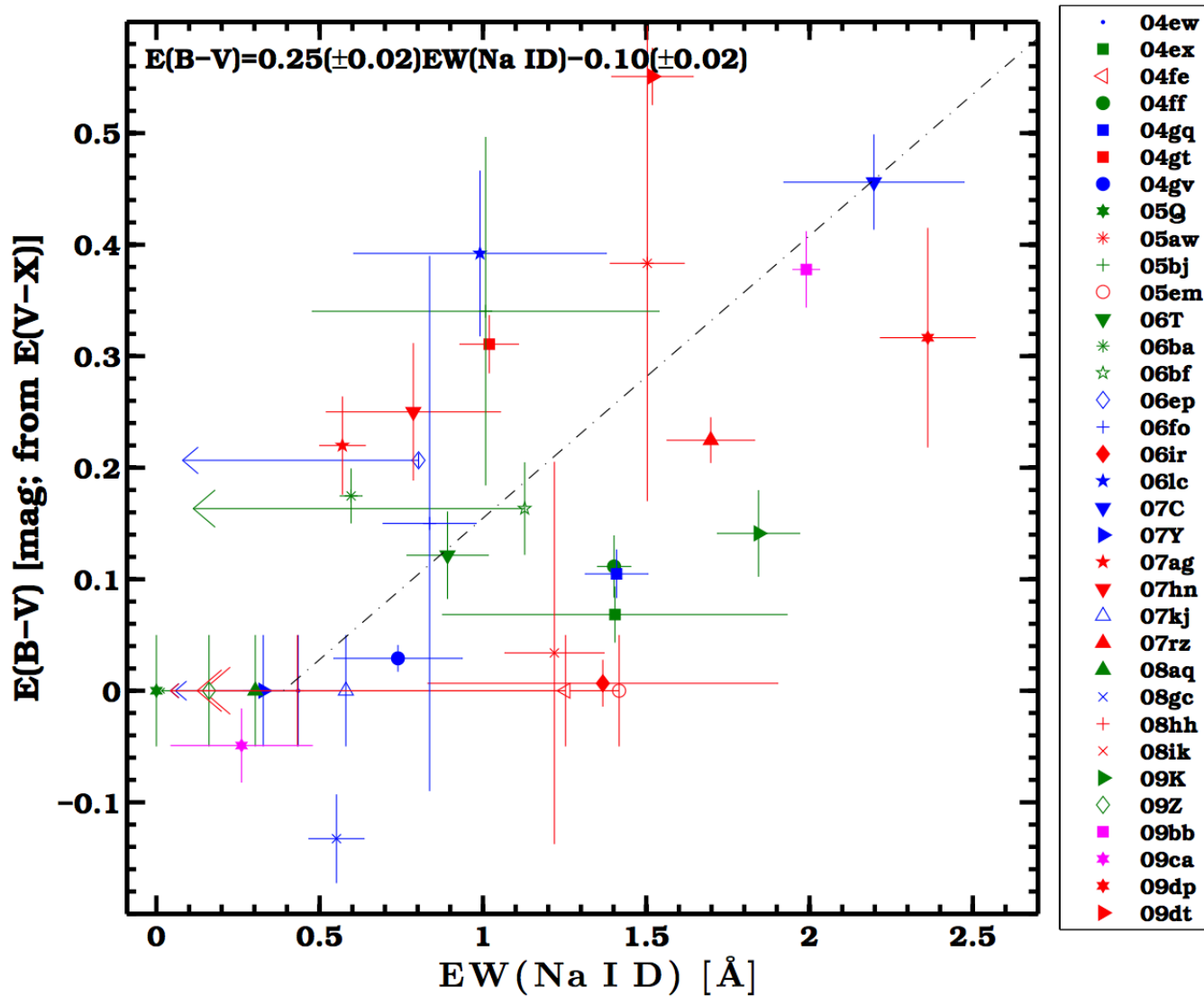
# $R_V$ & $E(B-V)$



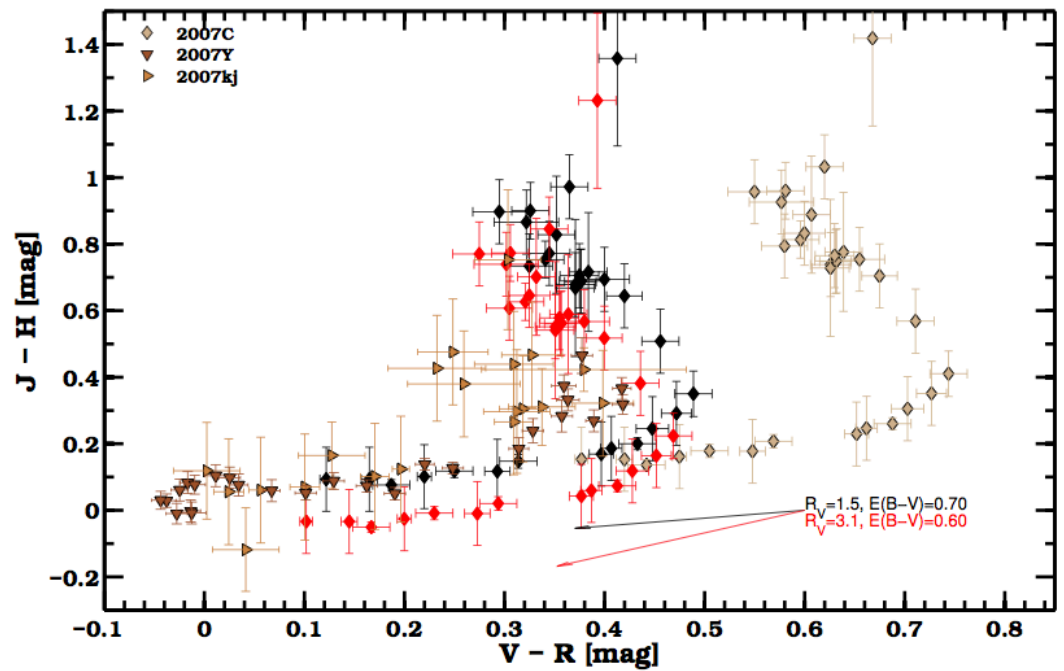
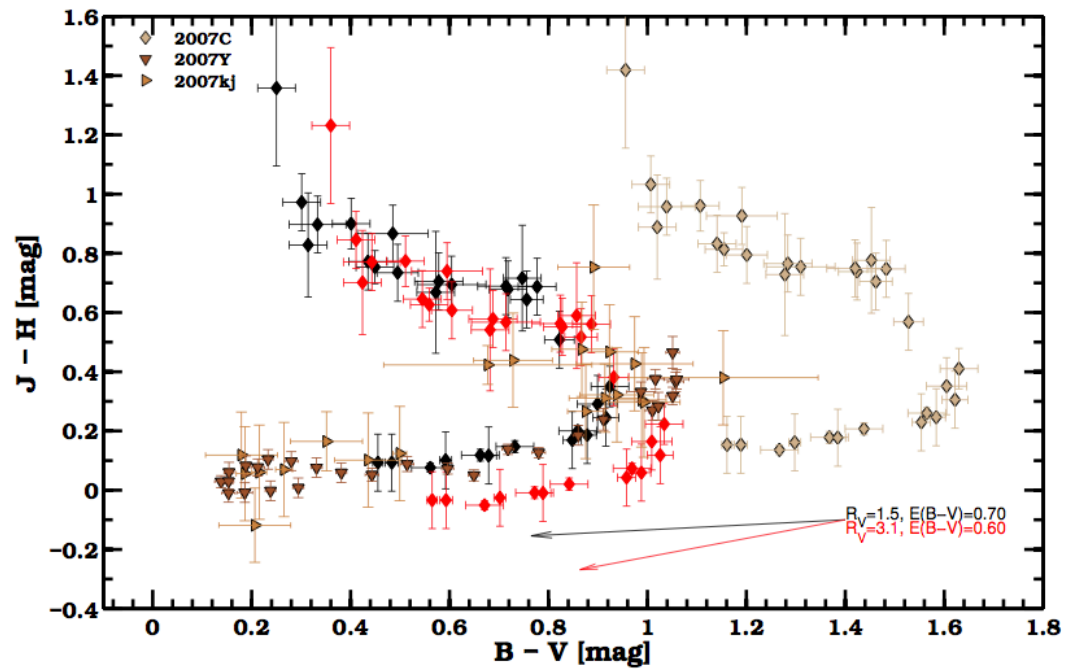
# Comparison of methods



