Thermonuclear supernovae & related transients

SOXS WG-5 2020

Virtual Meeting 2020

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9 slides of content, including questions for discussion

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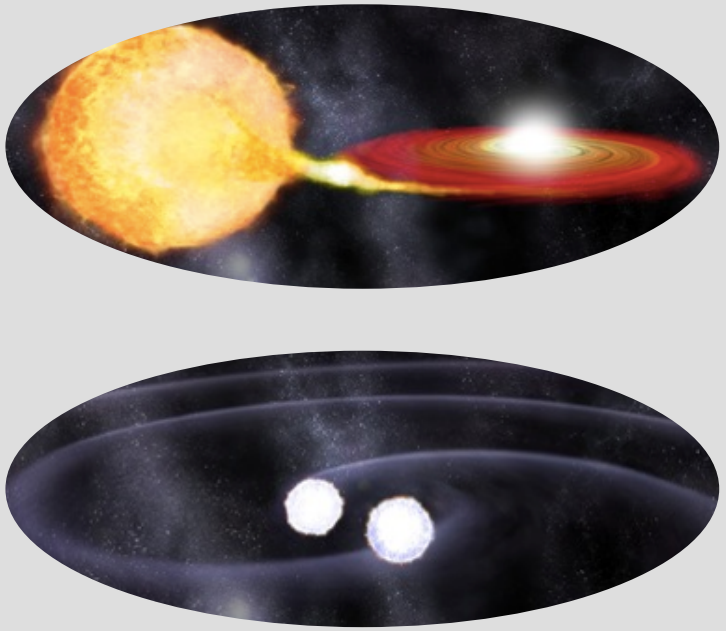
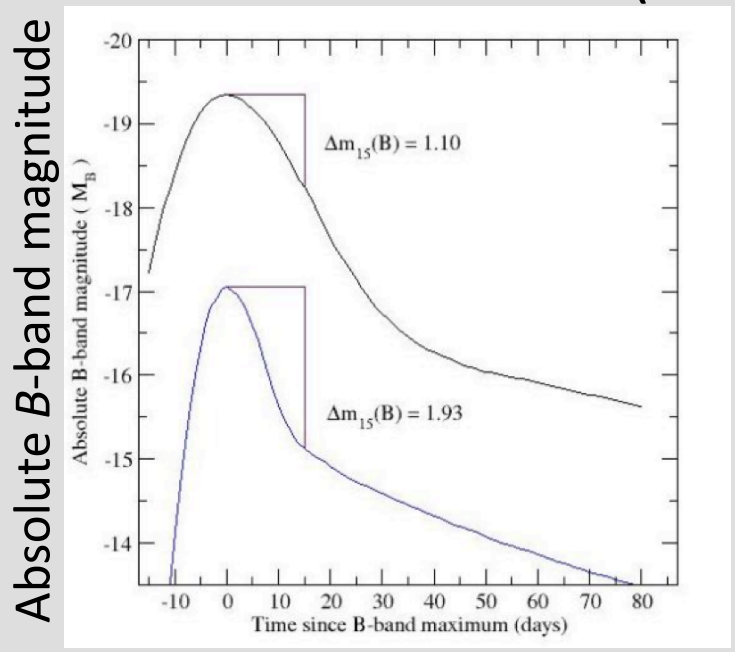
Type Ia supernovae

Progenitor systems

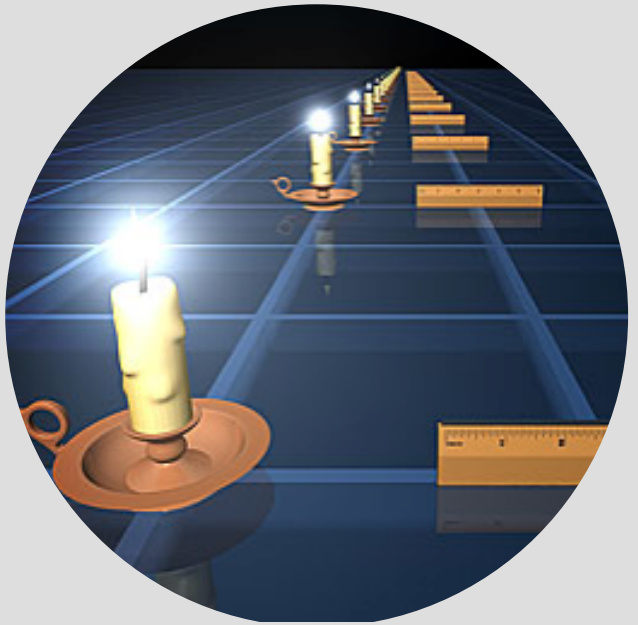


Standardizable Candles (LWR)



