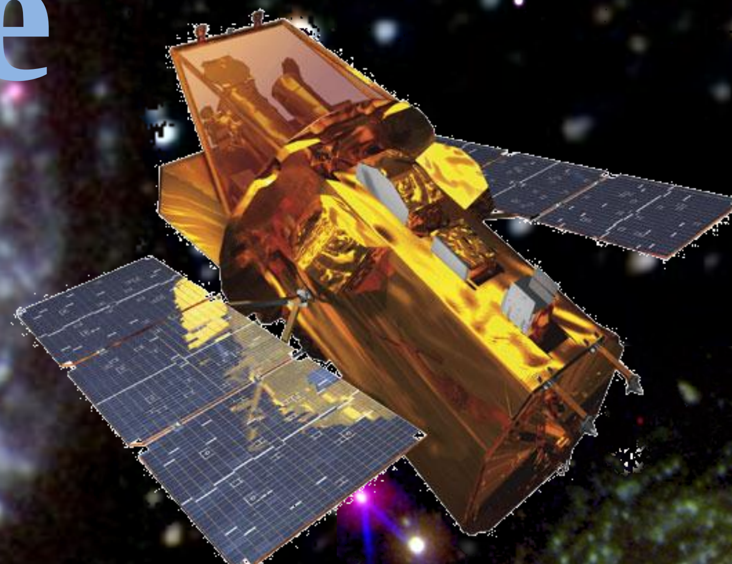
Ultraviolet Properties of Supernovae

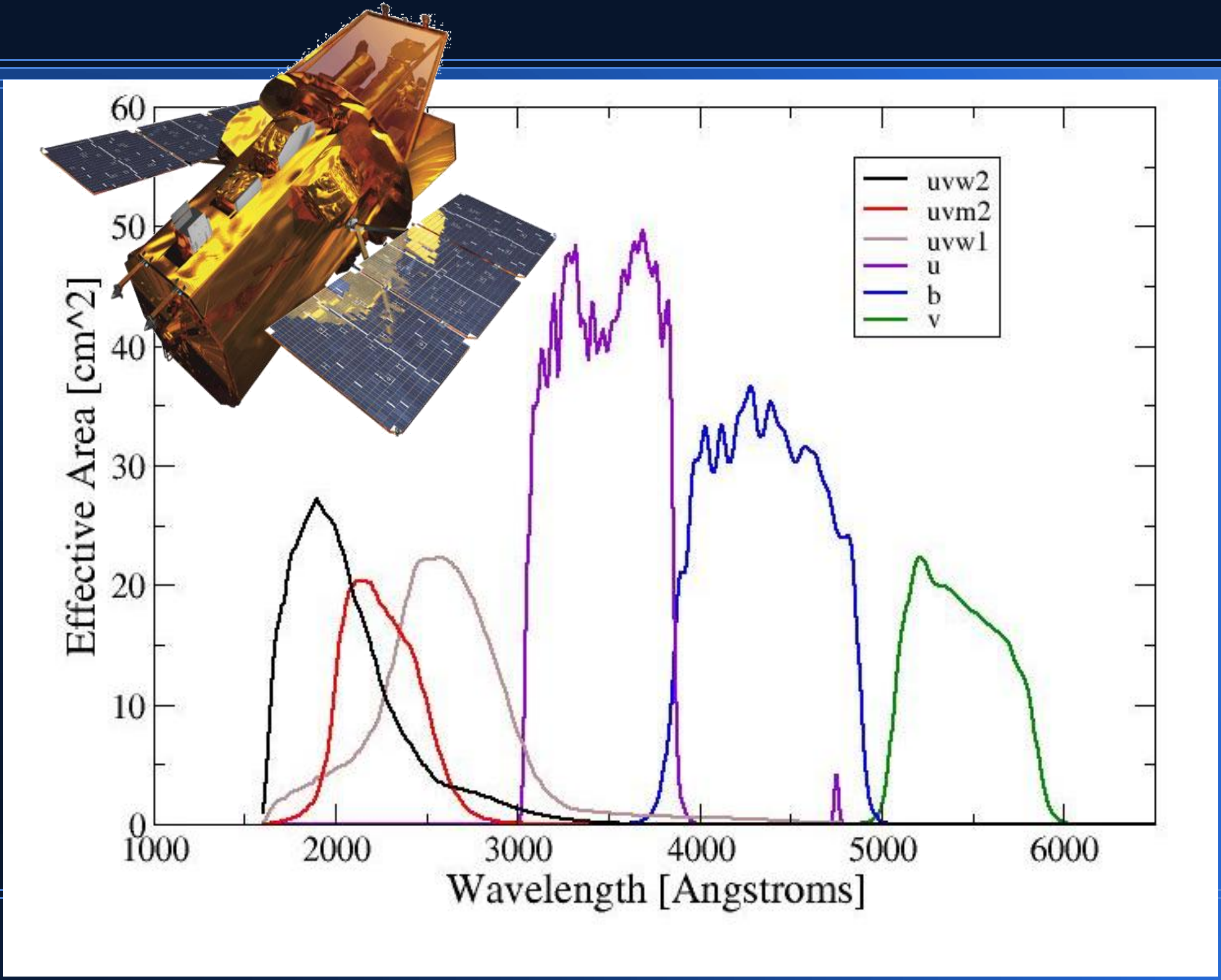


Peter J. Brown
University of Utah

XXVI IAP Colloquium
on SN Progenitors
June/July 2010

Pete Roming, Peter Milne,
Stephen Holland, Stefan Immler,
Tyler Pritchard, & others

Swift UVOT Filter Curves



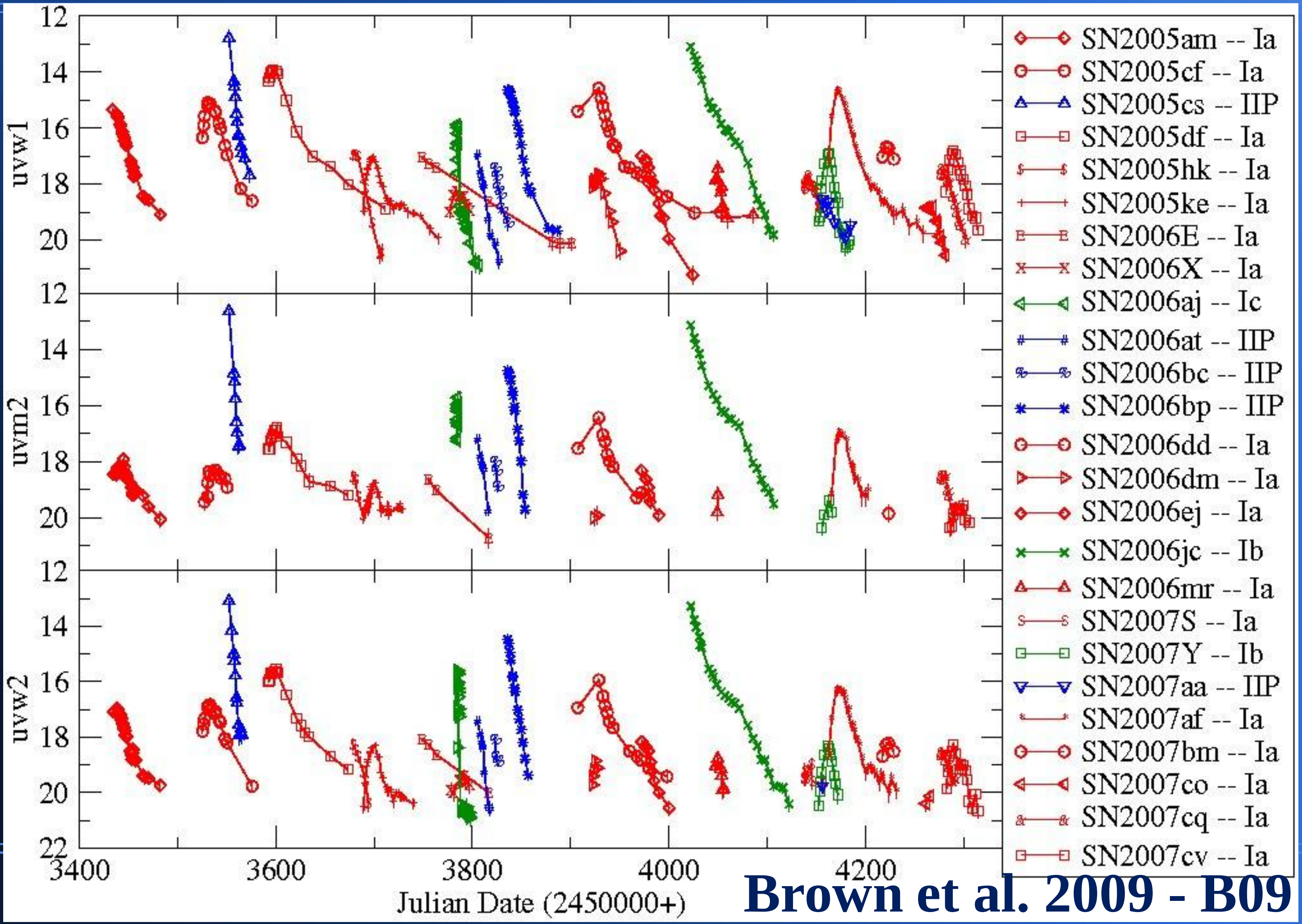
Timeline view of Swift SNe

(first 2 ½ years)

2600 A

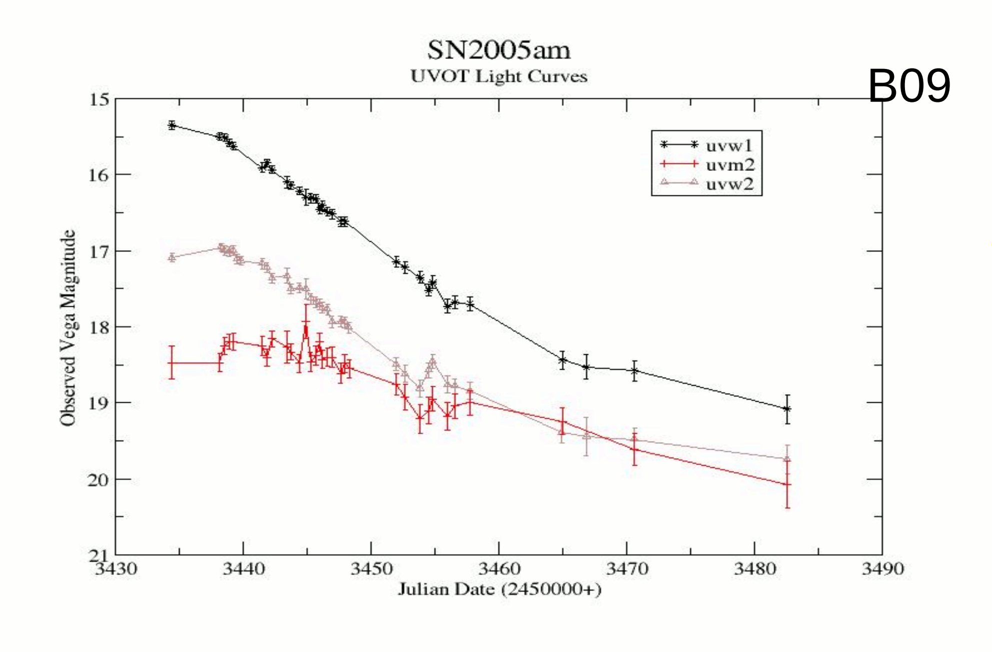
2200 A

1800 A

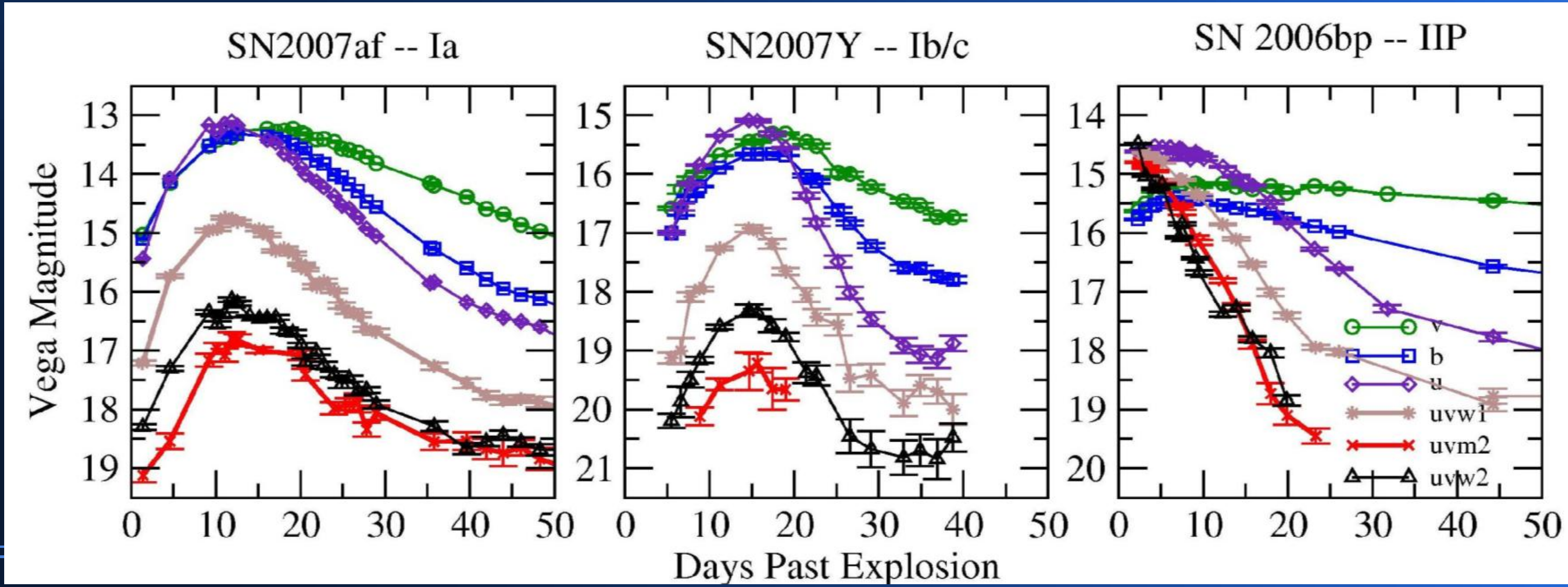


Brown et al. 2009 - B09

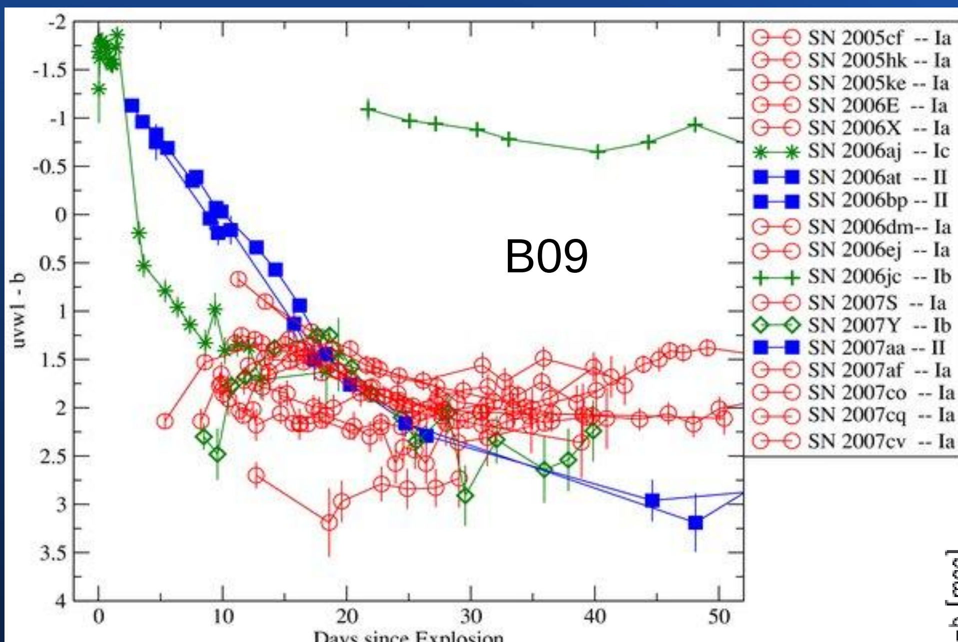
Growing Swift SN Sample



- Large sample allows comparisons between but also within types -- range of properties, subclasses, host environments, etc