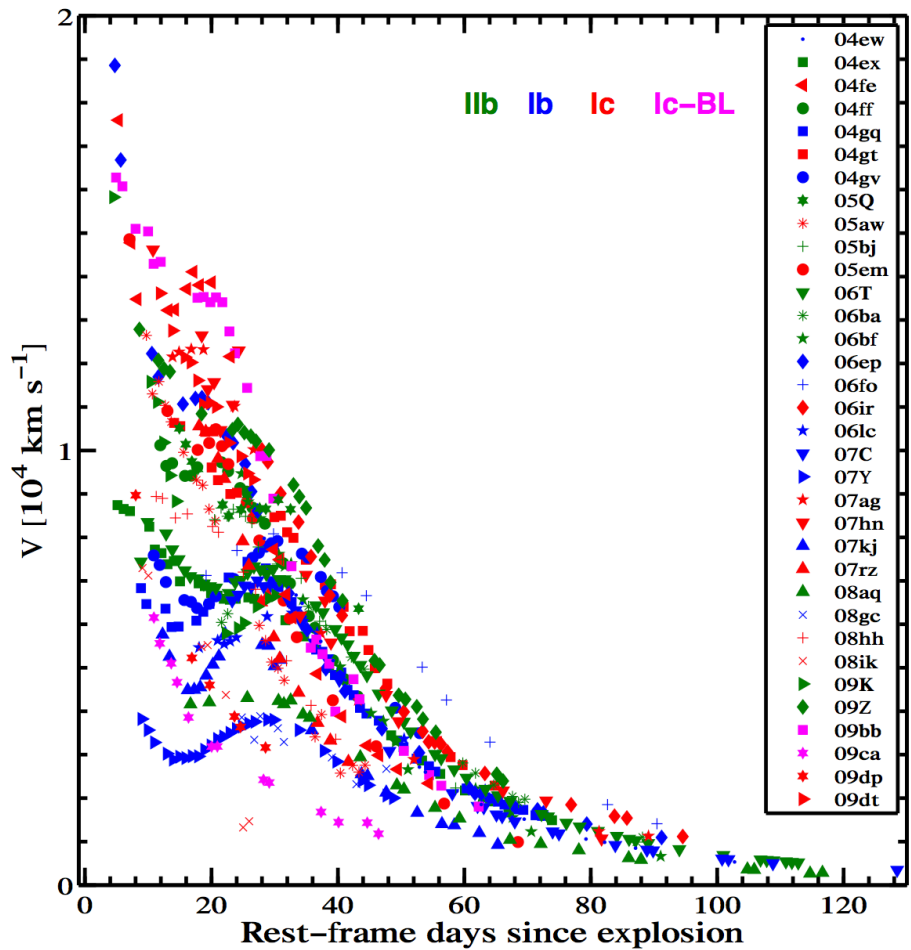
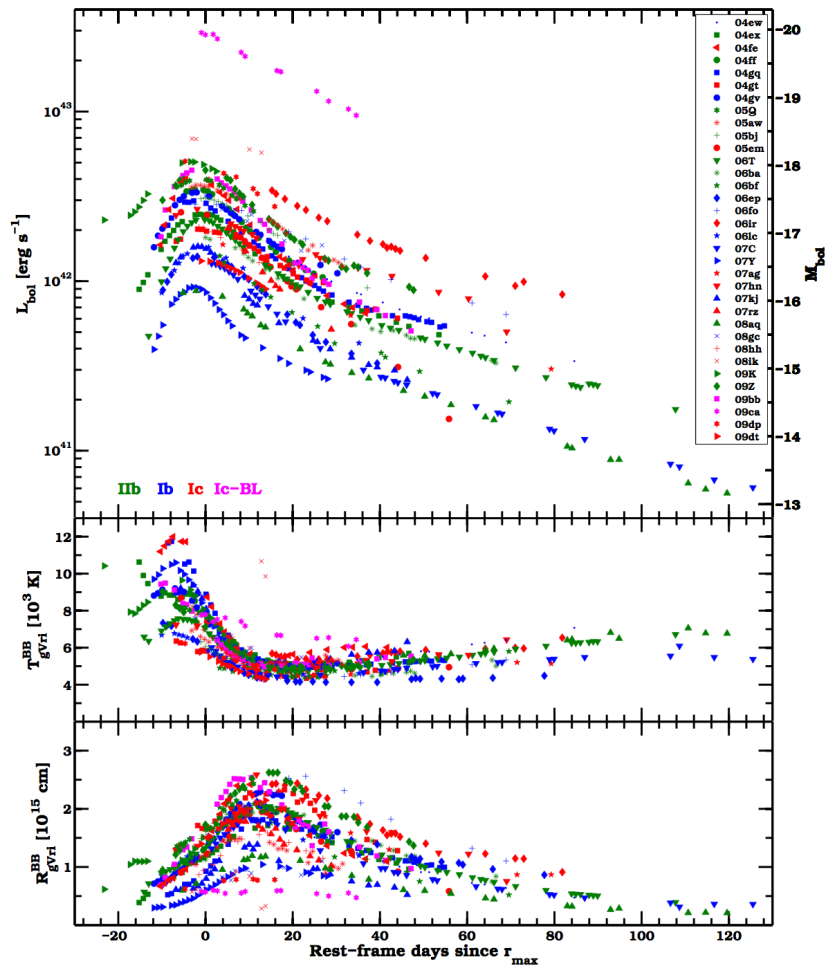
# Comparison of new method and Na I D color excesses