Days relative to *B*-band maximum

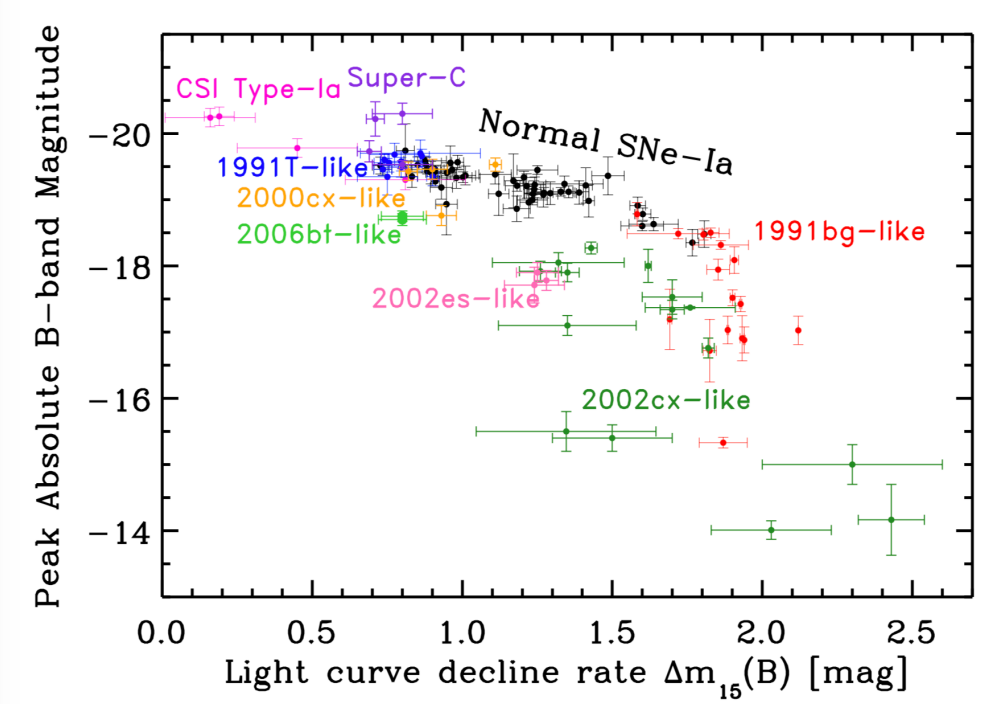
H_0 & Dark Energy



Despite over 30 years of detailed studies the origins of SNe-Ia and how they explode remains rather elusive

(due to lack of early observations that contain information on the progenitors and not the SN debris)

Width luminosity relation reveals a diverse “class”



Adapted from Stritzinger et al. 2015

WG-5 key work packages

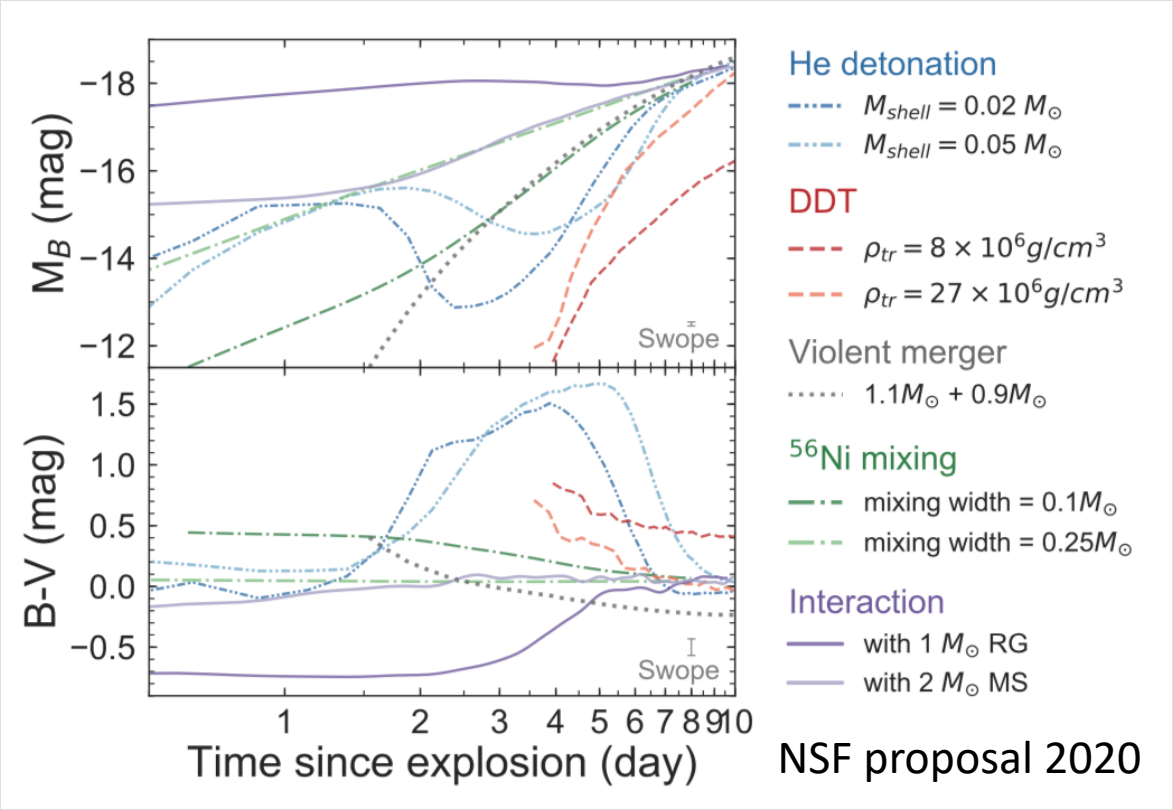
- Early observations of normal & peculiar SNe Ia
- Peculiar types (02cx-, CSI, Super-C) on the rise
  → abundance tomography
- SN+CSM interaction & dusty environments (rare)
- Improve the SN Ia absolute luminosity zero-point calibration (likely contained within the early sample populated by nearby objects)
- Objects located in peculiar environments, far from host center (e.g. 2005E), or even “hostless”

