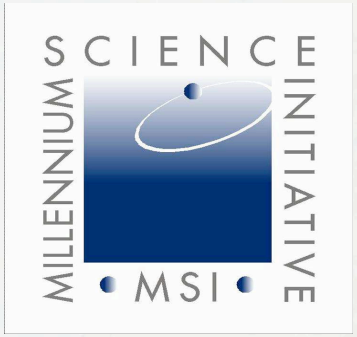
Millenniun Center for Supernova Science (MCSS)



Principal Investigator: Mario Hamuy (Universidad de Chile)
Associated Scientist: Alejandro Clocchiatti (Universidad Católica)
Associated Scientist: José Maza (Universidad de Chile)

Current members

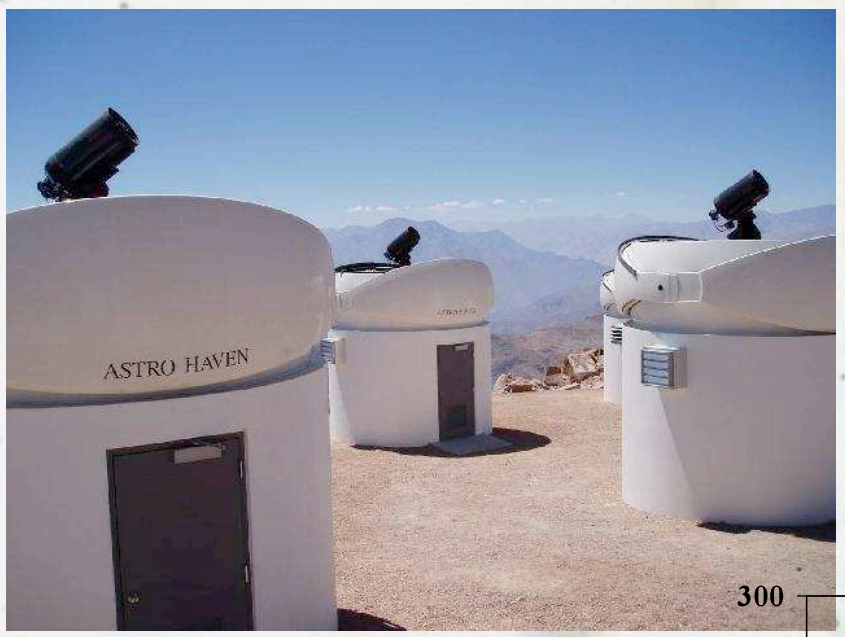
- Professors
  - Mario Hamuy
  - Alejandro Clocchiatti
  - José Maza
- Visiting Professor
  - Sidney Bludman
- Postdocs
  - Gastón Folatelli
  - Francisco Forster
  - Giuliano Pignata
  - Jason Quinn
- Ph.D. Students
  - Melina Bersten
  - Paula Zelaya
  - Regis Cartier
- M.Sc. Students
  - Matías Jones (graduated)
  - Felipe Olivares (graduated)
  - Francisco Salgado
- Undergraduates
  - Claudia Araya, Régis Cartier, Paulina González, Daphne Iturra, Paula López, María José Maureira, Felipe Murgas, Simón Silva, Tatiana Zapata
- Research Assistants
  - Roberto Antezana
  - Luis González

What are we doing?

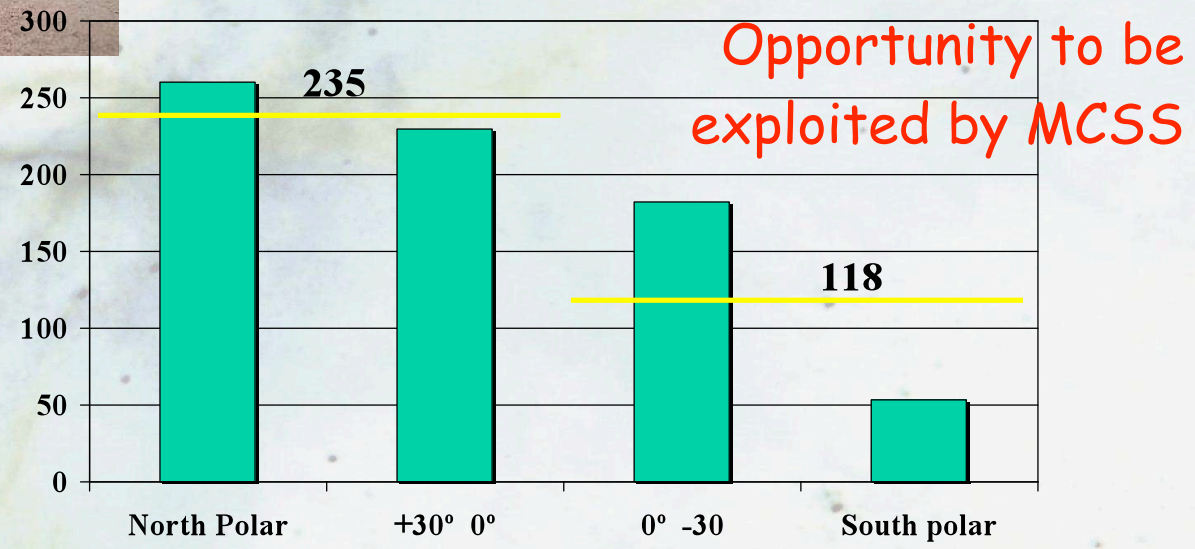
Scientific and technological goals:

- To refine the methods for distance determinations and provide a fundamental calibration at low redshift for the measurement of the expansion history of the Universe and the determination of the origin of the dark energy
- Use these same data to advance our understanding of the supernova progenitors and explosion physics
- Carry out a search for nearby supernovae in the southern hemisphere using the robotic telescopes
- Carry out a detailed follow-up program to obtain optical and near-infrared light-curves and spectra for several hundred supernovae

CHASE: CHileAn Supernova sEarch



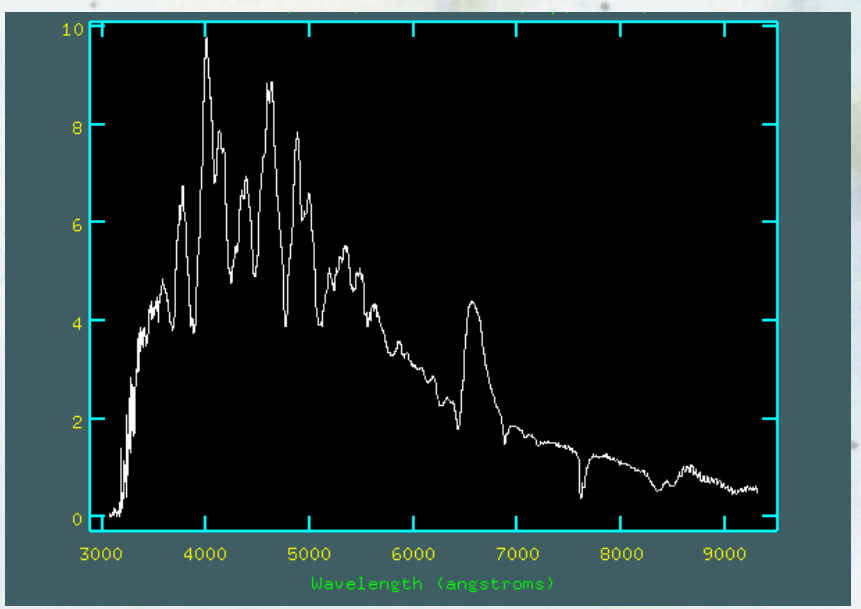
- Sample of 1000 nearby galaxies
- Cadence of 4 nights
- 20 new young supernovae every year

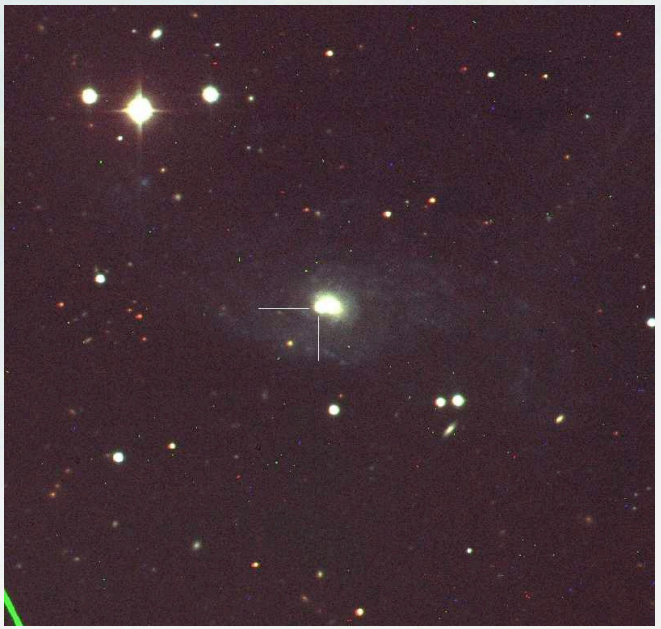


Opportunity to be exploited by MCSS

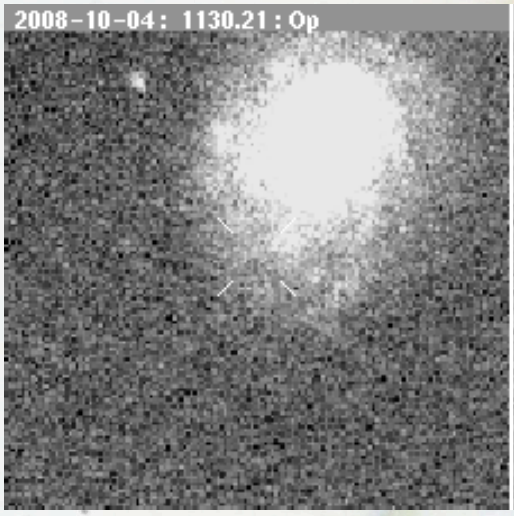
Supernova Discoveries in 2001-2005 (m <18.5)

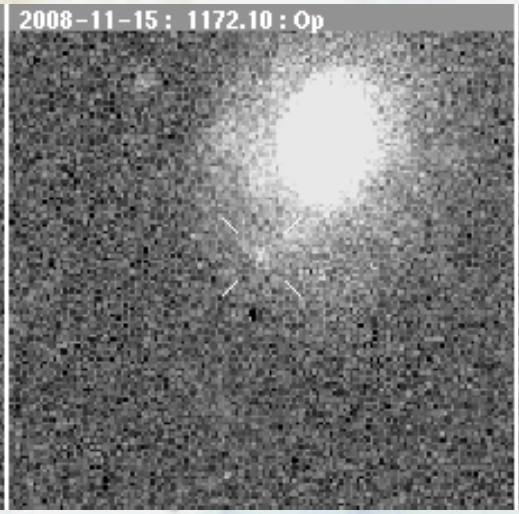
SN 2007oc -- First CHASE Discovery

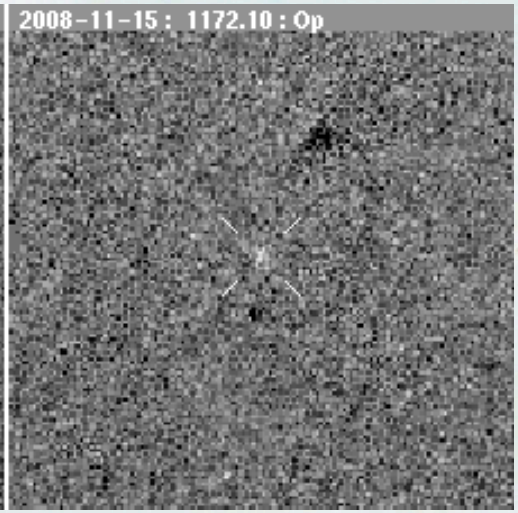


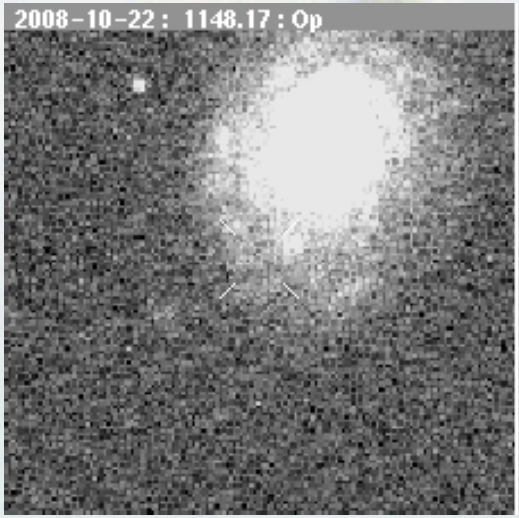


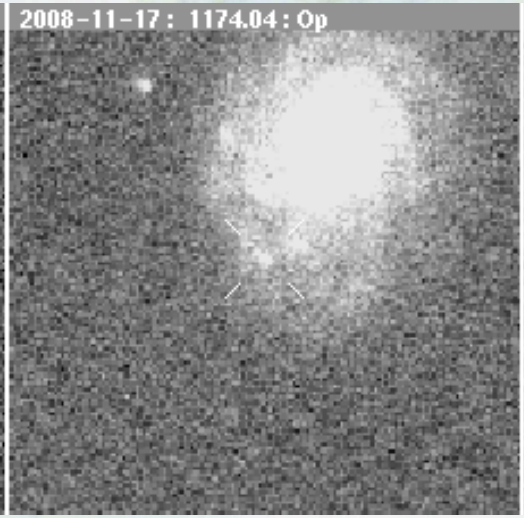
SN 2008xx -- Latest CHASE Discovery

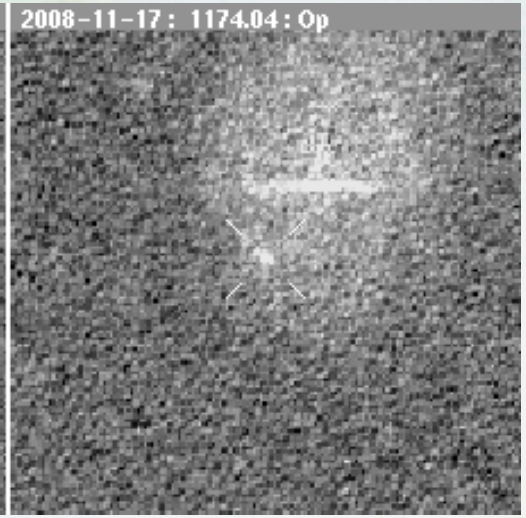












Summary of CHASE Discoveries

Year 2007: 2 discove

Year 2008: 24 discov
2008cc, 2008ci, 200
2008fd, 2008fl, 200

Redshifts: 1174-249

21+ CBET reports

bh, 2008bi, 2008bp,
y, 2008ed, 2008et,
2008gq,2008xx)