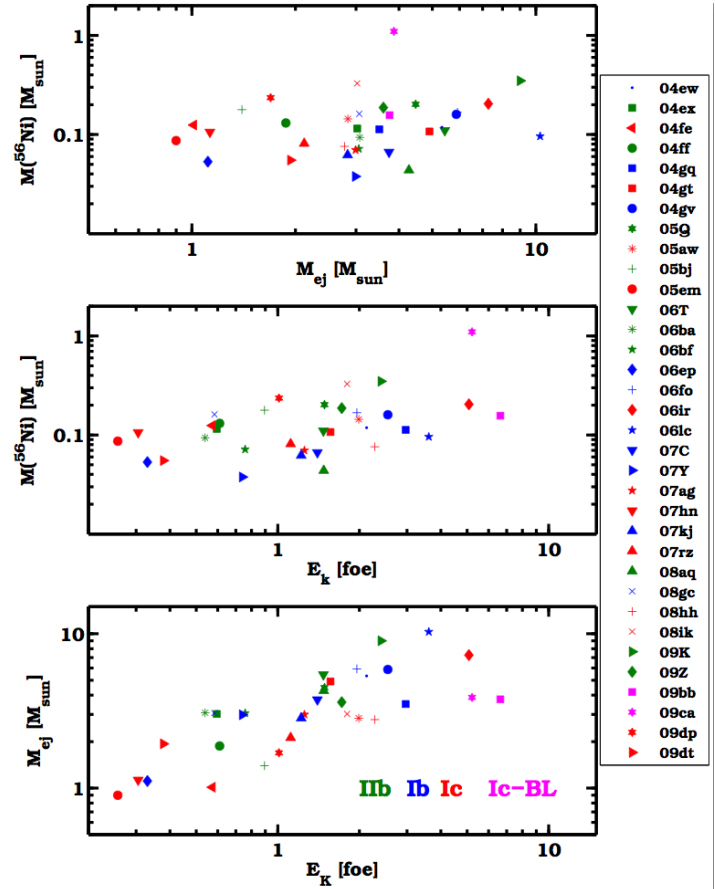
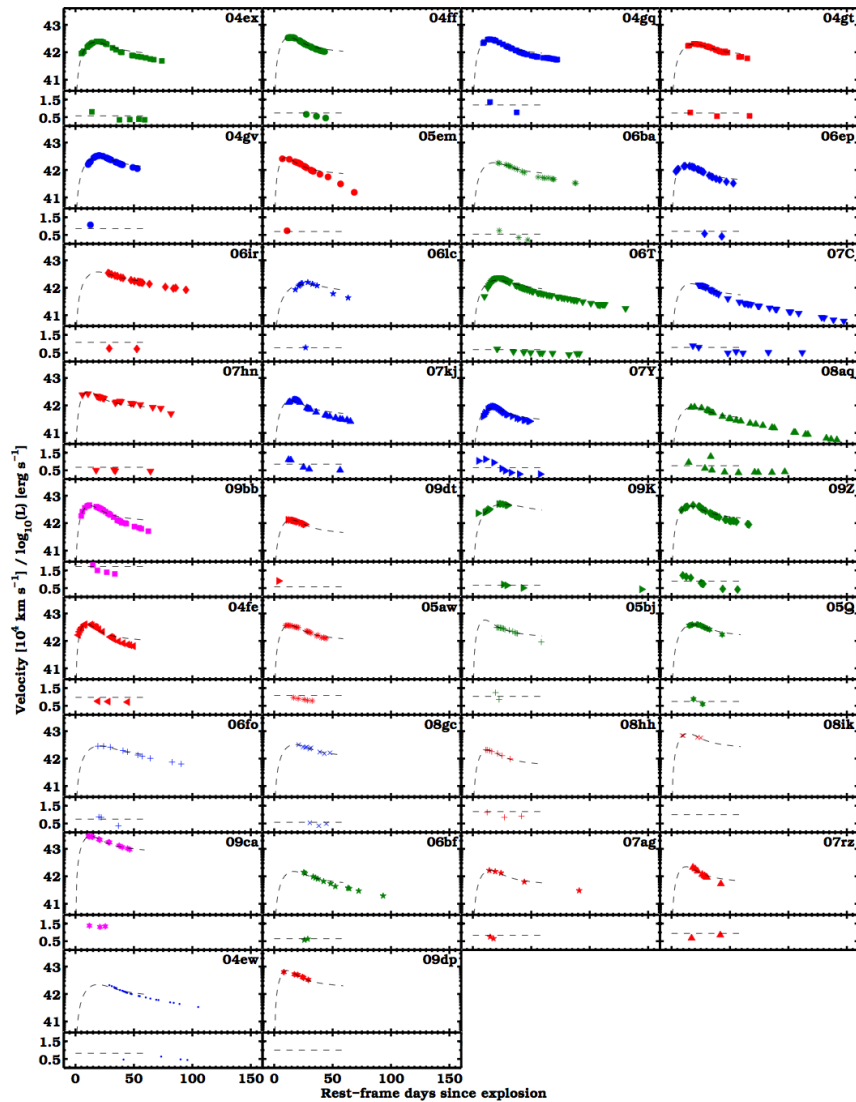
# Color color plots