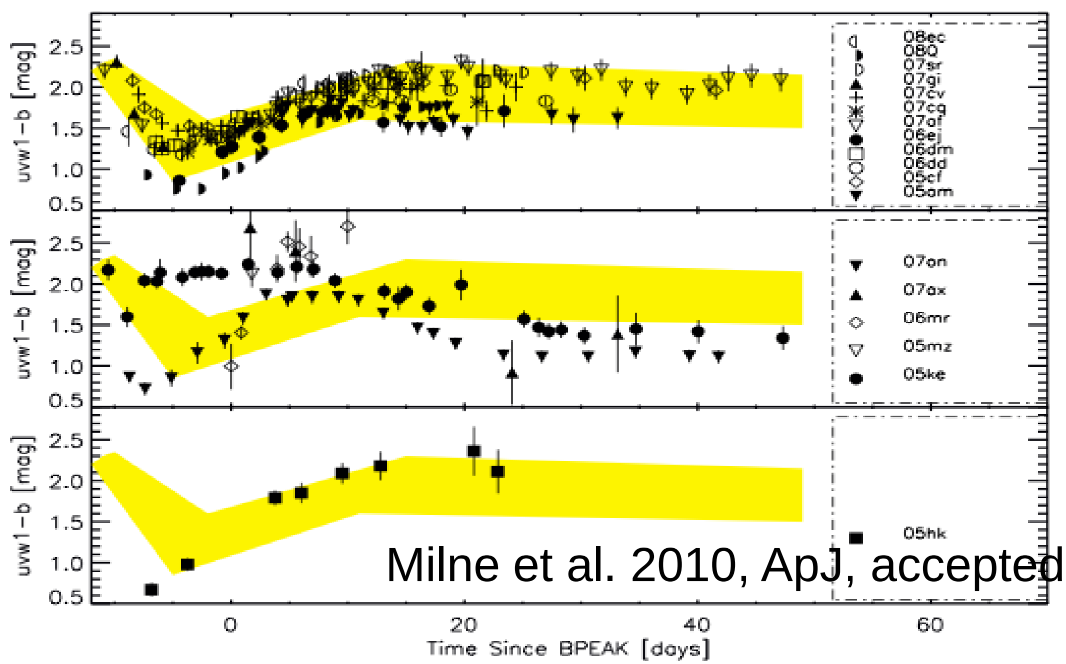


Differentiating SNe by UV colors



- Young SNe II are easily identified by their blue UV colors

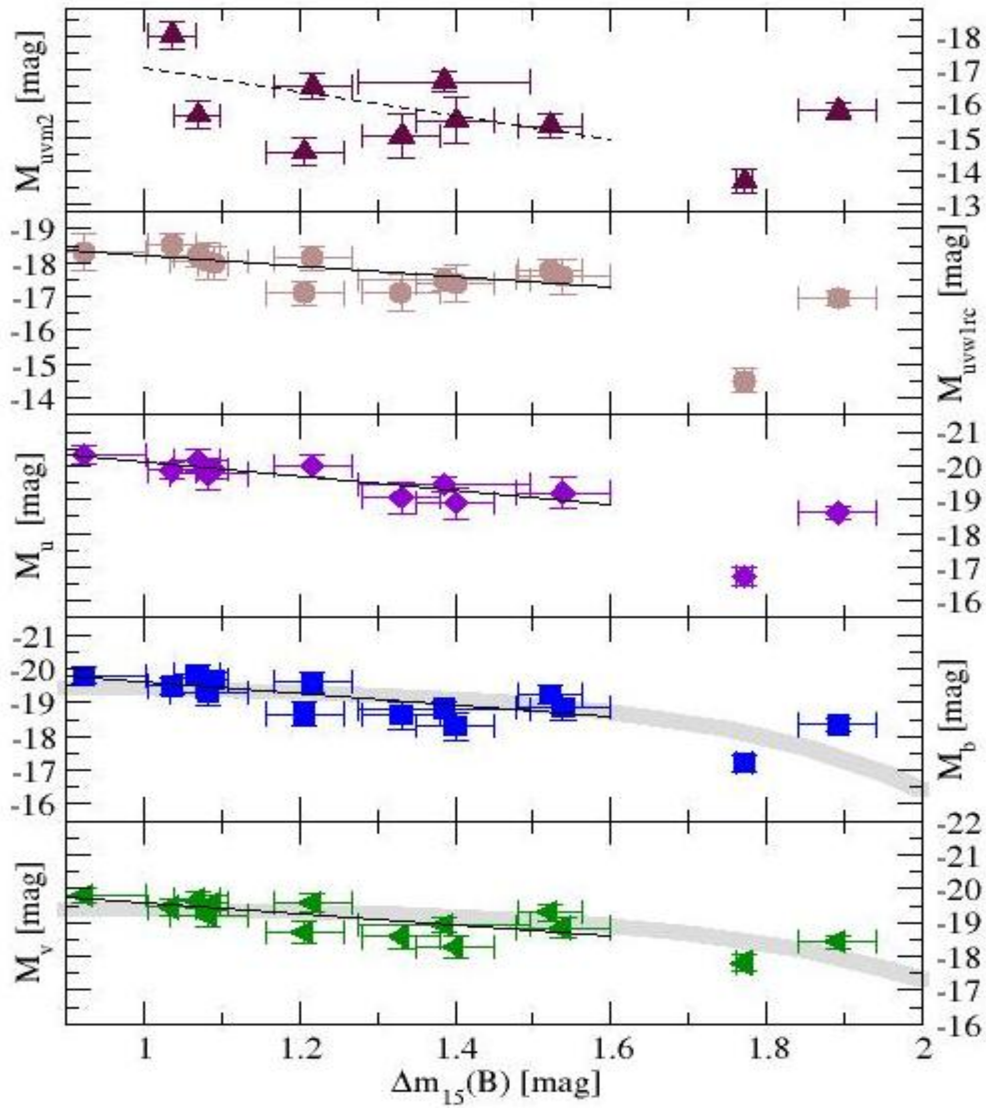
- SN Ia subtypes can also be identified by their peculiar UV-optical color evolution



Milne et al. 2010, ApJ, accepted

UV Absolute Magnitudes of SNe Ia

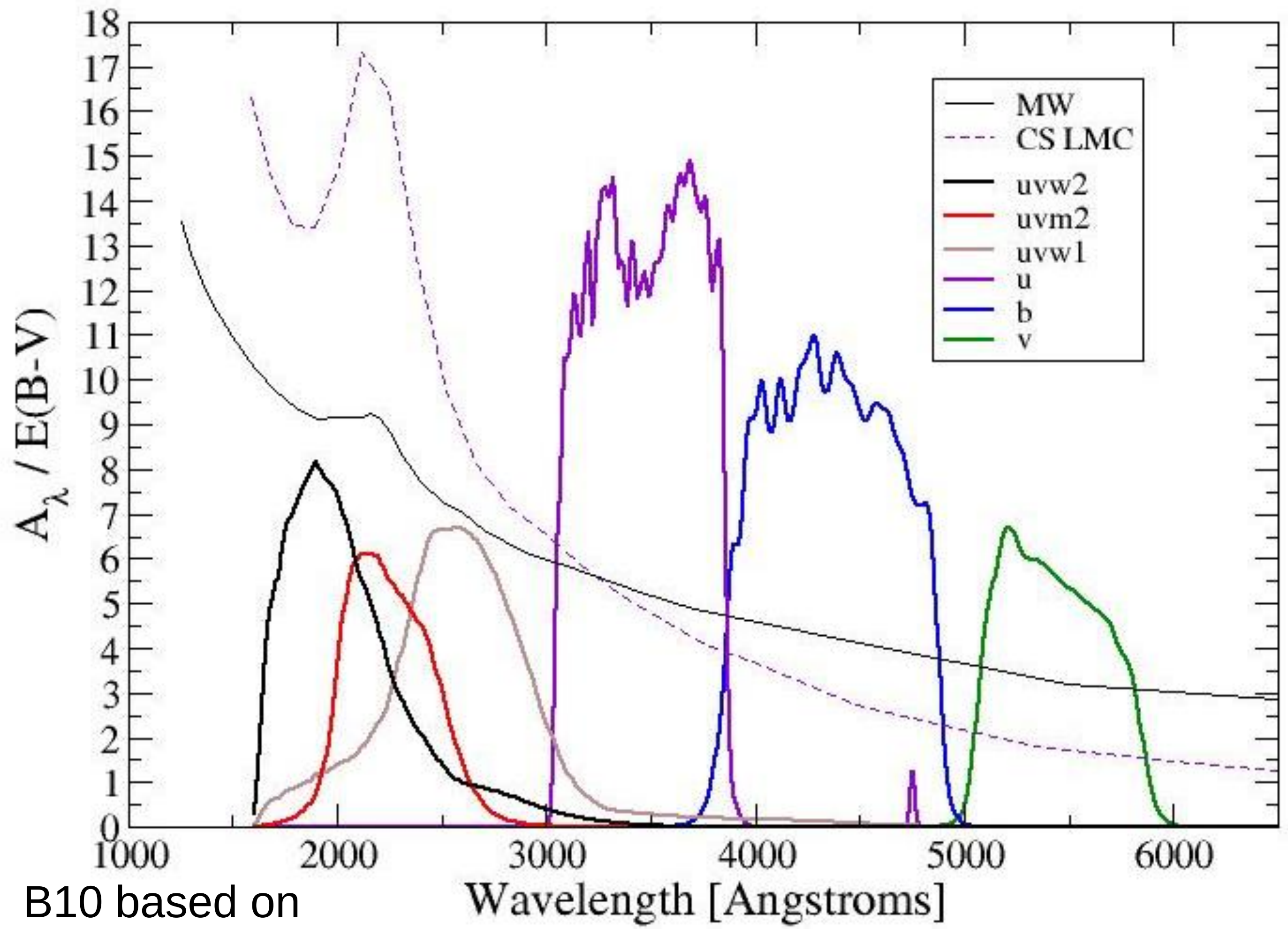
Brown et al. 2010, ApJ accepted – B10



- Scatter in optical and near-UV consistent with observational errors (primarily uncertainty in Hubble flow distance for this nearby sample)
- uvm2 absolute magnitudes show evidence for larger intrinsic scatter

What causes the uvm2 scatter? Extinction? Metallicity? Age?

Explosion Mechanism? Mixing? Velocity? Density Structure?



