A Confounding Class of Peculiar Type Ia Supernovae?

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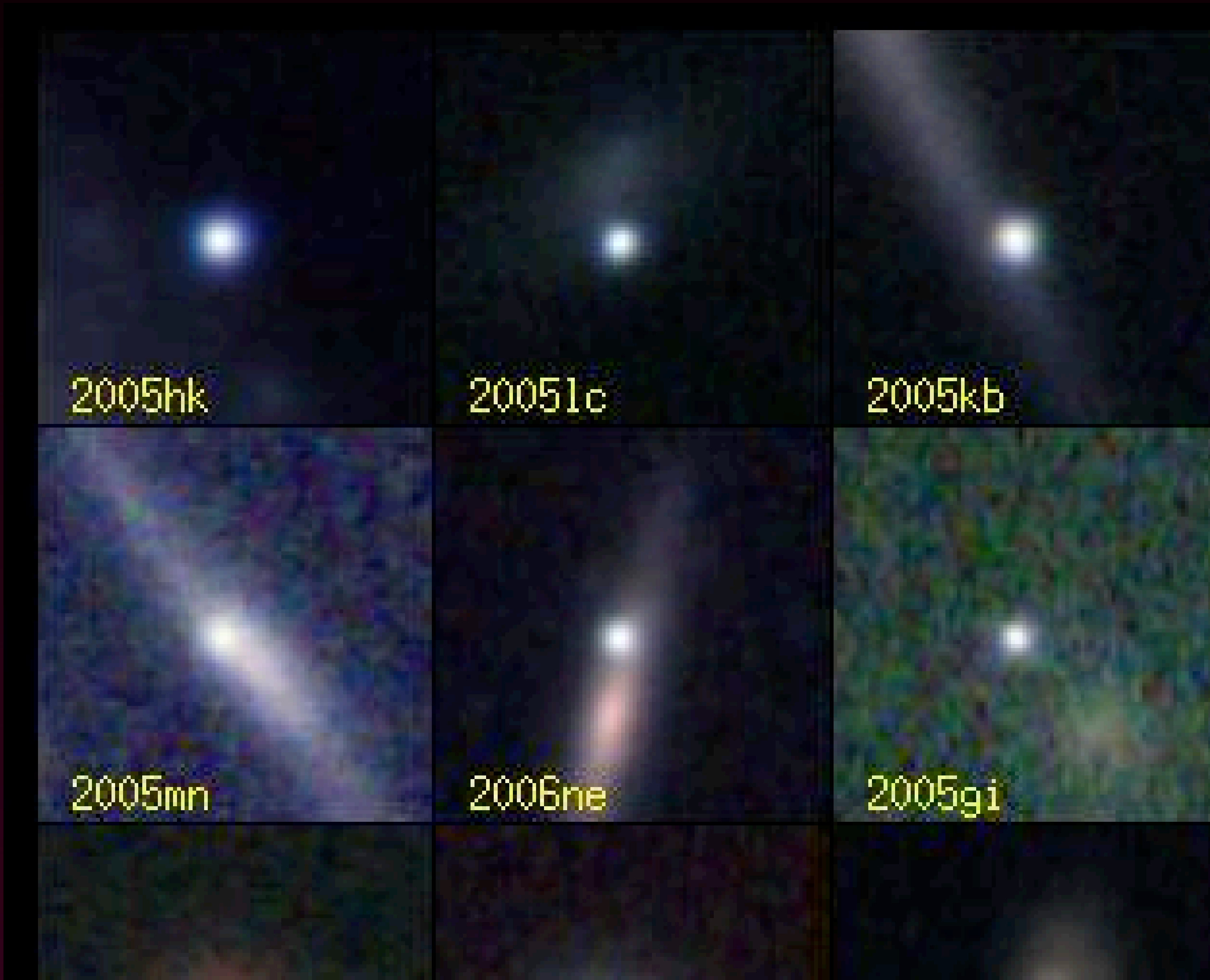
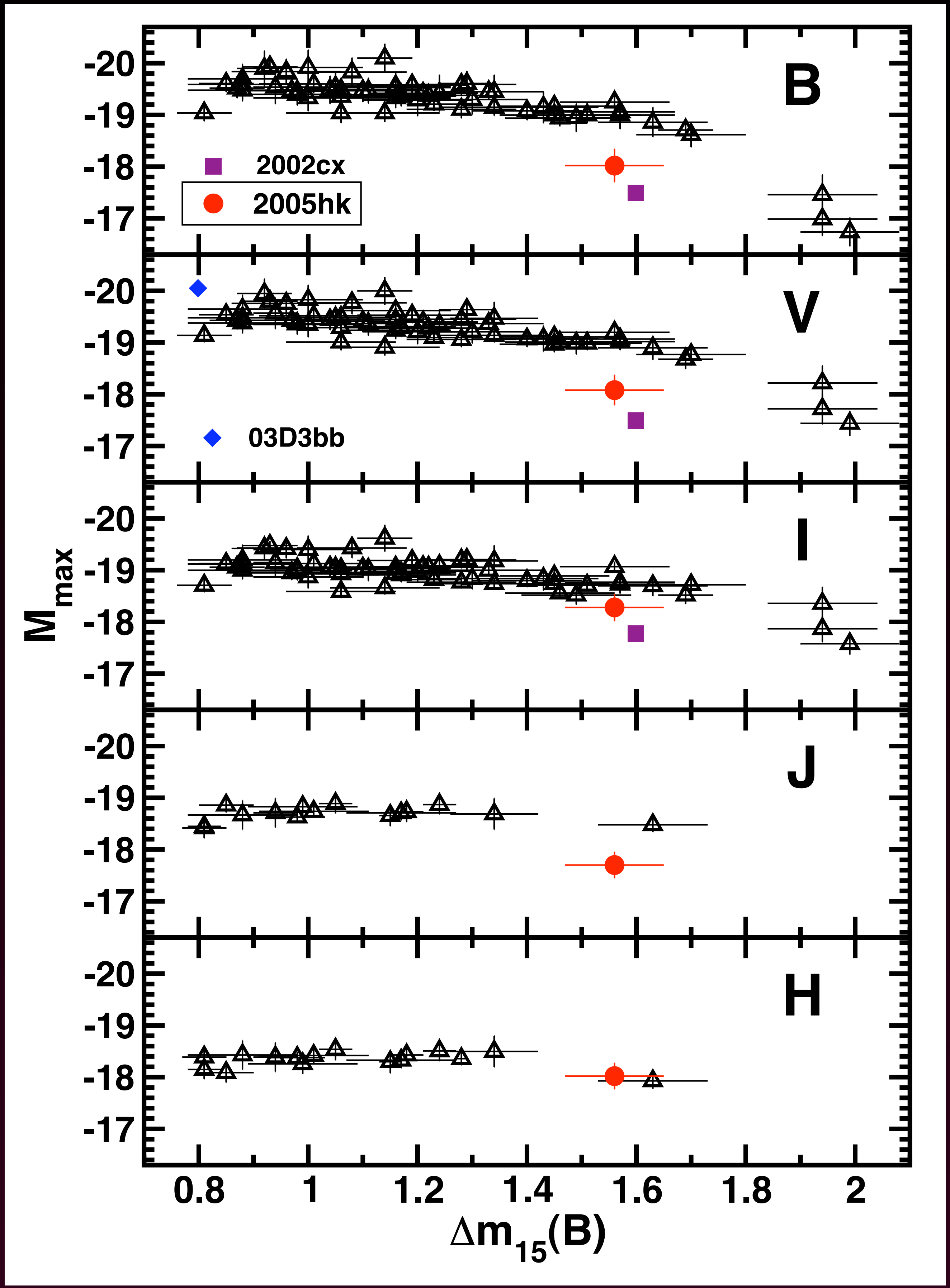


with
A. Filippenko, R. Chornock,
R. Foley, W. Li (UC Berkeley),
D. Branch (U. Oklahoma),
M. Phillips (LCO)
and the SDSS SN Survey

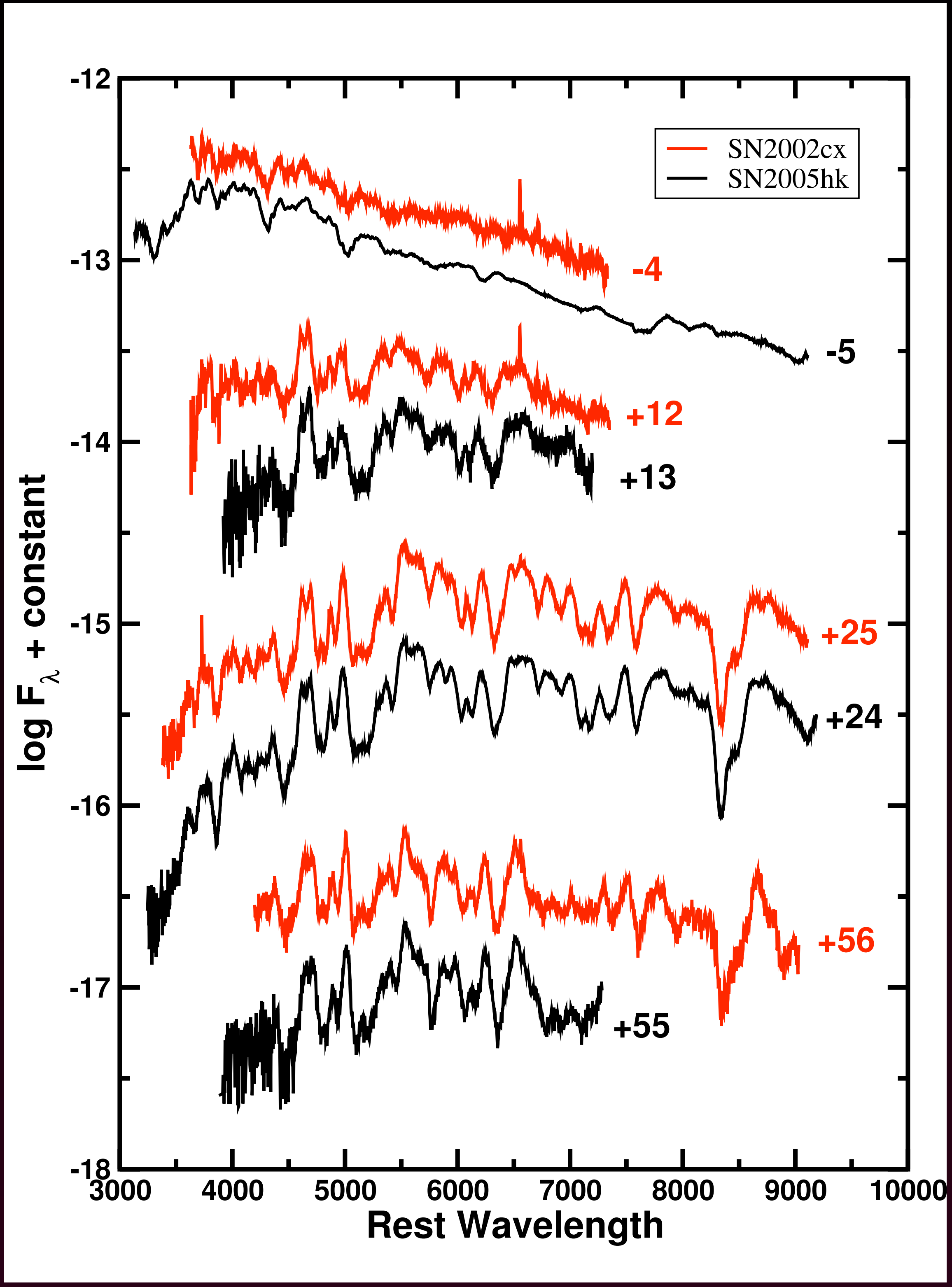
Accretion and Explosion:
The Astrophysics of Degenerate Stars
KITP/UCSB May 1, 2007

How peculiar is peculiar?

