近傍超新星のフォローアップ観測

2024年12月12日　OISTER Workshop

京都大学　川端美穂

About Supernovae

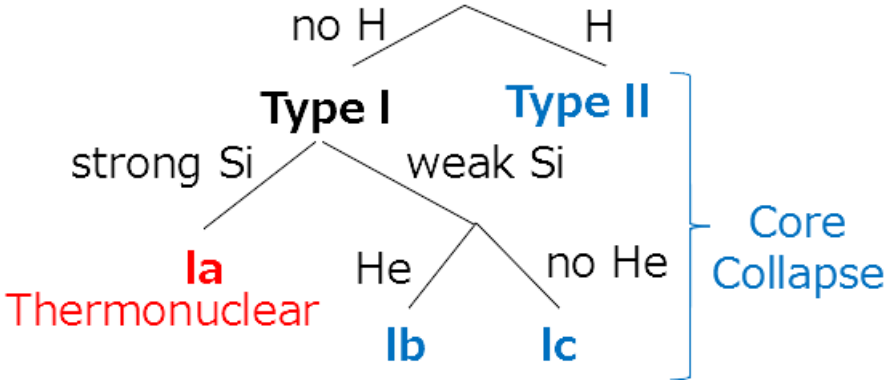
- Energy source

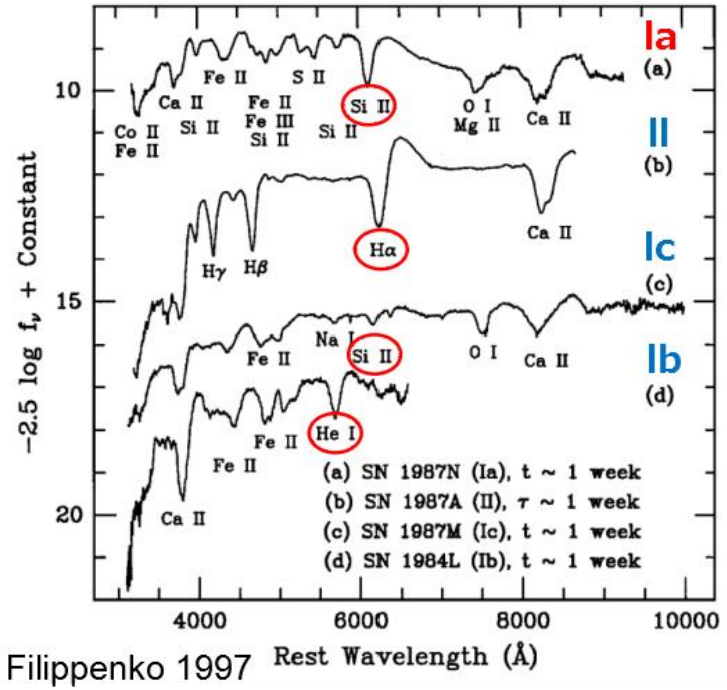
$$^{56}Ni \rightarrow {}^{56}Co \rightarrow {}^{56}Fe$$