# UVOIR light curves, BB fit parameters, & $V_C$



# Explosion parameters (via Arnett's equations)



# Explosion parameters (via hydro-calculations)

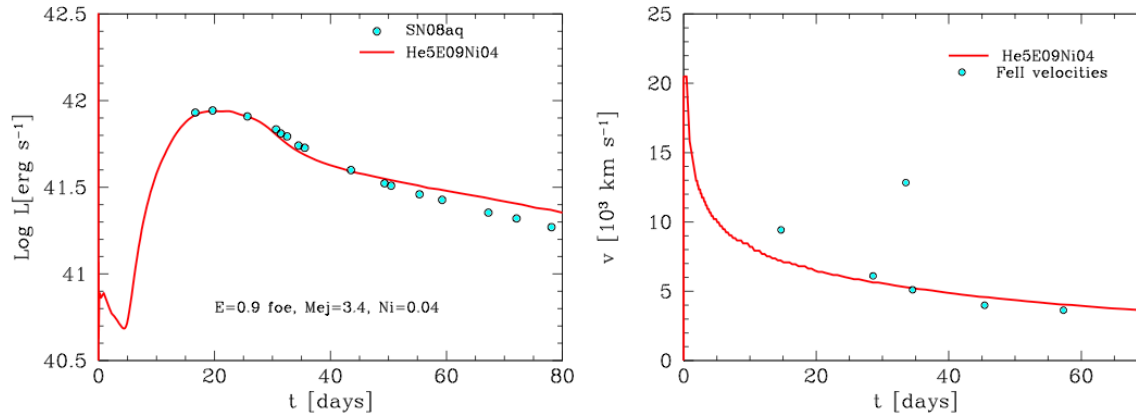


Figure 17: SN 2008aq: IIb. Problem with one vel data.

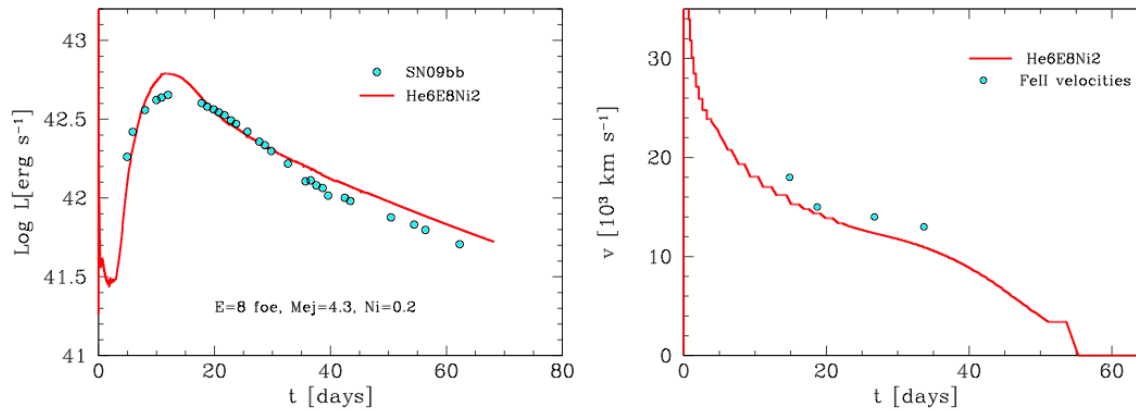
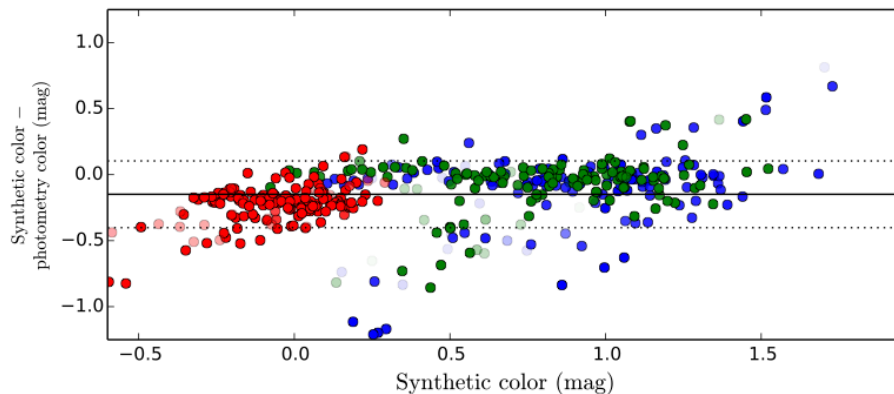
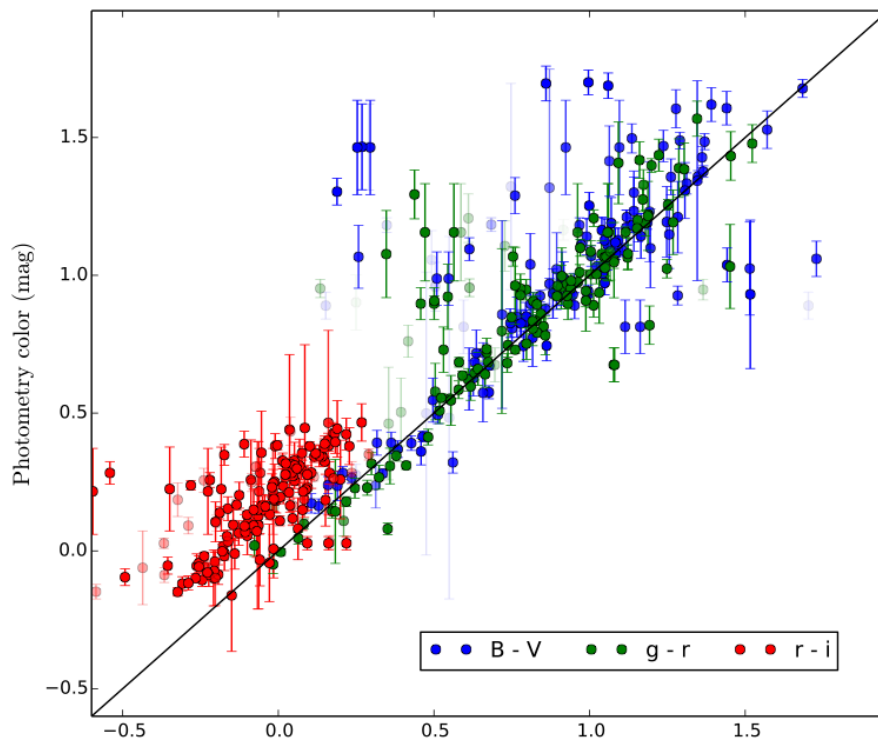
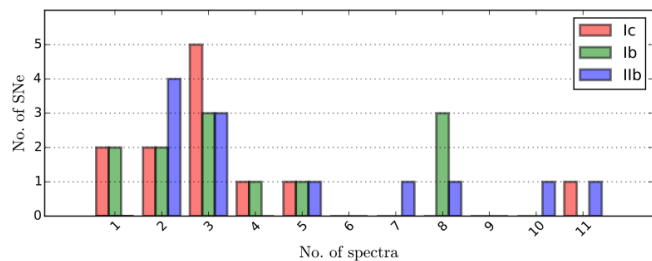
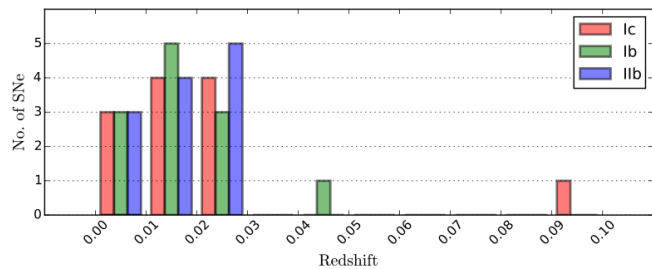
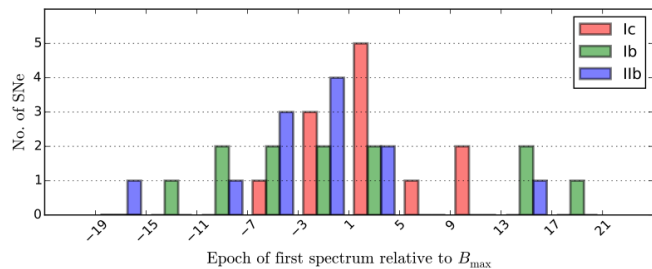
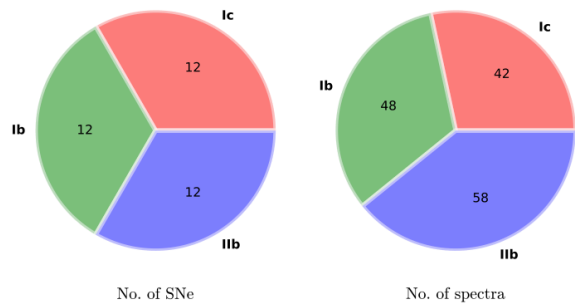