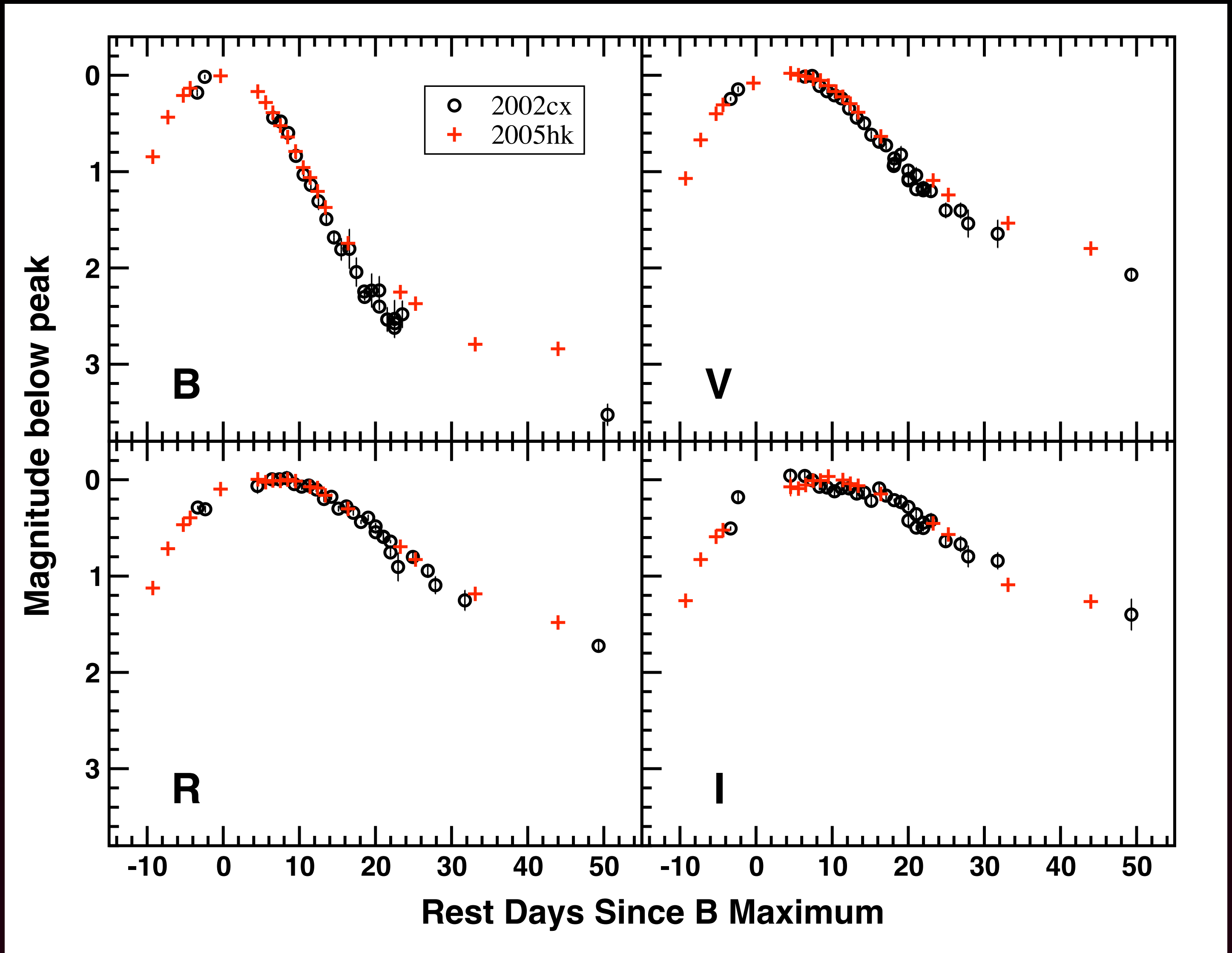


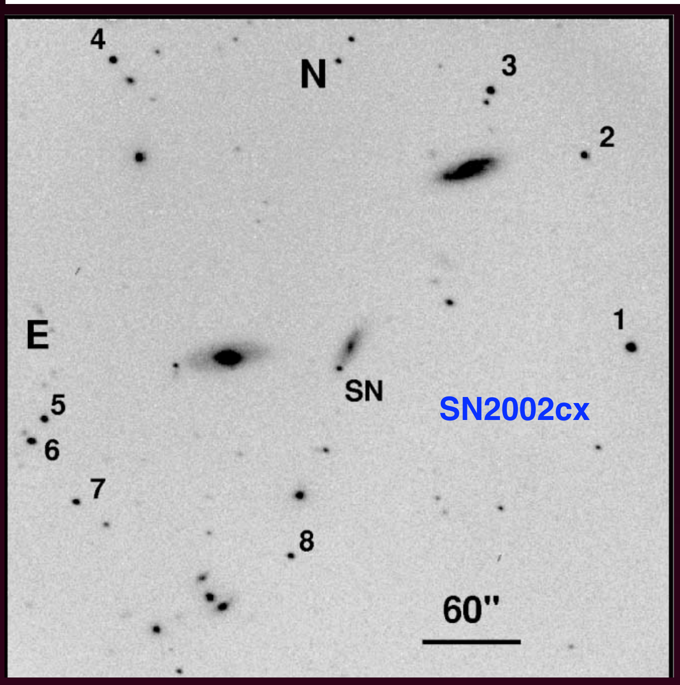
Phillips et al. (2007)

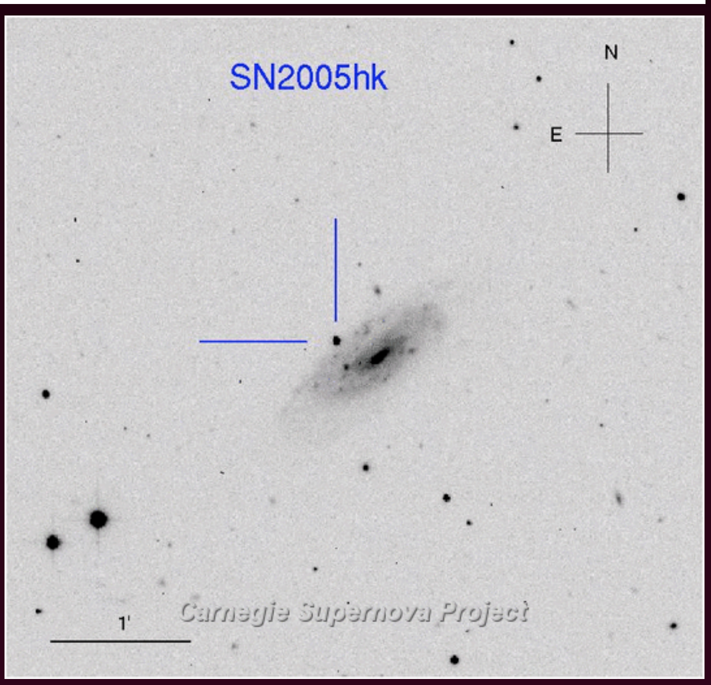
SN 2002cx and SN 2005hk



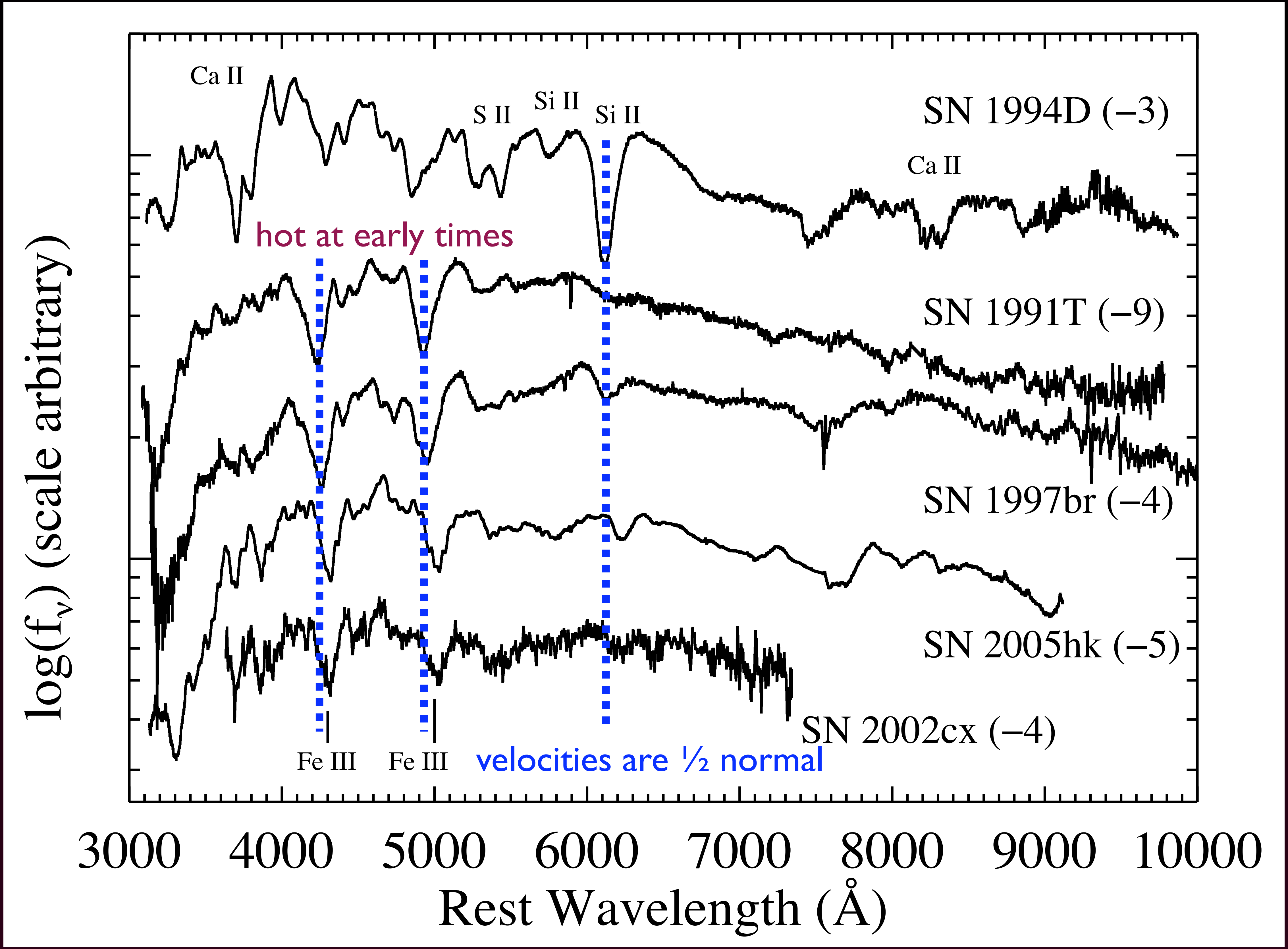
Li et al. (2003); Phillips et al. (2007)