Science Traceability-like Matrix for early observations

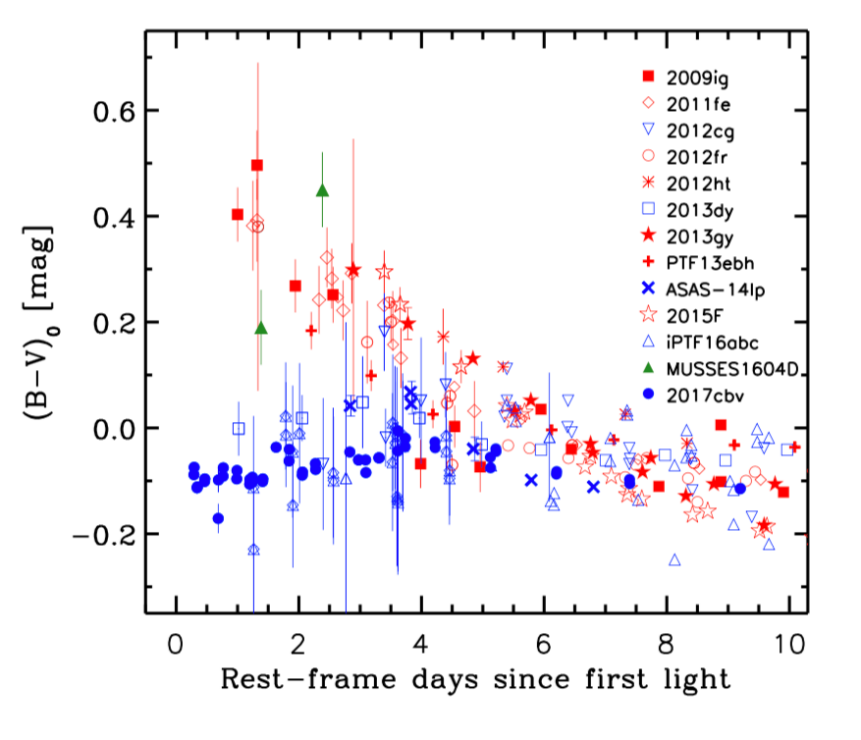
Key Questions	Science Objectives	Physical Parameters	Observables		
			Optical spectroscopy	NIR spectroscopy	Photometry
What are the progenitor systems?	What is the companion star?	Progenitor or companion star type, mass and radius	Embedded H at nebular phase	Embedded H and He 2 months after explosion	Early light and color curves within a few days of explosion
	What are the properties of CSM or wind?	Mass-loss rate and composition	Narrow H emissions	Narrow H and He emissions	
What are the explosion mechanisms?	What are the surface conditions?	Outermost burning products	Ti, Cr, and Ni within hours of explosion High-velocity extent of Si II	High-velocity extent of Mg	
		Strength, velocity and ionization of unburned material	C II within a few days of explosion	C I and He I within a few days of explosion	Speed of color evolution