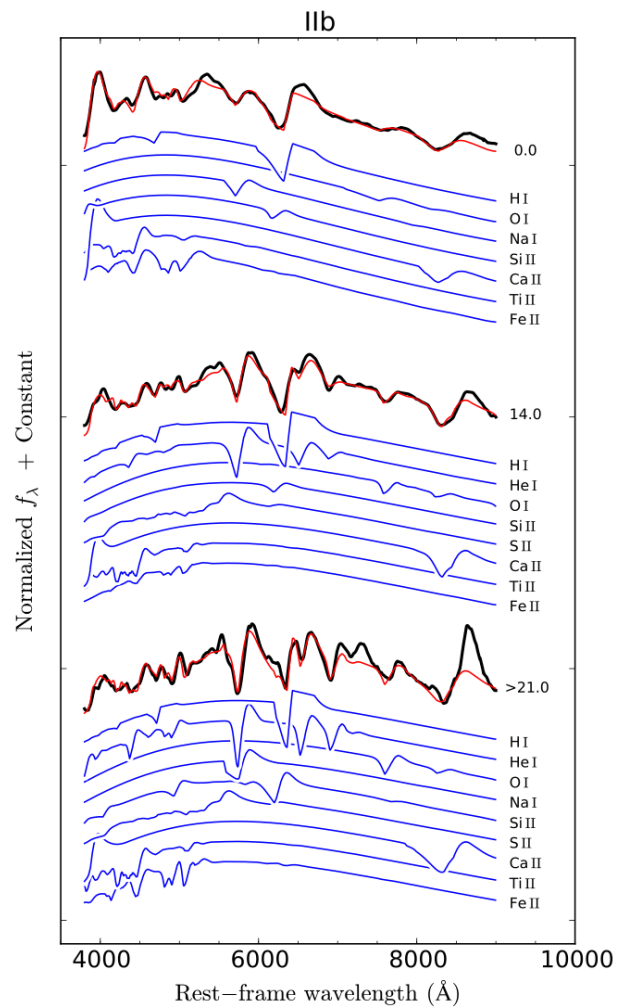
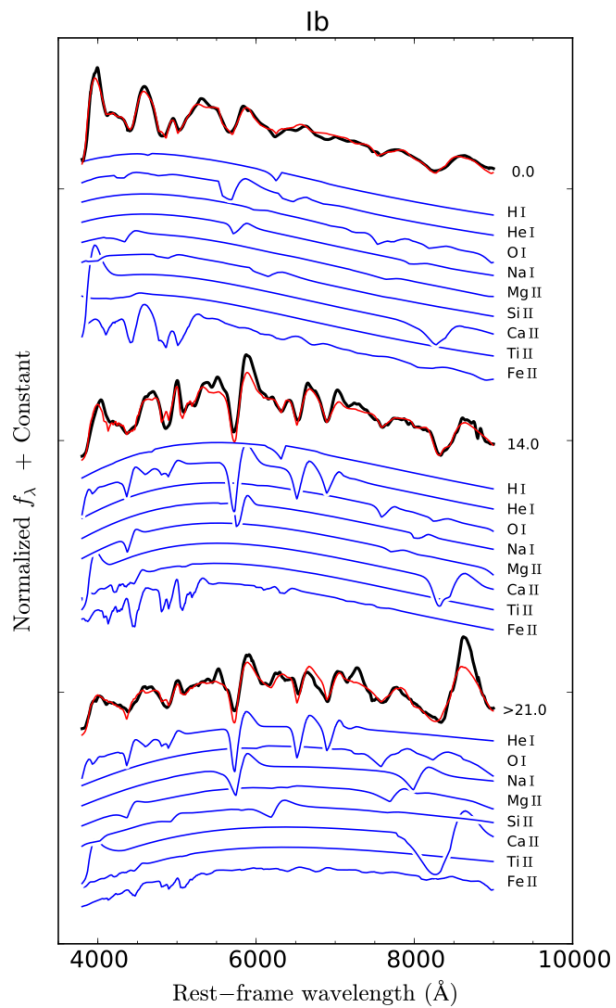
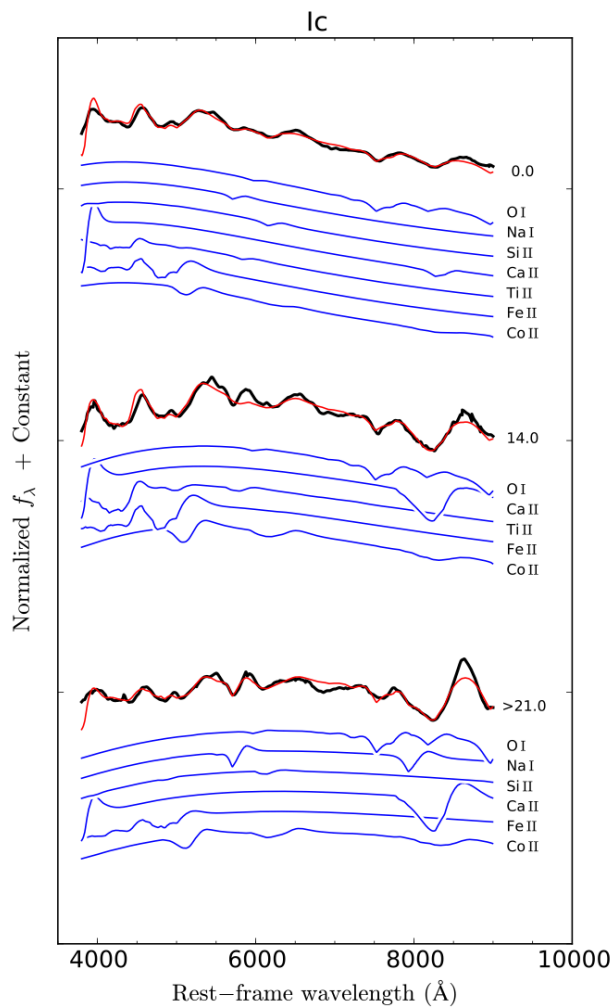
Figure 18: SN 2009bb: Ic-bl. No very good fit.