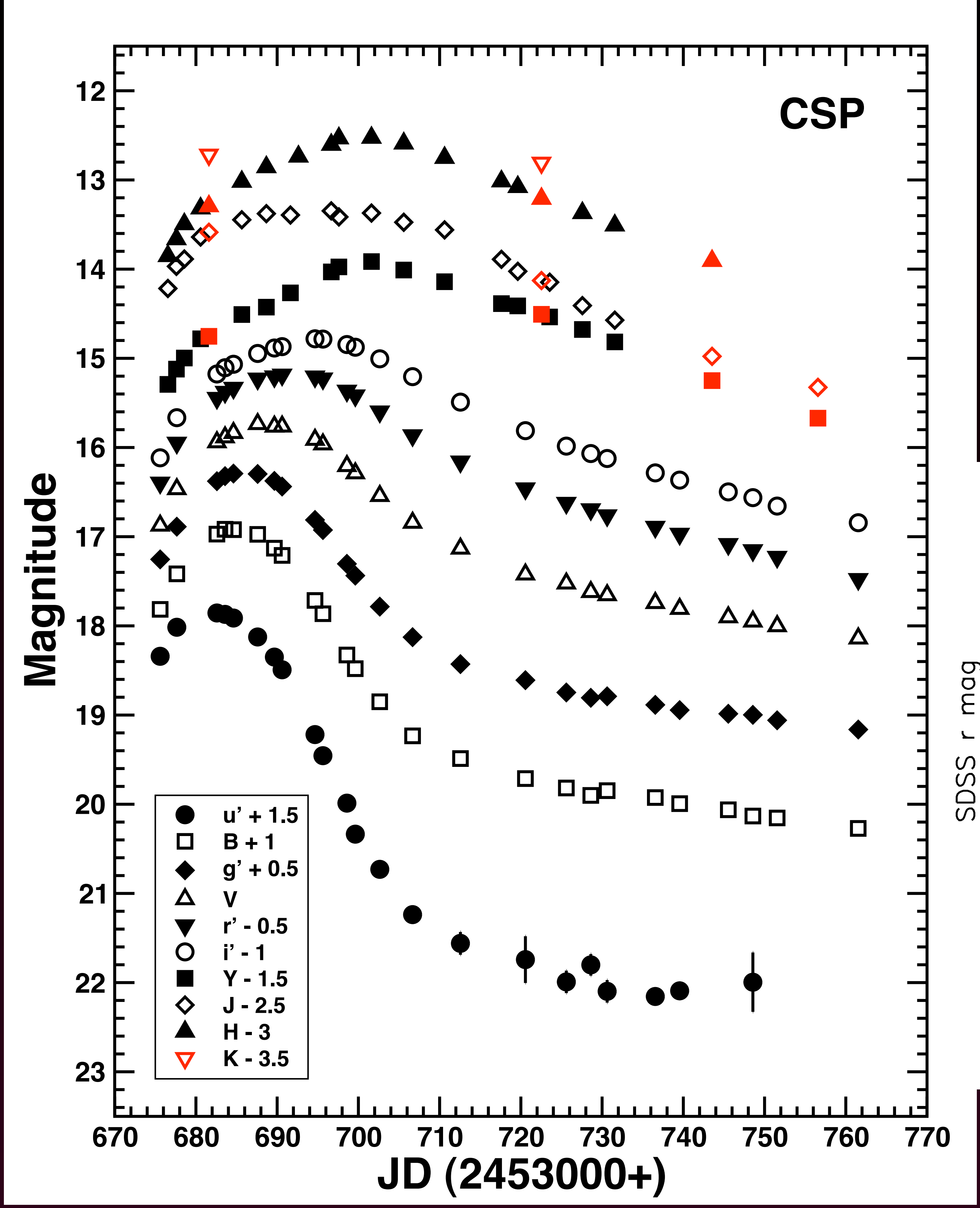


These are Type Ia Supernovae

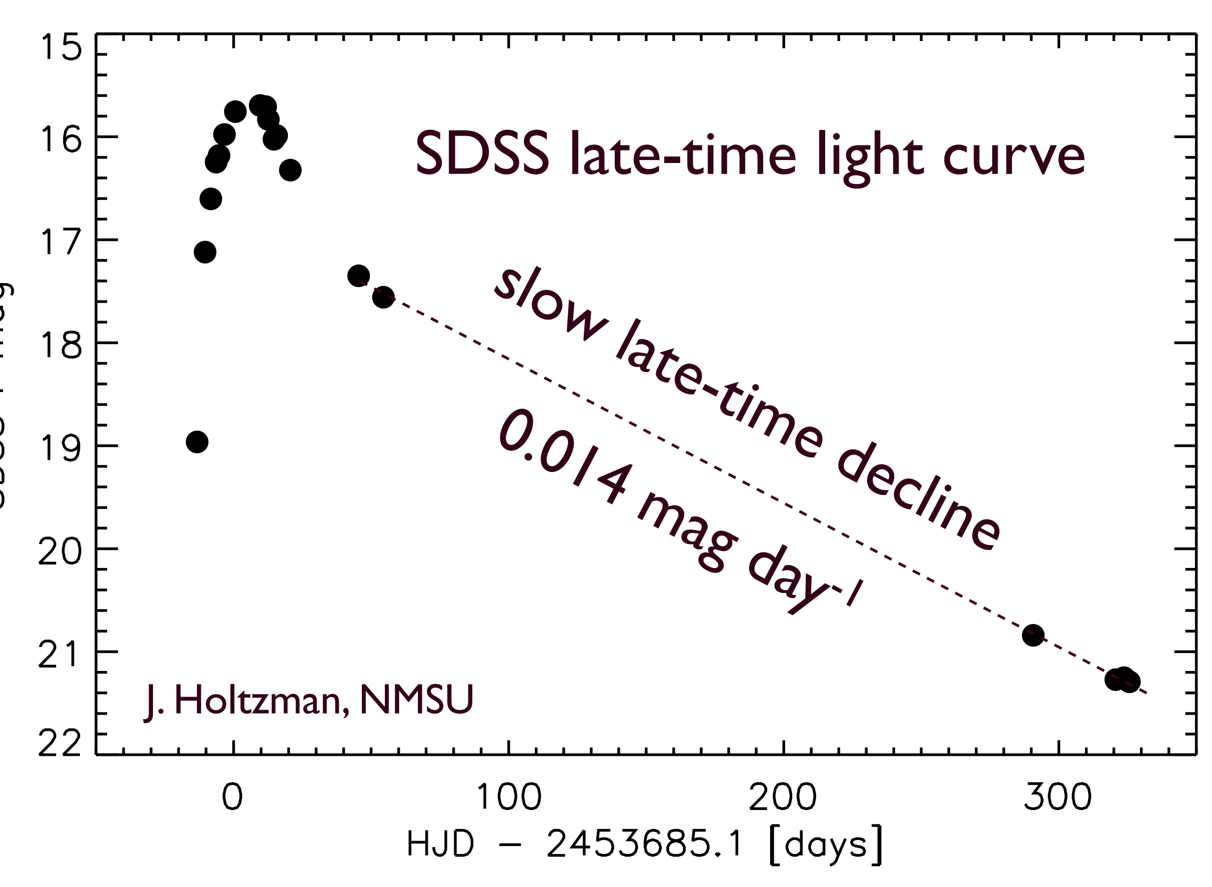


Chornock et al. (2006)

SN 2005hk light curves

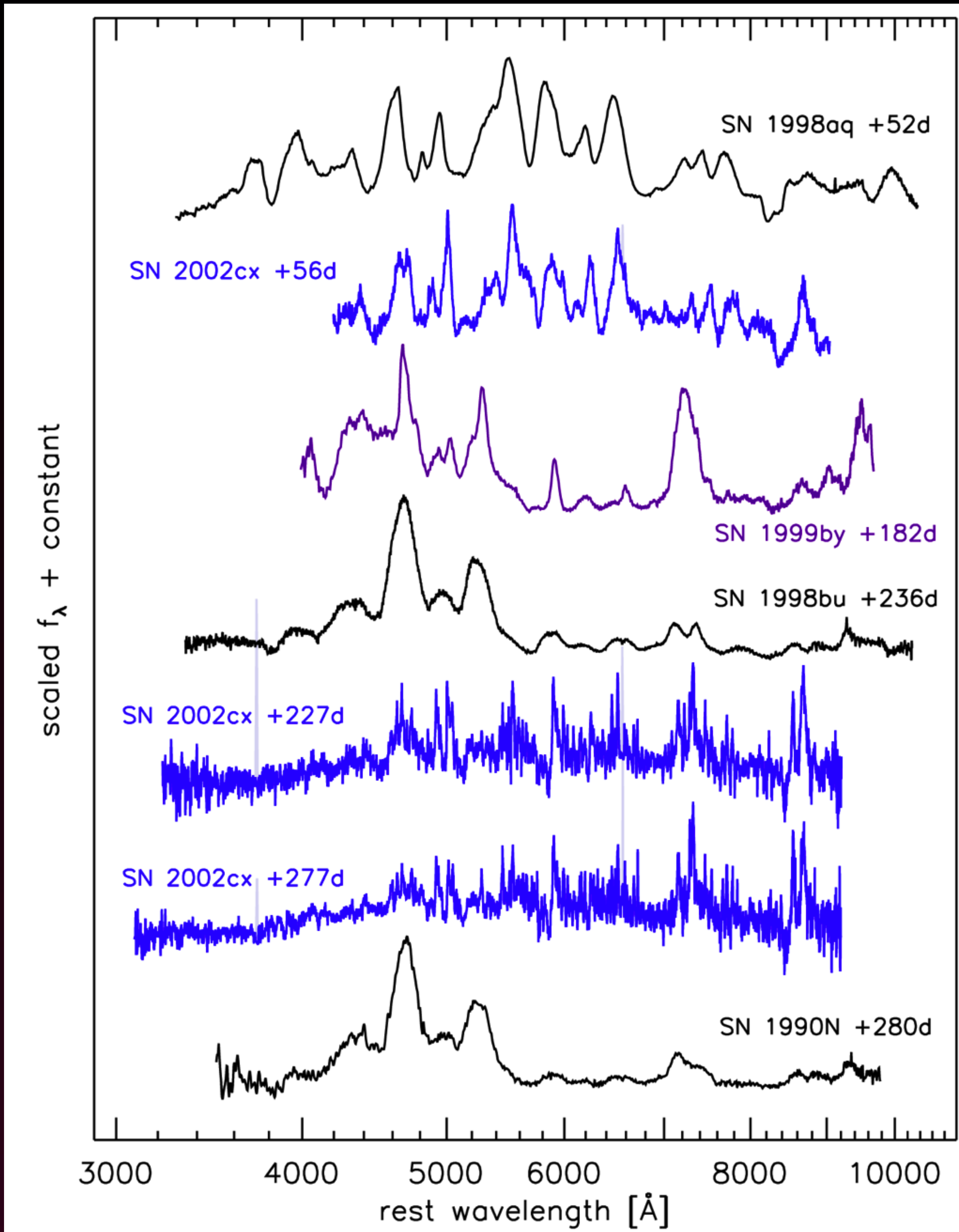


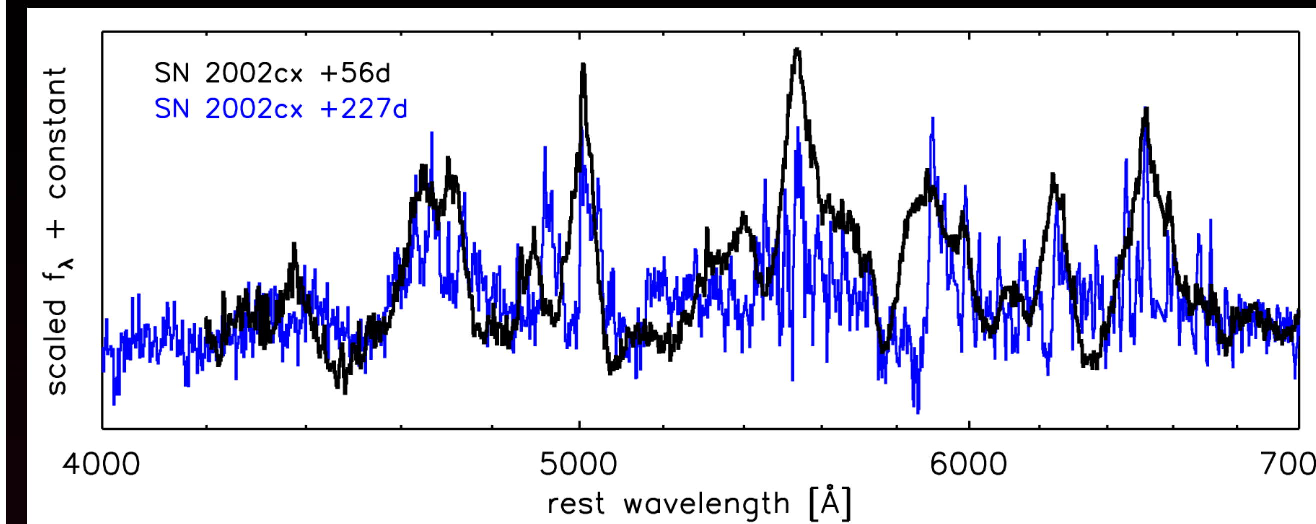
- relatively fast decline in B,V $\Delta m_{15}(B) \simeq 1.6$ mag (unlike 91T)
- broad, plateau-like in R
- no second peak in IR
- slow decline after the knee