γ線+陽電子　γ線+陽電子

京都大学岡山天文台/東京大学

- Classification
  Spectra @ maximum





Filippenko 1997

KASTOR

Kanata And Seimei Transient Observation Regime

- 3.8m Seimei

  Optical spectroscopy and photometry

- 1.5m Kanata

  Optical spectroscopy and photometry

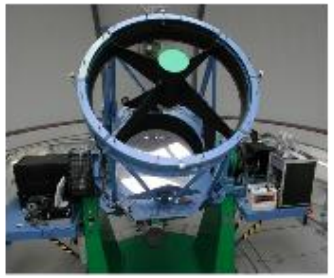
  NIR photometry

  Optical + NIR polarimetry

- Follow-up of new transients discovered in surveys such as Tomo-e, WFST

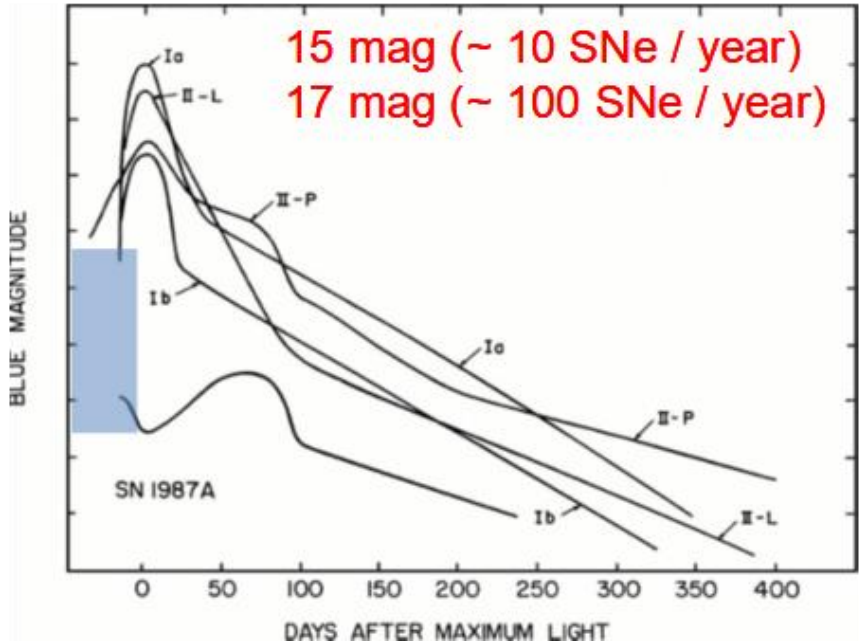
- Collaborate with other telescopes

  NOT, Indian Telescope, Subaru, and ALMA



	Tomo-e SN Survey
instrument	Tomo-e Gozen
sensor	CMOS
readout time	~0 sec
period	2018/9-
survey area [deg2]	10,000
cadence	2 hours / 1 day
exposure time / visit	3 sec
depth	18 mag / 19 mag
filter	no (~g+r)
#(SBOs), #(SNe) / yr	5, 1000
data storage	daily-stacked image SN cutout images
reference	-

© Morokuma



Follow-up observations

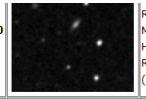
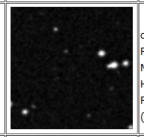
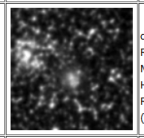
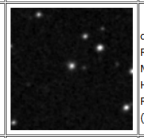
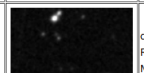
- Observation of Seimei telesco

  Kyoto Univ. time +

  Open use time

  Classical + ToO

- About 50 SNe are observed each year

2024adtd-0		R.A. = 01:40:07.002, Decl. = -69:51:05.02 Mag: 20.19 Host: null (z=0.0) Remark: (References: TNS Tomo-e)	WISEAJ013901.40-695434.6	01h39m01.4s	-69d54m35s	>30000	0.119428
2024adth		discovered: 2024-12-05 10:17:34.000 R.A. = 11:22:22.861, Decl. = +59:04:31.49 Mag: 20.586 Host: NGC3642 (z=0.005287) Remark: SN candidate in NGC 3642 discovered using the public ZTF alerts (References: TNS Tomo-e ZTF)	NGC3642	11h22m17.9s	+59d04m28s	1585	0.005287
			SDSSJ112218.07+590356.0	11h22m18.1s	+59d03m56s	1610	0.005372
			SDSSJ112212.43+590444.4	11h22m12.4s	+59d04m44s	1578	0.005263
			WISEAJ112231.34+590348.5	11h22m31.3s	+59d03m49s	>30000	0.349964
			SDSSJ112234.76+590404.9	11h22m34.8s	+59d04m05s	>30000	0.359000
			GMBCGJ170.64488+59.06806	11h22m34.8s	+59d04m05s	>30000	0.359000
			WISEAJ112235.19+590632.3	11h22m35.2s	+59d06m32s	>30000	0.472976
2024adtg		discovered: 2024-11-26 10:07:52.999 R.A. = 08:53:28.451, Decl. = -11:08:26.89 Mag: 20.3333 Host: null (z=0.0) Remark: (References: TNS Tomo-e ZTF)	WISEAJ085330.02-111215.5	08h53m30.0s	-11d12m16s	>30000	0.119394
			WISEAJ085331.98-110342.0	08h53m32.0s	-11d03m42s	>30000	0.112679
			WISEAJ085307.12-110444.1	08h53m07.1s	-11d04m44s	9897	0.033013
2024adtf		discovered: 2024-12-07 04:25:43.000 R.A. = 05:50:00.136, Decl. = -71:09:47.74 Mag: 20.18 Host: null (z=0.0) Remark: (References: TNS Tomo-e)	WISEAJ055000.01-710956.4	05h50m00.0s	-71d09m56s	11808	0.039387
			MQSJ055031.03-710957.1	05h50m31.0s	-71d09m57s	2998	0.010000
			WISEAJ055017.29-711421.9	05h50m17.3s	-71d14m22s	11978	0.039954
			MQSJ054950.04-710404.4	05h49m50.0s	-71d04m04s	>30000	0.719000
2024adte		discovered: 2024-12-09 06:44:41.856 R.A. = 09:51:36.408, Decl. = -25:00:07.62 Mag: 19.27 Host: null (z=0.0) Remark: (References: TNS Tomo-e)	WISEAJ095122.87-250349.0	09h51m22.9s	-25d03m49s	21052	0.070221
			WISEAJ095120.61-245613.3	09h51m20.6s	-24d56m13s	>30000	0.107833
2024adtc		discovered: 2024-12-07 03:40:44.000 R.A. = 04:24:26.700, Decl. = -55:30:30.11 Mag: 20.42					