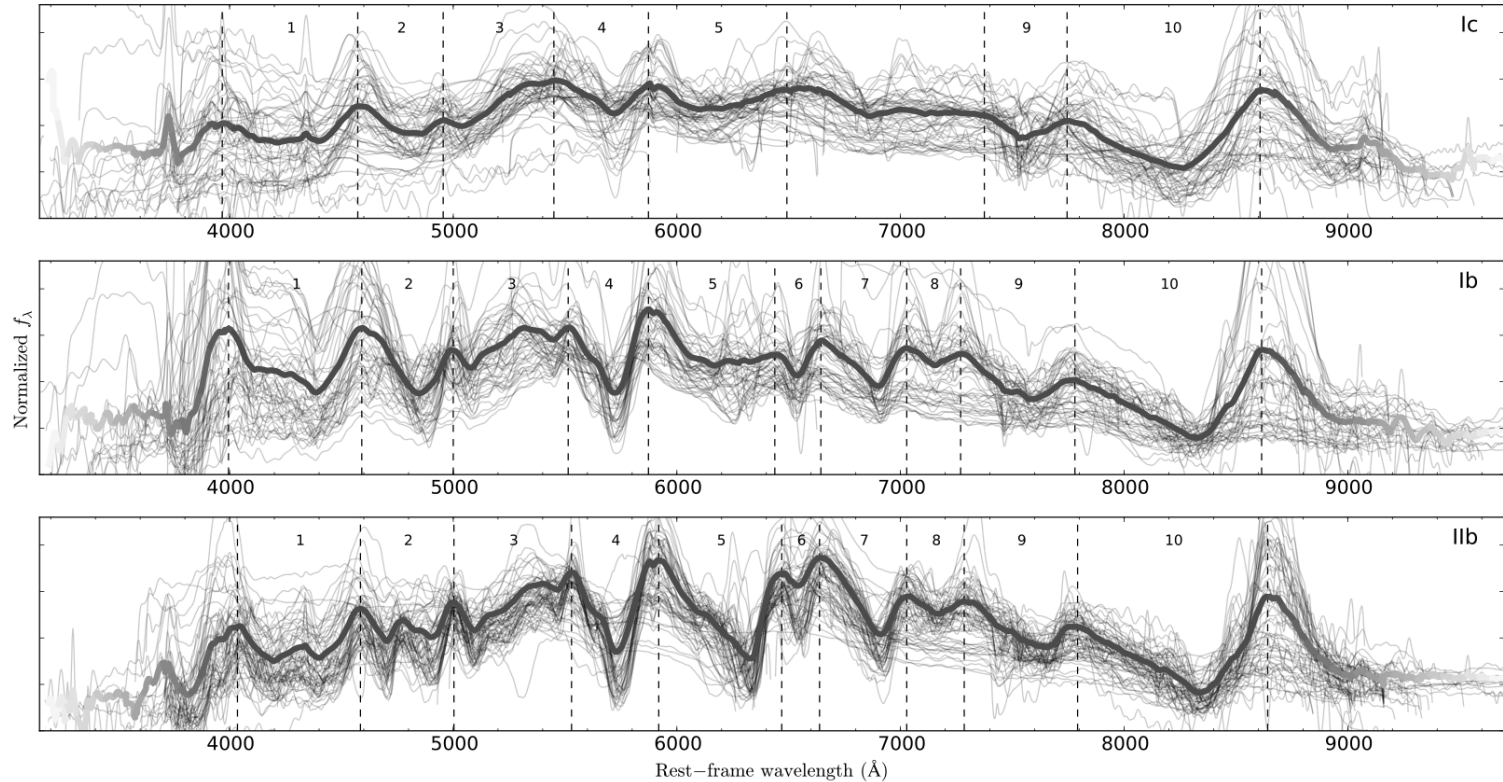
# Visual-wavelength Spectroscopy



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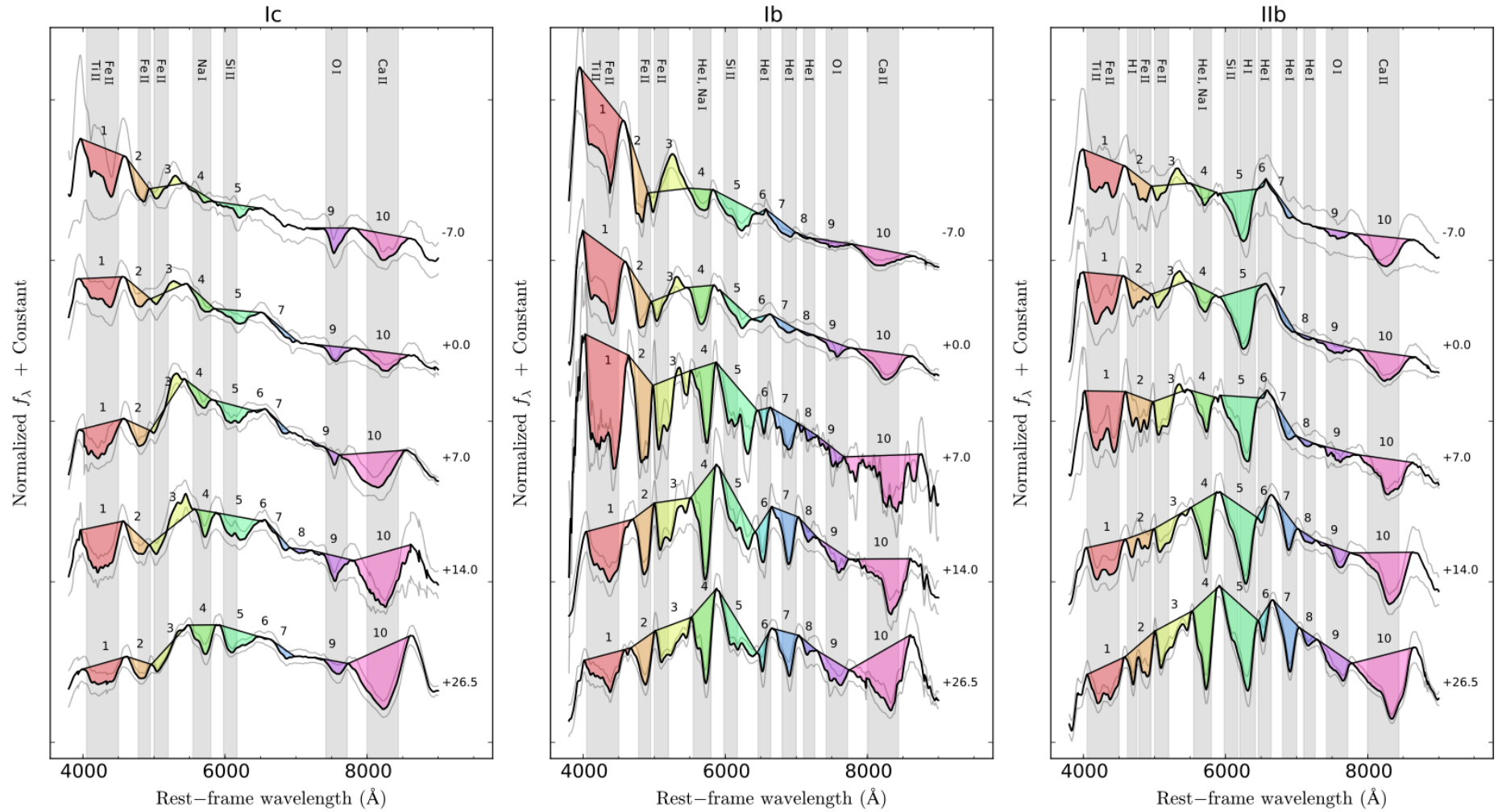


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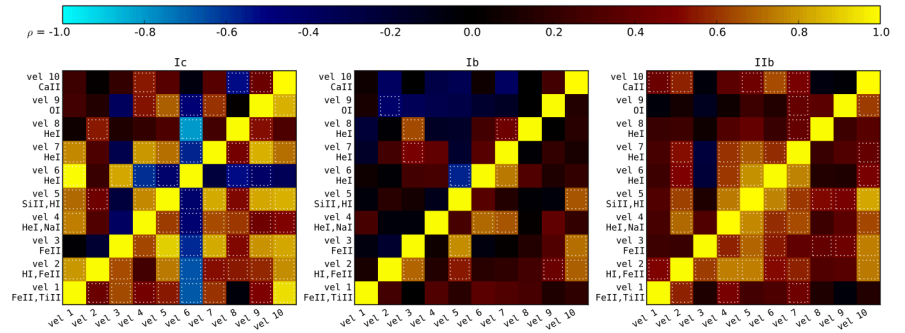