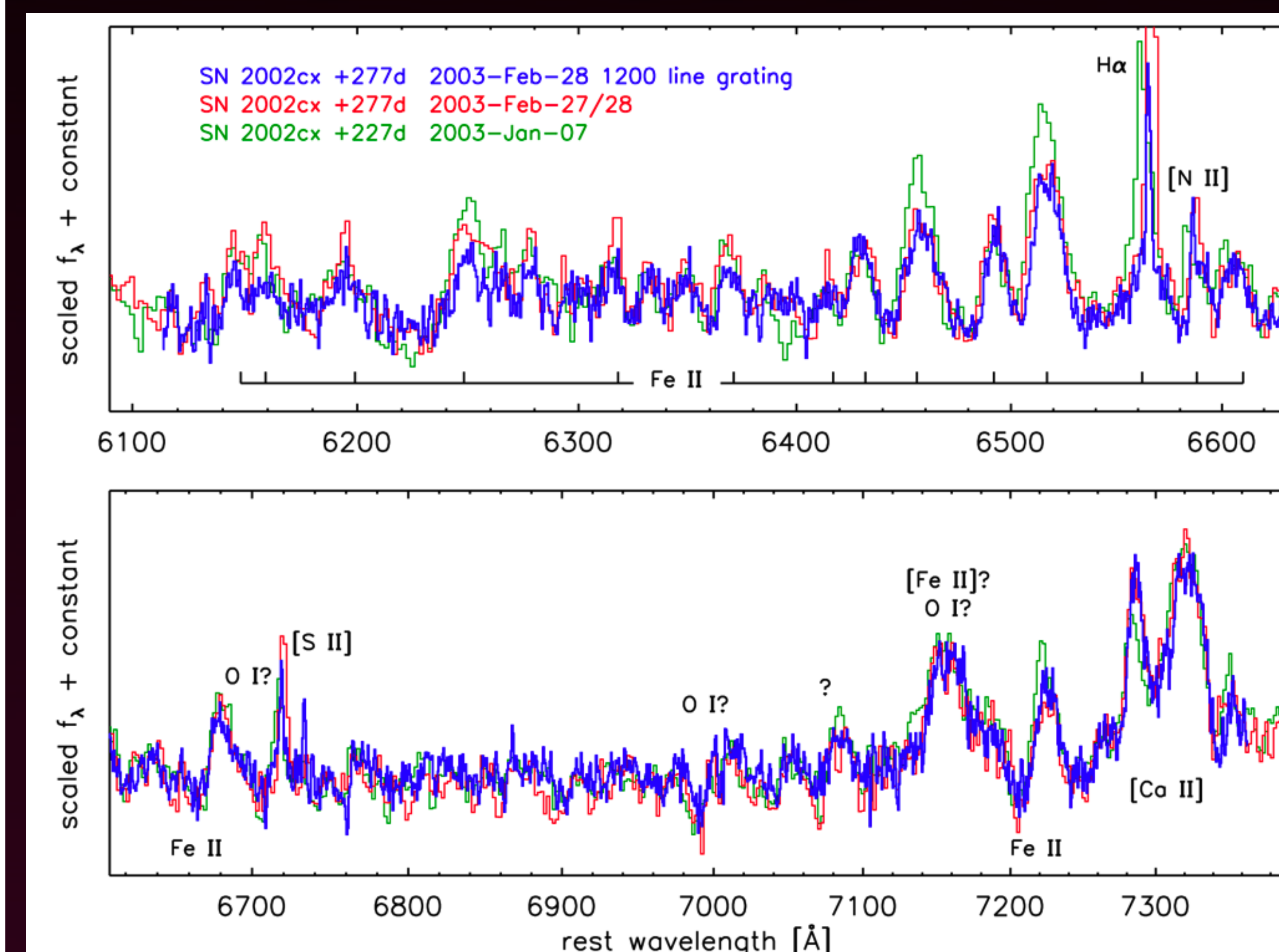


Phillips et al. (2007)

SN 2002cx Late-Time Spectra







Jha et al. (2006)

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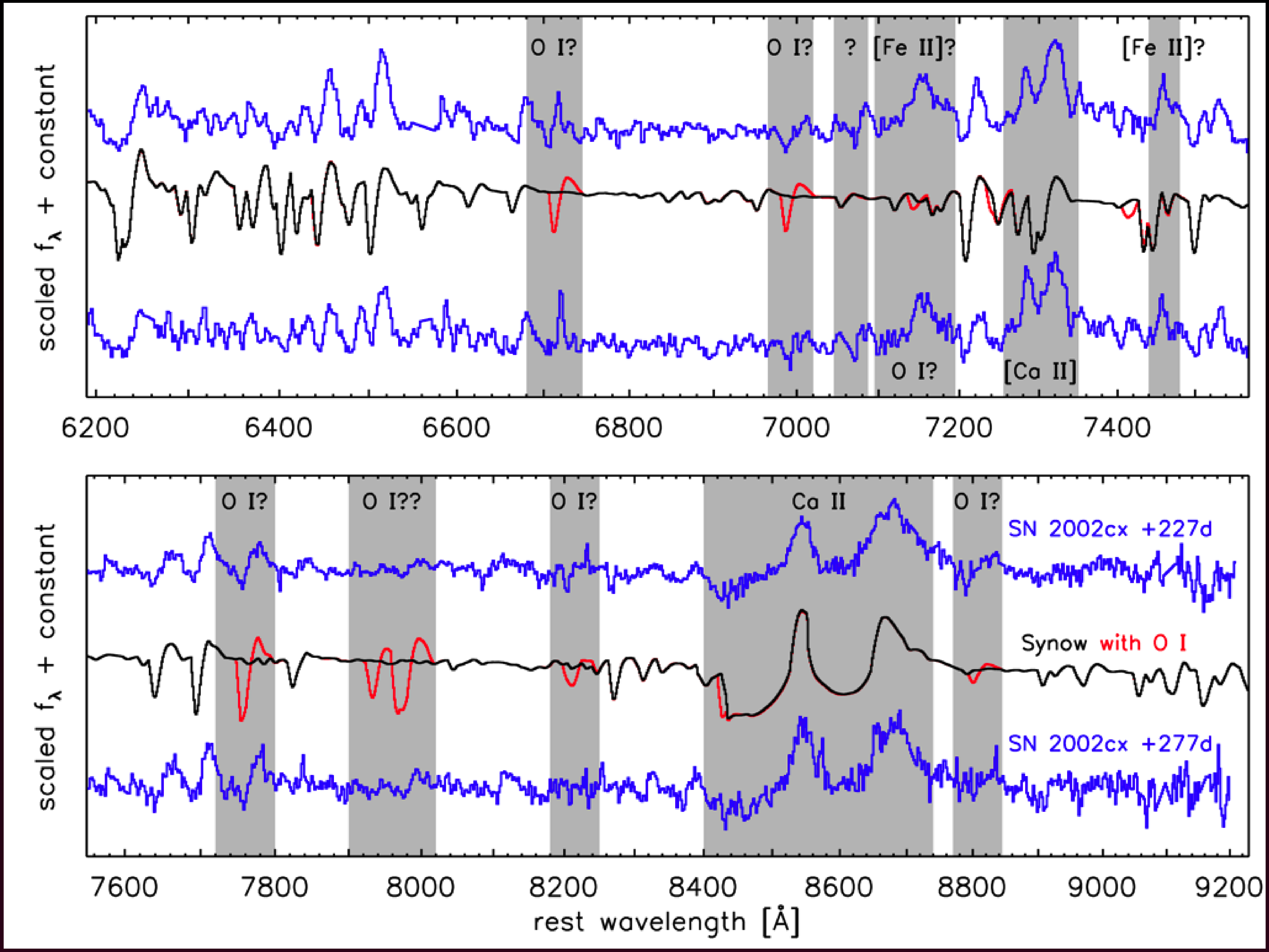
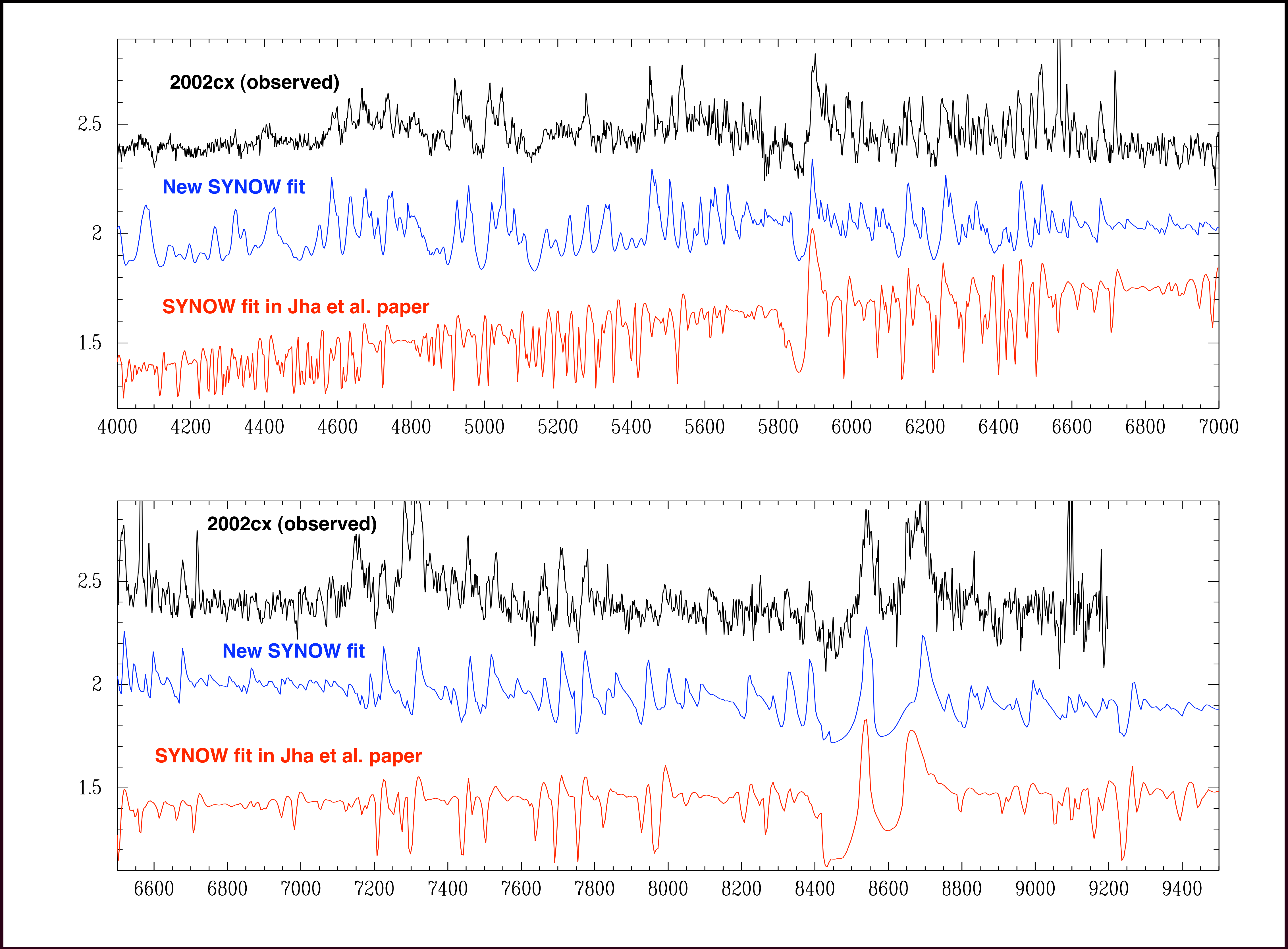