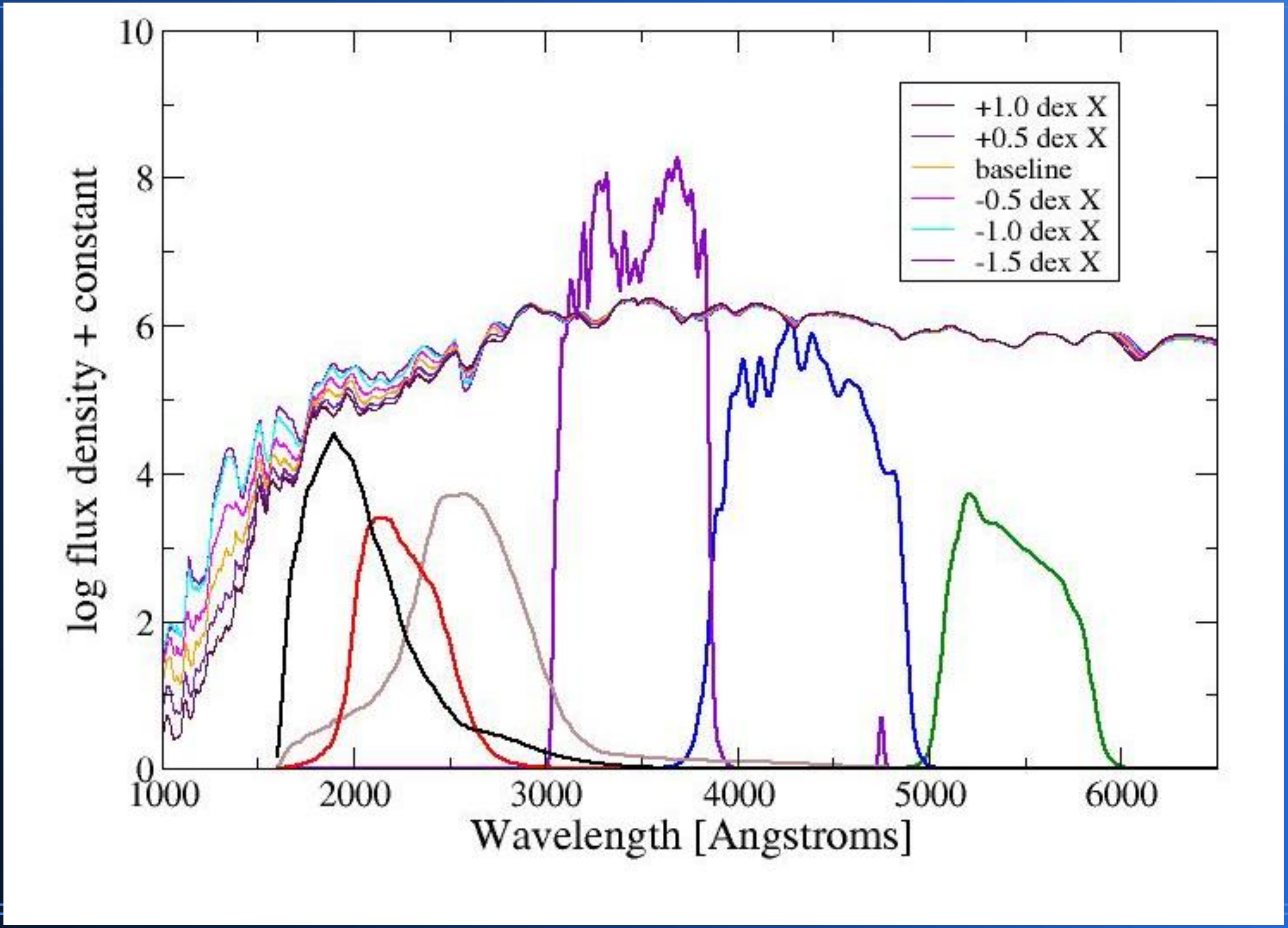
B10 based on Goobar 2008

Metallicity effects in nature and modeling of Type Ia Supernovae

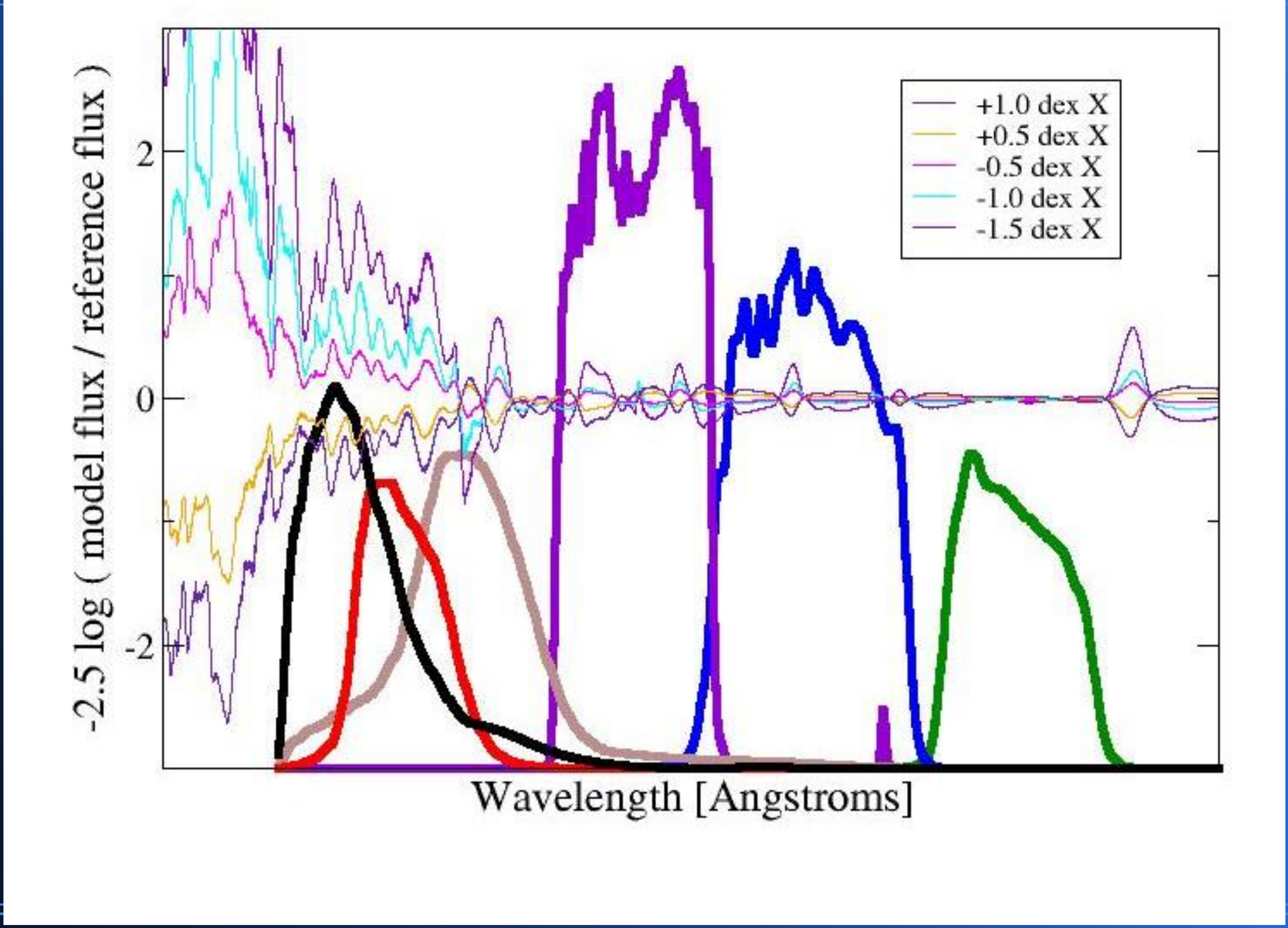
- Original progenitor composition
- stellar evolution/winds
- white dwarf composition
- explosion/flame propagation
- Density structure
- Metal abundance in outer layers
- Ratios of particular elements