NSF proposal 2020

Early luminosity and color evolution of leading models



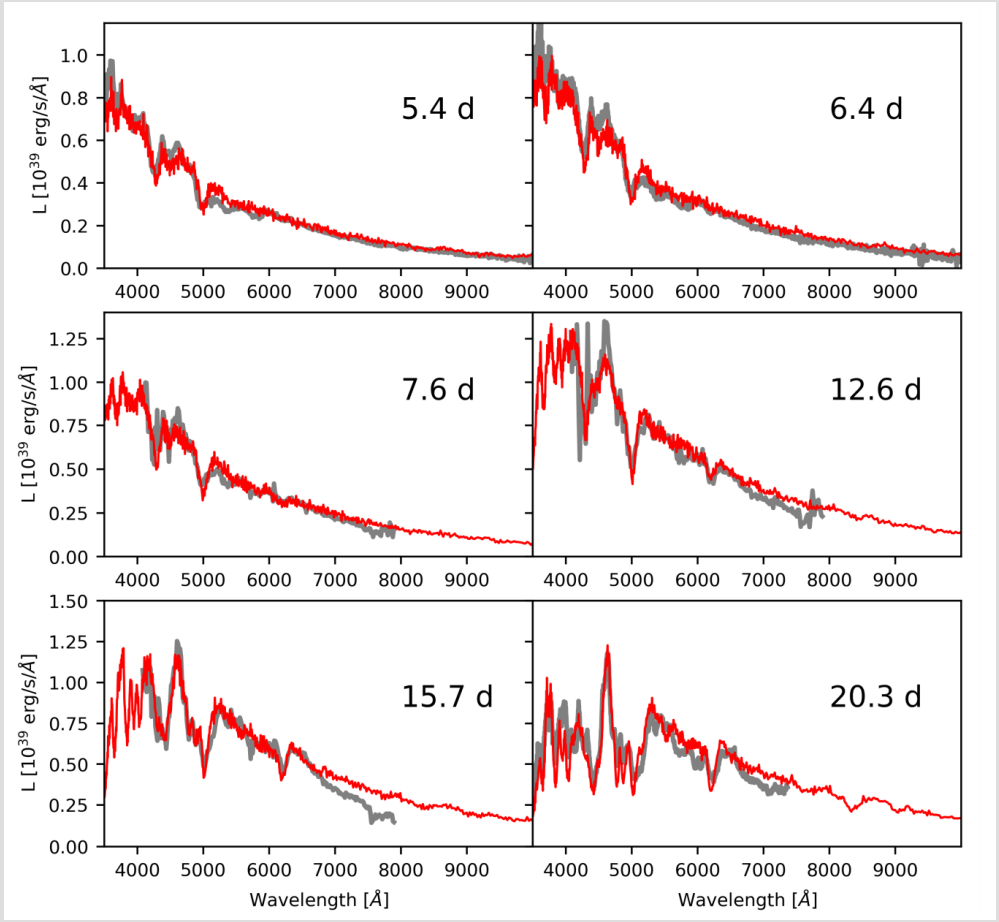
NSF proposal 2020



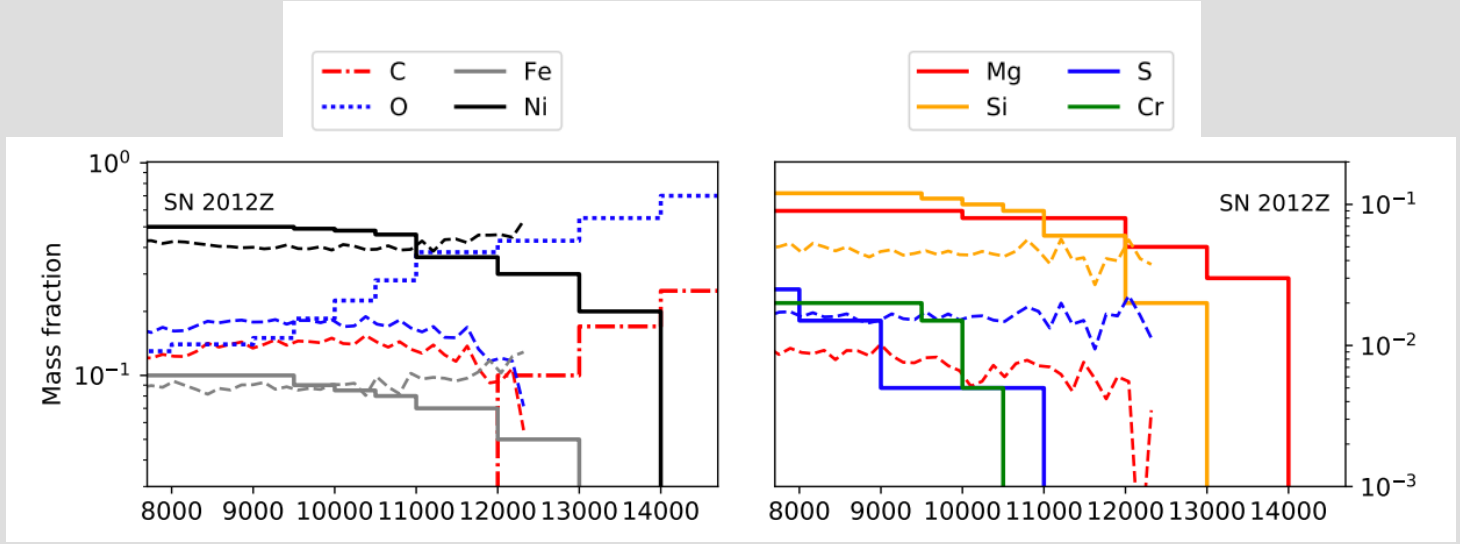
Stritzinger et al. 2018

- Early and accurate photometry in only a handful of SN Ia
- Early spectra *are extremely rare to non-existent*
  --> SOXS offers a unique opportunity to obtain new and significant constraints on SNe Ia