Checkers

- **Research assistants:**
  - **Roberto Antezana**
  - **Luis González**
- **Undergraduate students:**
  - **Paulina González**
  - **Paula López**
  - **Daphne Iturra**
  - **Simón Silva**

Technological developments
50 cm robotic telescope for MCSS

- SN search & photometry

- look for new class of events

- 1.4x PROMPT area
3.5x CHASE # of photons

- 50 cm A&M optical tube.
Italian mech., Russian optics
SN search optimized design

- El Capitan mount.
Astro-Physics Inc. long tradition
High load, tested in Antarctica

- train next generation of astronomers in time domain astrophysics and data analysis

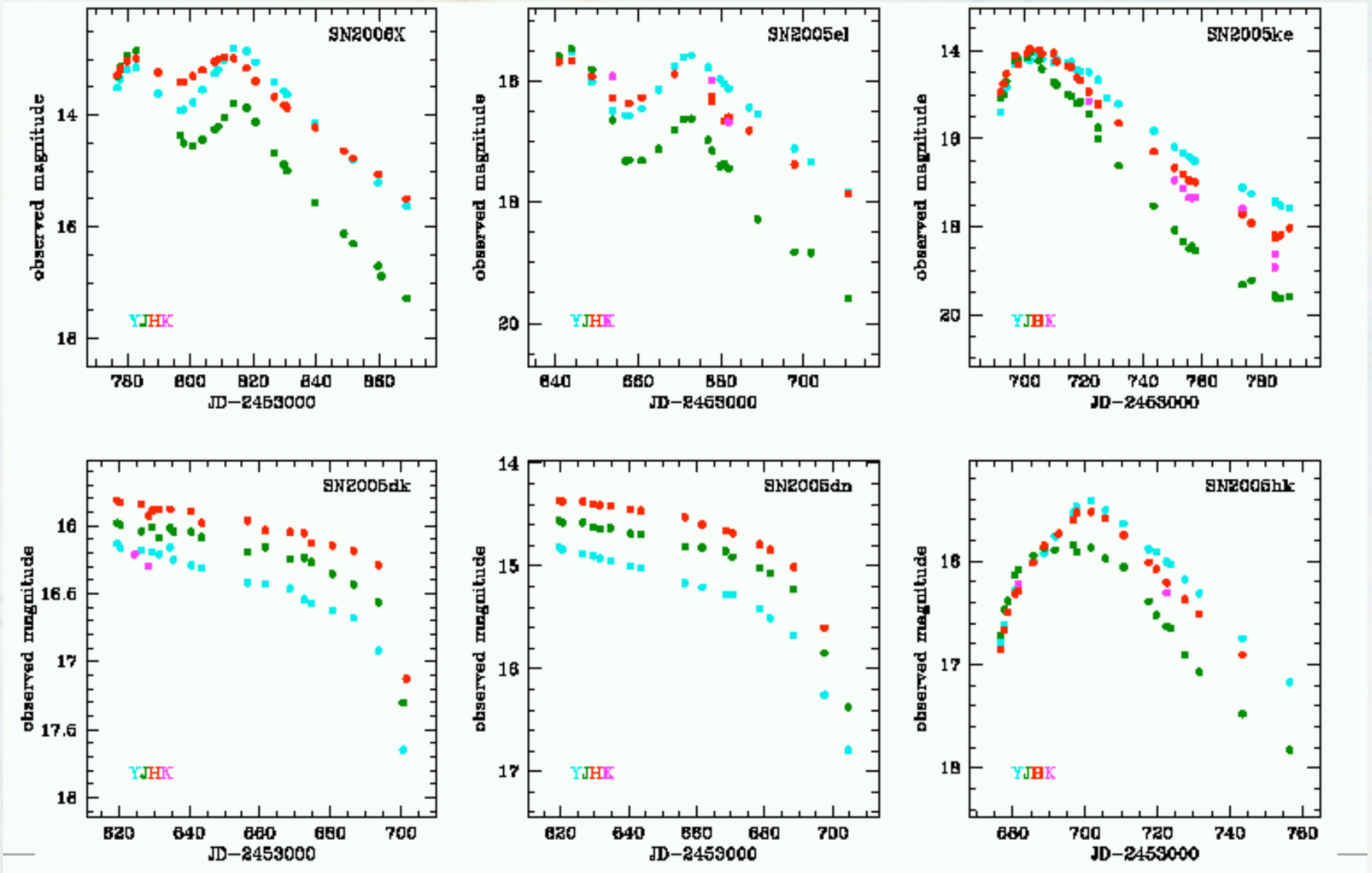
- potential synergy between engineering and astronomy departments

Supernova Follow-up built upon the Carnegie Supernova Project

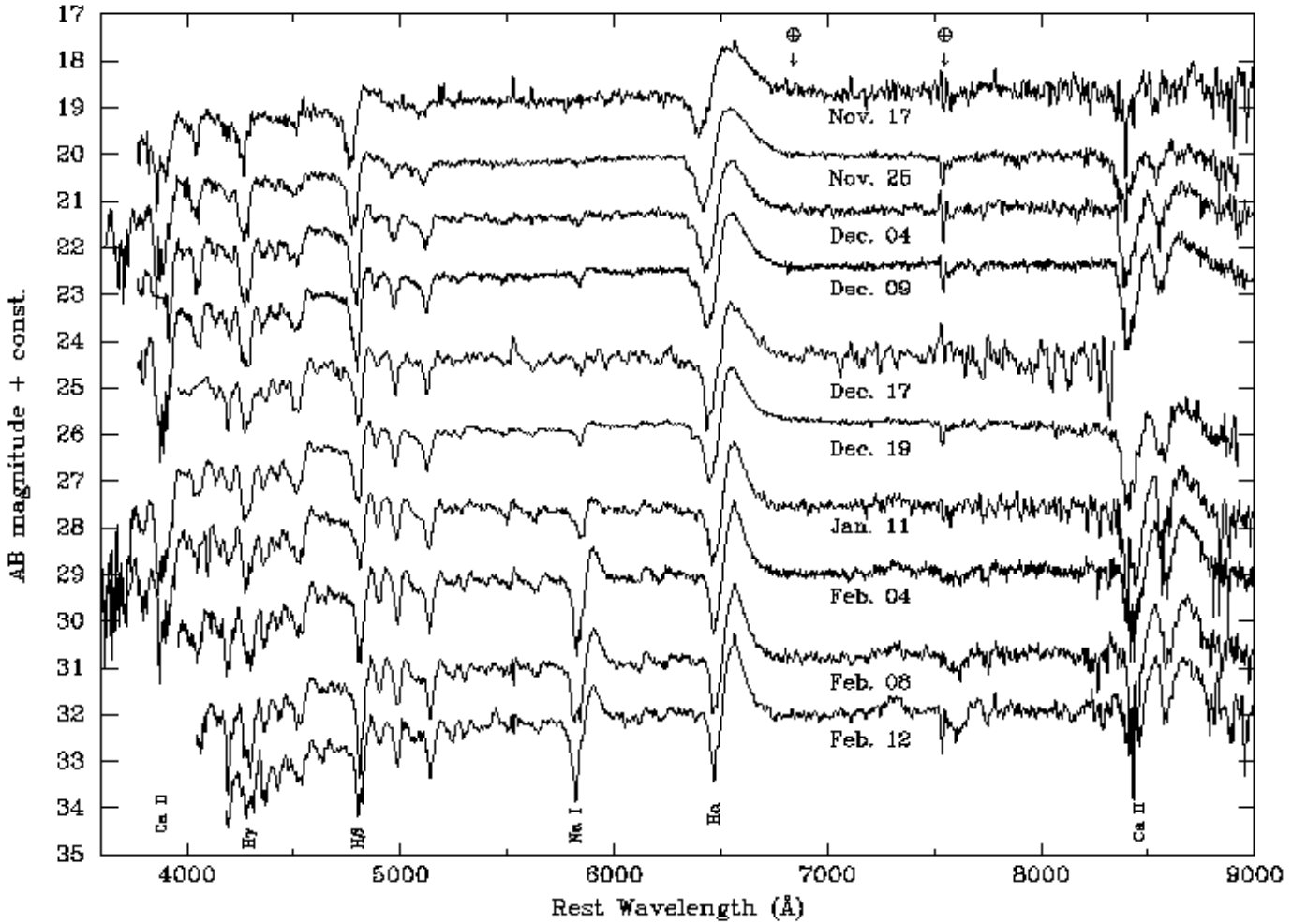
CSP: Phillips, Suntzeff, Hamuy, Freedman, Persson,…

One 9-month campaign per year 2004-2009

Results - Lightcurves



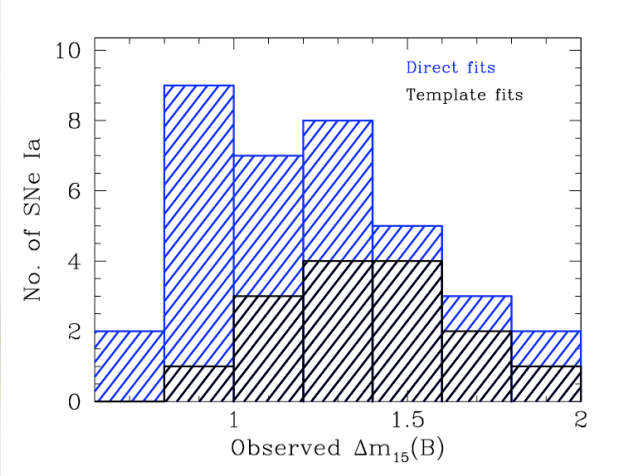
Results - Outstanding Spectroscopy

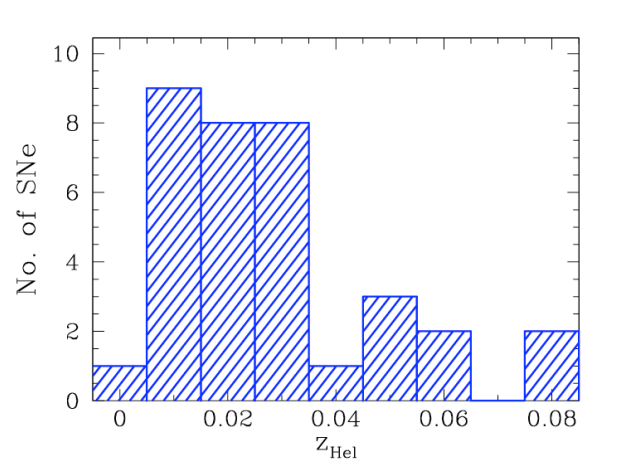


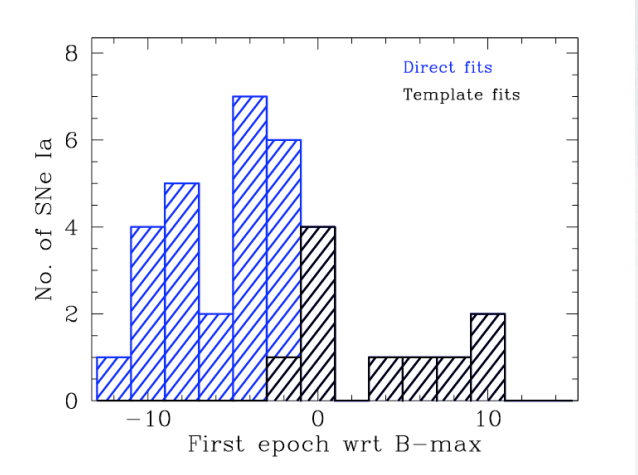
Summary of Follow-up Program

	Ia	II	Ibc	Total
2004/2005	17	13	9	39
2005/2006	22	27	0	49
2006/2007	34	14	7	55
2007/2008	31	20	3	54
Total	104	74	19	197