Effect of heavy element abundances on UV Spectra of SNe Ia

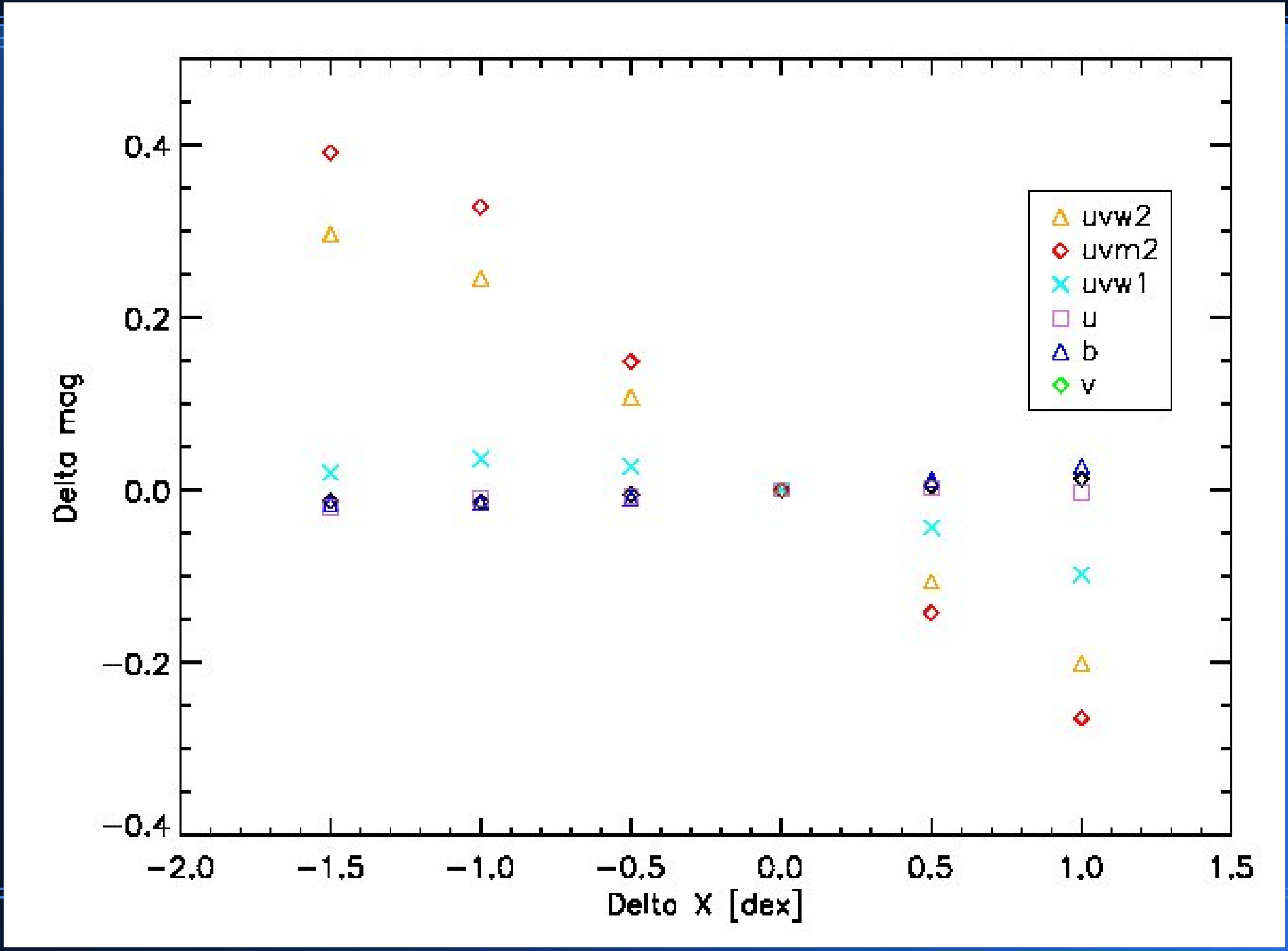
Lentz et al. 2000



Effect of heavy element abundances on UV Spectra of SNe Ia

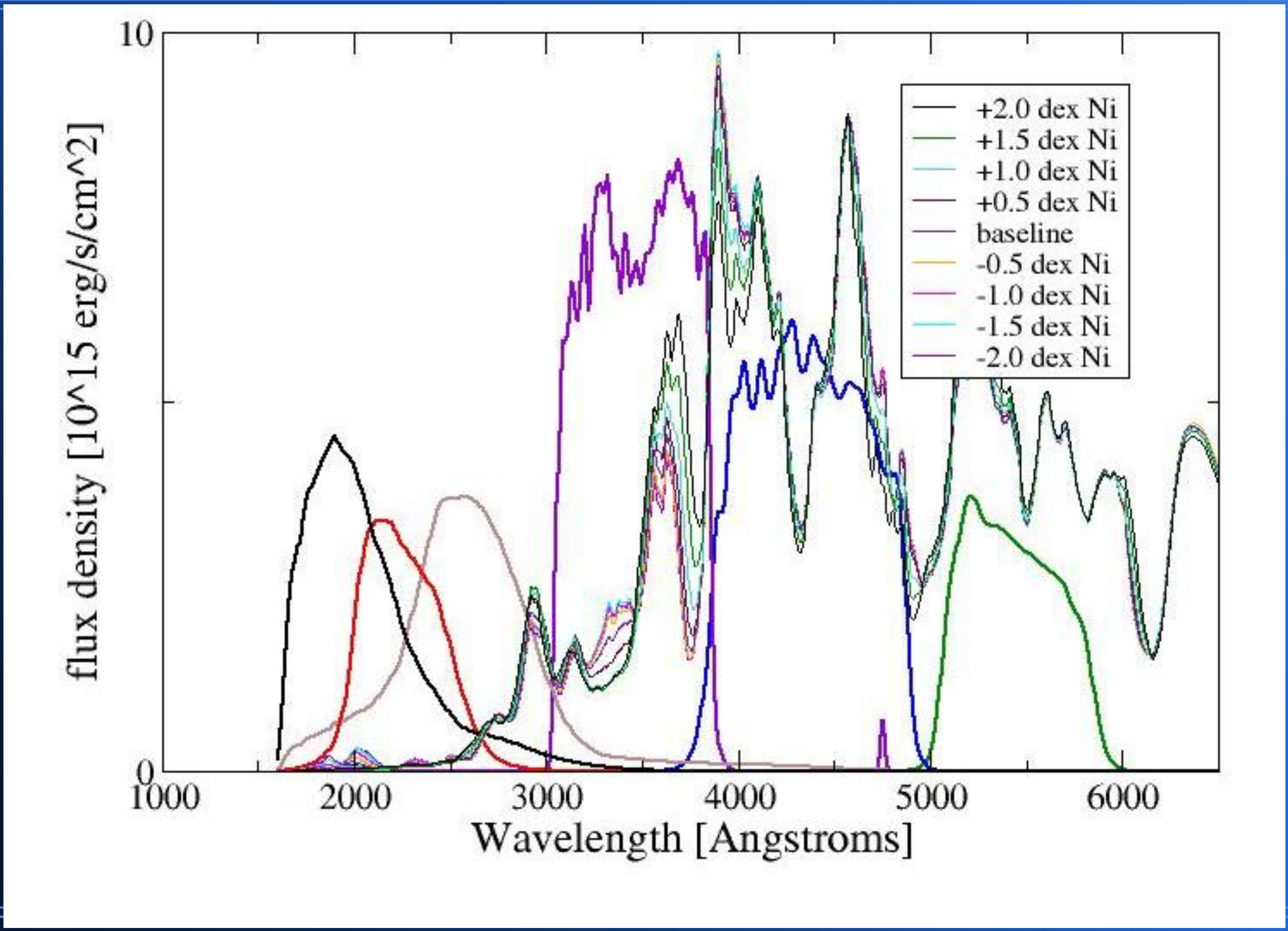


Effect of heavy element abundances on UV photometry of SNe Ia

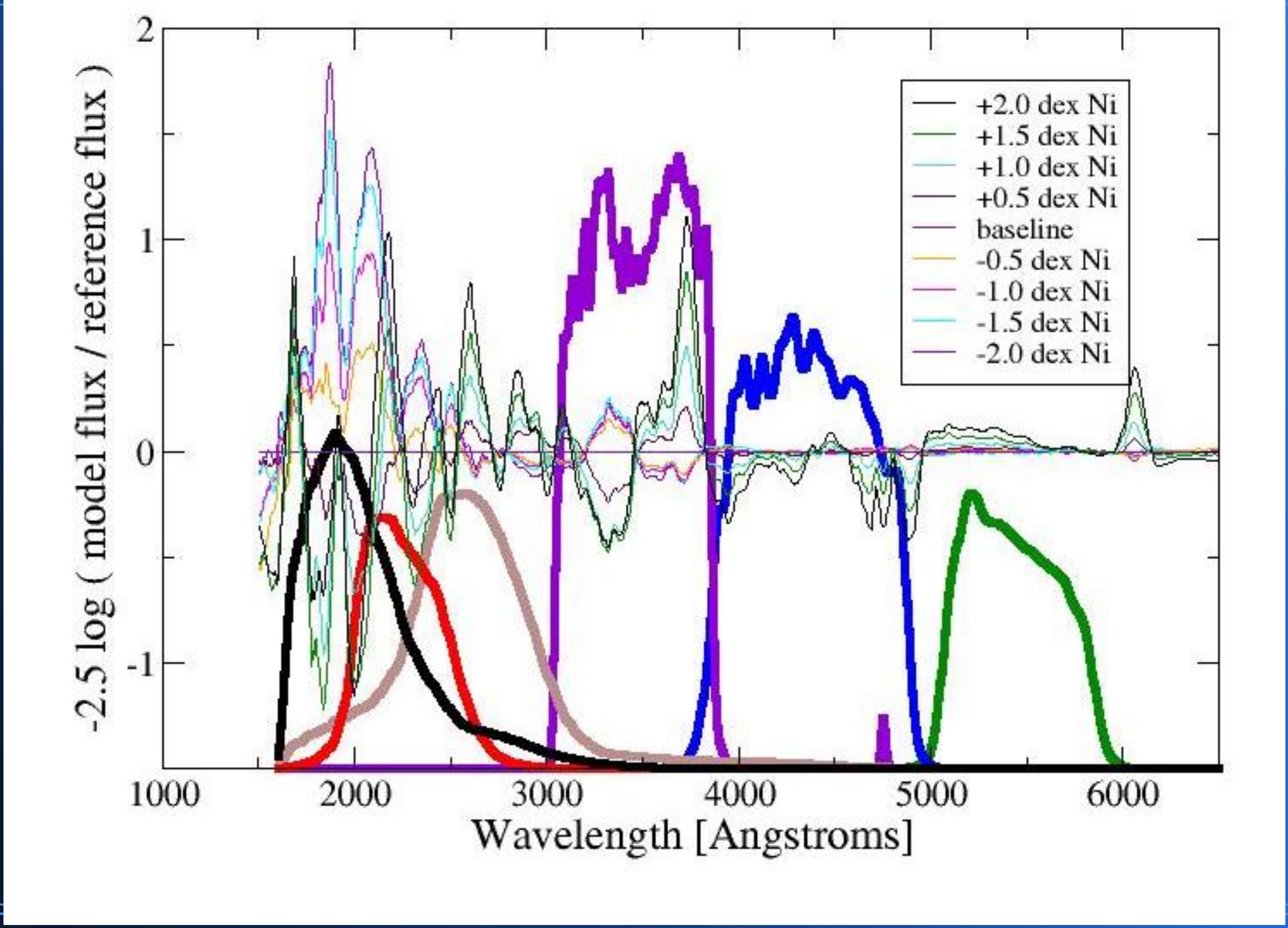


Effect of ^{56}Ni abundance on UV spectrum of SNe Ia

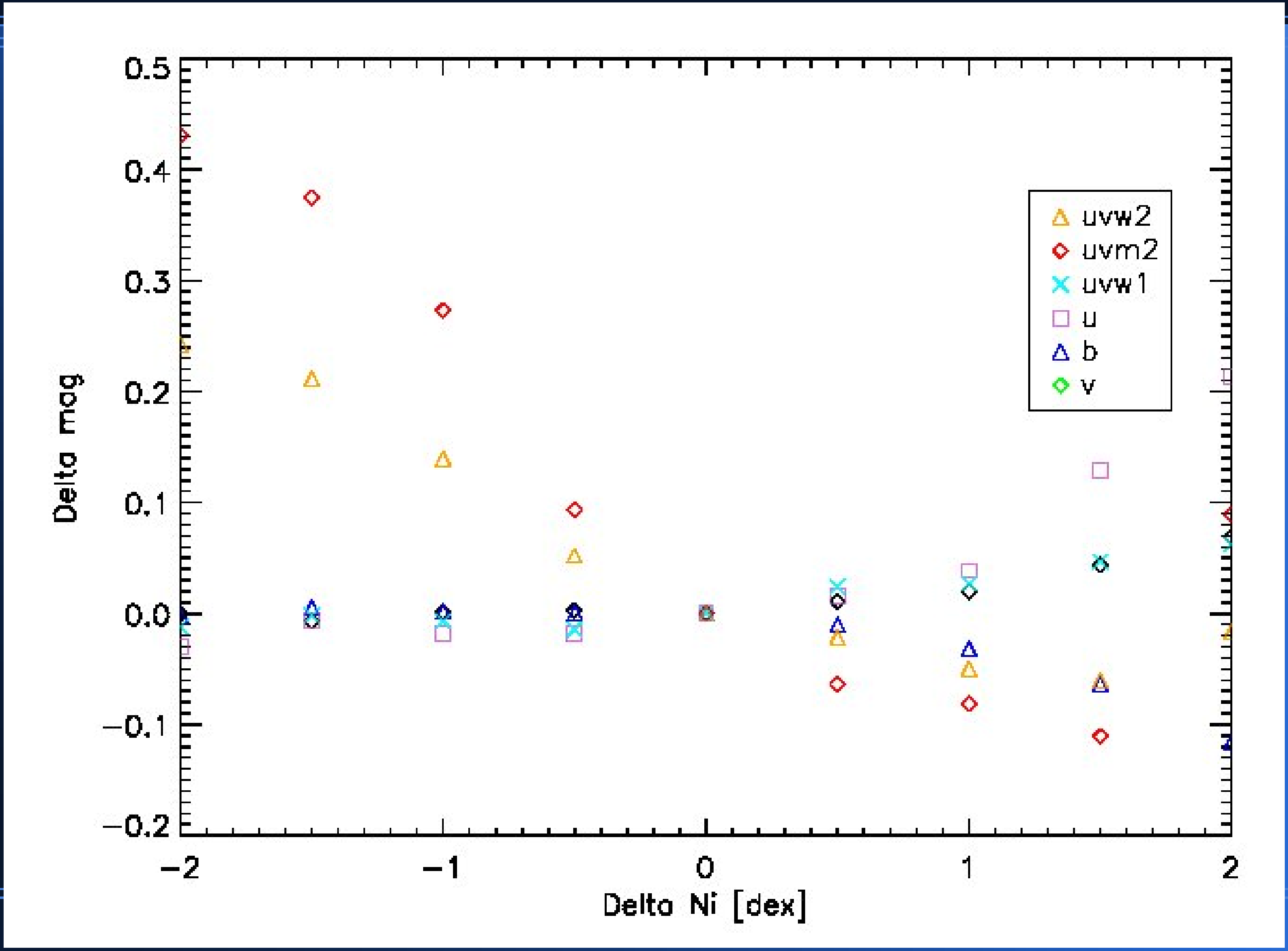
Spectra from Sauer et al. 2008



Effect of ^{56}Ni abundance on UV spectrum of SNe Ia

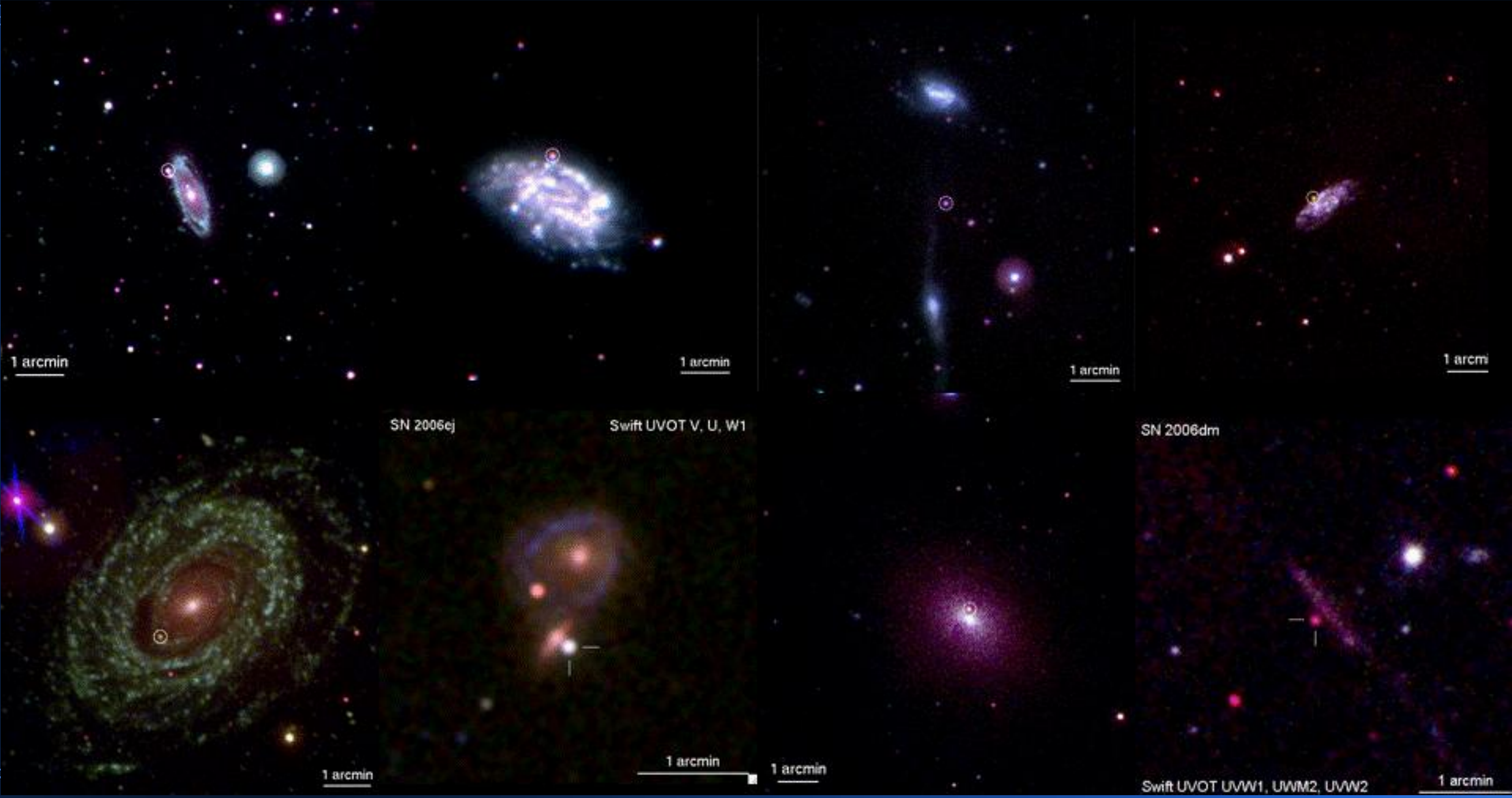


Effect of ^{56}Ni abundance on UV photometry of SNe Ia

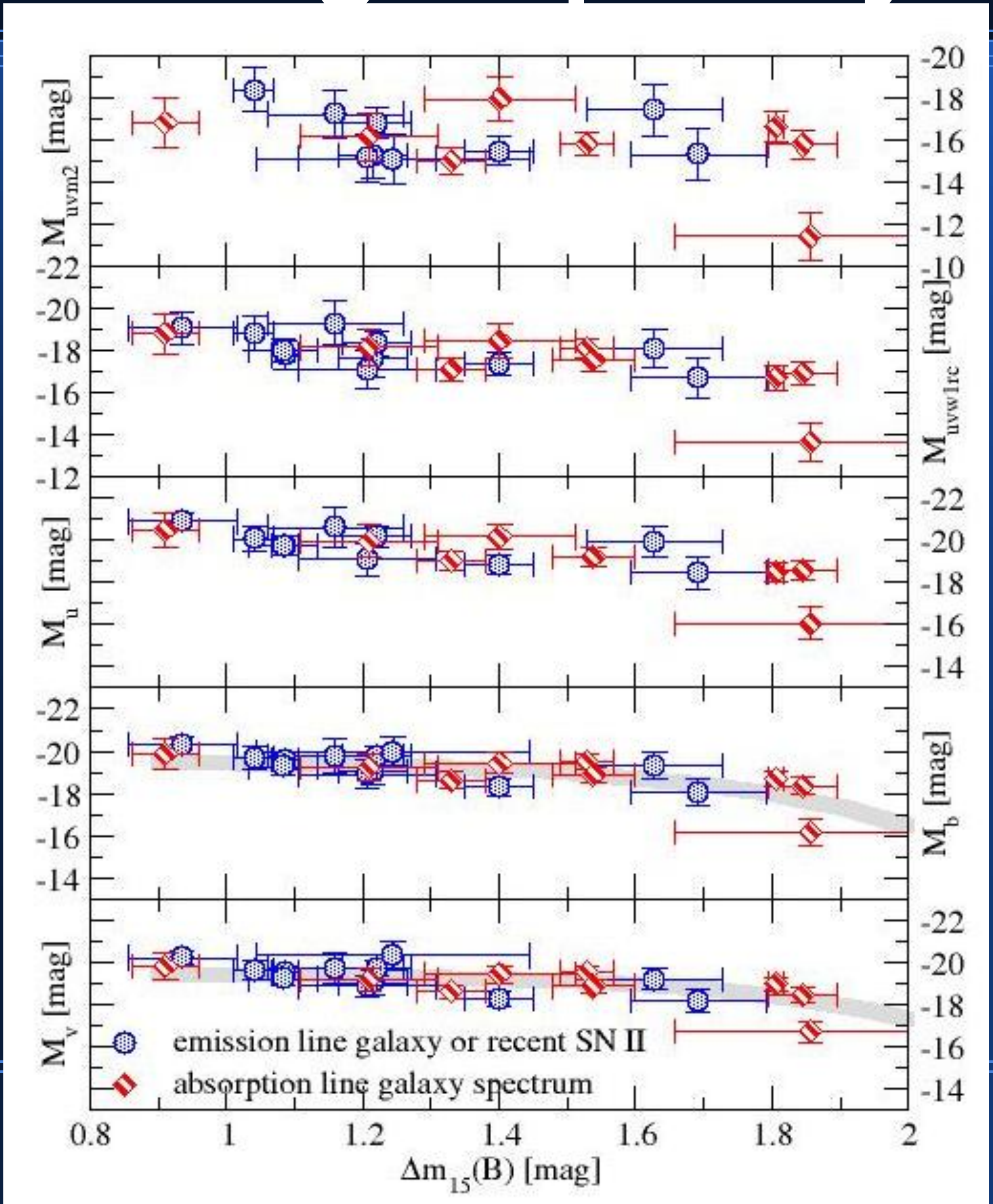


- Effects of metallicity strong in UV, particularly shortward of 2500 Angstroms
- The many ways that metallicity could effect the progenitor/evolution/explosion/radiation and the many ways that those differences could be modeled make it difficult to uniquely determine parameters based on UV photometry
- However, UV photometry can narrow down the allowed parameter space for better modeling