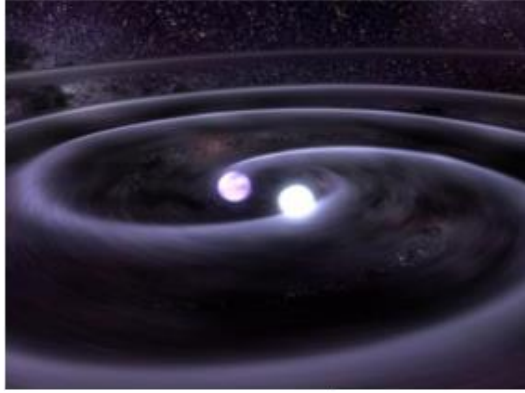
	Ia	Ib, Ic	II	other	?	TNS
24年	14	4	19	4	15	6
23年	17	11	19	10	4	13
22年	22	7	12	6	13	13
21年	17	4	17	7	5	4
20年	19	6	9	3	17	3
19年	22	5	12	6	17	2

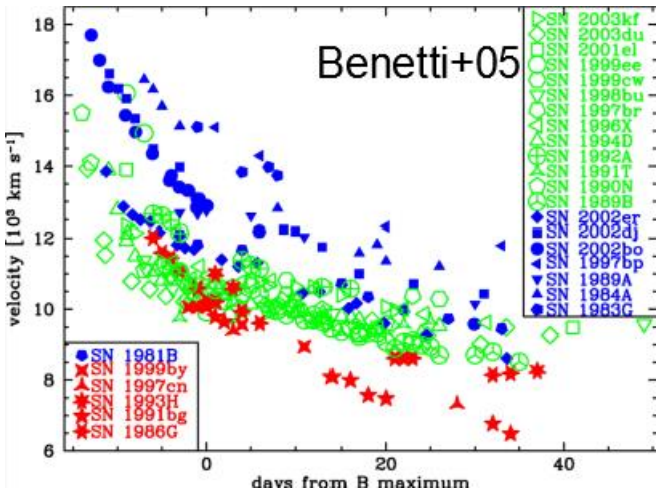
Unresolved Problems : SNe Ia

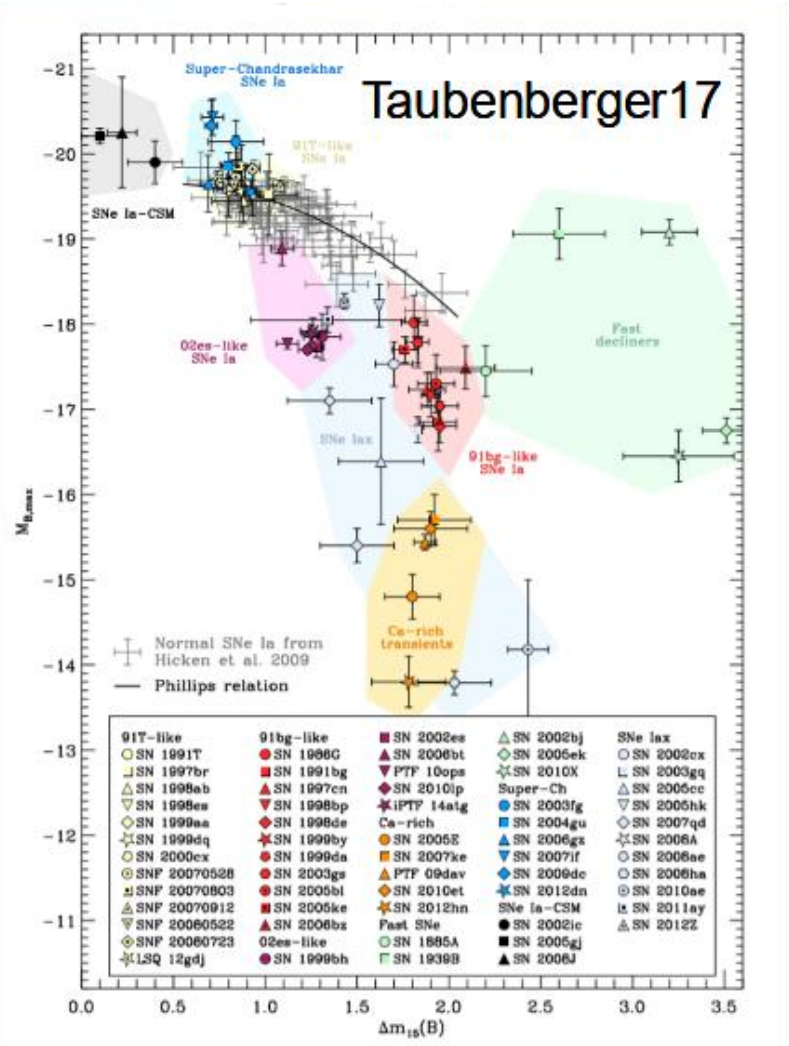
- Progenitor?
  - Single Degenerate?
  - Double Degenerate?

- Explosion mechanism
  - Initial ignition point?
  - Detonation? Deflagration?