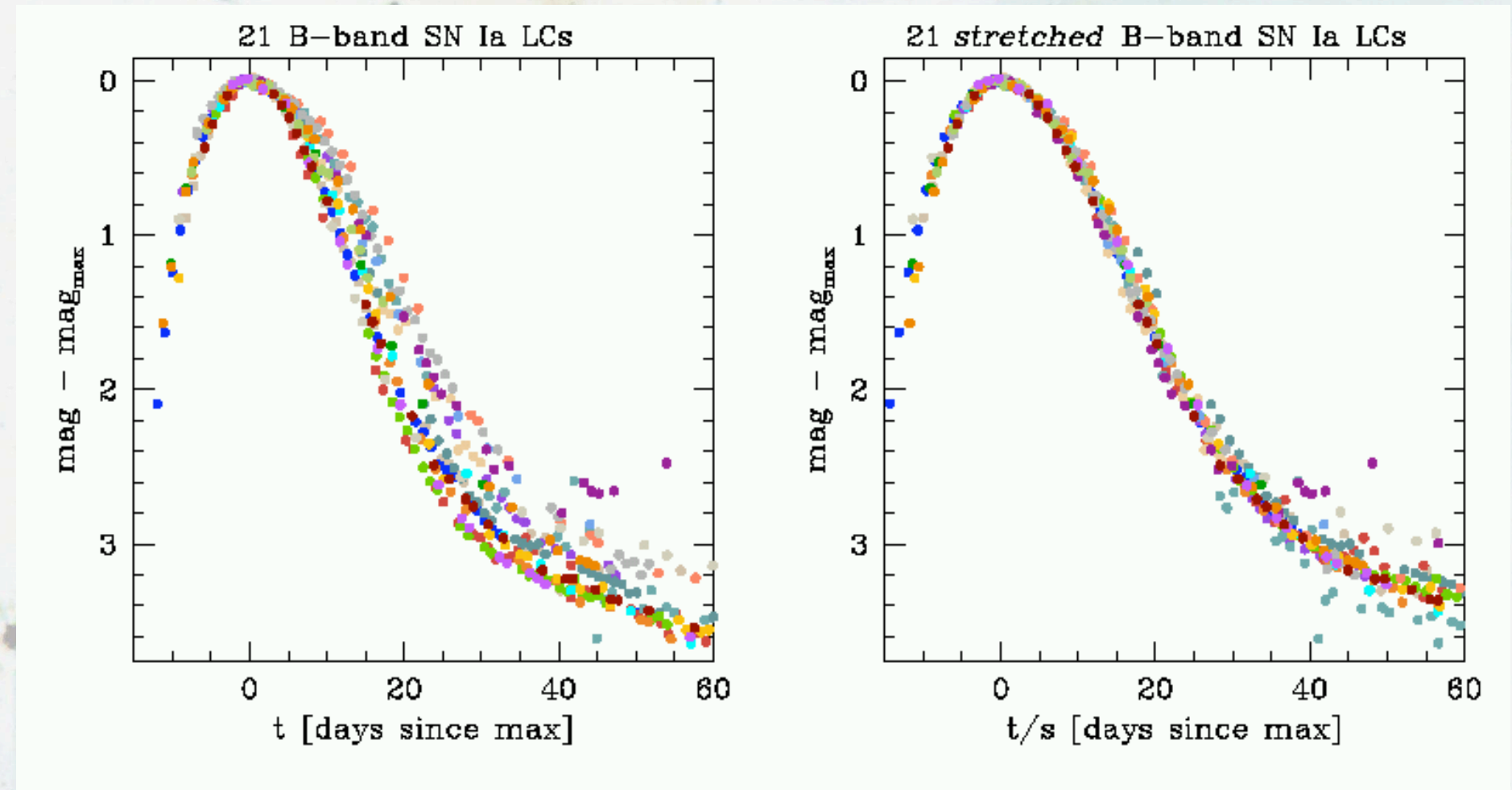
Results on SNe Ia – First two years



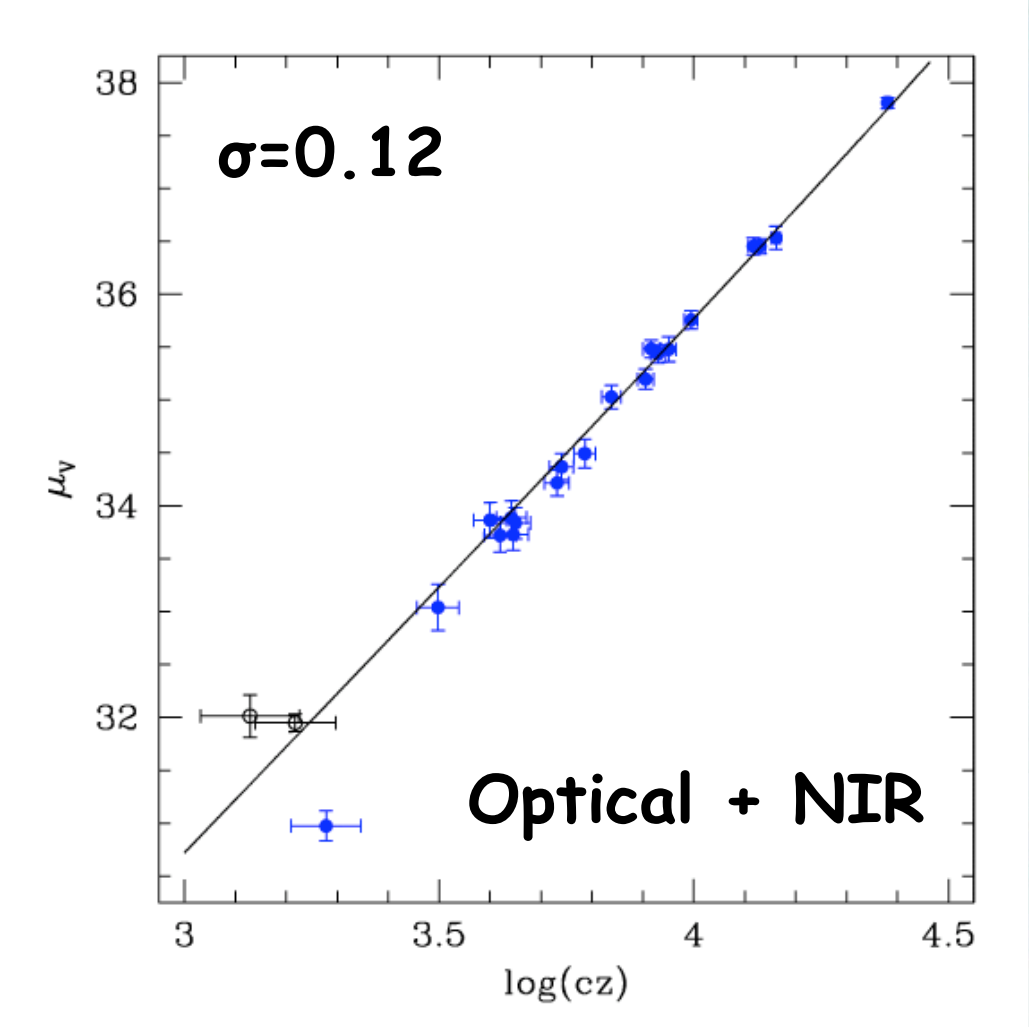




Analysis of Type Ia Supernovae

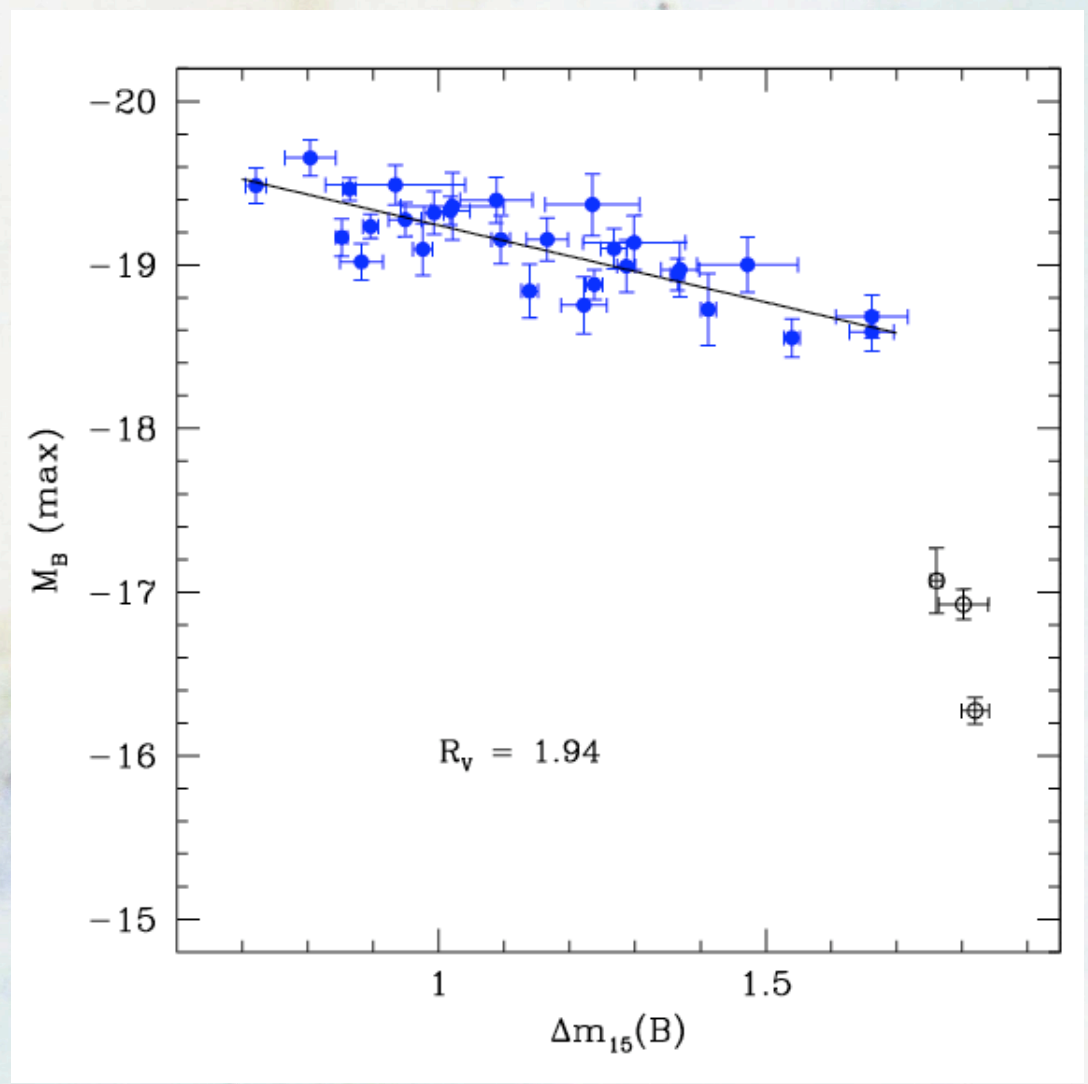


Hubble Law for Type Ia Supernovae



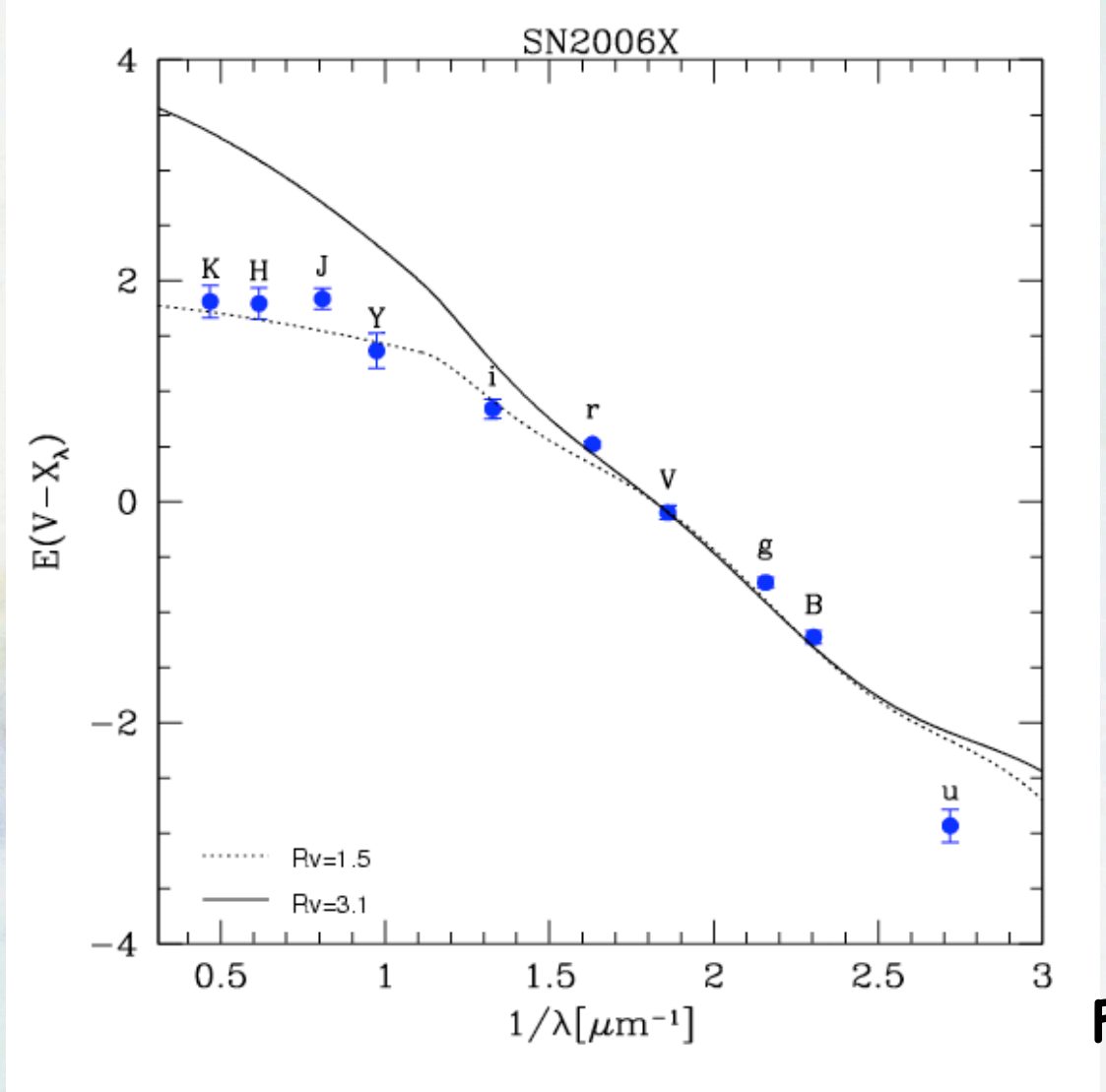
Folatelli et al.

Phillips relation for Type Ia Supernovae



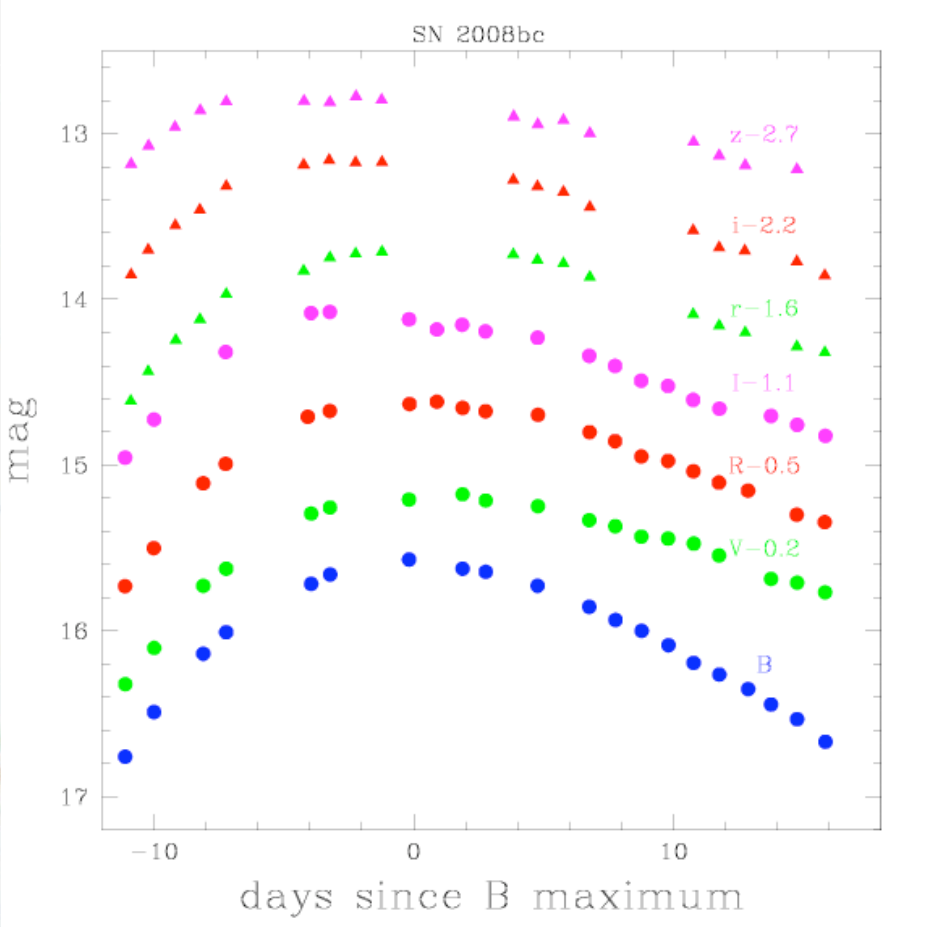
Folatelli et al.