Abundance tomography: The luminous SN Iax 2012Z



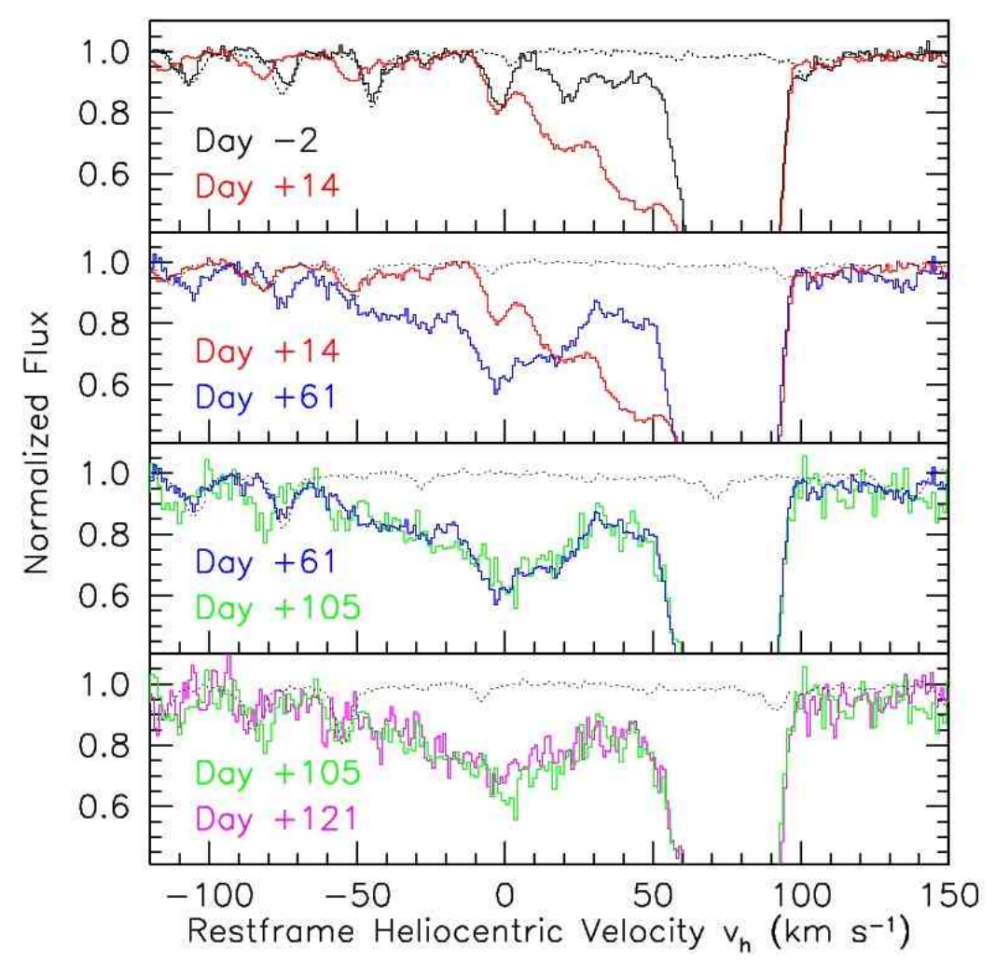
Barna et al. 2018



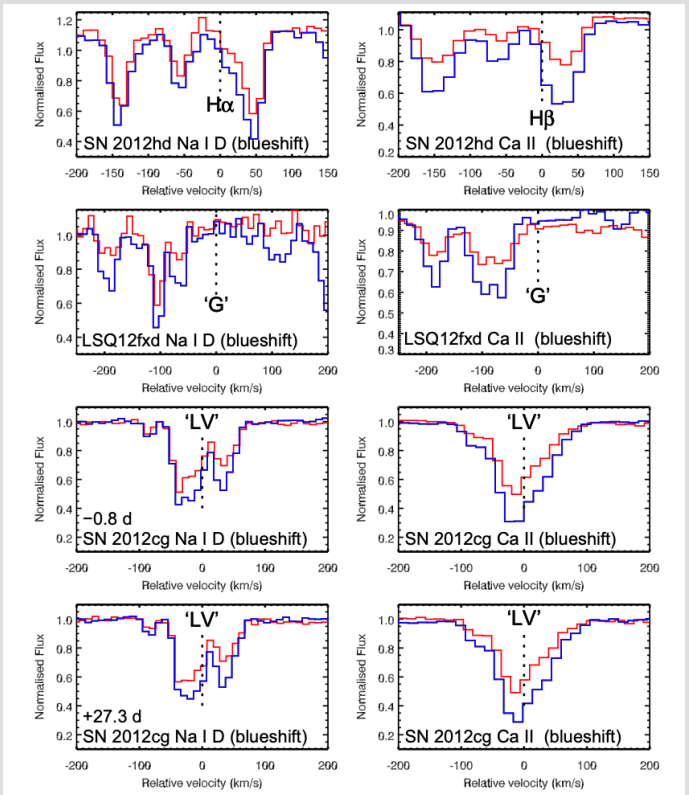
- Tardis 1-D spectral modeling the spectral time-series reveals distribution in mass/velocity space of various (emitting) elements
- Compare tomography results to those predicted from various classes of models
- Here the tomography suggests a layered structure (similar to normal SNe Ia), which is inconsistent with pure deflagration (dashed lines) model. (How does apply to low luminosity SNe IaX?)