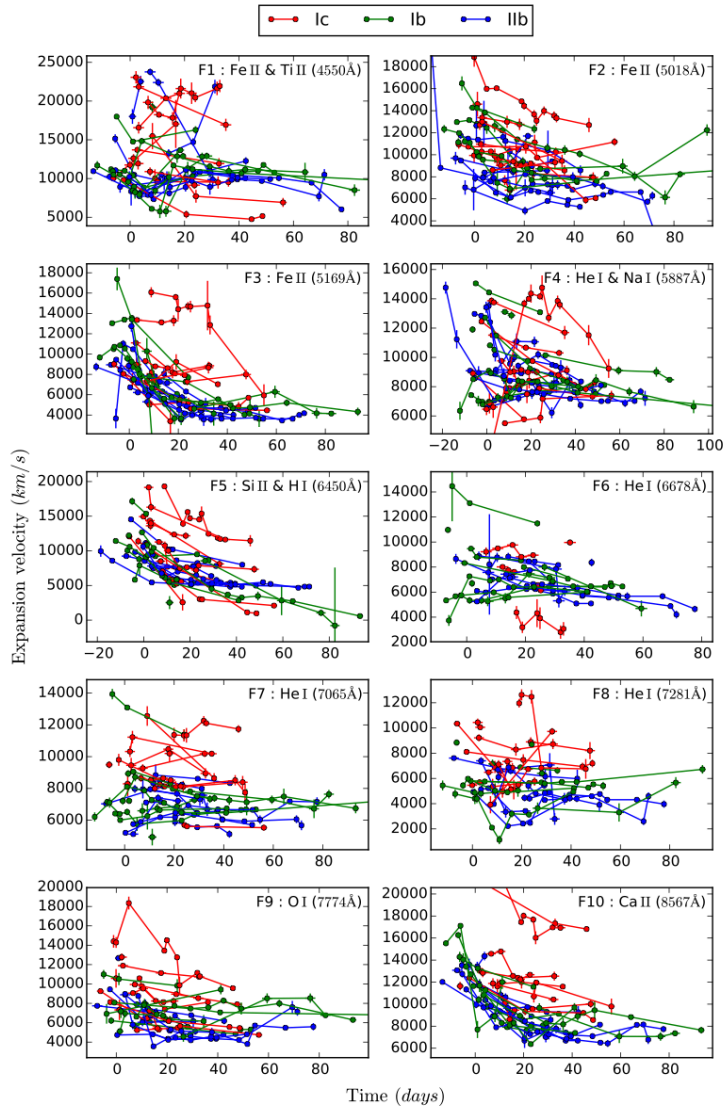


**Figure 6.** The average of all spectra of each type. The dashed lines define 10 areas of interest. Areas 1-5, 9 and 10 are usually present in all spectra. Areas 6-8 are only present at certain epoch intervals.