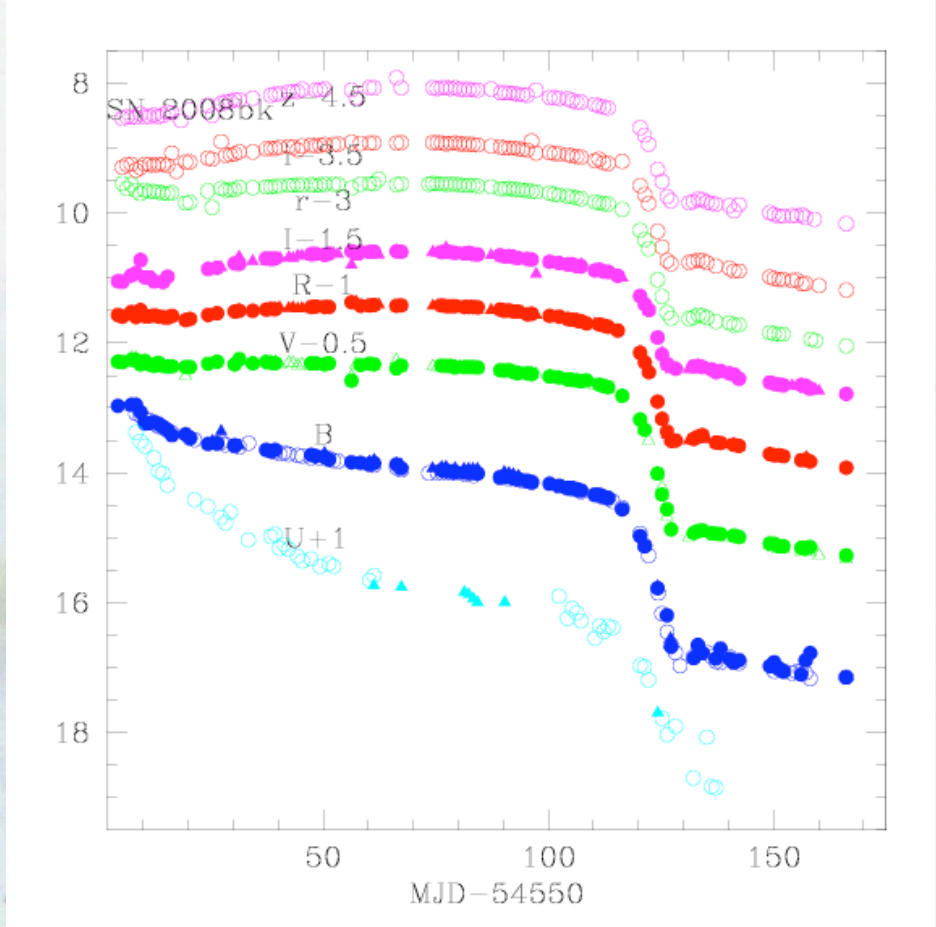
Extinction law for Type Ia Supernovae



Folatelli et al.

Followup observations with PROMPT



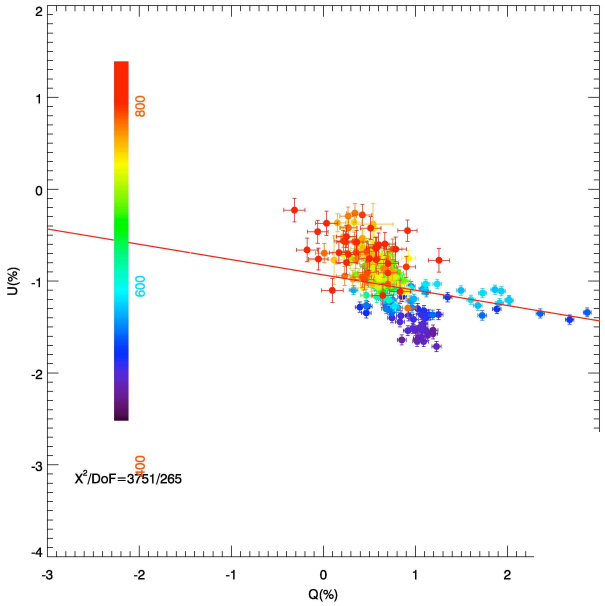


Pignata

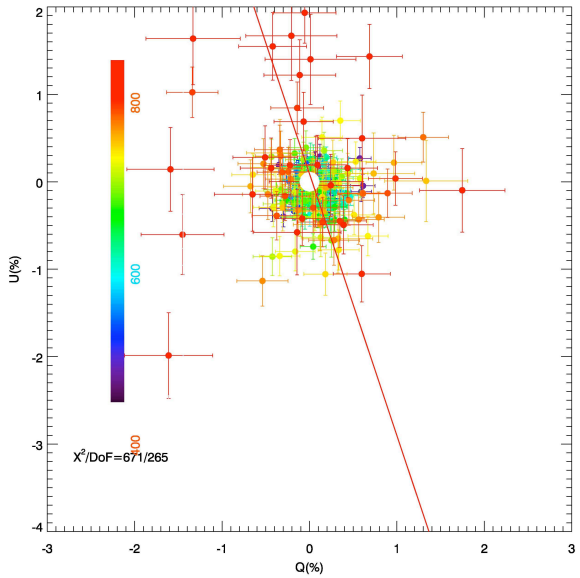
Spectropolarimetry

Millennium Center for Supernova Science

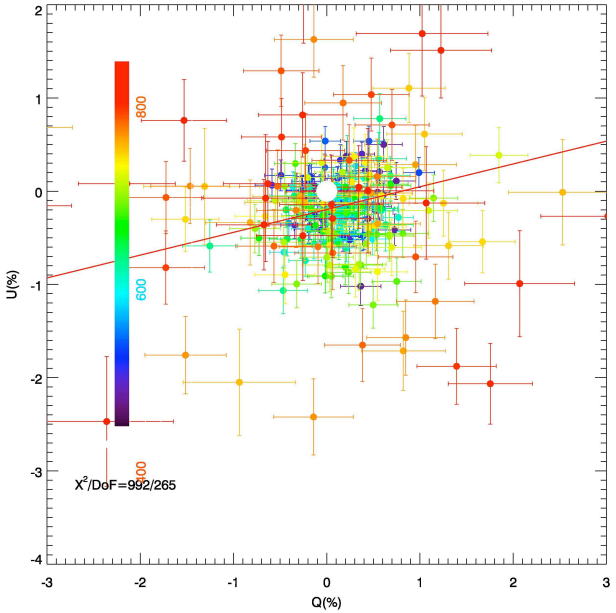
Qisp = 0.00000 Uisp = -0.0093312728 Daxis = -0.082556202



Qisp = 0.00030524232 Uisp = 0.00000 Daxis = -0.62426027



Qisp = 0.00000 Uisp = -0.0019717417 Daxis = 0.11989333



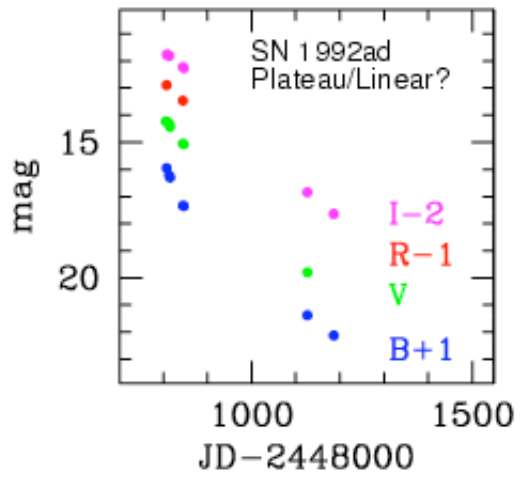
Clocchiatti & Quinn

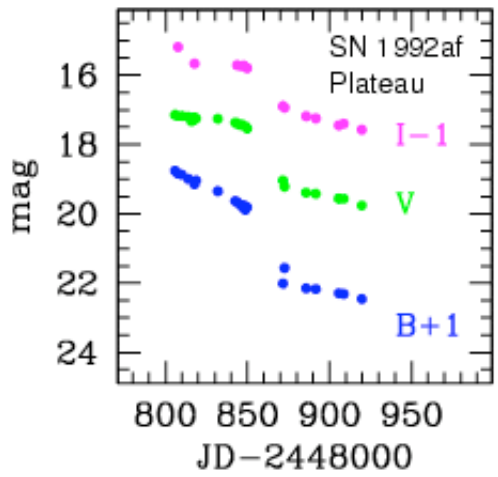
Type II science using CTIO, Calán/Tololo, SOIRS, CATS

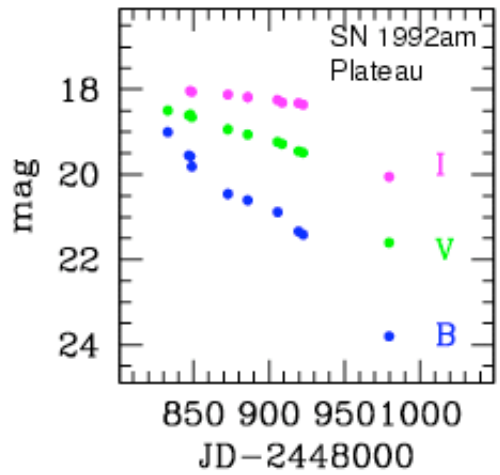
CTIO (1)	Calán/Tololo (10)	SOIRS (6)	CATS (34)	
1986L	1991al	1999br	2002ew	2003cv
	1992T	1999ca	2002fa	2003cx
	1992U	1999cr	210	2003dq
	1992ad	1999eg	2002gd	2003ef
	1992af	1999em	2002gw	2003eg
	1992am	2000cb	2002hj	2003ej
	1992ba		2002hx	2003fb
	1993A		2002ig	2003gd
	1993K		2003B	2003hd
	1993S		2003E	2003hg
			2003T	2003hk
			2003bg	2003hl
			2003bj	2003hn
			2003bl	2003ho
			2003bn	2003ib
			2003ci	2003ip
			2003cn	2003iq