Analysis of circumstellar material (Claudia/Kotak)

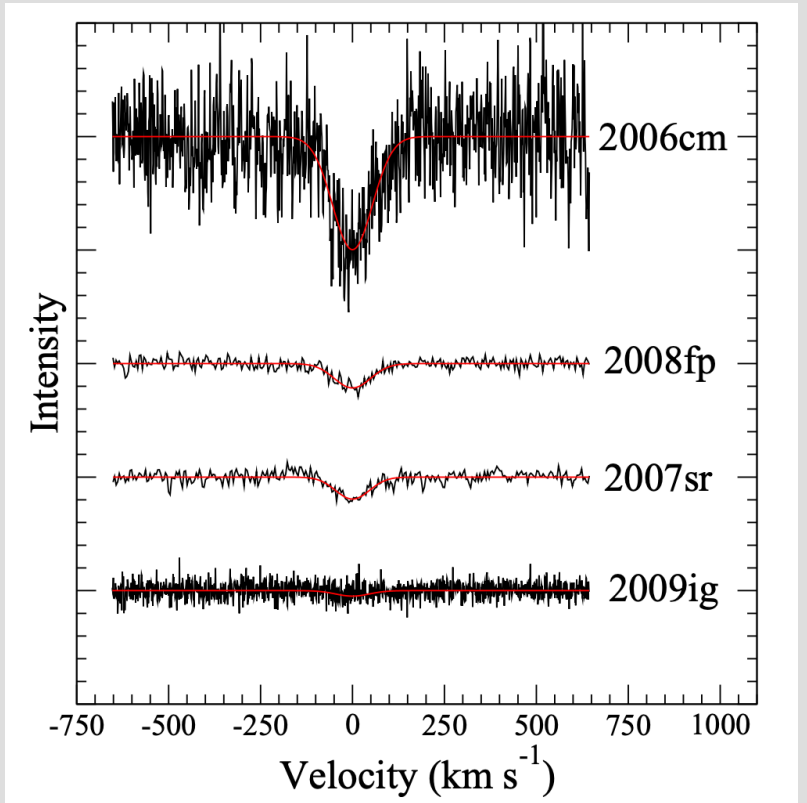
Patat et al. 2007



McQuire et al. 2013

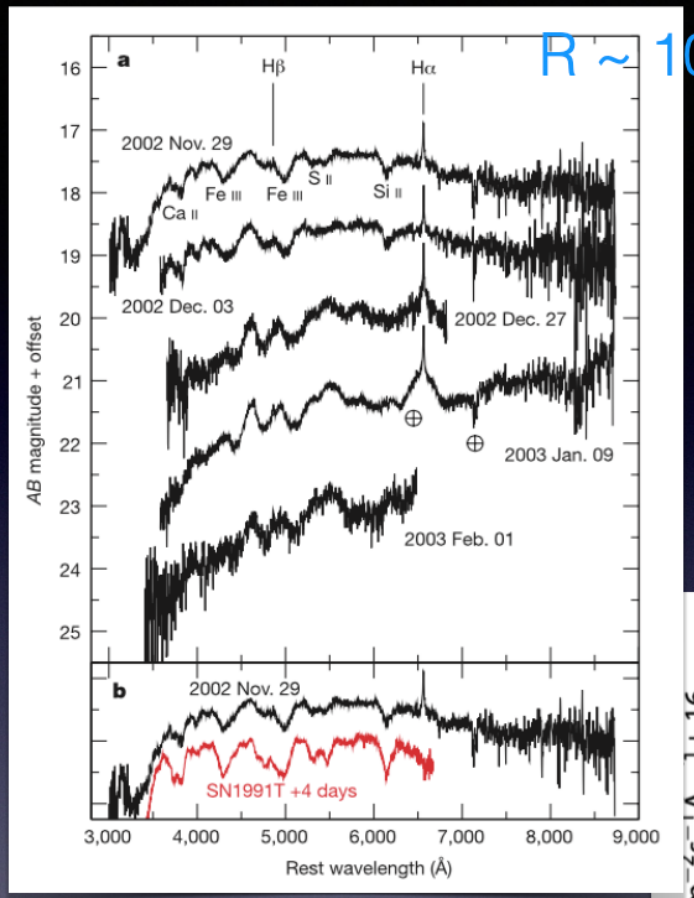


Phillips et al. 2013

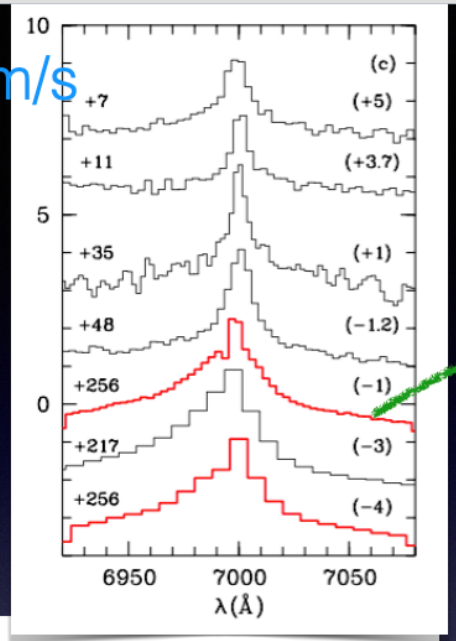


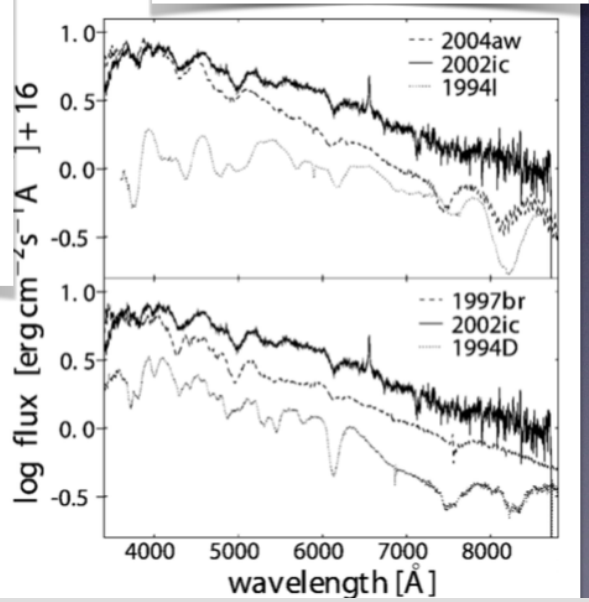
- Some cases reveals blue-shifting of Na ID lines, which may be correlated with host-galaxy type
- DIB 5780 line among others enables probe of underlying dust

Circumstellar Interacting SNe Ia + AGB companion?



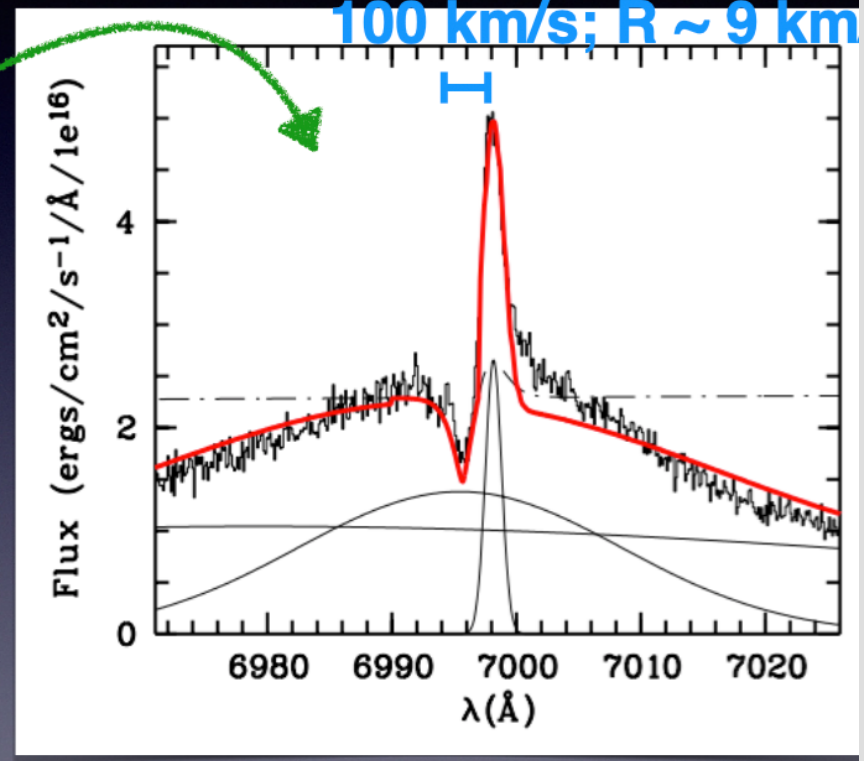
SN2002ic, WD+AGB progenitor: Hamuy+03





(Rubina/Hanin)

Kotak+04



Benetti+06

WG-5 initial assessment of SOXS time

- Rate of discovery → approx. 10 golden (< 3 d past t_{exp}) SN Ia per year between 20-100 Mpc & discovered by ZTF [ATLAS, La Silla Schmidt (PI Nugent?), LSST]

- Following estimates by Pignata: average of 10.5 hours per for objects
  (Nearby objects get a 100 day “nebular” spectrum while more distance ones do not)

- SNe IaX, rare and/or peculiar objects on the rise (i.e., a week past t_{exp}) → ~5 per year

  Total time: 15 objects x 10.5 hours per object = 80 hrs per semester (upper limit)

- Exact WG time request will require a discussion among members, keeping in mind how each institute intends to split their total contributing time among the various WGs.