Host galaxies

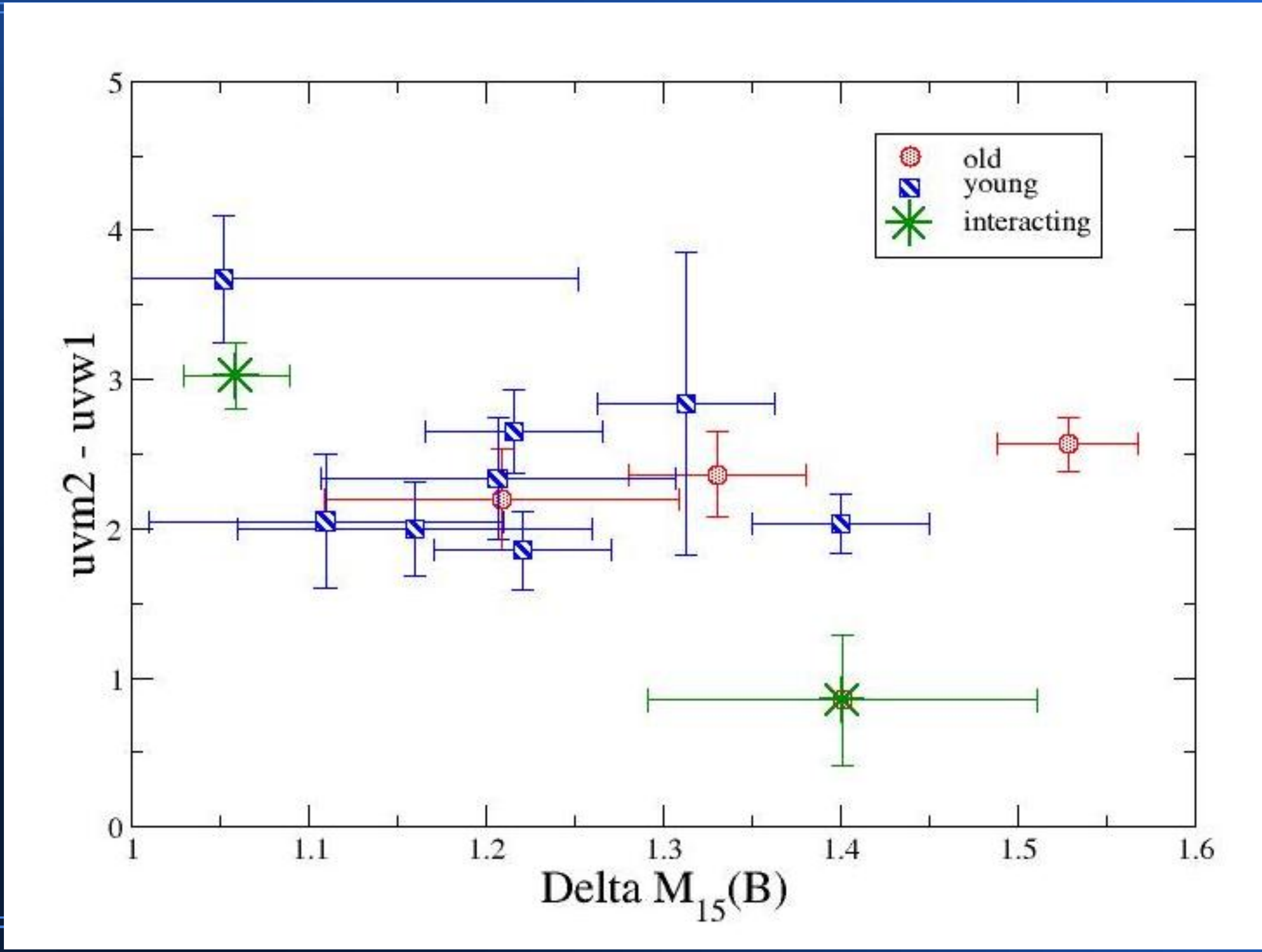


SNe Ia Absolute Magnitudes grouped by host type



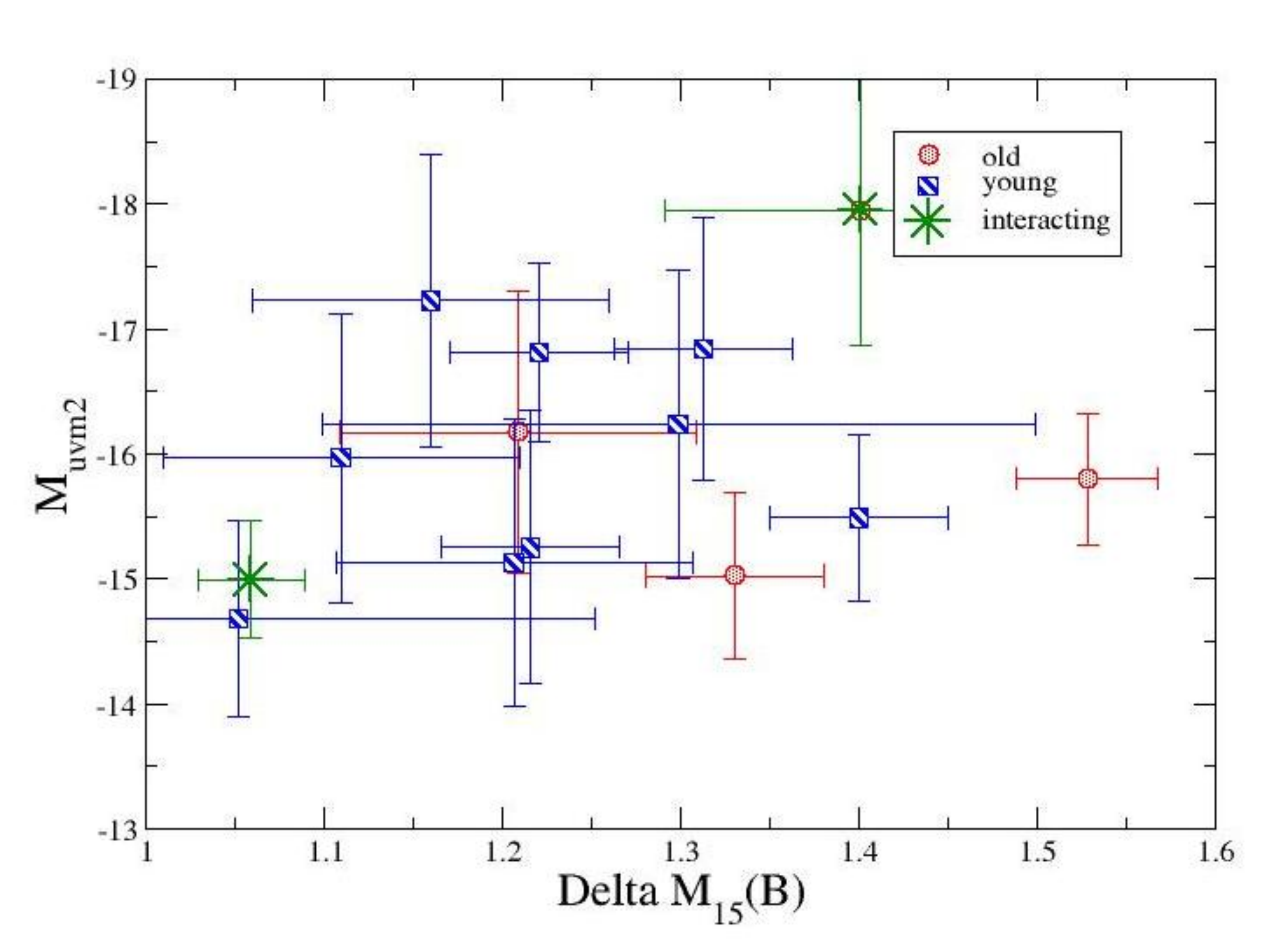
- SNe from young hosts dominate 1-1.3
- SNe from old hosts are mostly 1.3-1.9 The “old” host at 0.9 is a galaxy with an old bulge/bar but star formation in the fainter disk
- How about the differences for normal SNe with similar Dm15(B)?

UV colors grouped by host type



- No clear color differences, but sample size is still very small
- Host properties might not represent the progenitor

uvm2 absolute magnitudes grouped by host type



- No clear color differences, but sample size is still very small
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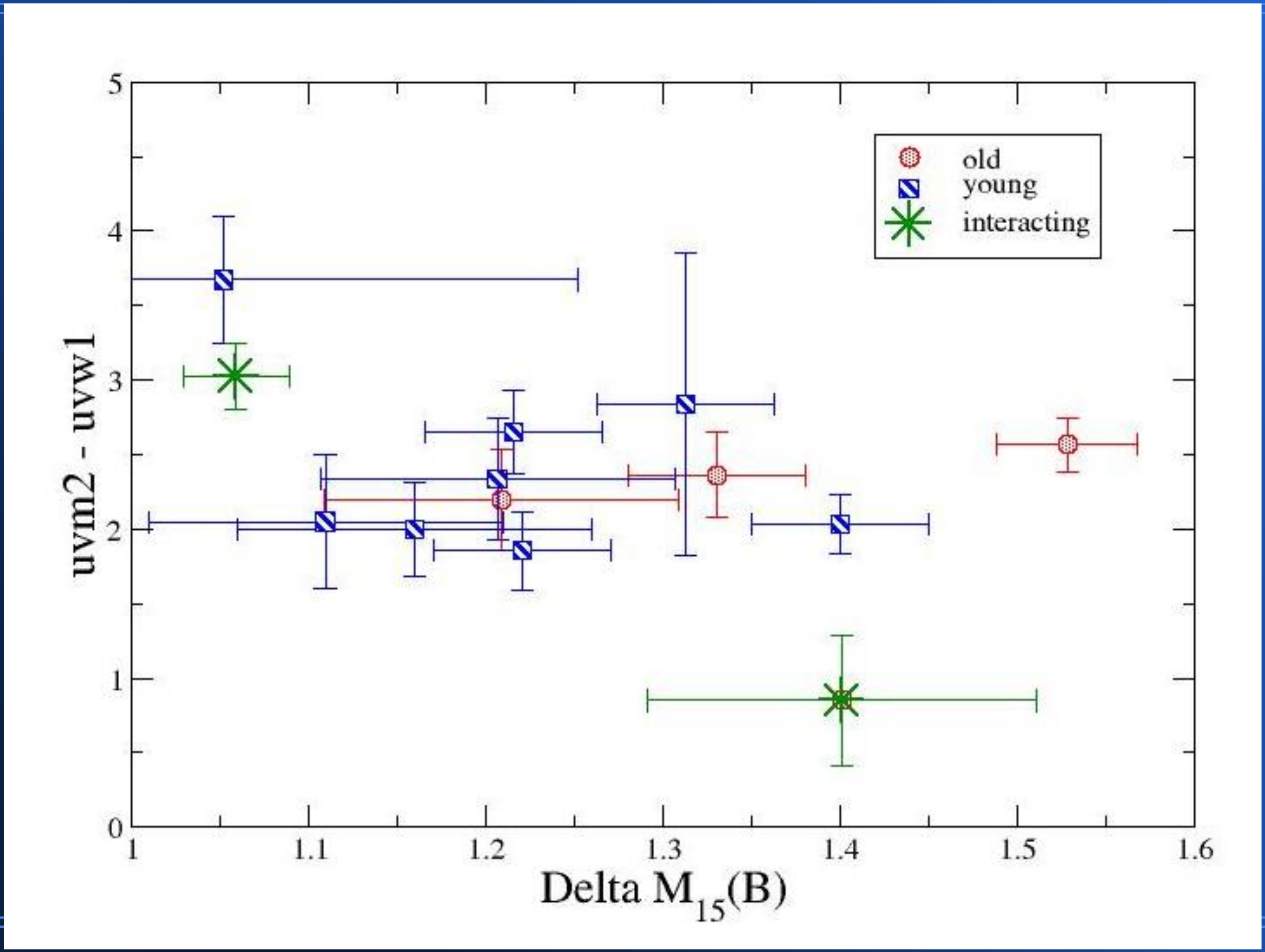
UV colors grouped by host type



- No clear color differences, but sample size is still very small
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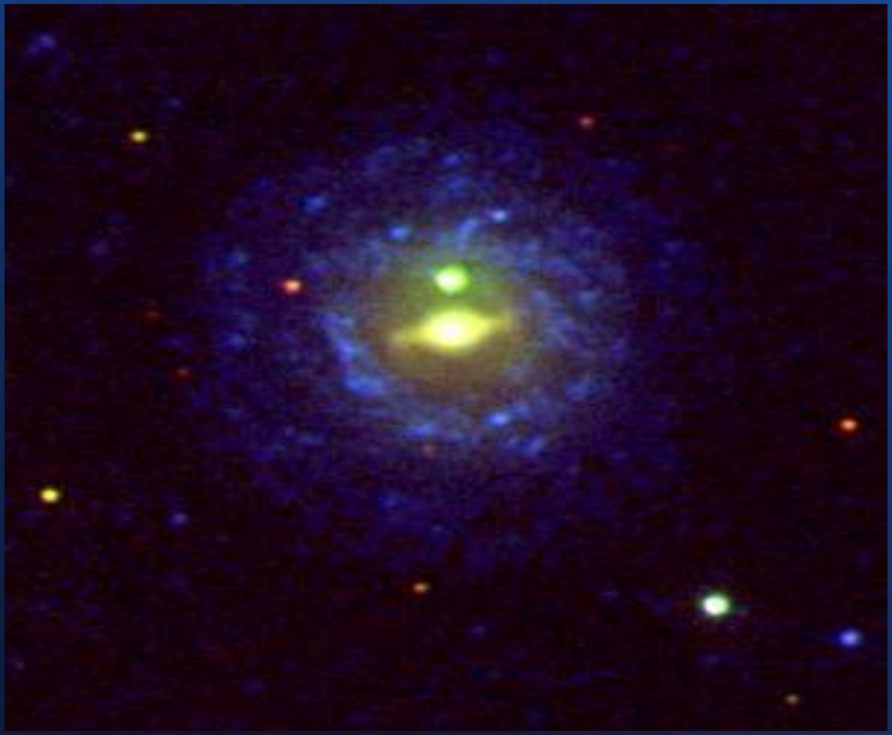
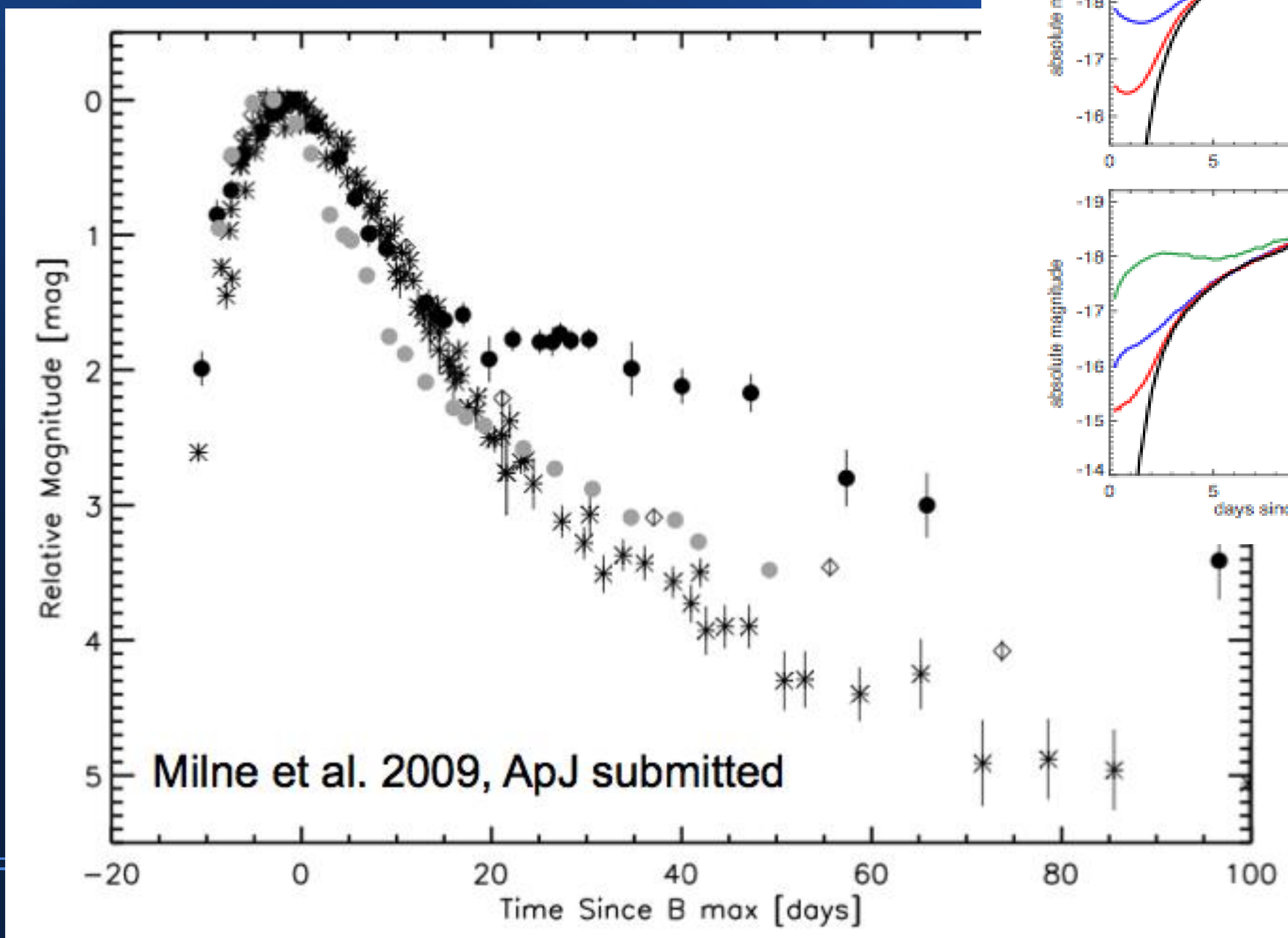
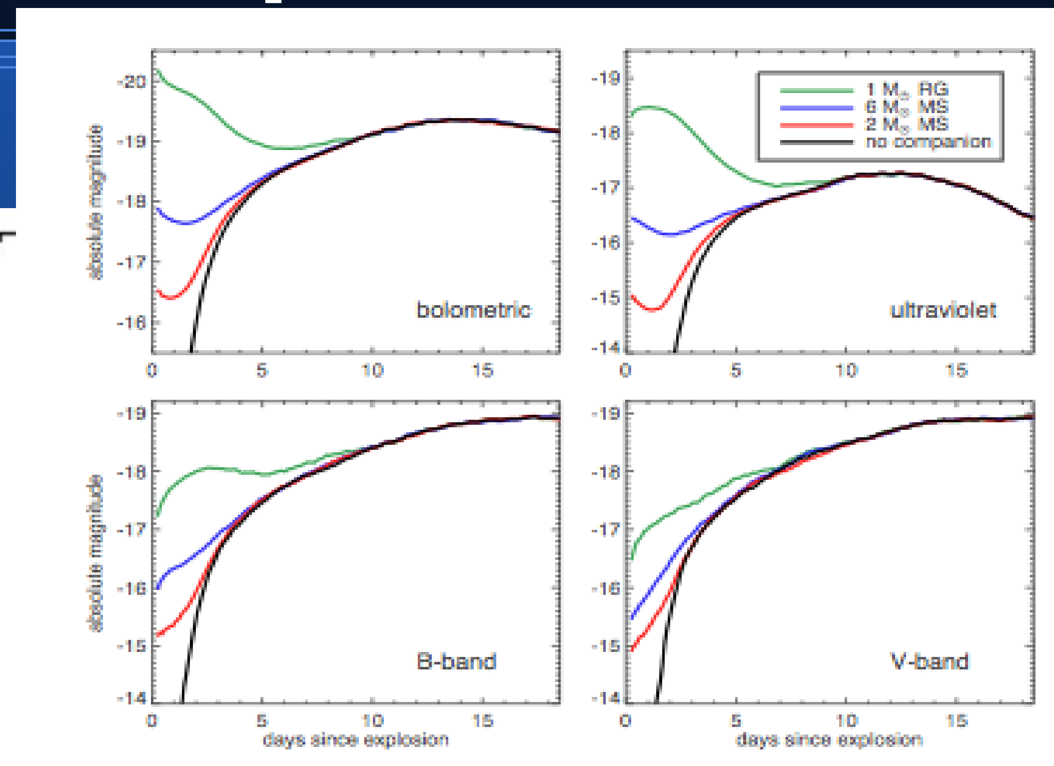
Still to do . . .