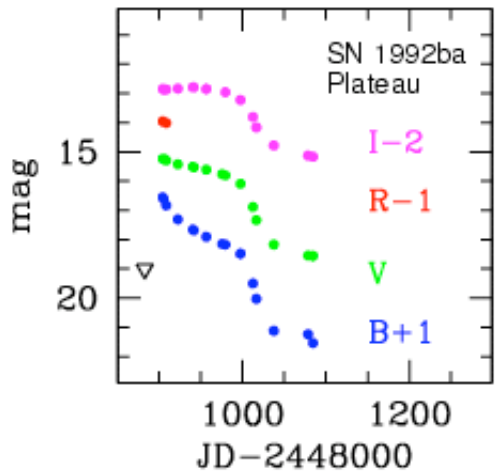
Total: 51 SNe

Low-z Type II science
BVI + R + U photometry

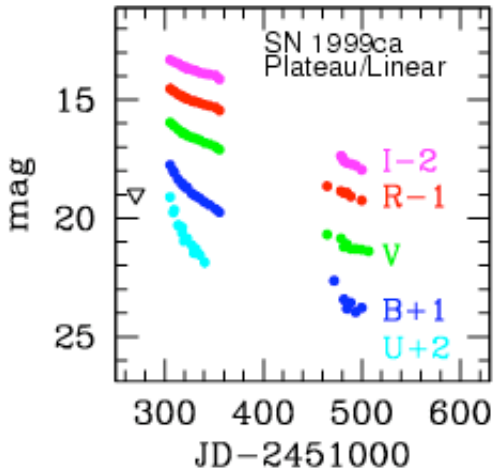


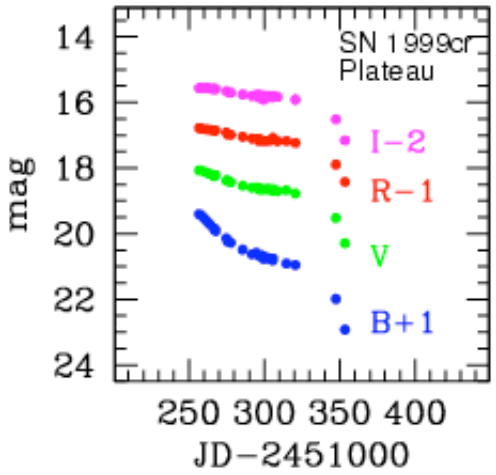


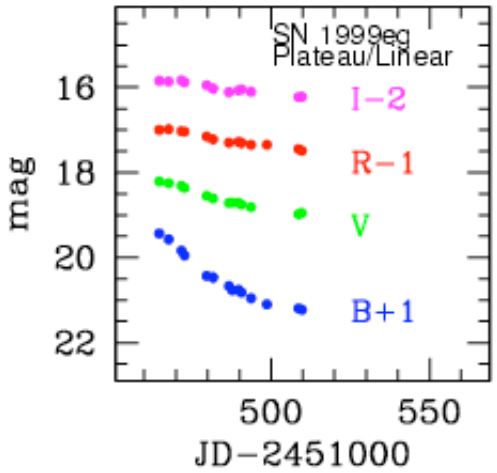


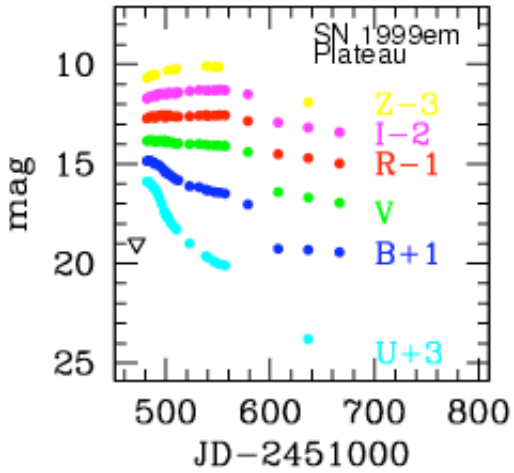


Low-z Type II science
BVI + R + U photometry

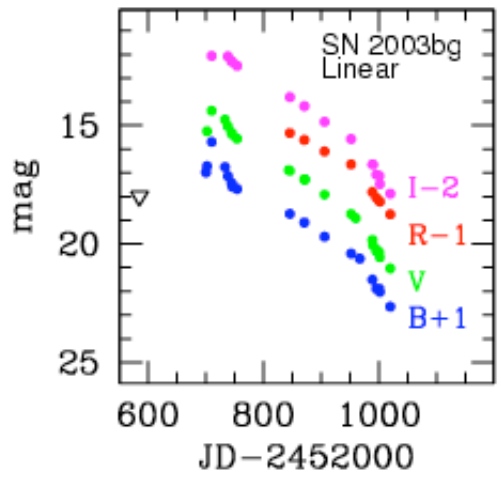


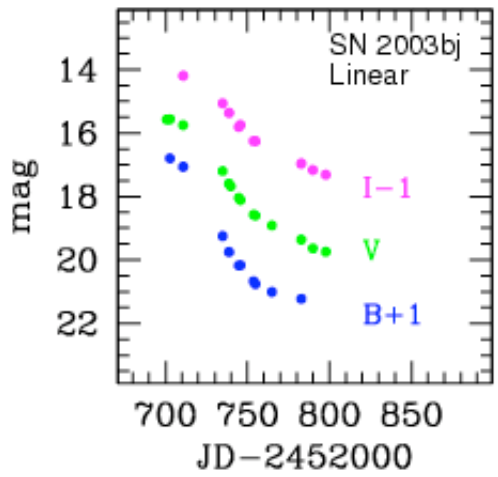


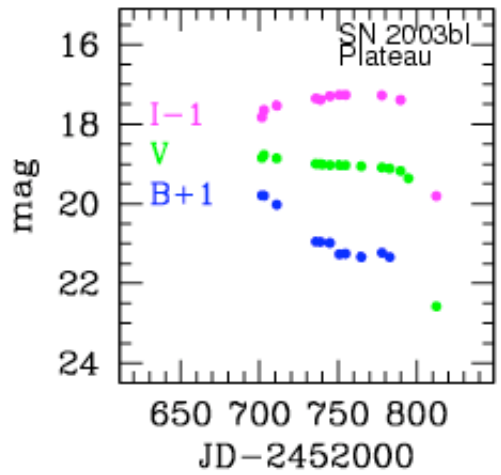


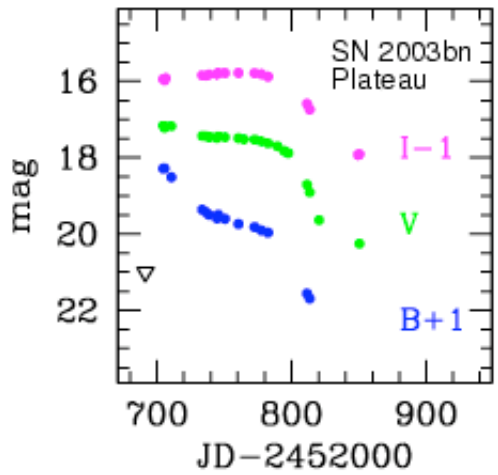


Low-z Type II science
BVI + R + U photometry

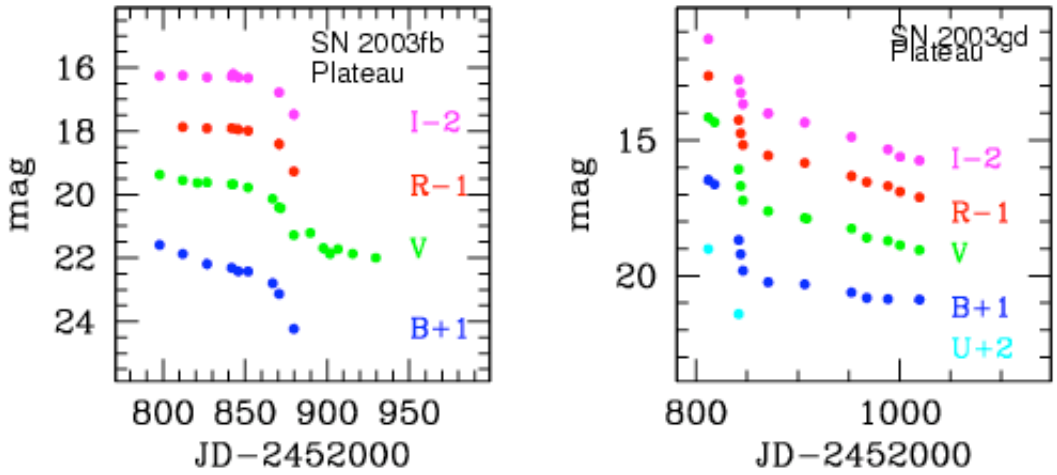


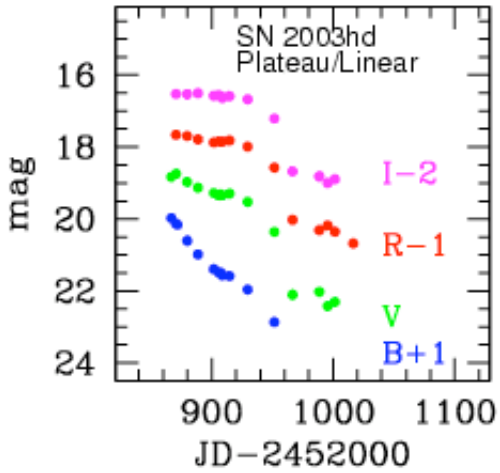


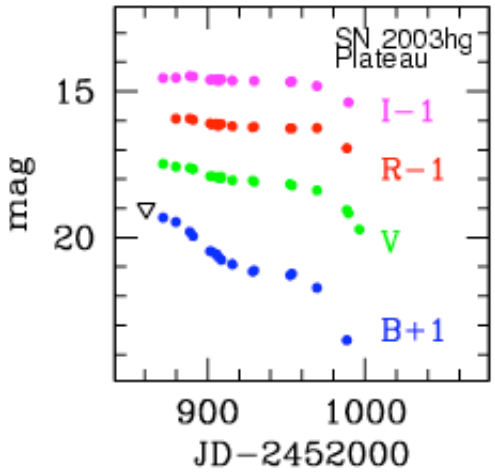




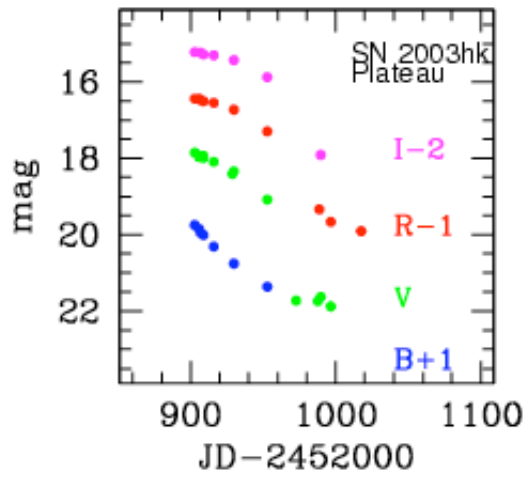
Low-z Type II science
BVI + R + U photometry