- Diversity, Peculiar SNe Ia

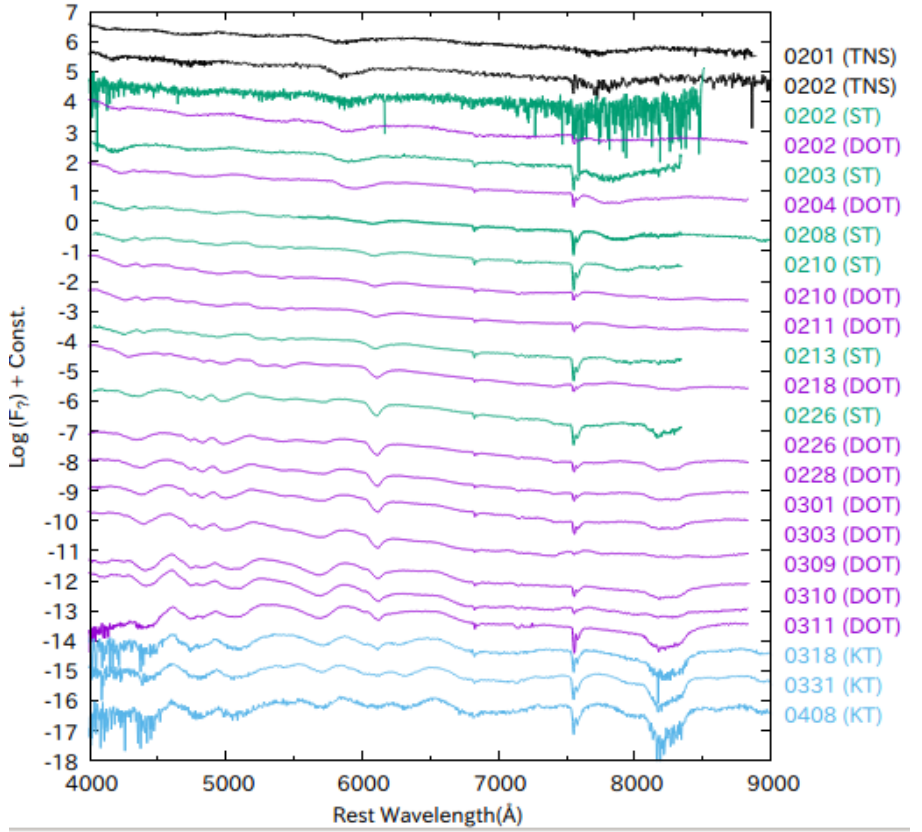




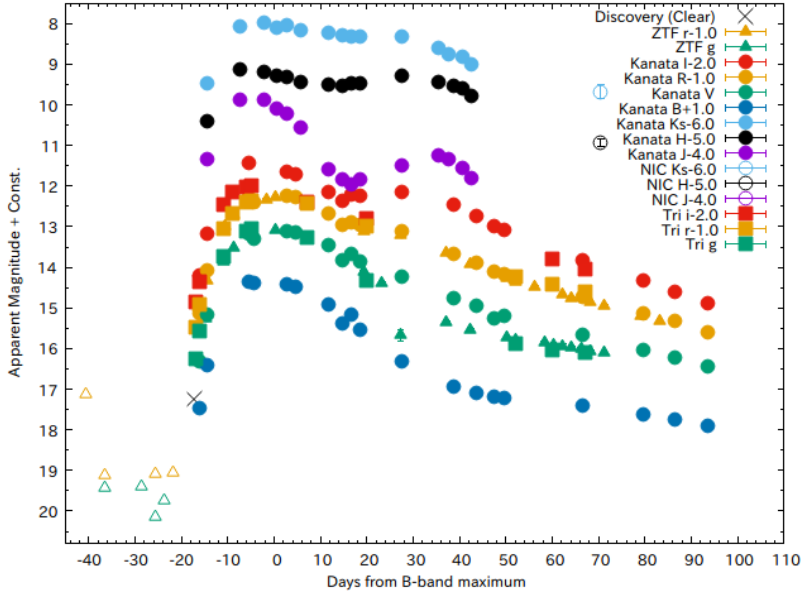


SN 2023bee

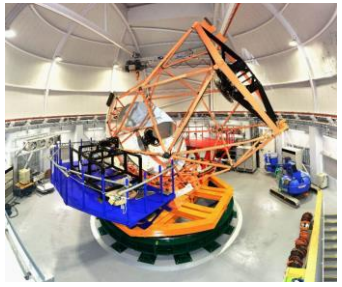
- Discovered by DLT40 on Feb. 01.75

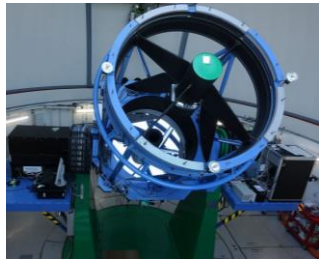


- Classification report 20 miniteus after discovery
  → Ic or Ic-BL
  → Reclassified as SN Ia on the next day