# Visual-wavelength Spectroscopy

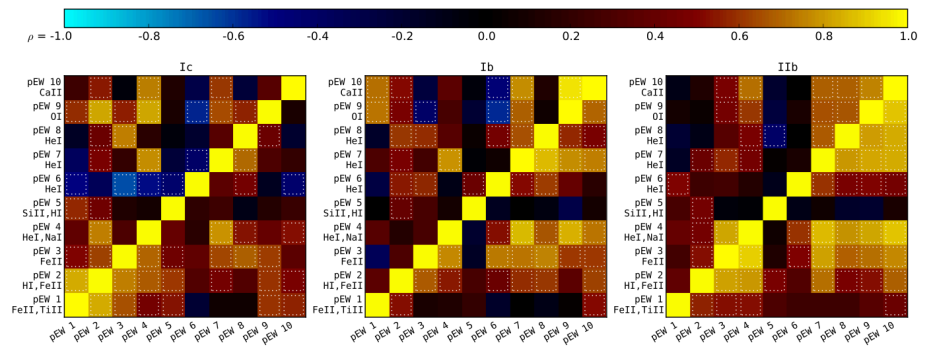
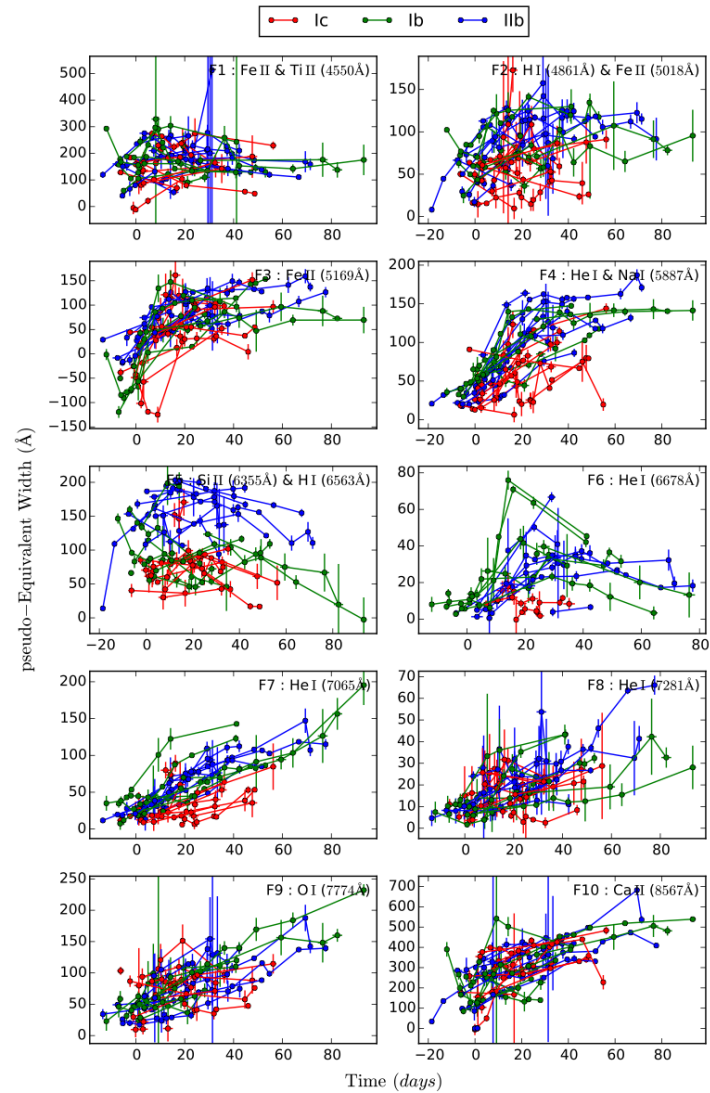


# Visual-wavelength Spectroscopy: $V_{\text{exp}}$



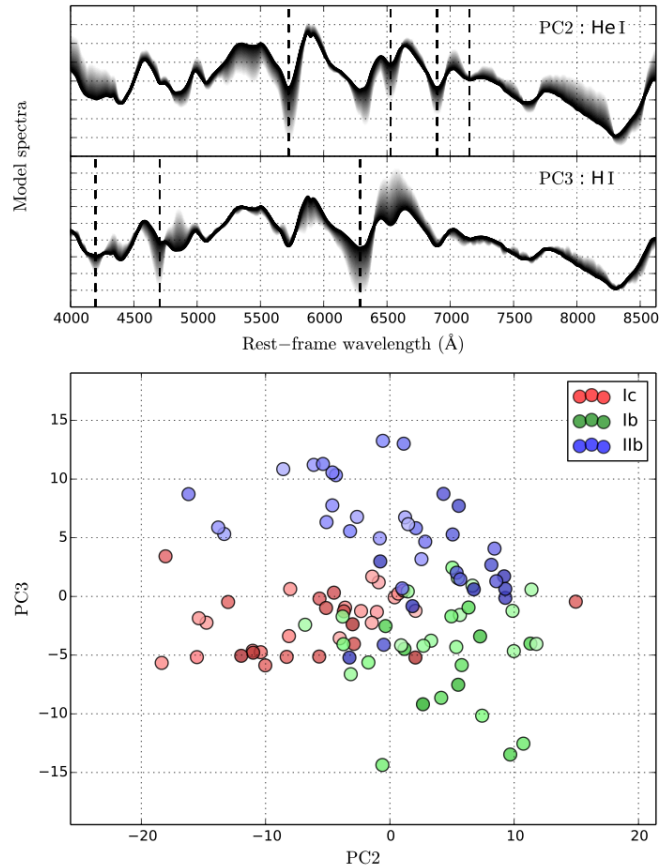
**Figure 11.** Showing Spearman correlations between the expansion velocity measurements as color matrices. The rank correlation coefficients  $\rho$  are visualised by the colorbar at the top of the figure. The lighter the color, the stronger the correlation. The upper left triangle shows correlations of spectra obtained from the time of  $B$ -band maximum magnitude to 21 days later and lower right triangle shows correlations for all spectra. The white dotted squares mark rank correlation coefficients above .4 or below  $-0.4$ .

# Visual-wavelength Spectroscopy: psuedo-EW



**Figure 10.** Showing Spearman correlations between the pseudo-Equivalent Width measurements as color matrices. The rank correlation coefficients  $\rho$  are visualised by the colorbar at the top of the figure. The lighter the color, the stronger the correlation. The upper left triangle shows correlations of spectra obtained from the time of *B*-band maximum magnitude to 21 days later and lower right triangle shows correlations for all spectra. The white dotted squares mark rank correlation coefficients above .4 or below  $-.4$  described as above weak correlation.

# Visual-wavelength Spectroscopy: PCA



**Figure 12.** The first and second principal components of the sample from one week before to five weeks after *B*-band maximum. The second component in the upper panel shows features related to helium and the third component in the middle panel shows hydrogen. The brightness of the points indicate the age of the spectrum (brighter points are older).

# CSP-II SN Ib/c