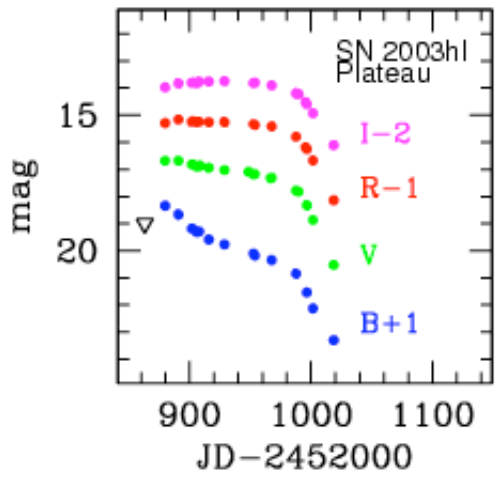


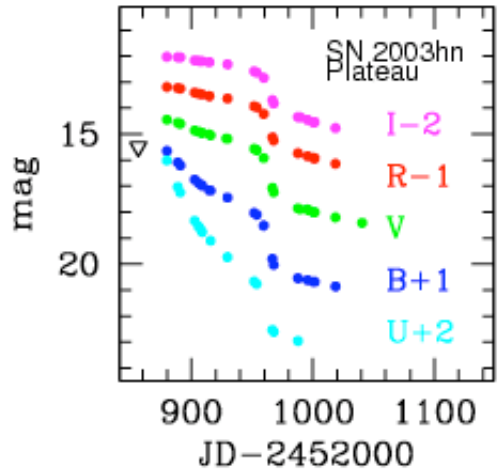


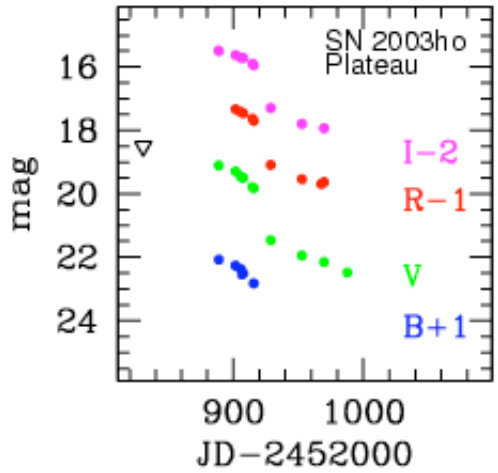


Low-z Type II science
BVI + R + U photometry

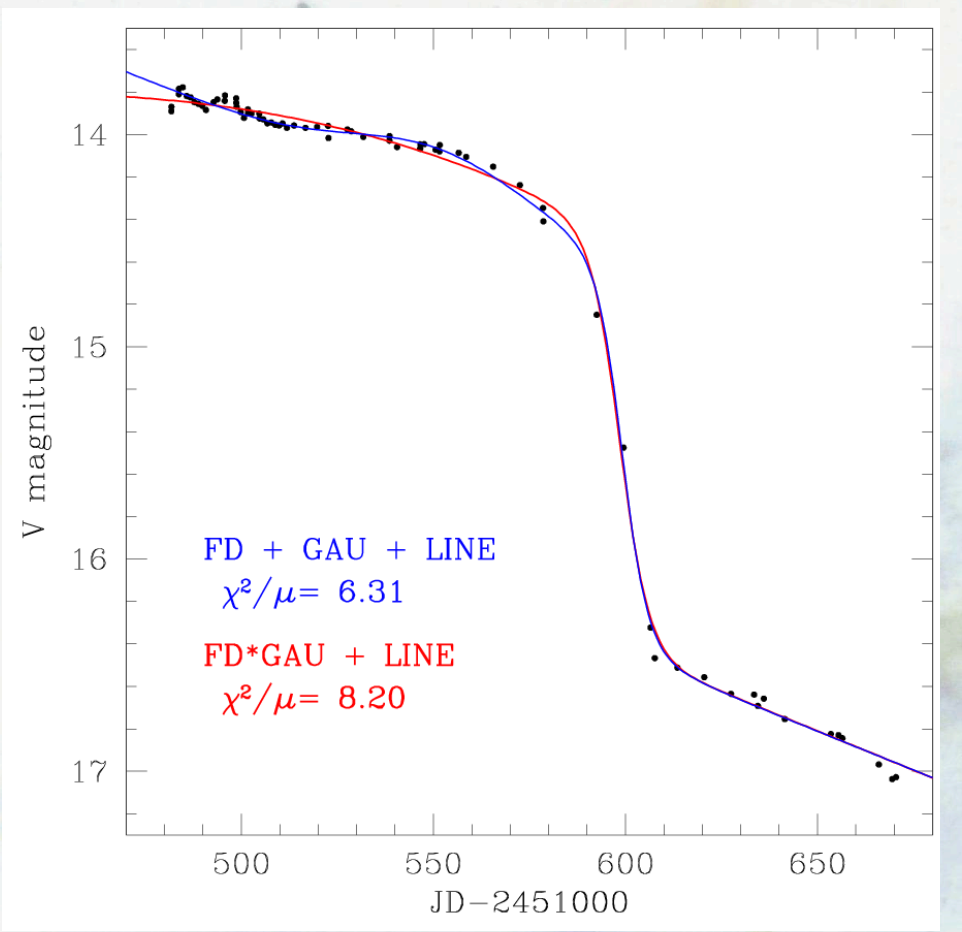


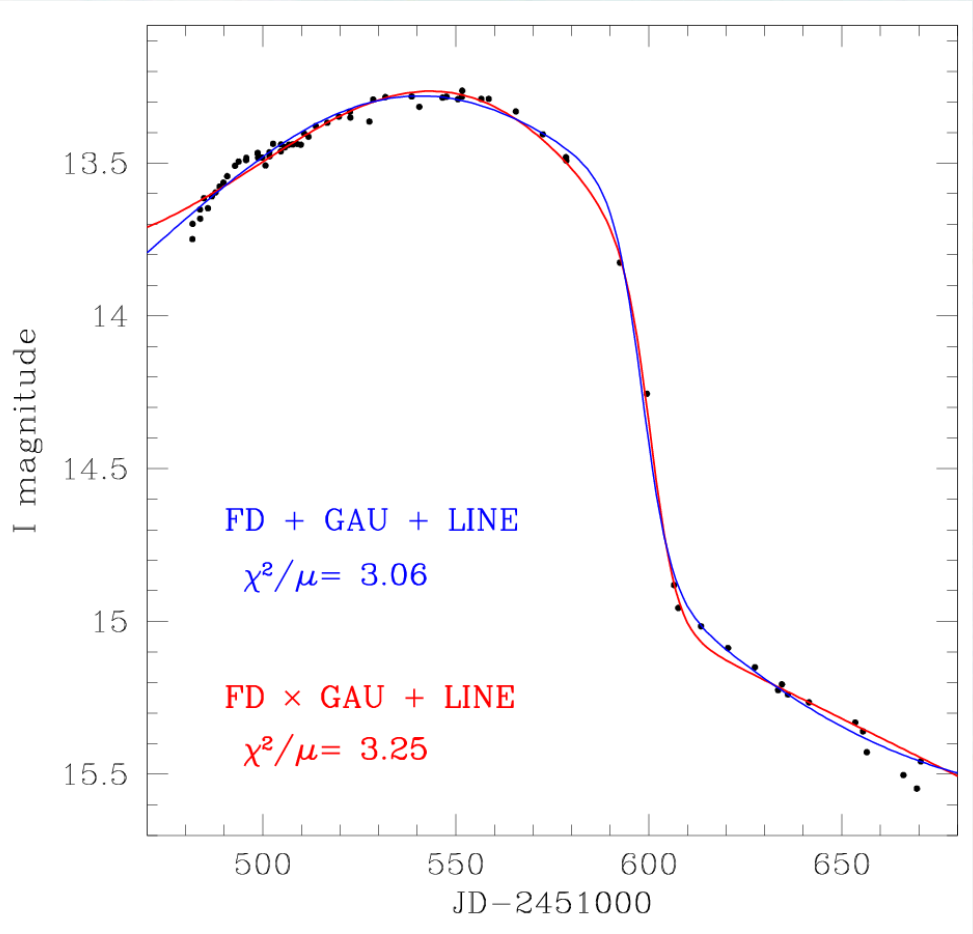






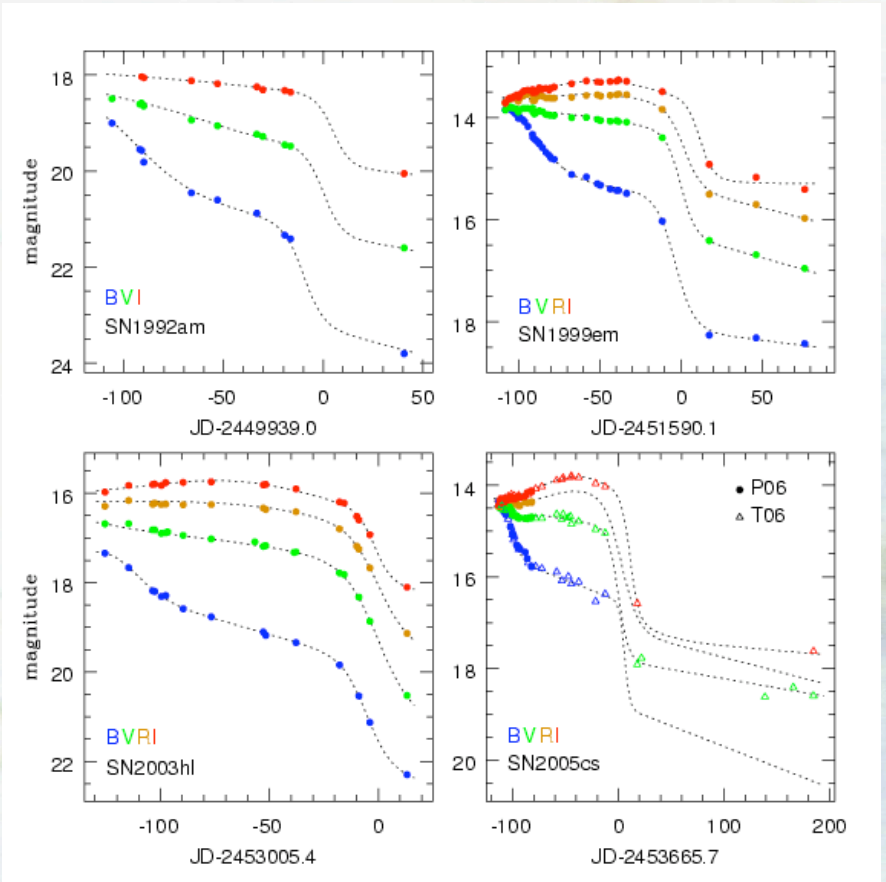
Light Curve Fits to Type II Plateau SNe

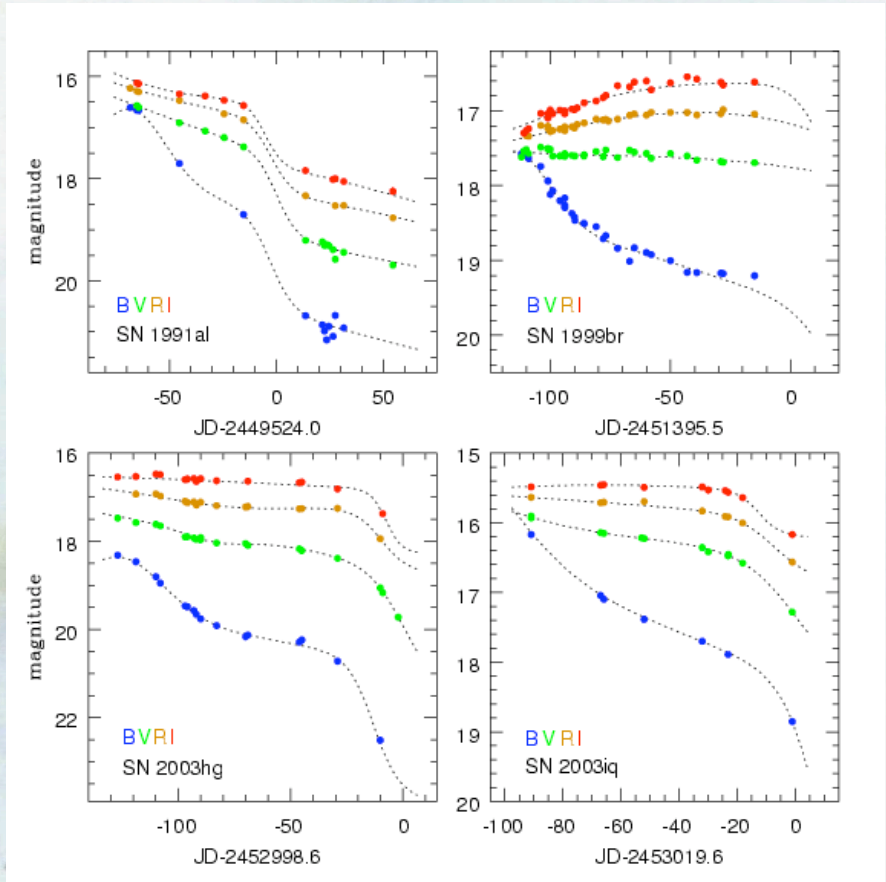




Olivares

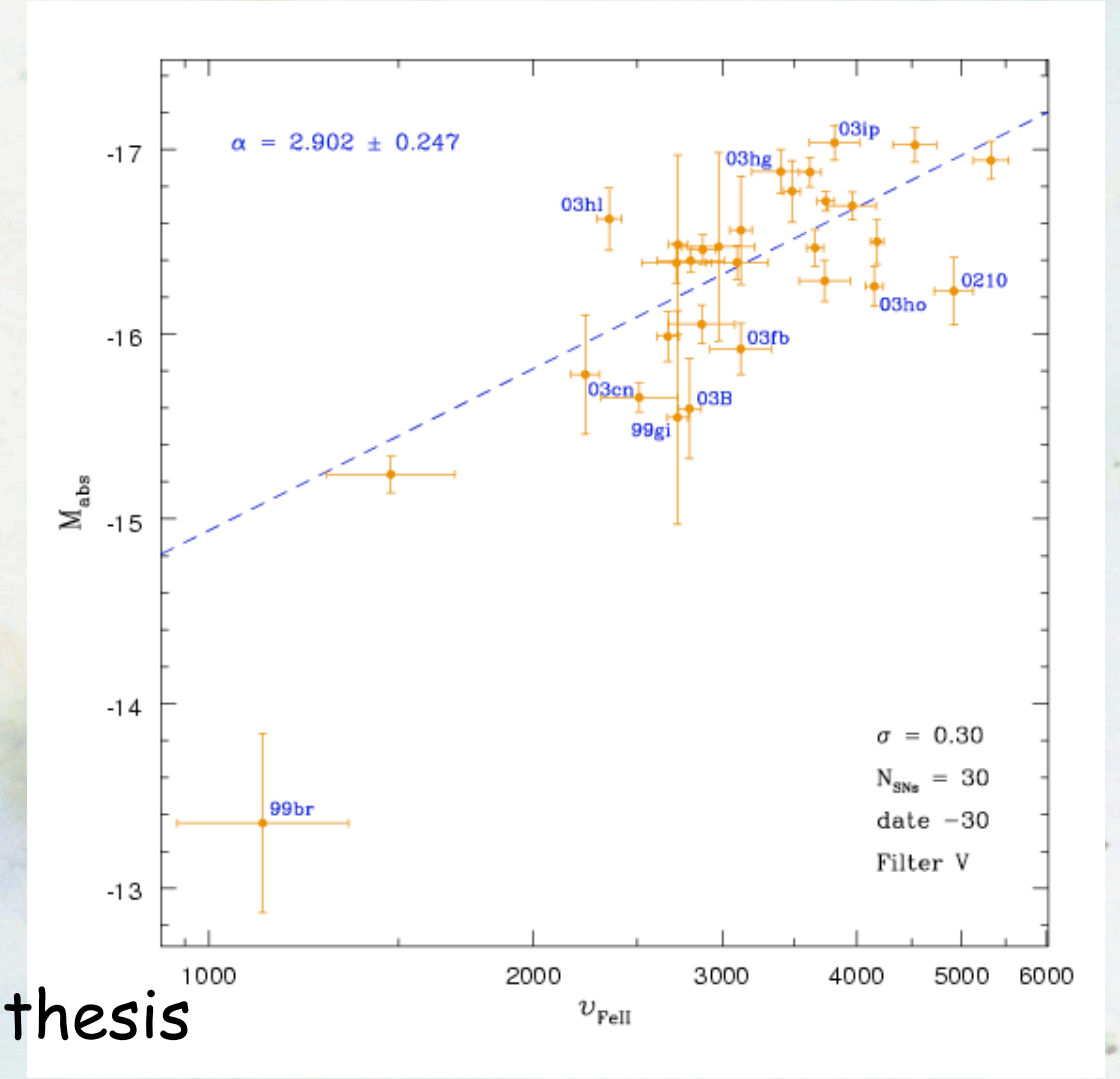
Light Curve Fits to Type II Plateau SNe





Olivares

The Standardized Candle Method for Type II Plateau Supernovae

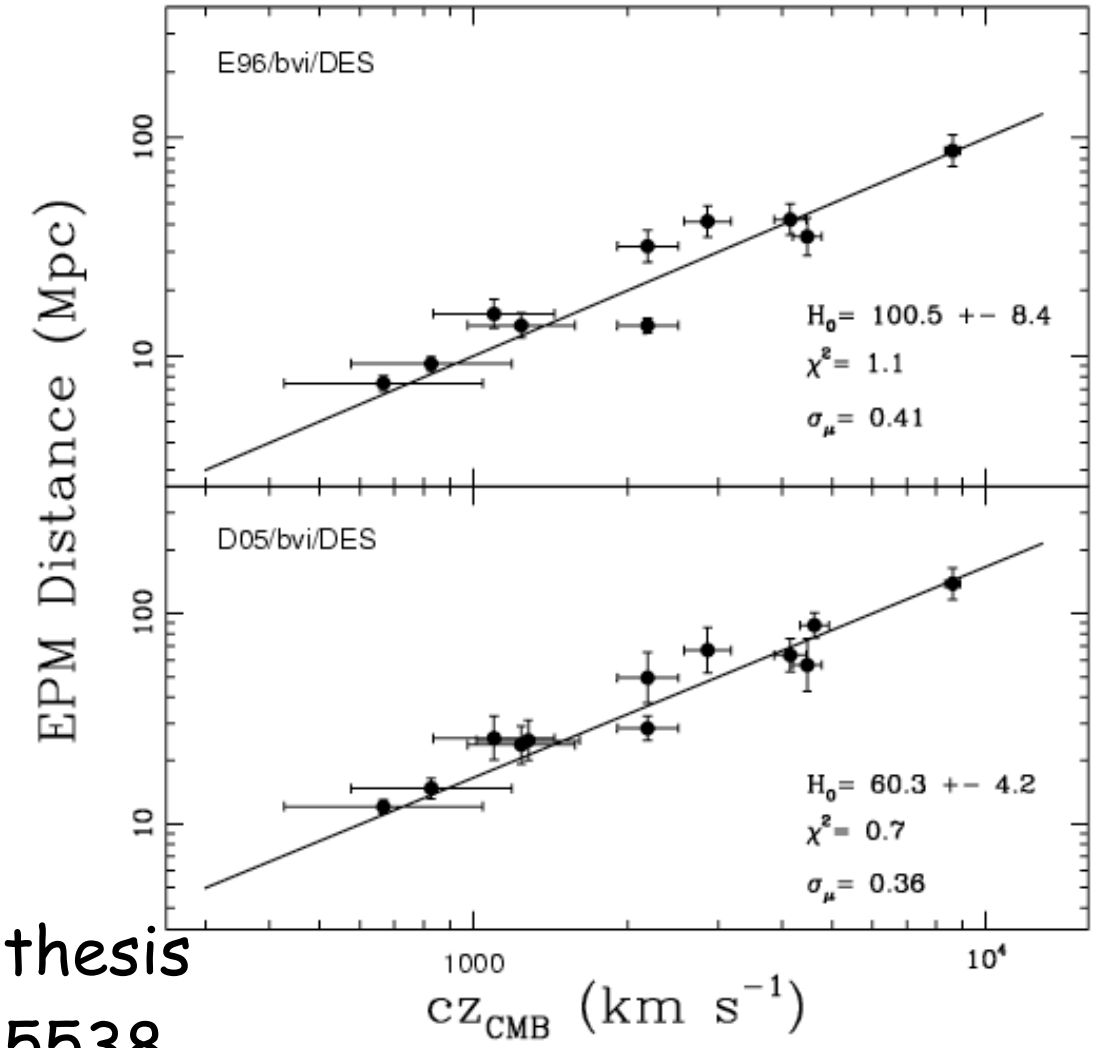


Olivares, MS thesis

arXiv:0810.5518

Leaving R_V as a free parameter, we obtain a value of 1.4

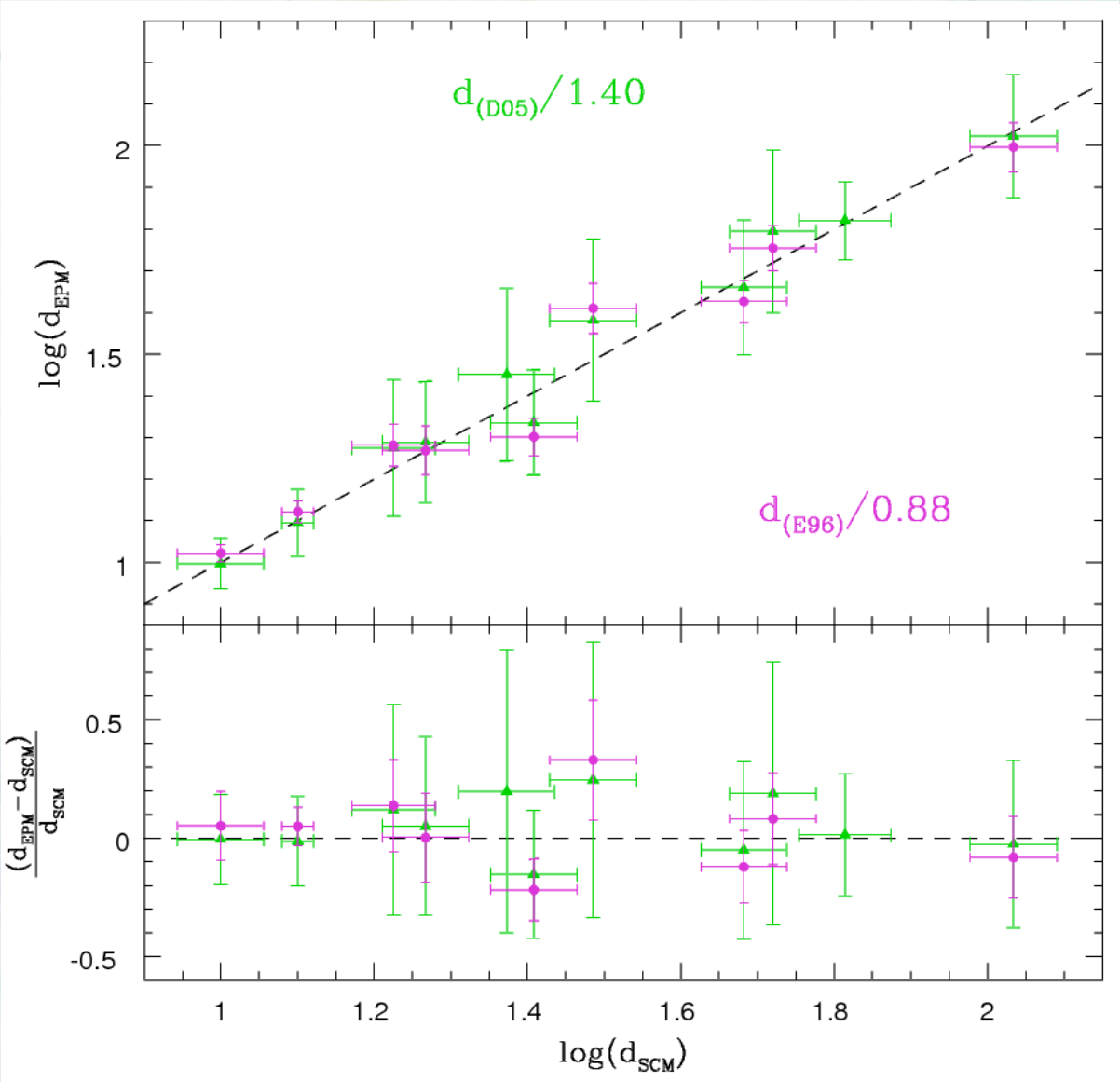
The Expanding Photosphere Method for Type II Plateau Supernovae