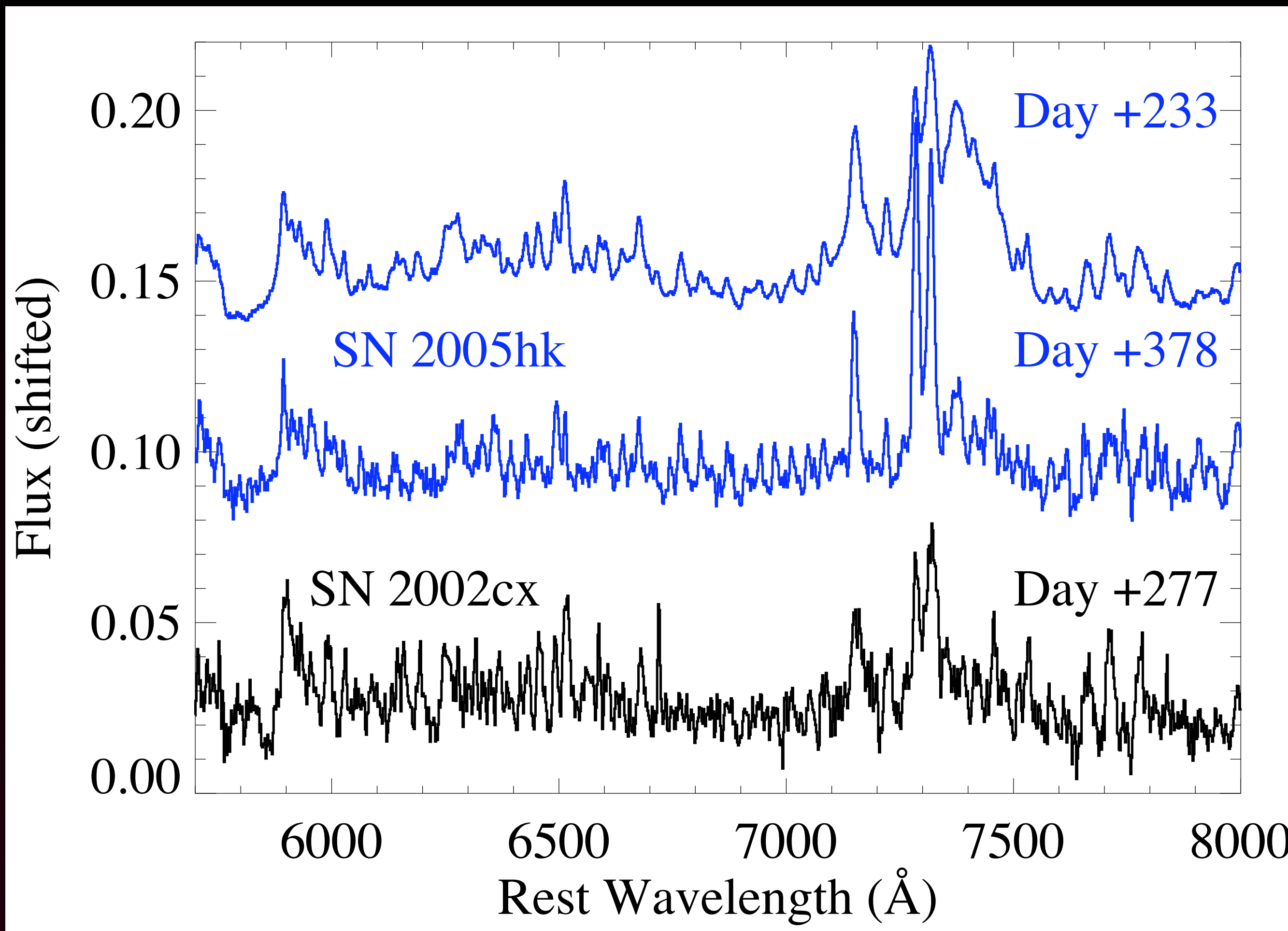
Jha et al. (2006)

SN 2002cx: full of iron



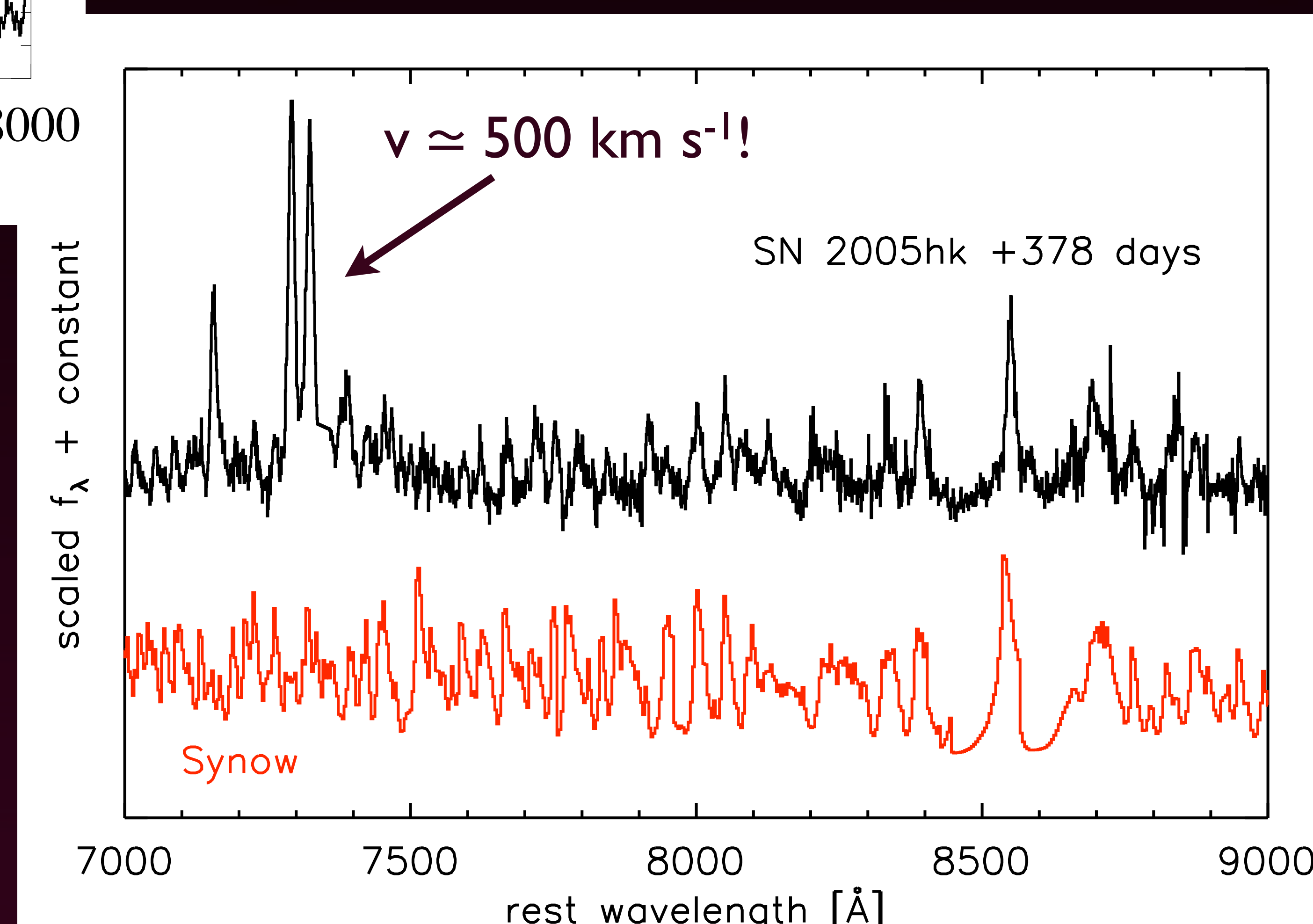
Li et al. (2007, in prep)

SN 2005hk observed even later



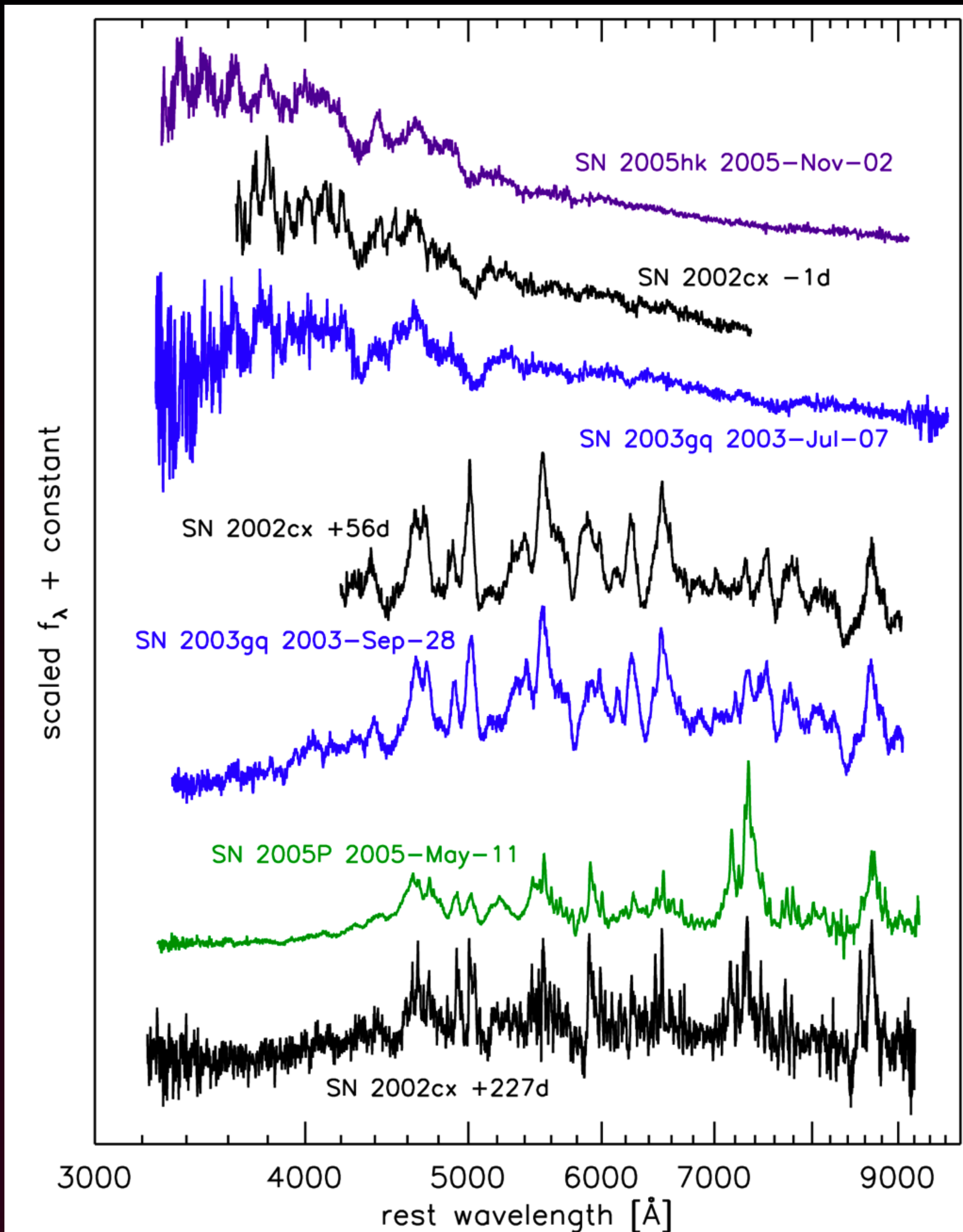
Chornock, Foley, & Filippenko (2006)