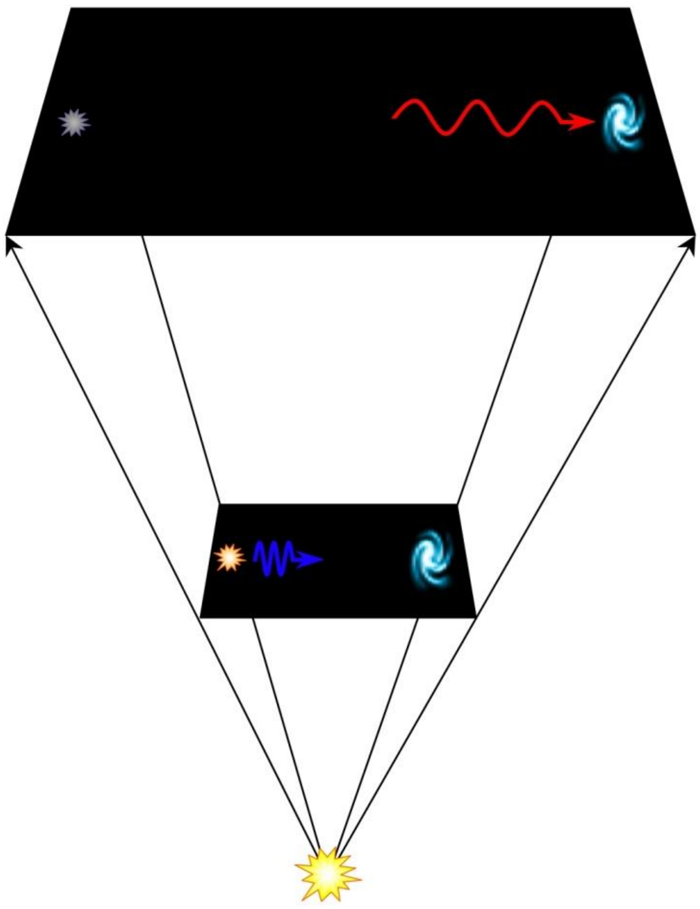
- Increase the sample to be less sensitive to a few peculiar SNe or hosts
- Quantify properties such as SFR, age, and metallicity of hosts and at position of SN
- Look for correlations of UV with spectroscopic properties of SN, eg Fe strength

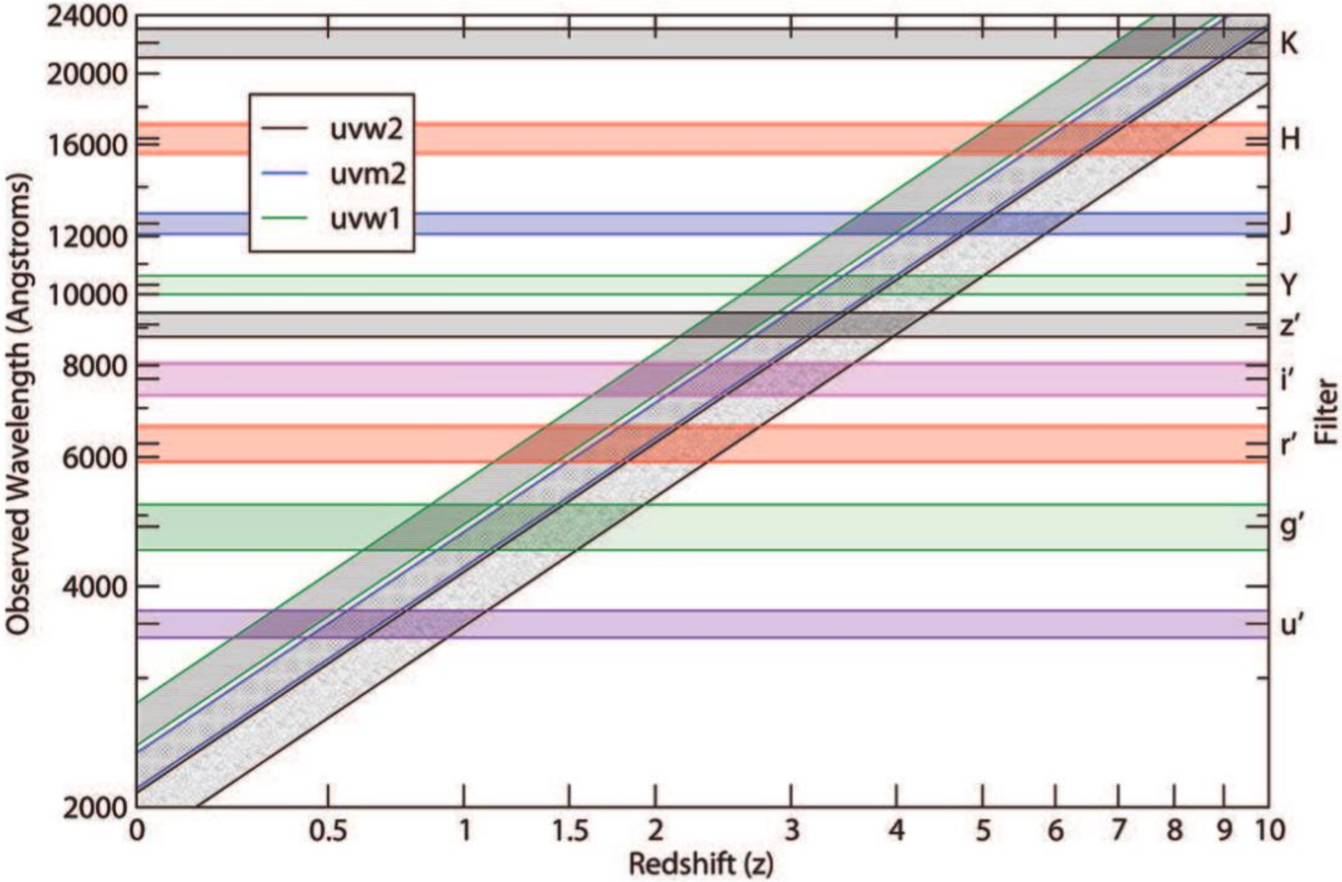
UV light curves as a probe of progenitor companion