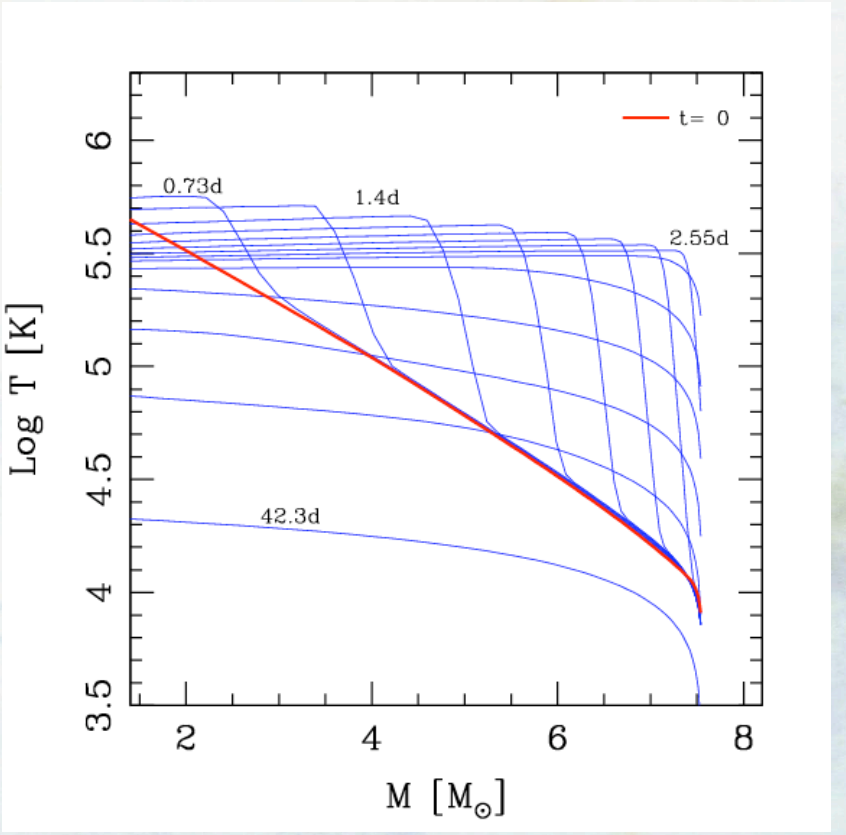
Jones, MSc thesis

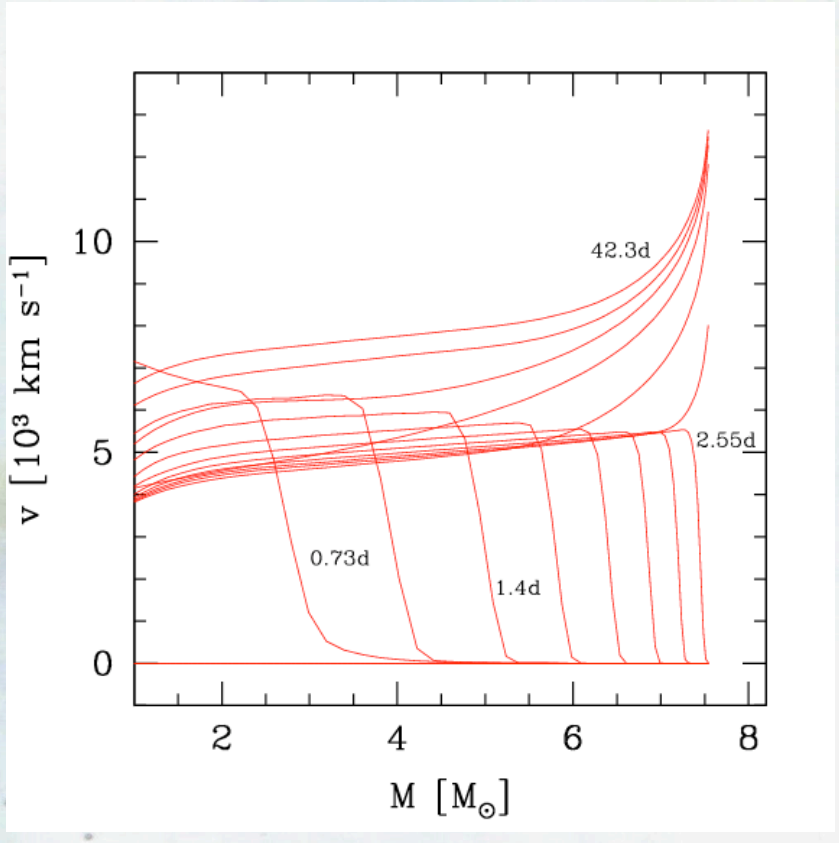
arXiv:0810.5538

SCM versus EPM



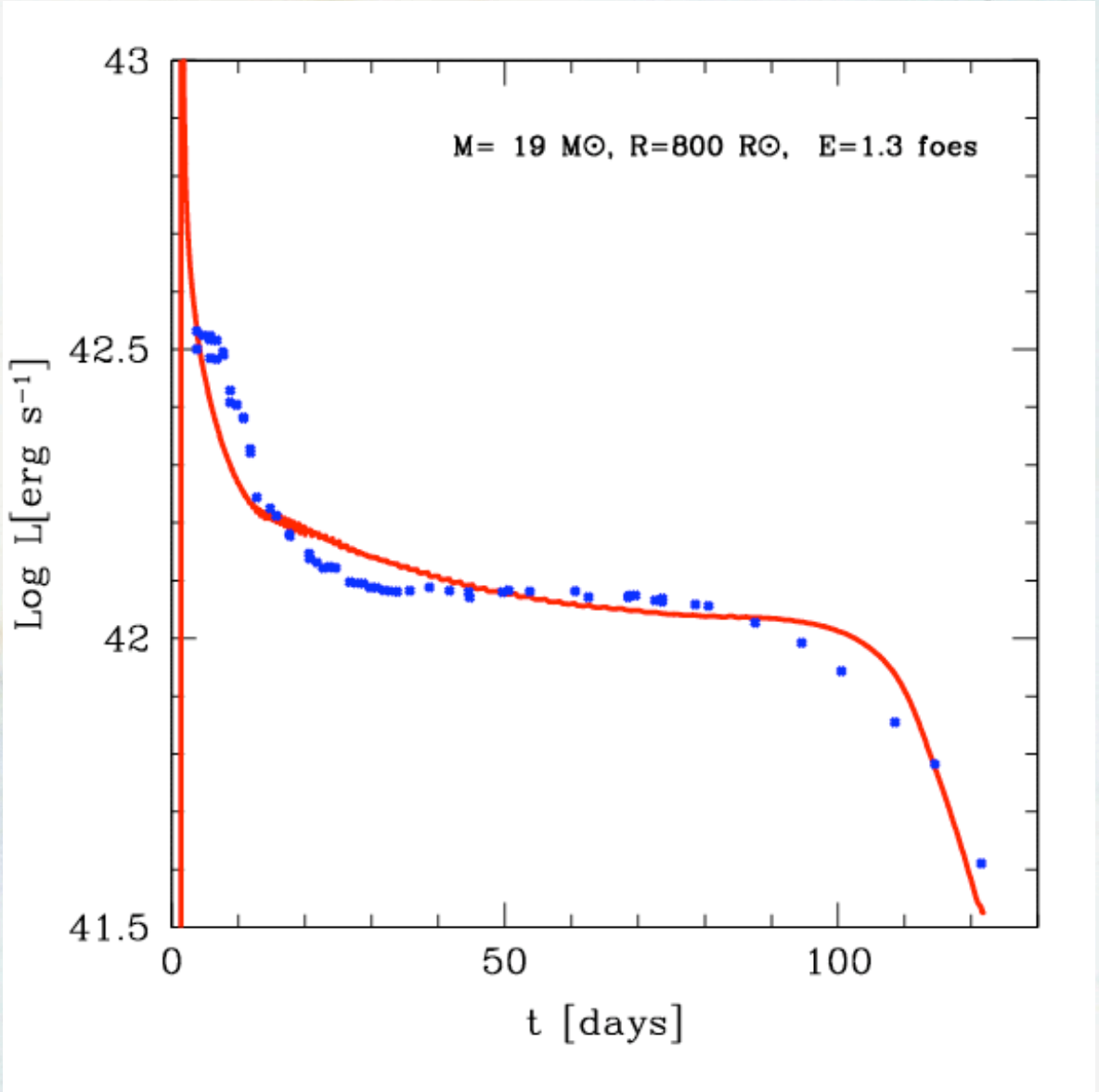
Theoretical Modeling of Type II Plateau Supernovae