- unprecedentedly low velocities
- still dominated by permitted Fe
- no sign of [O I] 6300 A
- good density diagnostics: [Ca II]/Ca II, [Fe II]/Fe II, $\gtrsim 10^2$-10^3 higher than normal SN Ia



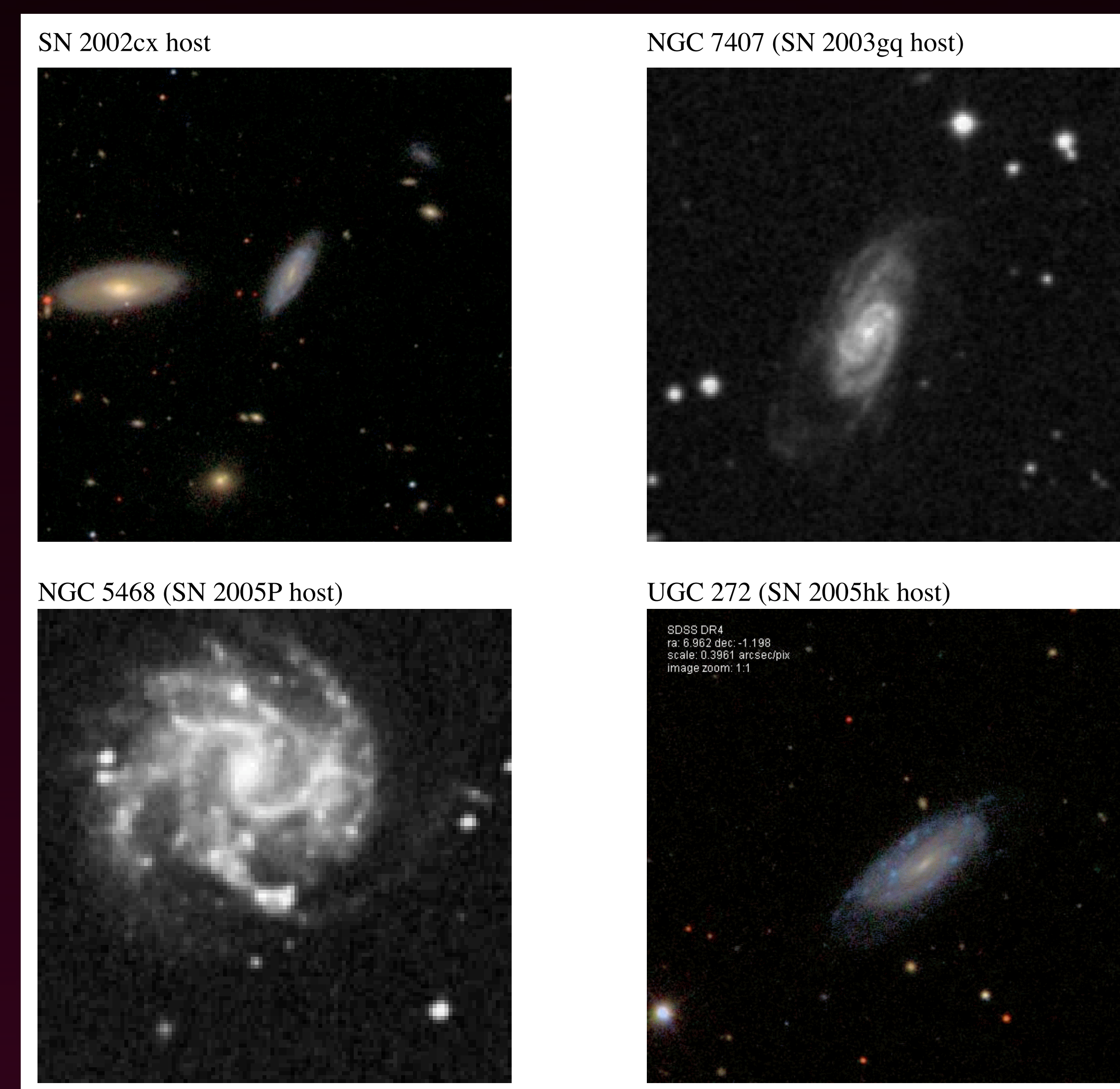
Li et al. (2007, in prep)

The SN 2002cx-like Subclass



Jha et al. (2006)

- SN 2002cx, 2005hk, 2003gq, 2005P, 2005cc, 1991bj (Stanishev 2006)
- Like normal SN Ia, 2005hk has low polarization (Chornock et al. 2006)
- very low velocities and luminosities
- all in blue, late-type hosts



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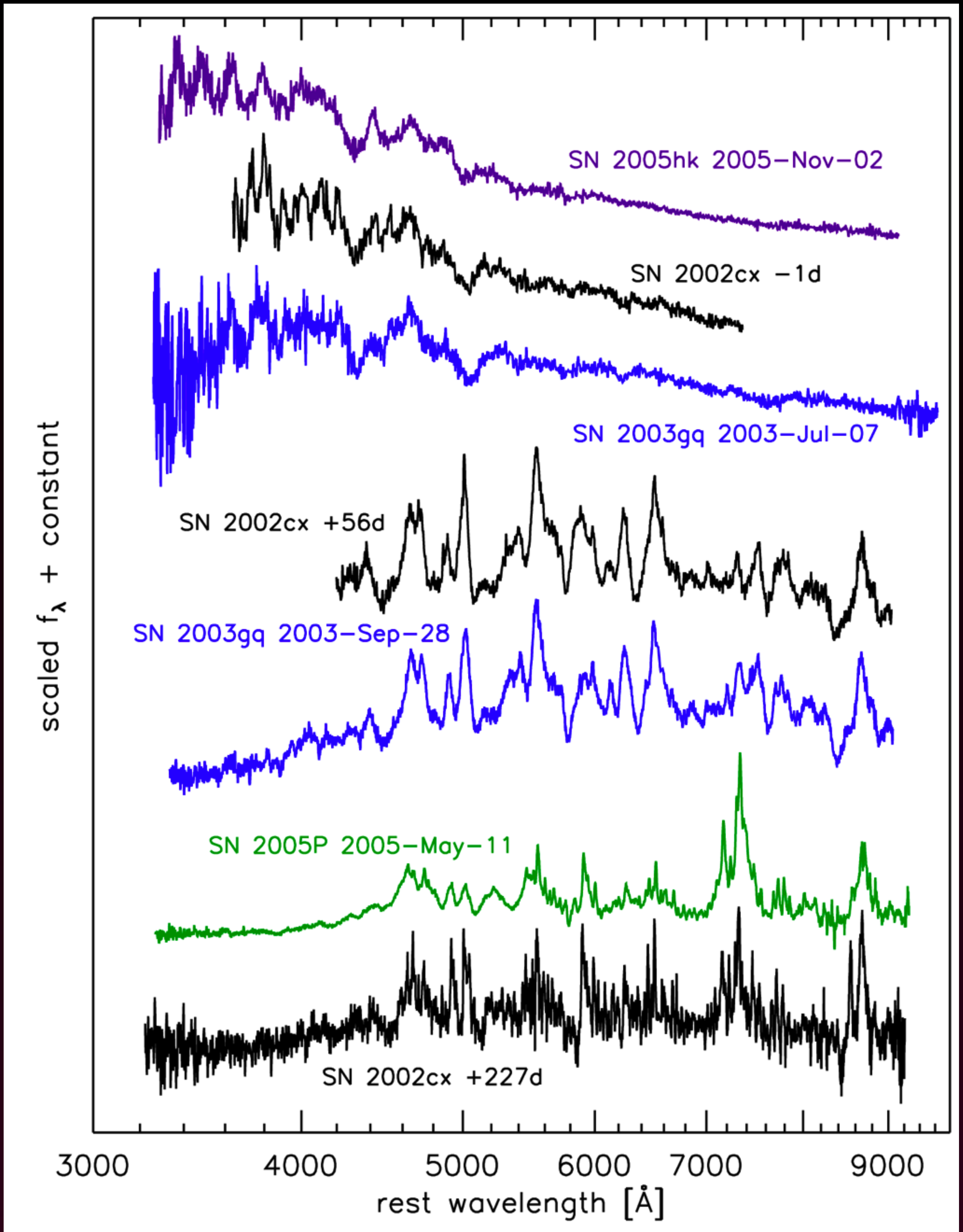

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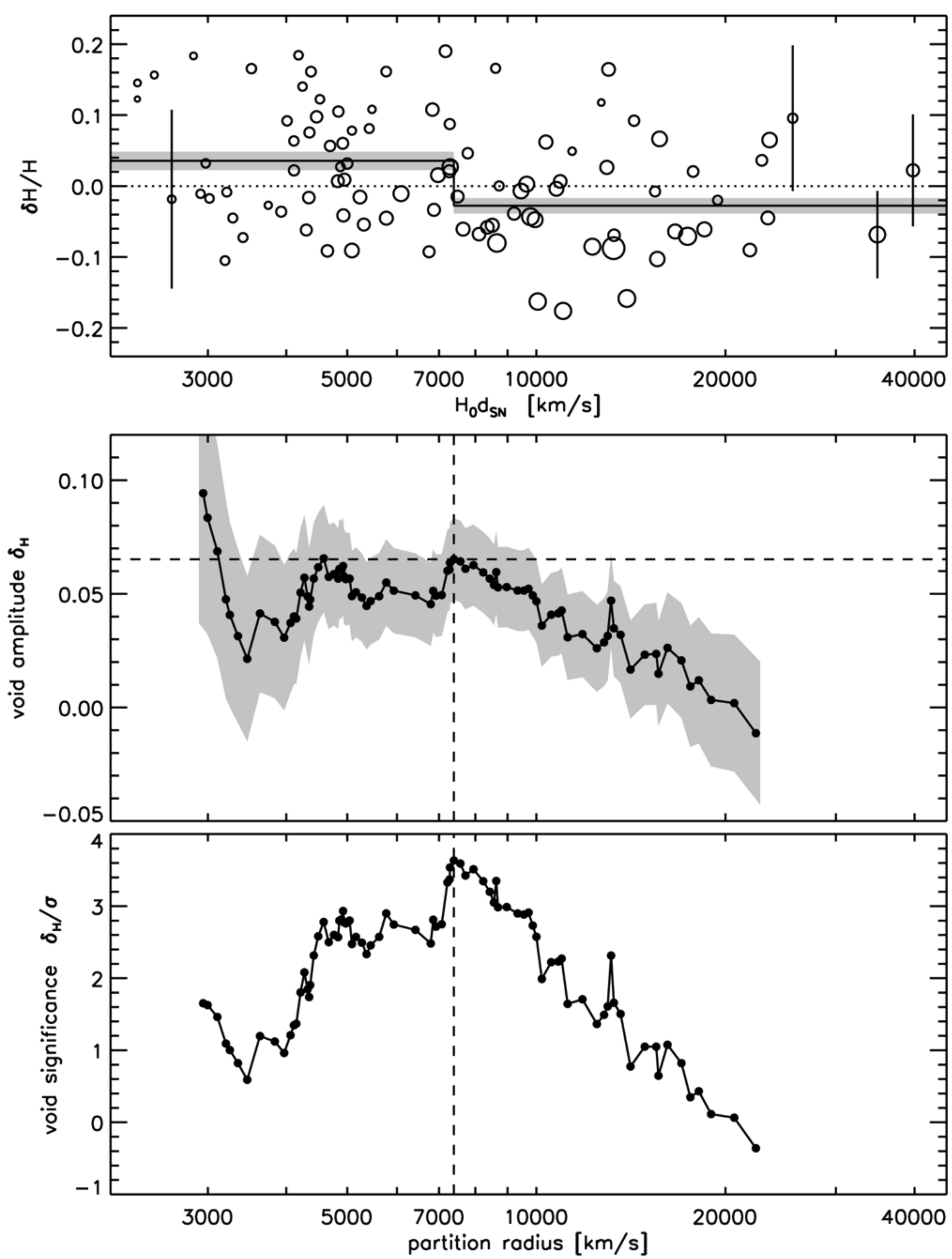
- cosmological implications?
- progenitor models:
  - mixed layers, low ^{56}Ni mass
  - low-velocity unburned material
  - weak 3-d deflagration?
  - high mass and density at low velocity: "failed" SN Ia? CC?
- peculiar objects may be the key to understanding normal SN Ia!