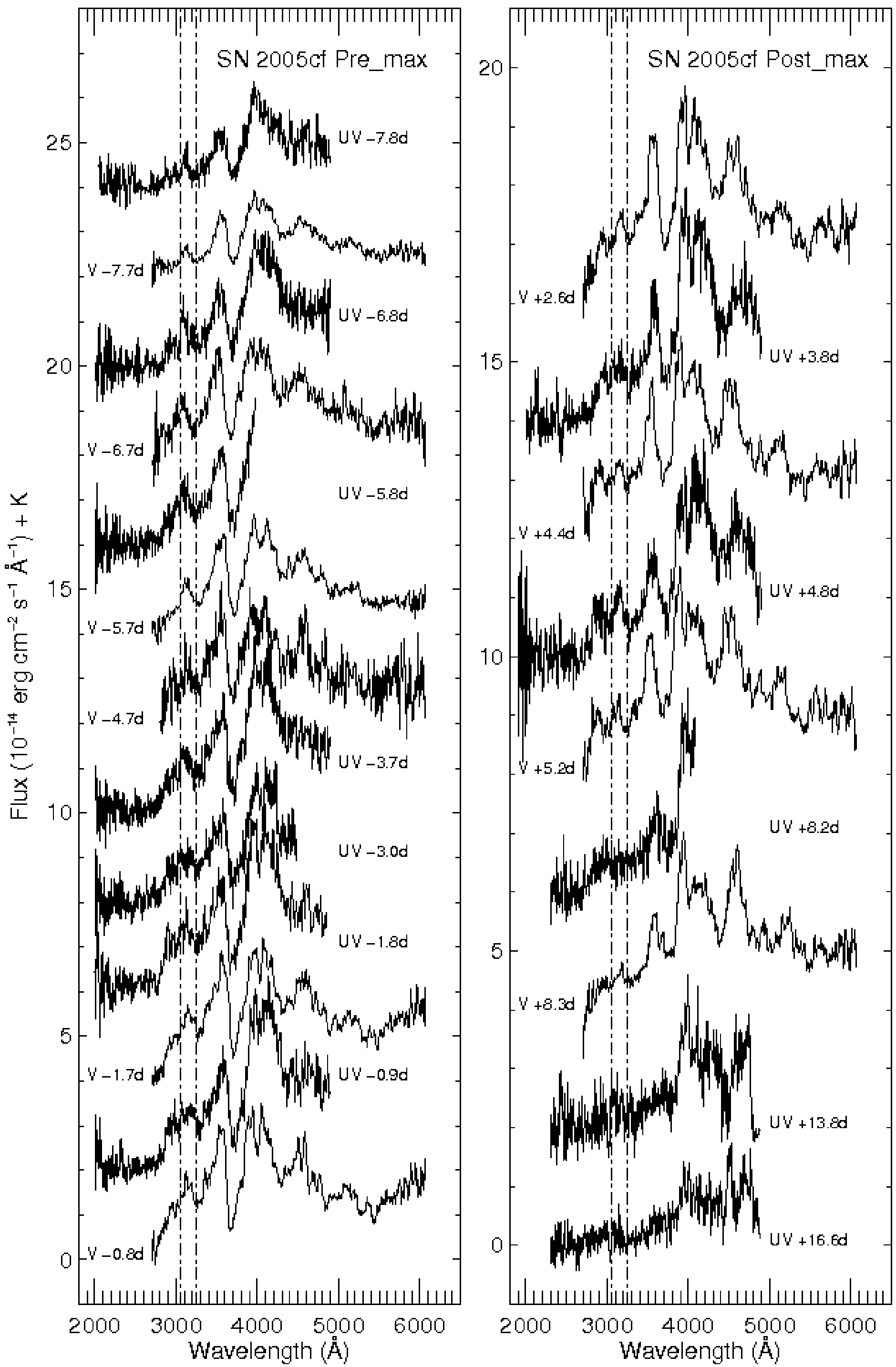


Rest Frame UV of high redshift objects will be observed in the optical

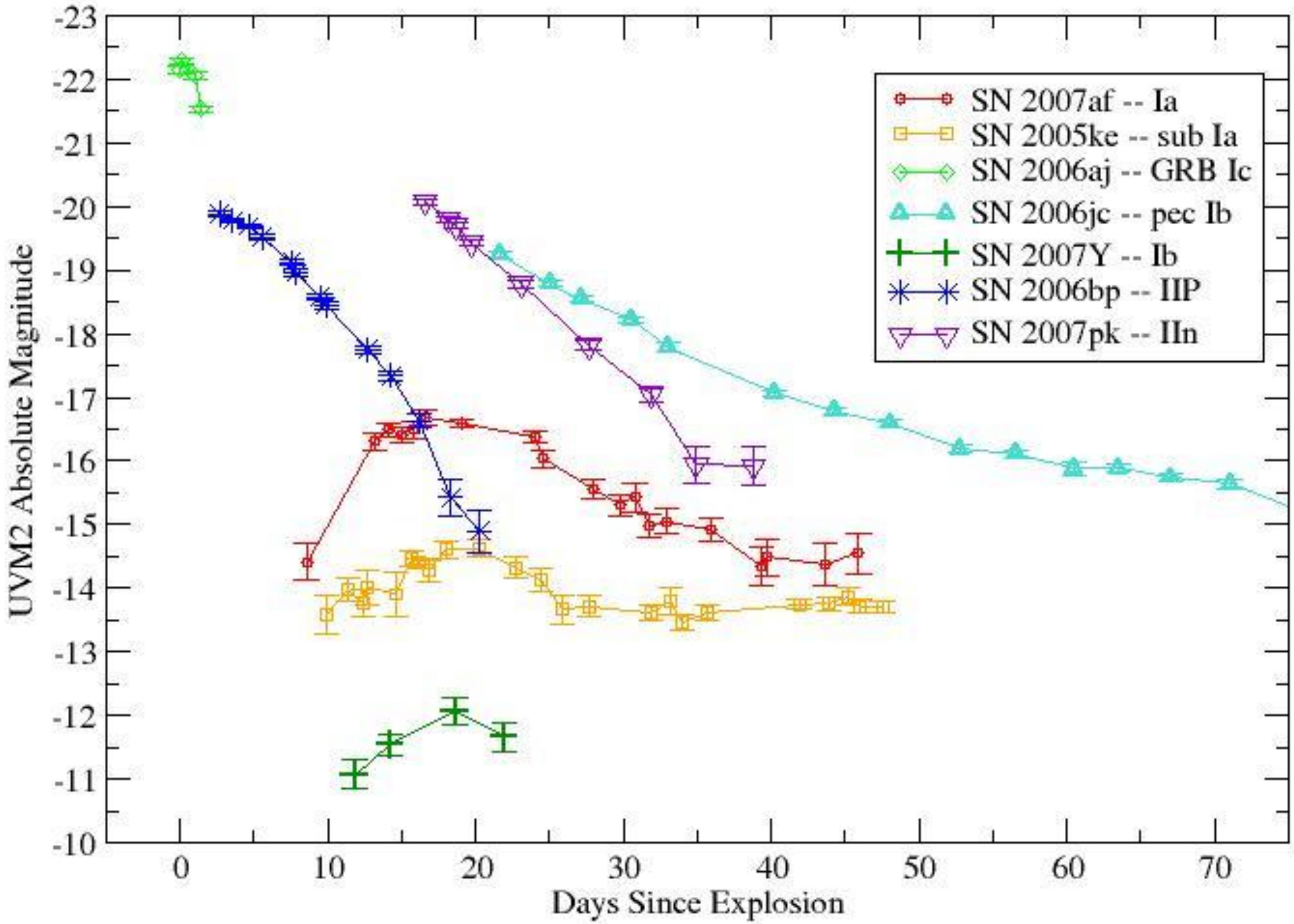




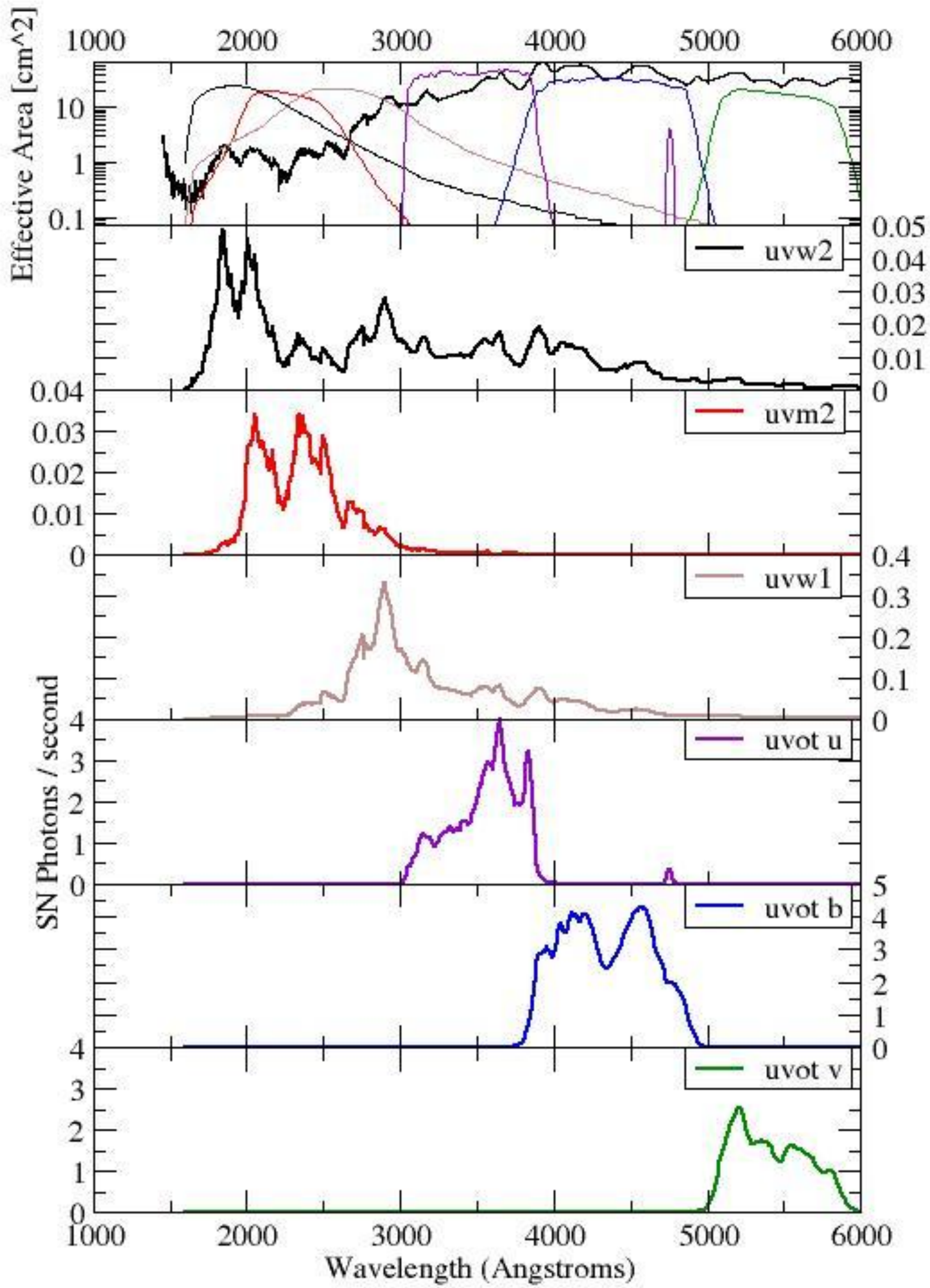
Grism Observations of SNe



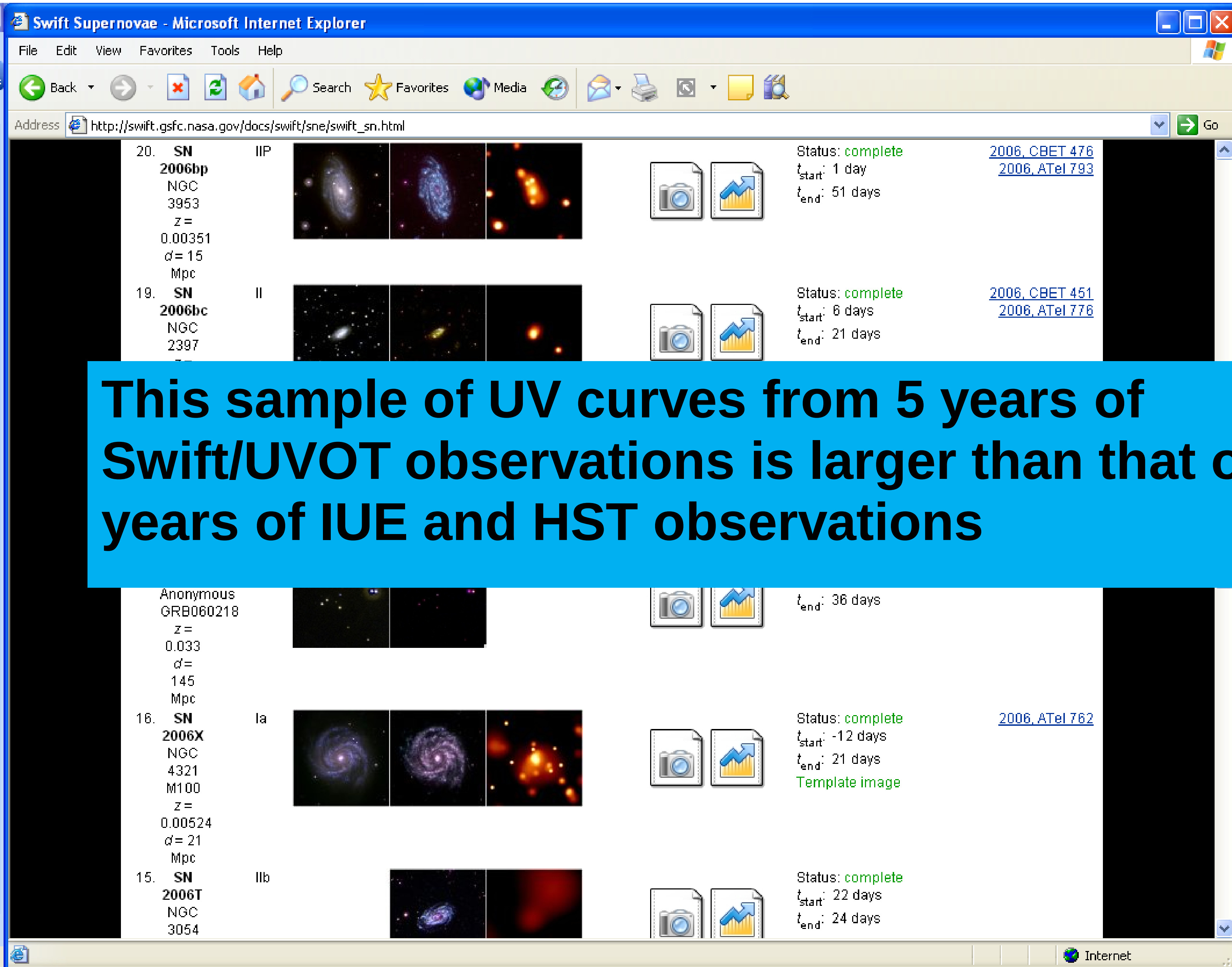
Absolute Magnitudes in the UV



SN Ia Photons

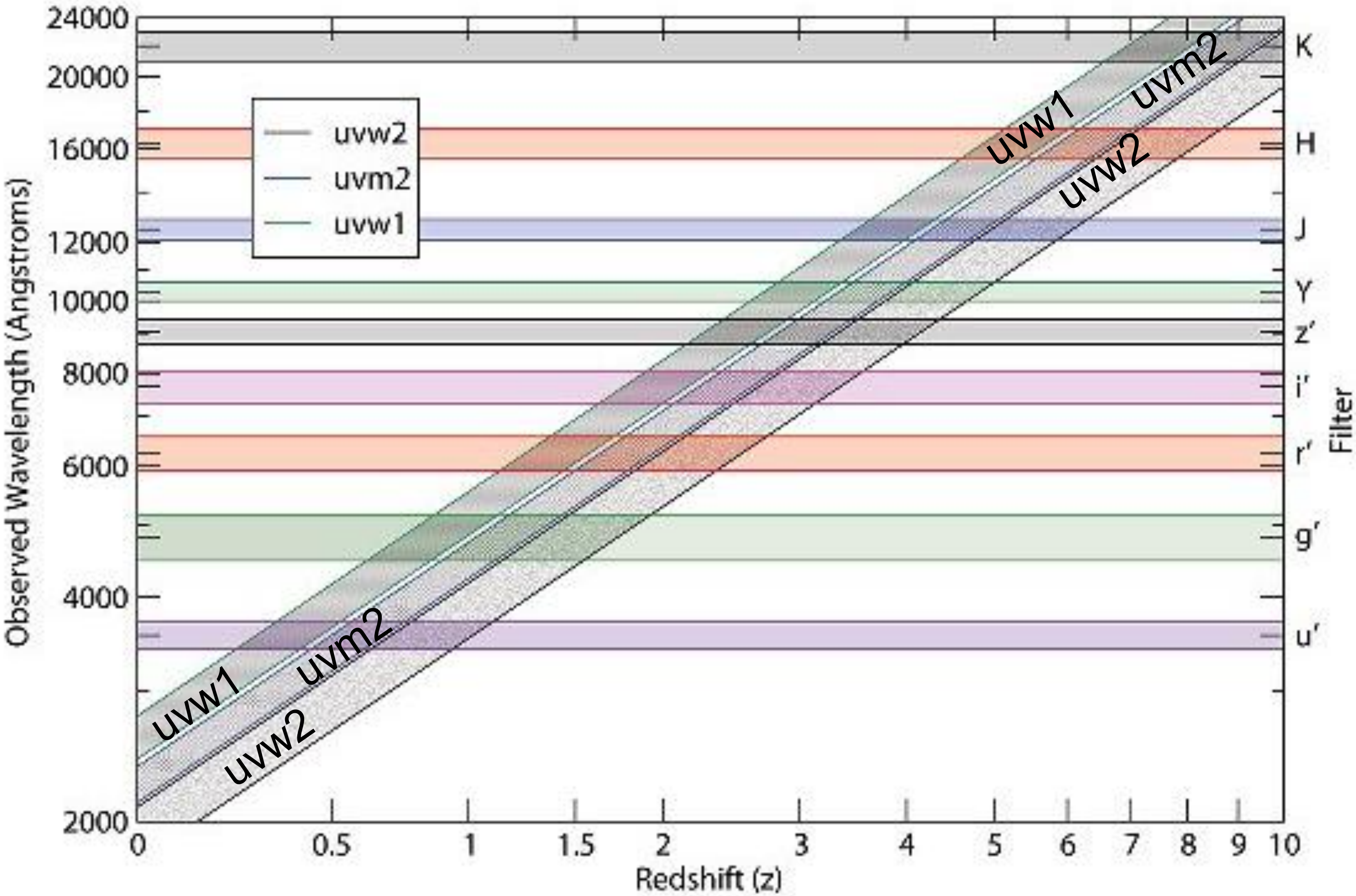


More Swift SNe

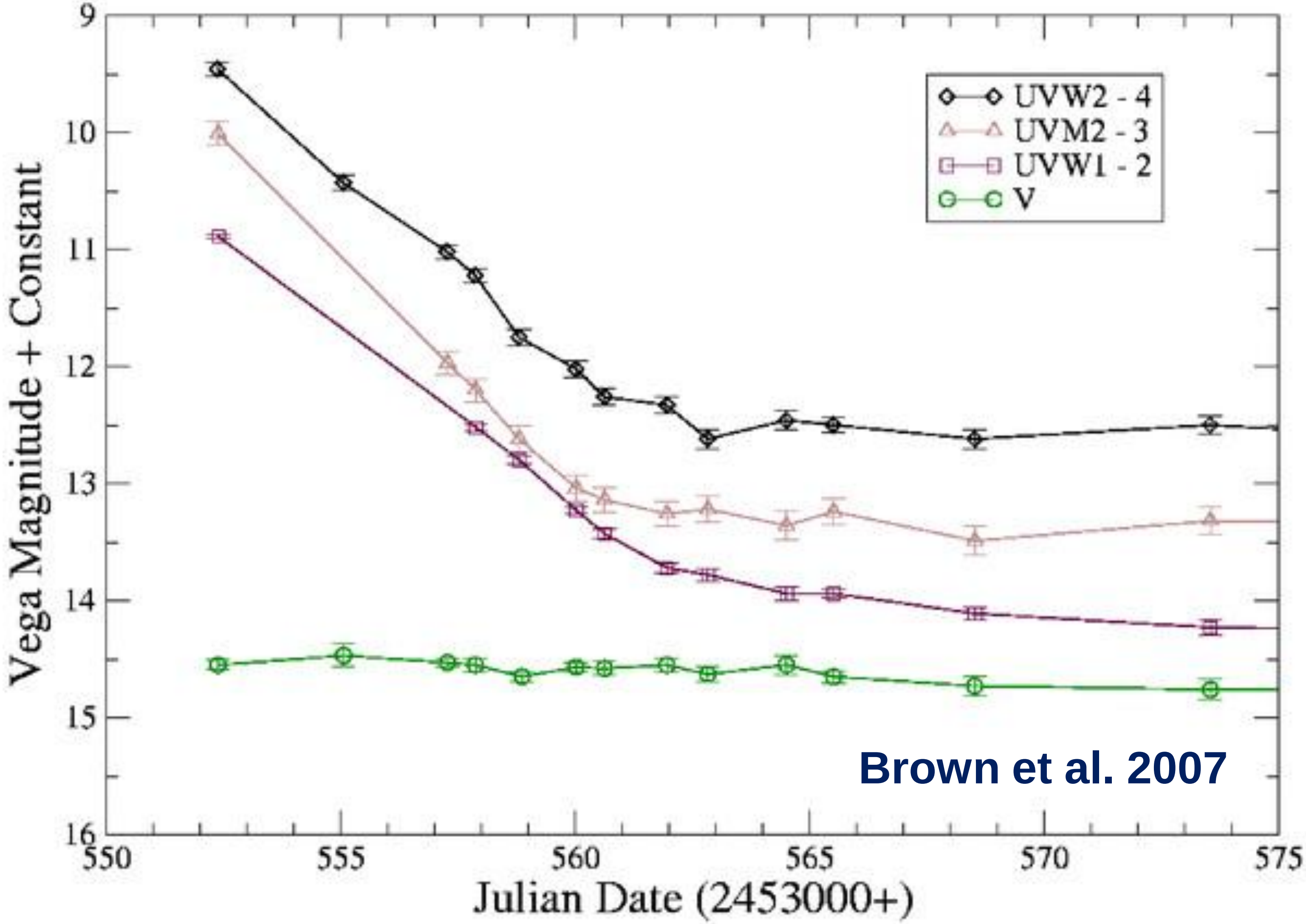


This sample of UV curves from 5 years of Swift/UVOT observations is larger than that of 40 years of IUE and HST observations