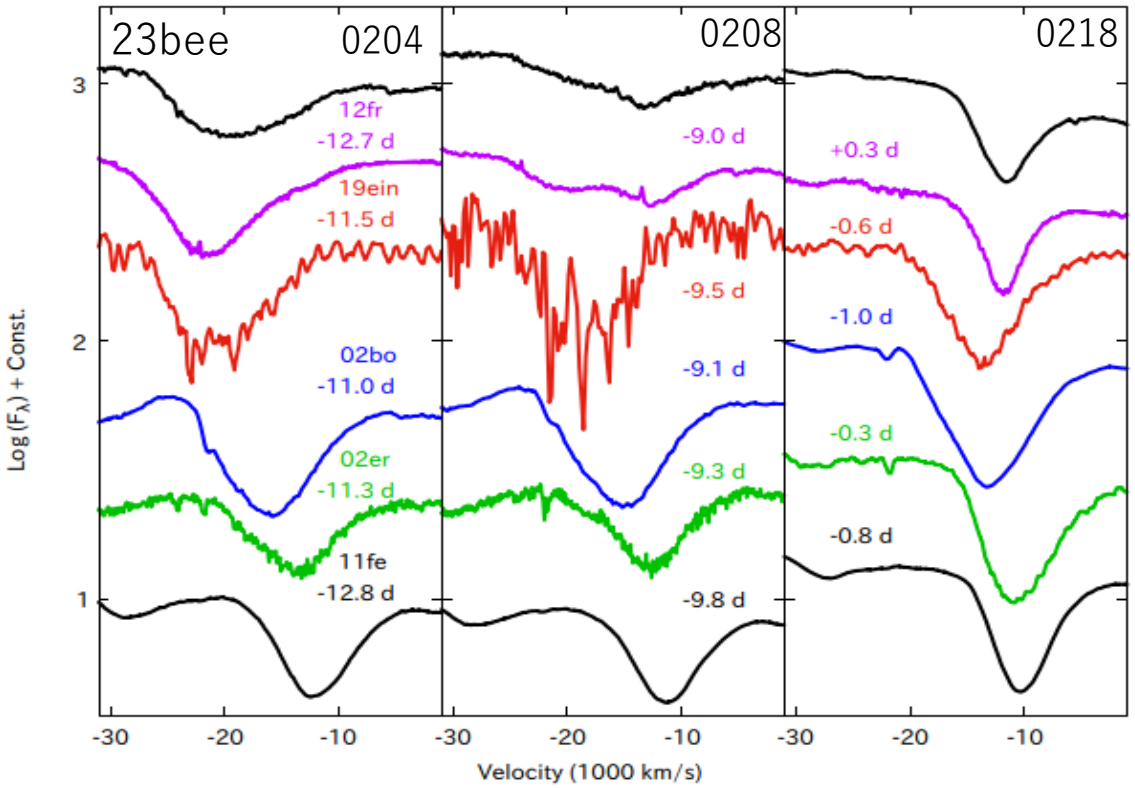
- Decline rate : ⊿m15(B) ~ 0.79 mag
  → Slightly slower than typical SNe Ia