A Hubble Bubble?

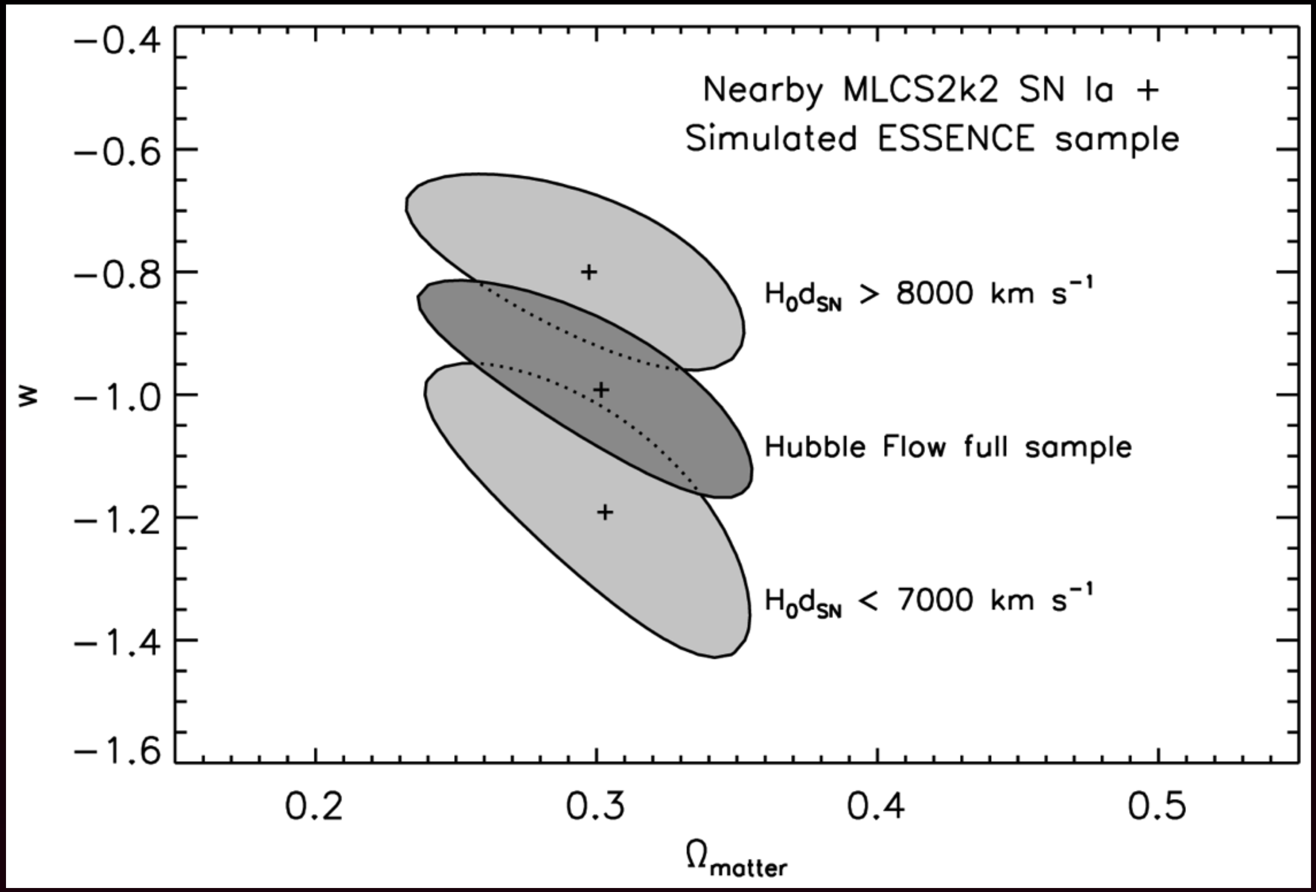


Jha, Riess, & Kirshner (2006)

a 6% difference in the expansion rate at a radius of 100 Mpc, roughly isotropic

statistical signifcance is 2.5σ, but robust with subsamples, other distance techniques

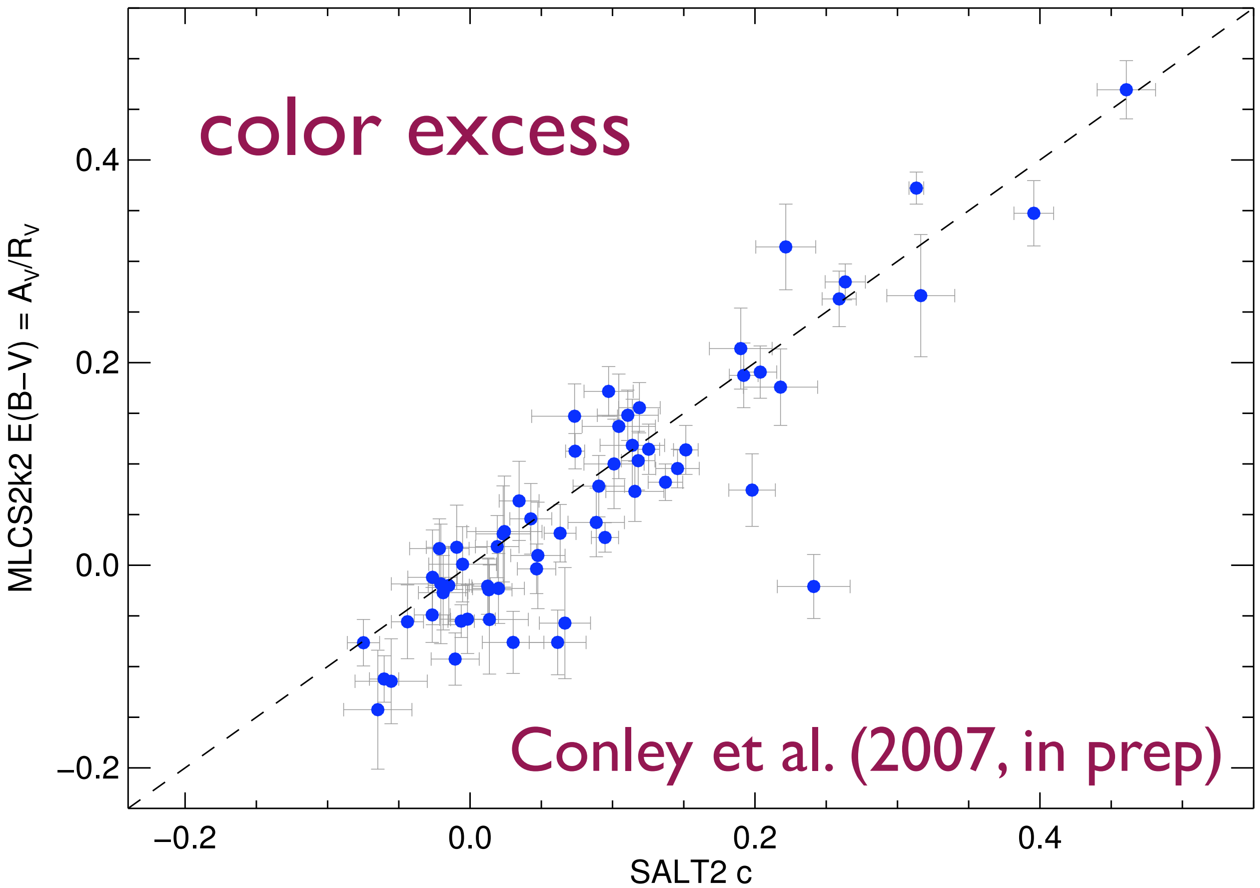
A Hubble Bubble?

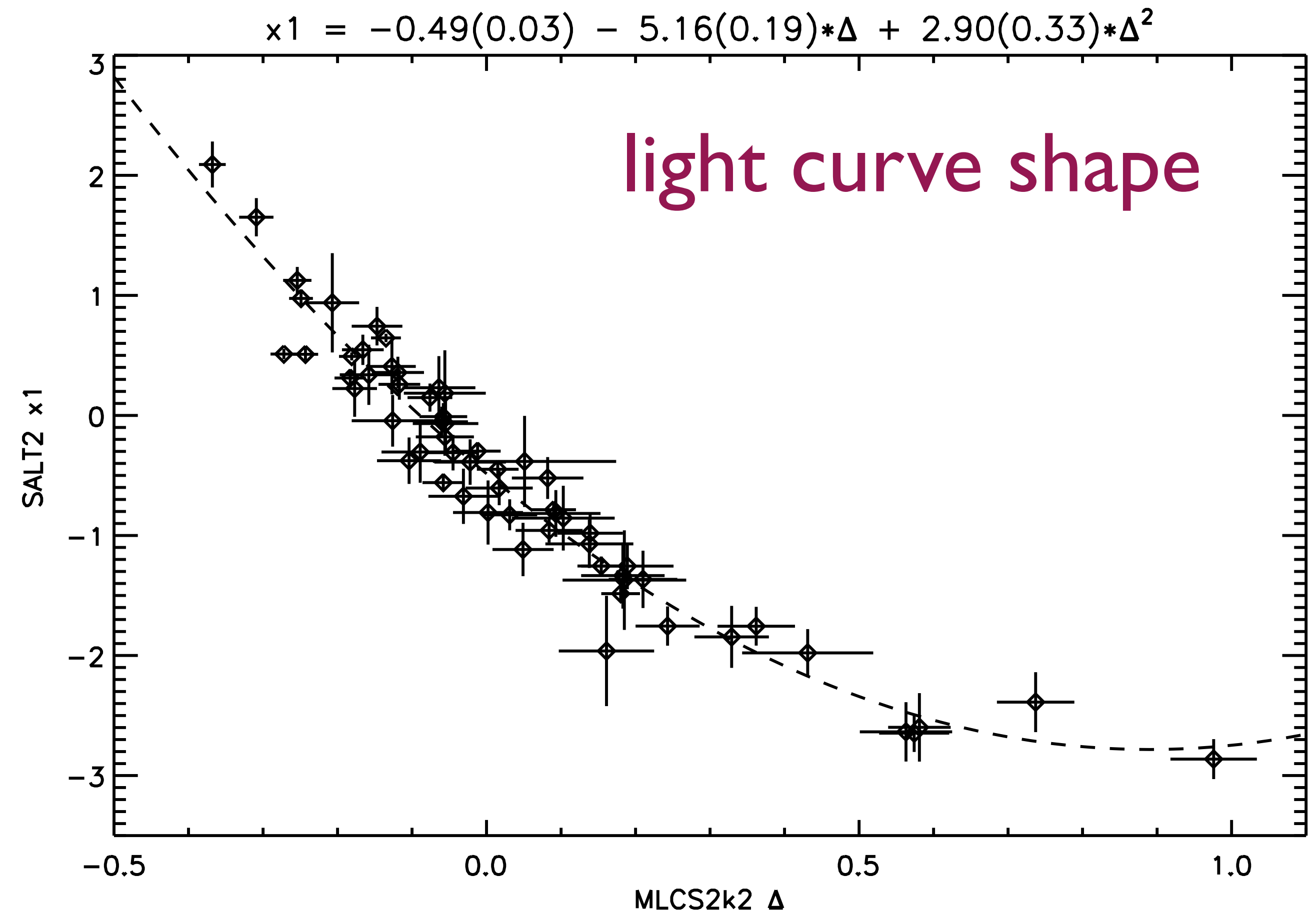


- a real local void?
- K-corrections?
- photometric offset?
  - new data vs. Calán/Tololo?
  - morphology/extinction?