Last slide

- Figure of early detection and followup

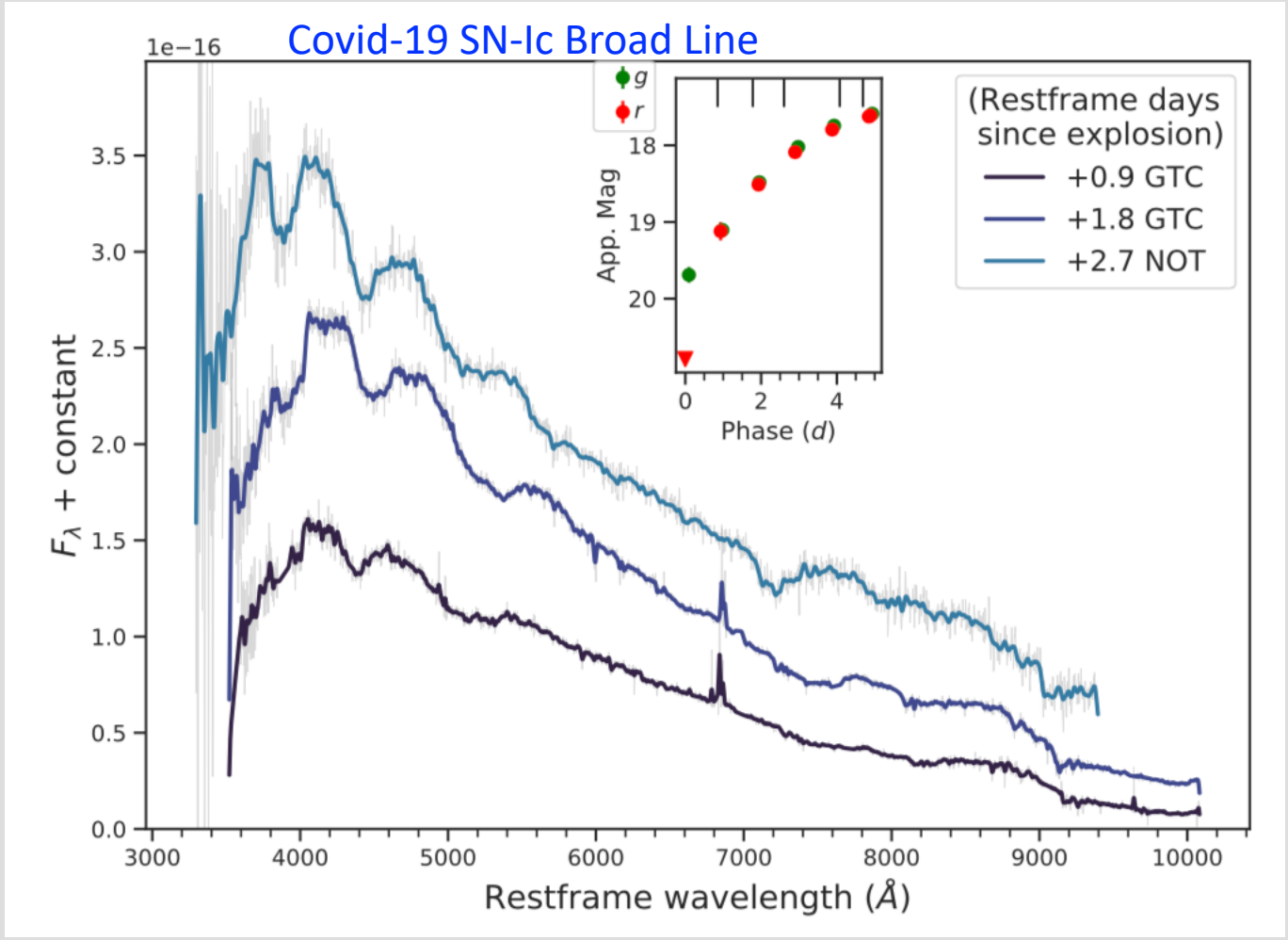
  (1) Demonstrates single facility is not ideal for high cadence rapid followup (+weather, +queue)

  (2) e.g., ZTF targets discovered in first part of night are in principle observable by SOXS in the Chilean morning. Facilities West of California are a key to early high cadence followup

  → What is the strategy to obtain multiple spectra of very young candidates with ~6 to 12 hour cadence?

- SOXS as a facility to obtain “snapshot” spectra(?) in combination with other facilities (NOT+NTE, VLT+X-shooter, VLT+FORS, etc)

  → this could alter the time requests per target type or work package



Courtesy: Karamehmetoglu, Galbany, Stritzinger, NUTS2


YURI
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