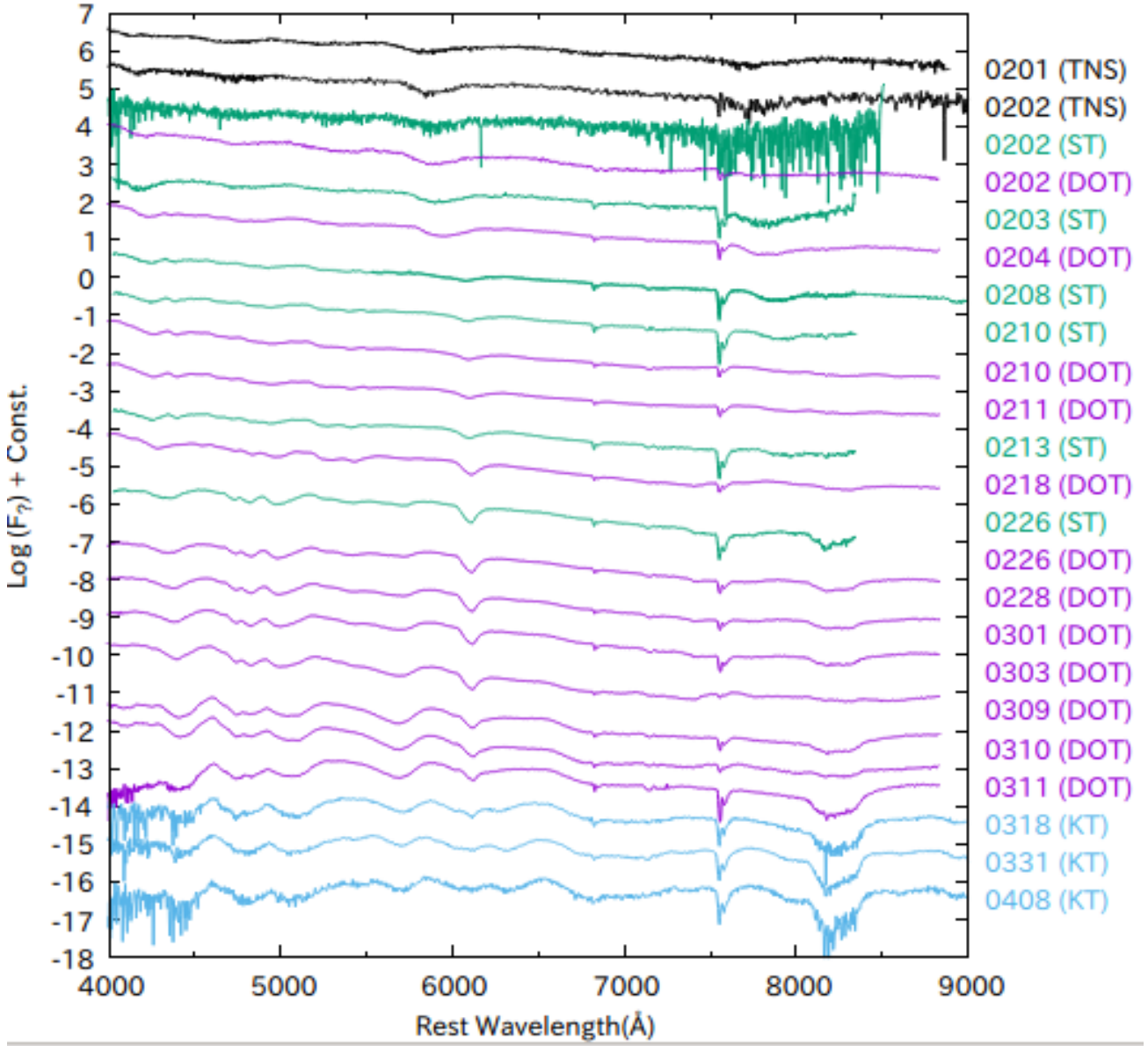




SN 2023bee

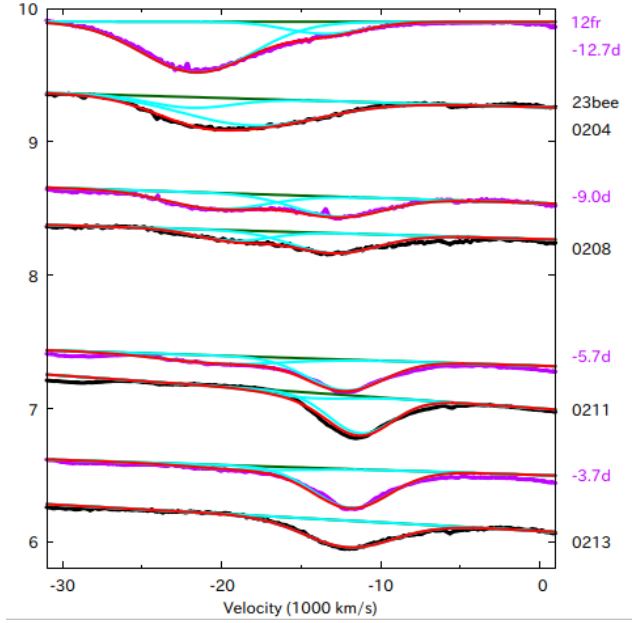
- In early phase, 23bee shows
  high velocity Si line
- similar to SN 2012fr
  -> Asymmetric absorption line