a potentially huge systematic
→ *test with more nearby objects!*

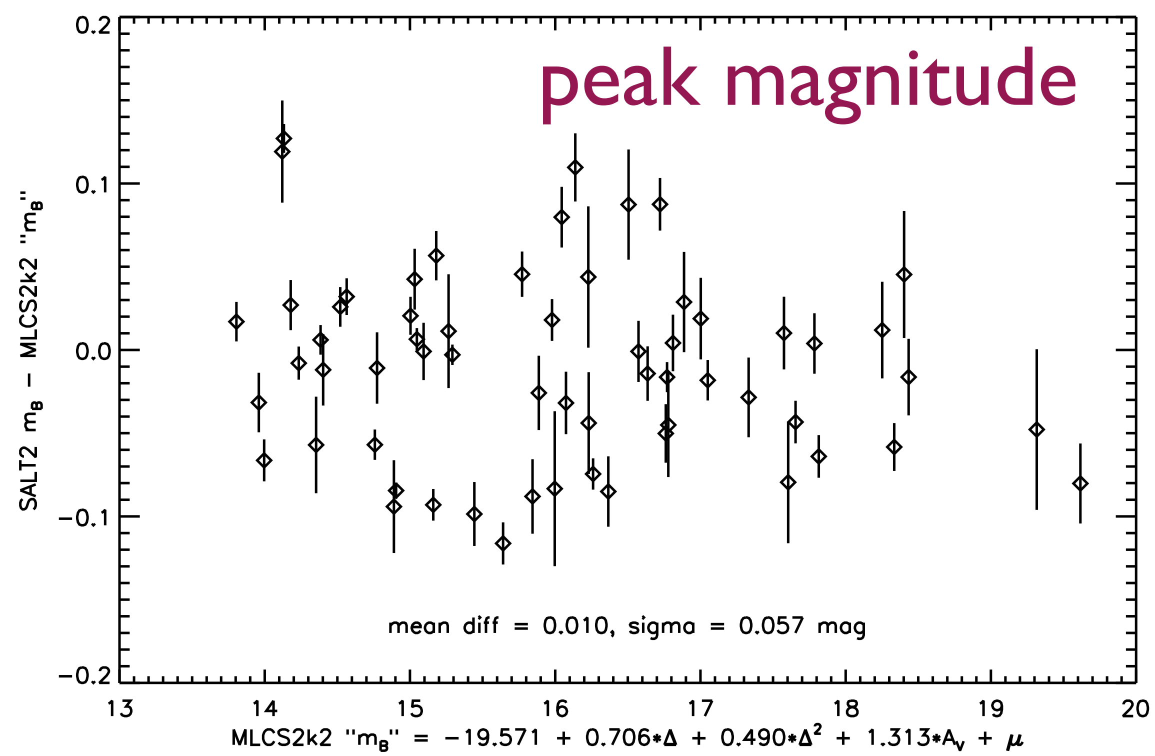
Comparing light-curve fitters





MLCS2k2 and SALT2 give tightly correlated light curve parameters!

Small (few percent) differences arise in converting these parameters to distances.



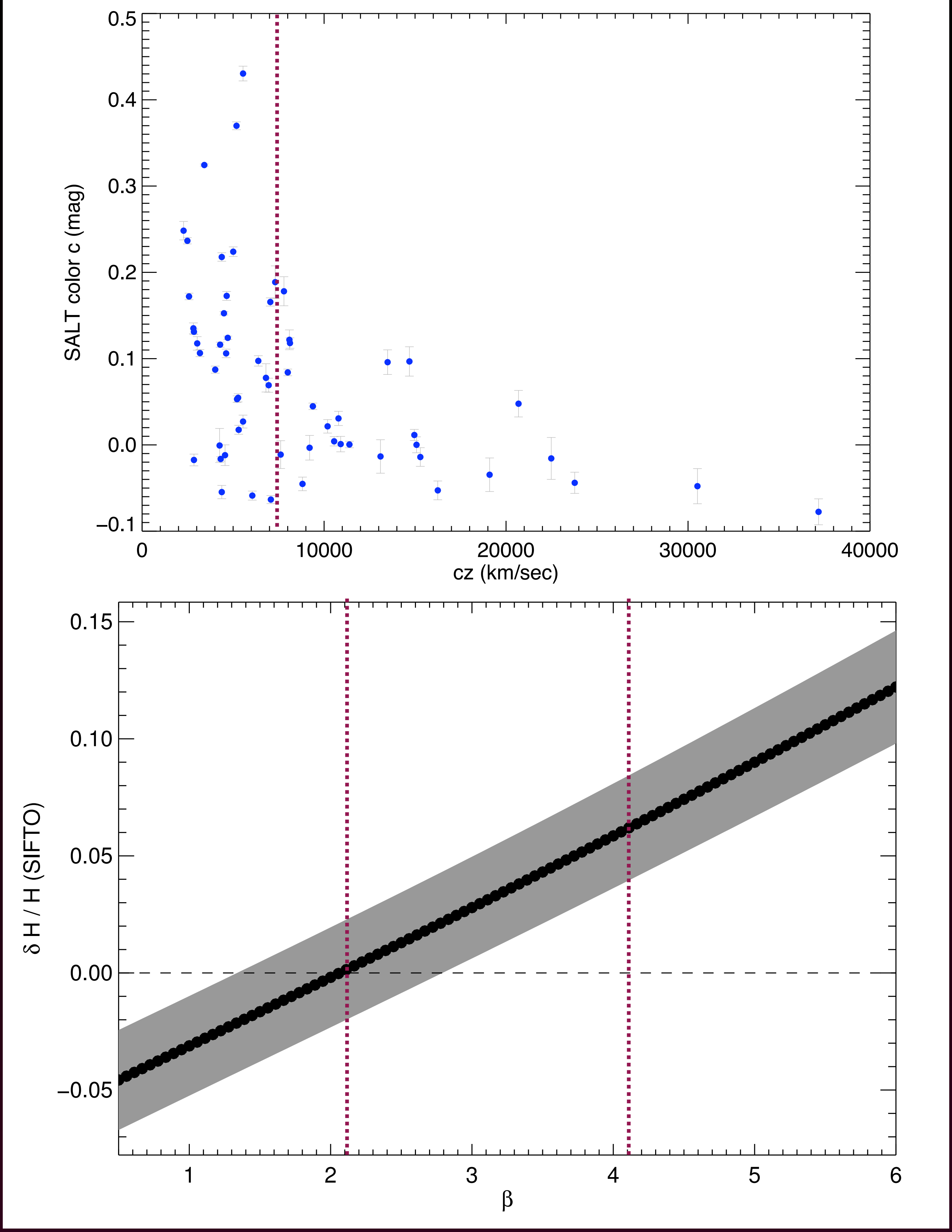
Comparing light-curve fitters

a strong change in color excess across the low-redshift sample

the Hubble Bubble signature depends critically on the luminosity/color-excess correction

using the same correction, all the light-curve fitters (MLCS2k2, SALT, SALT2, and SIFTO) agree.

Conley et al. (2007, in prep)

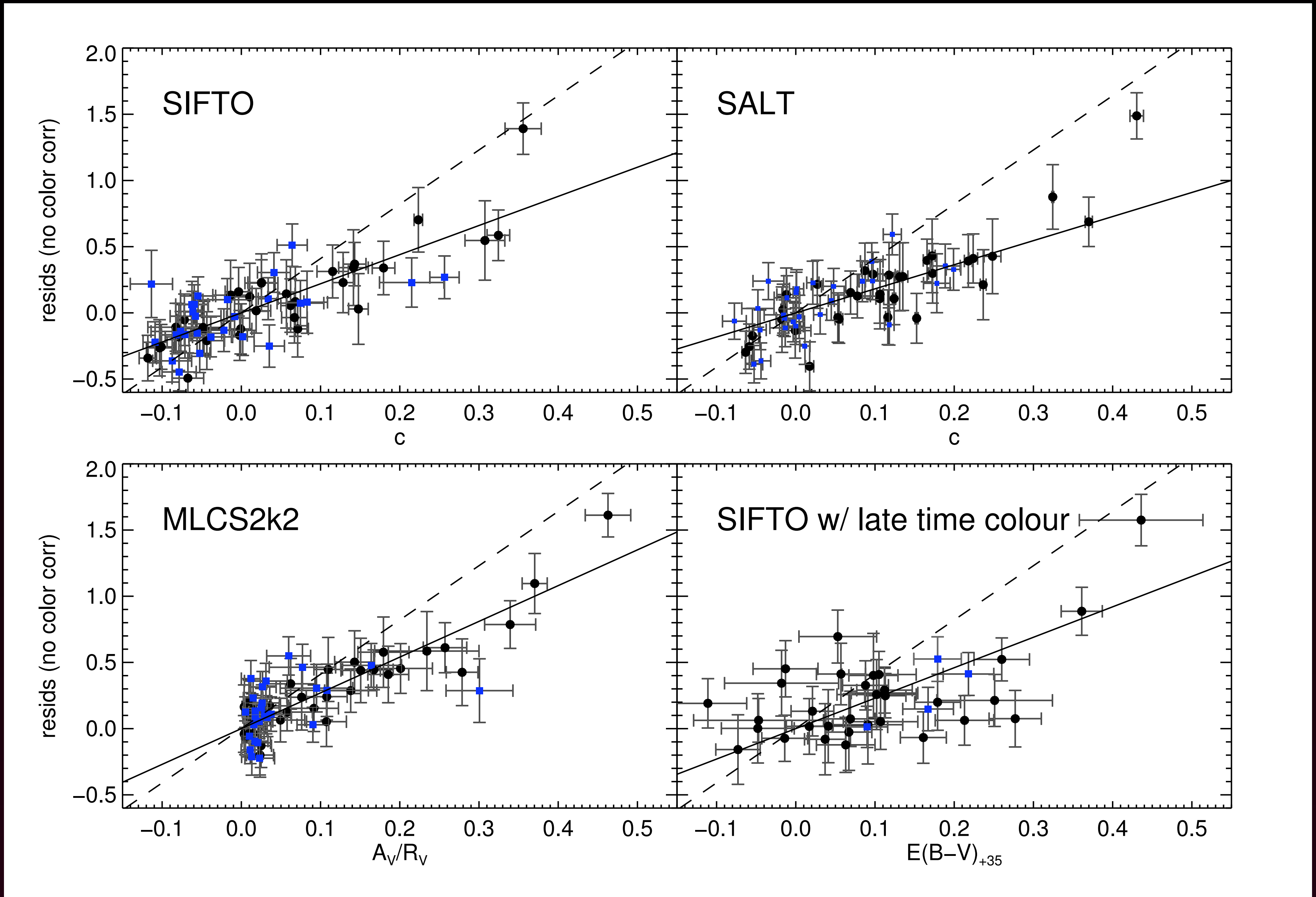


What's the correct correction?

Conley et al. (2007, in prep)

empirical fits:
$\beta \simeq 2$

normal dust:
$\beta \simeq 4$



So what's the answer?

Weird dust, even in cases with low extinction? (e.g., scattering: Wang 2005)
A second parameter? Luminosity correlated with an intrinsic color excess?

A combination of normal dust, weird dust, intrinsic variations!?