Rest Frame UV at high z

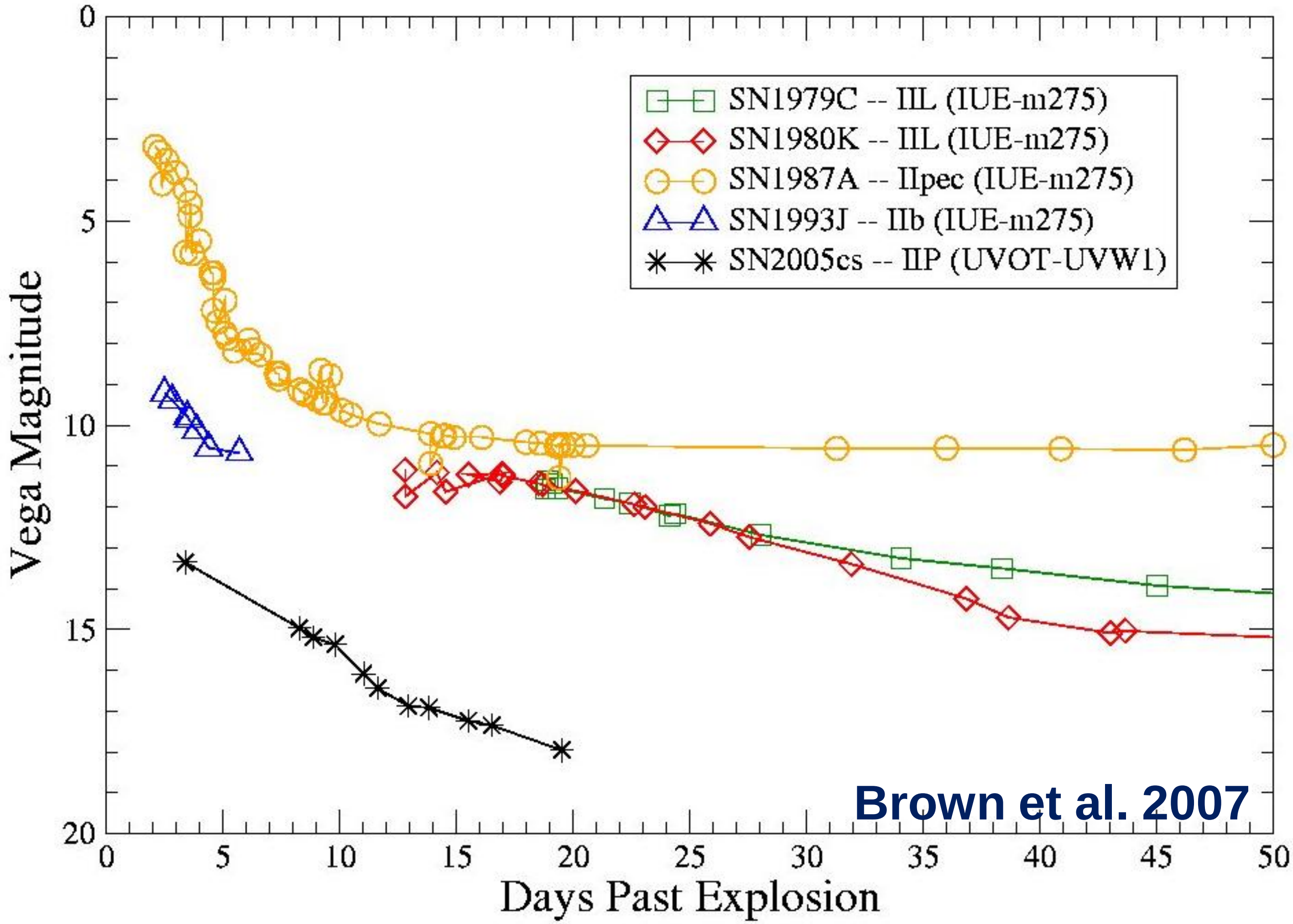


SN 2005cs (IIP) Light Curves

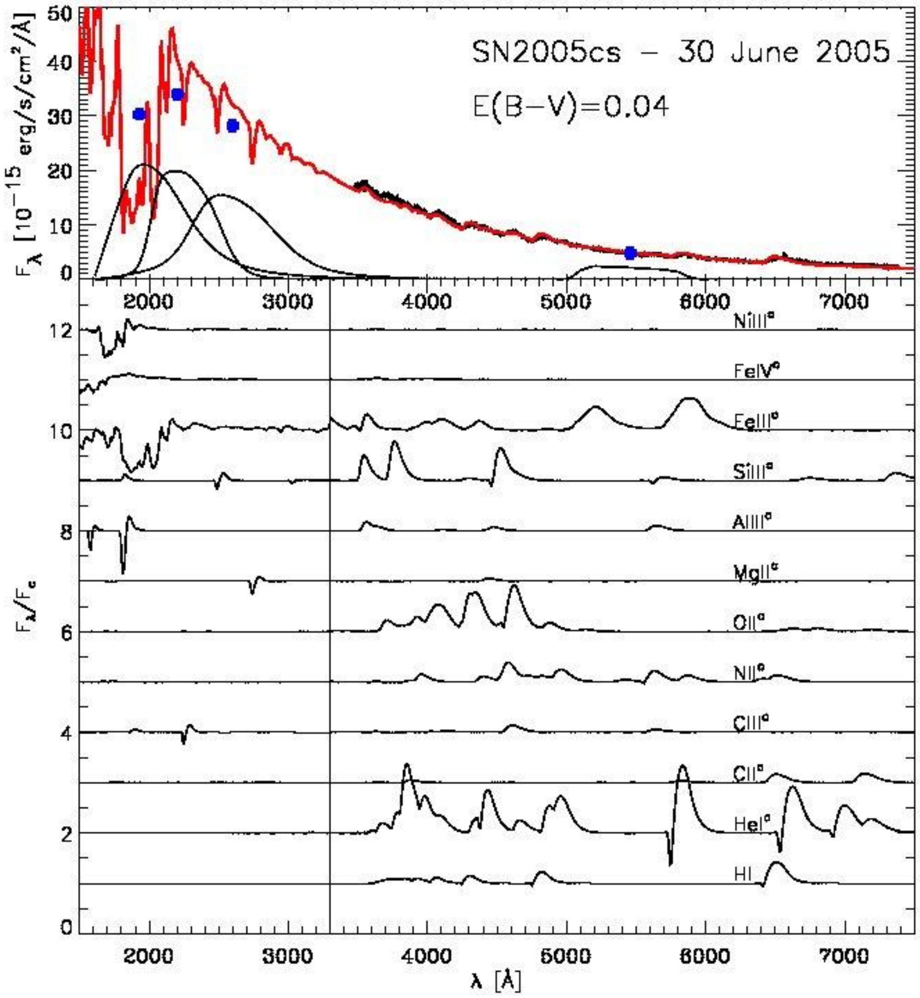


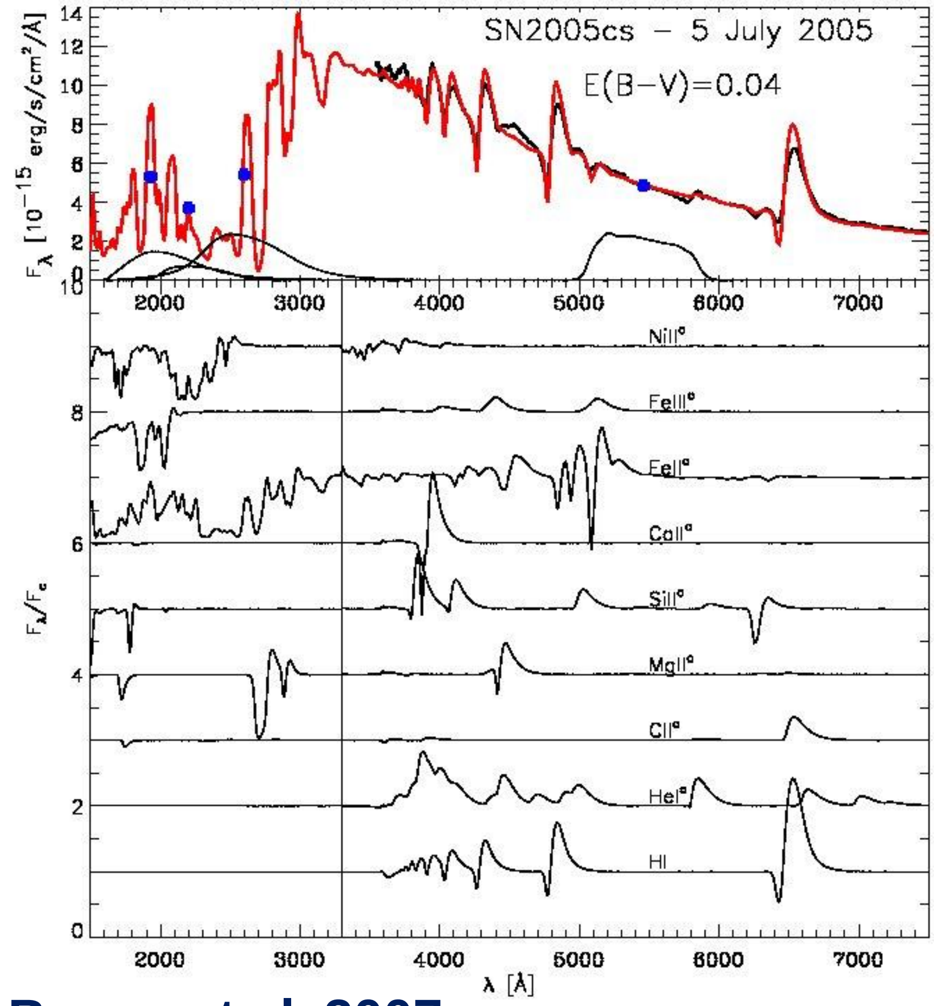
UV flux drops rapidly while the V band remains constant (signature of the “Plateau” subtype)

Rapid UV fading common to SNe II



SED Modeling of SNe II

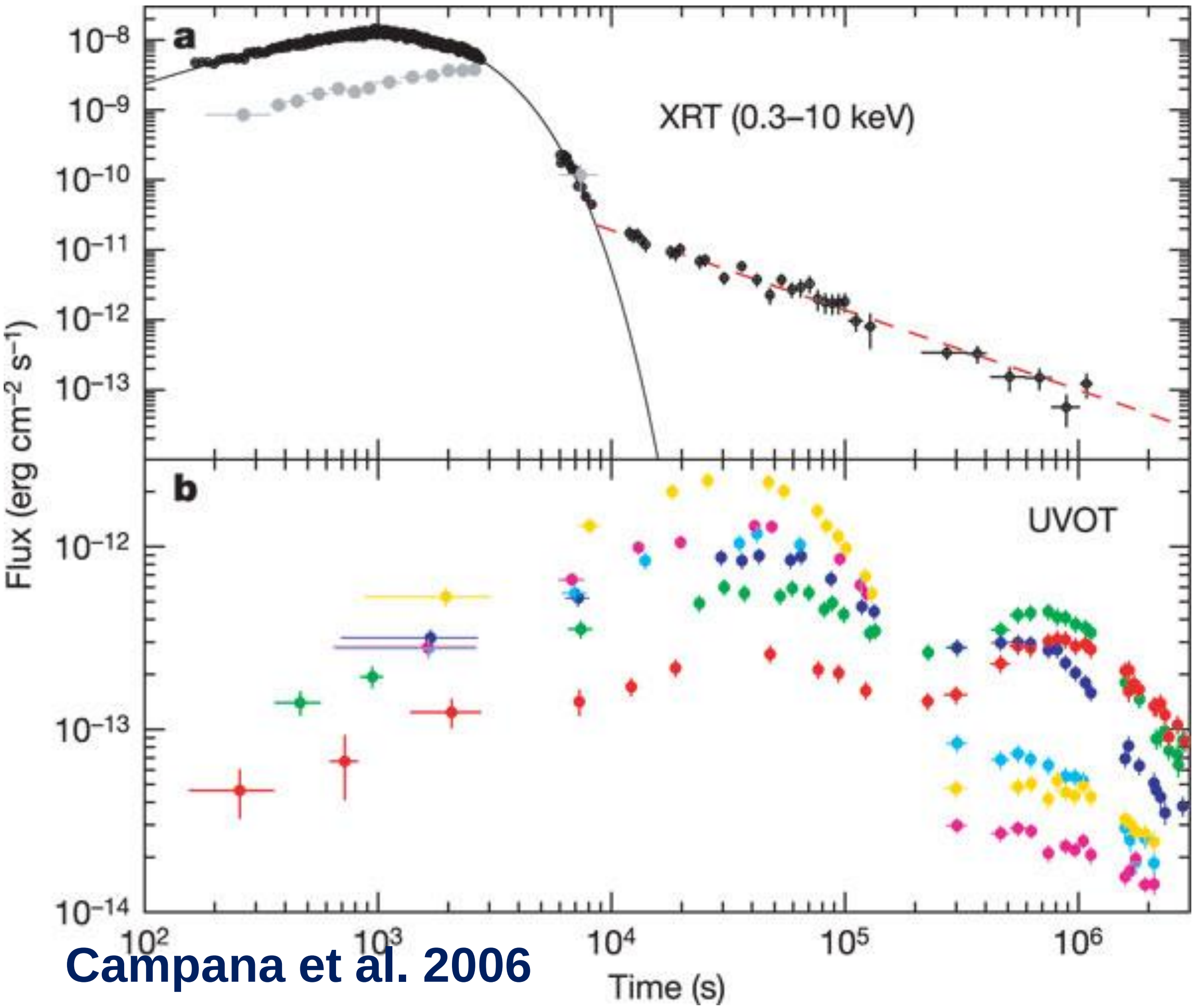




Brown et al. 2007

SED becomes redder with time as SN photosphere cools and
metal lines absorb the shorter wavelengths (CMFGEN modeling by L. Dessart)

Shock Breakout of GRB060218/SN2006aj



Campana et al. 2006

SN2006aj – the “SN” bump