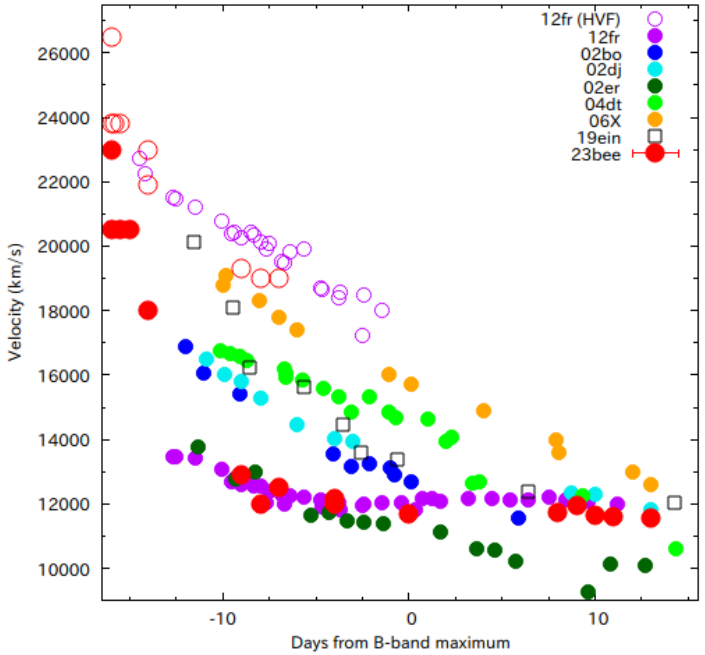




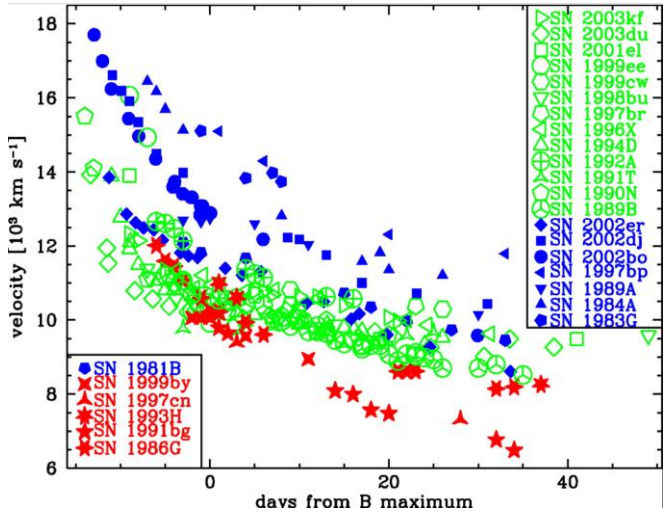
SN 2023bee

- Fitted with two gaussian function
- Si II 6355 ~12,000 km/s @max
- Asymmetric absorption line, high velocity Si
  → Photospheric component +
  HVF component





Benetti et al. 2005



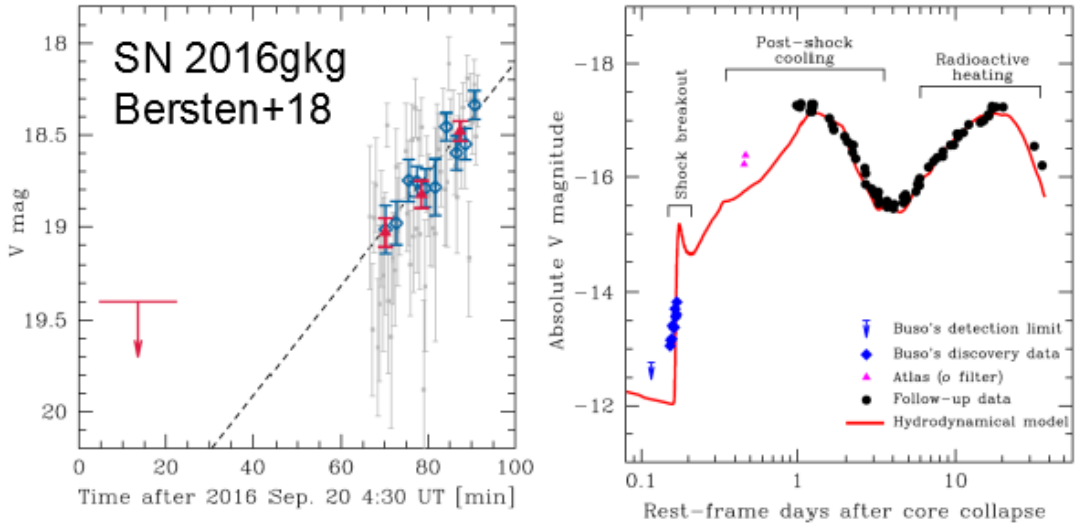
Unresolved Problems : Core Collapse SNe

- Some massive stars lose outer envelopes
  → stripped-envelope SNe

- Mechanism of mass loss ?