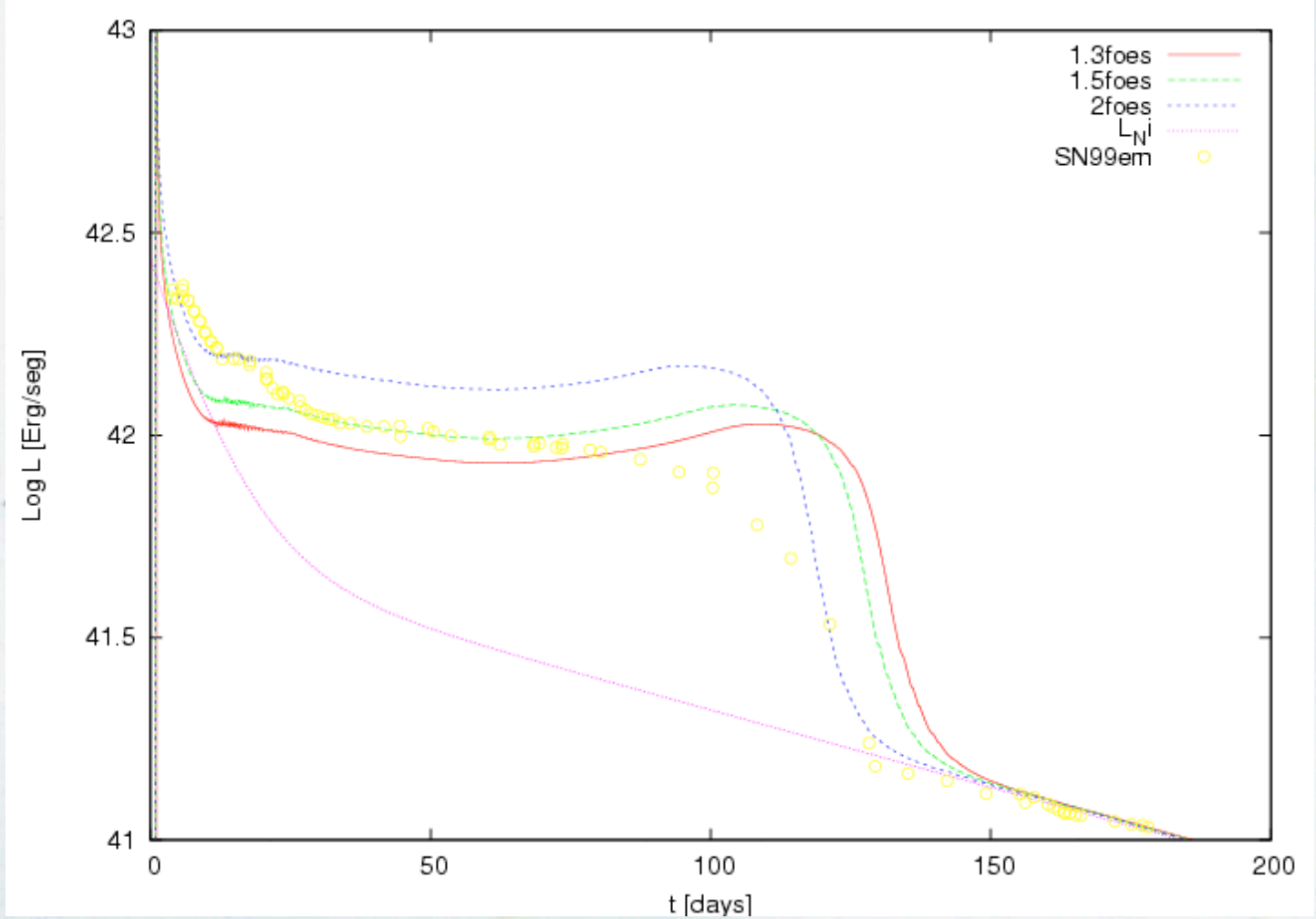
Bersten

Theoretical Modeling of Type II Plateau Supernovae



Bersten

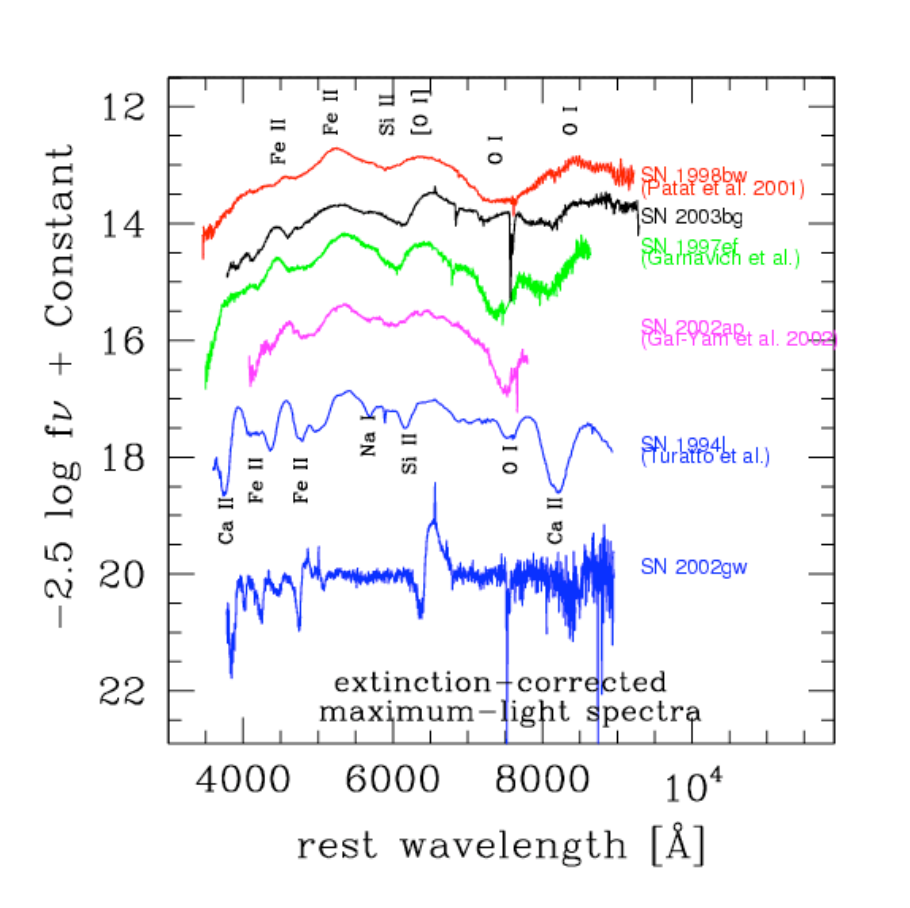
Theoretical Modeling of Type II Plateau Supernovae

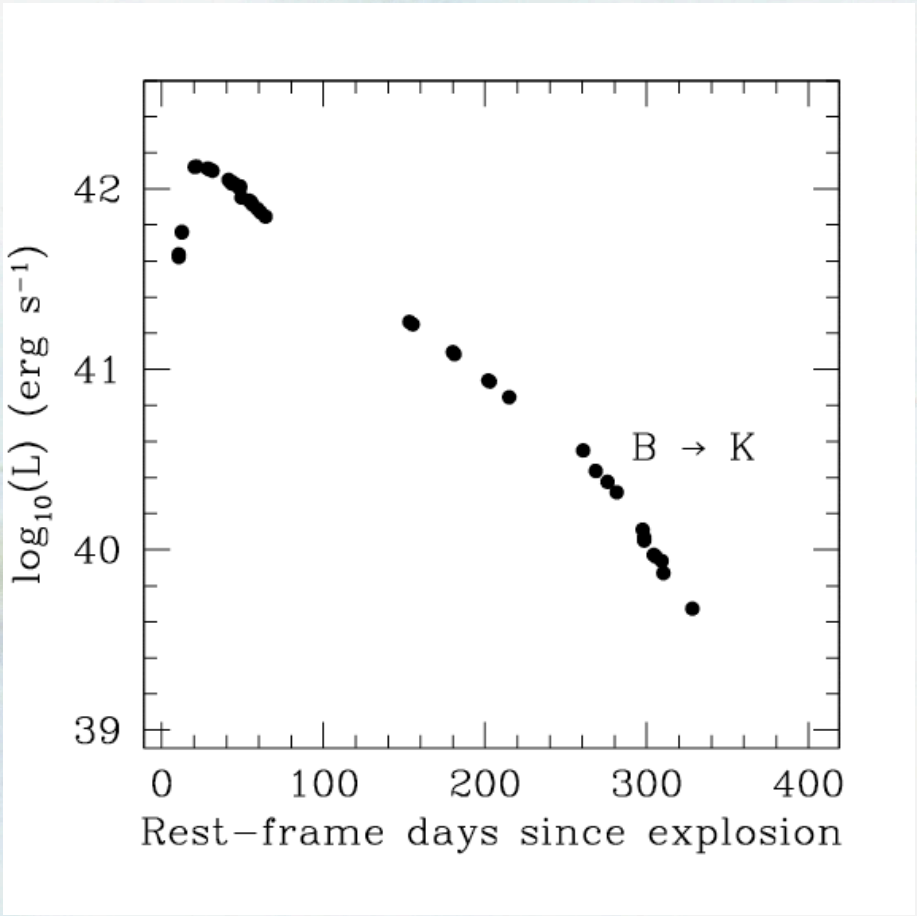


Bersten

SN 2003bg

Discovered by Chassagne at cz = 1367 km/sec

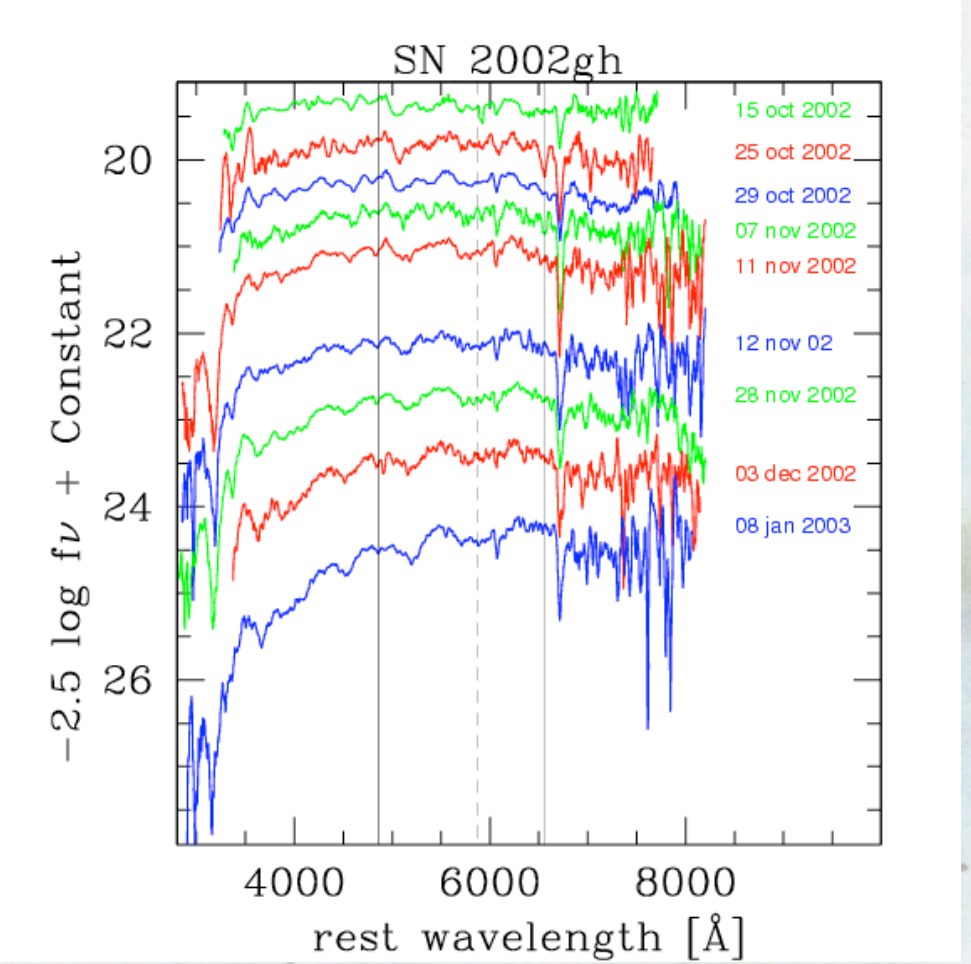


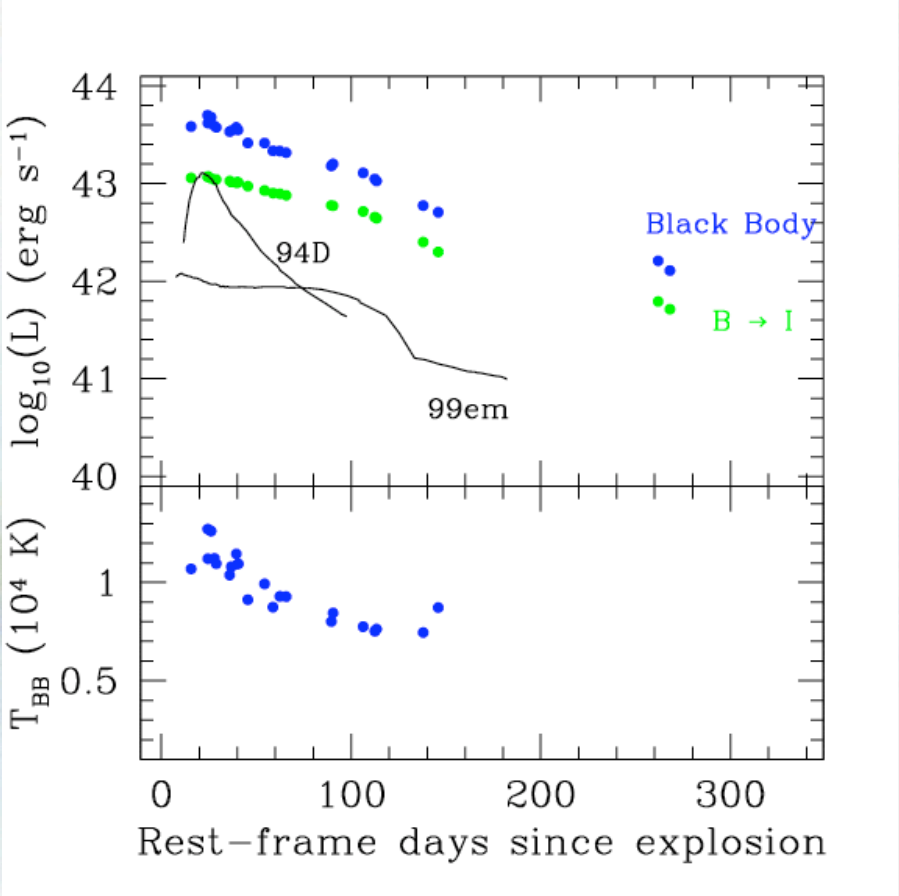
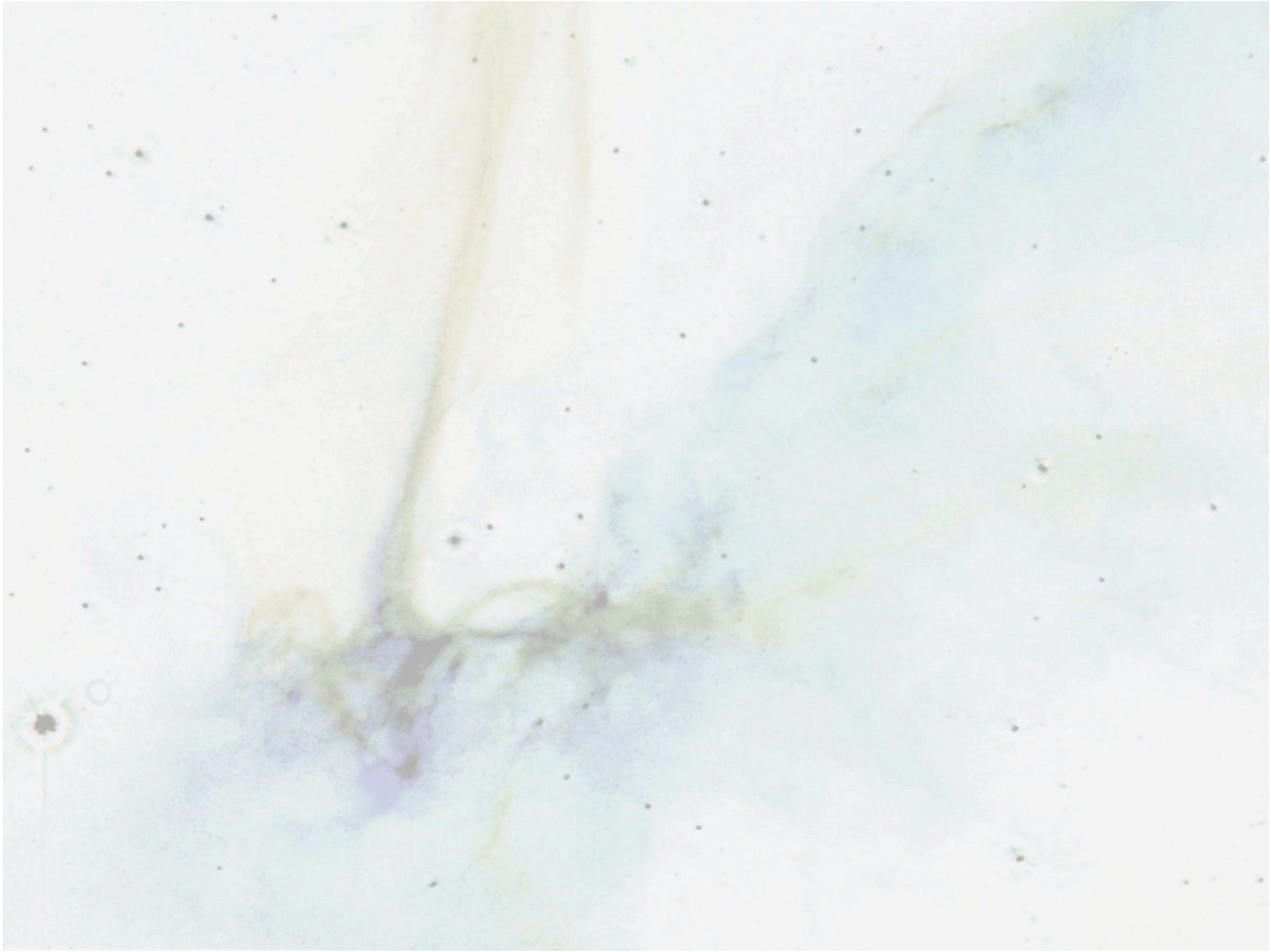


Clear example of a Type II hypernova

SN 2002gh

Discovered by the SN factory (Wood-Vasey et al) at cz=39900 km/sec





Type III supernova?