  → Shock cooling emission

  → Estimate radius and stellar structure of progenitors



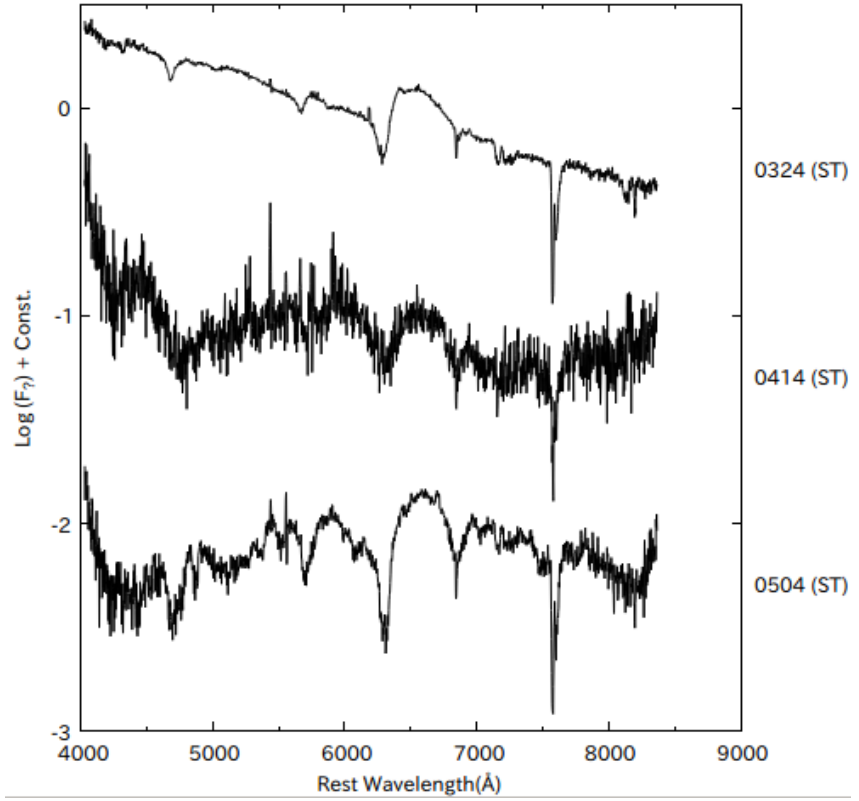
SN 2024ehs

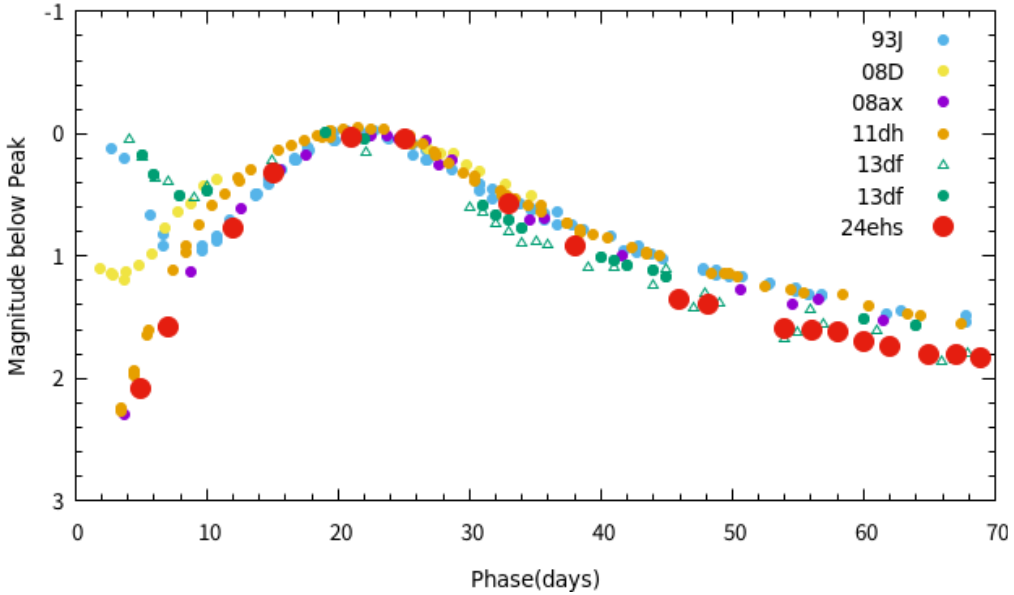
- Discovered by ATLAS on Mar. 15

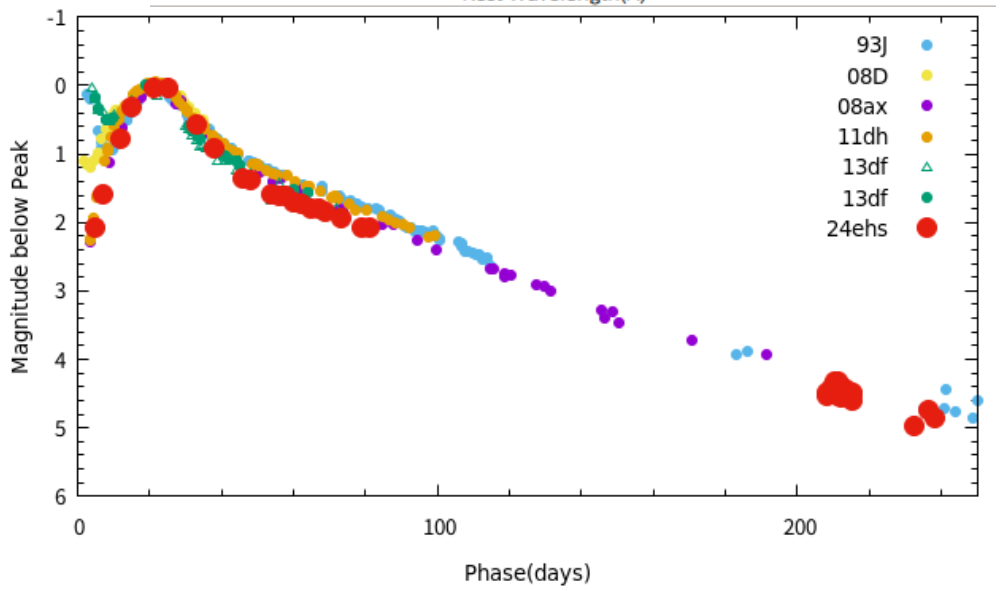
- Classified as Type IIb

  → Similar to SN 1987A at extremely early phase

  It is also possible that it is a 08ax-like SN IIb

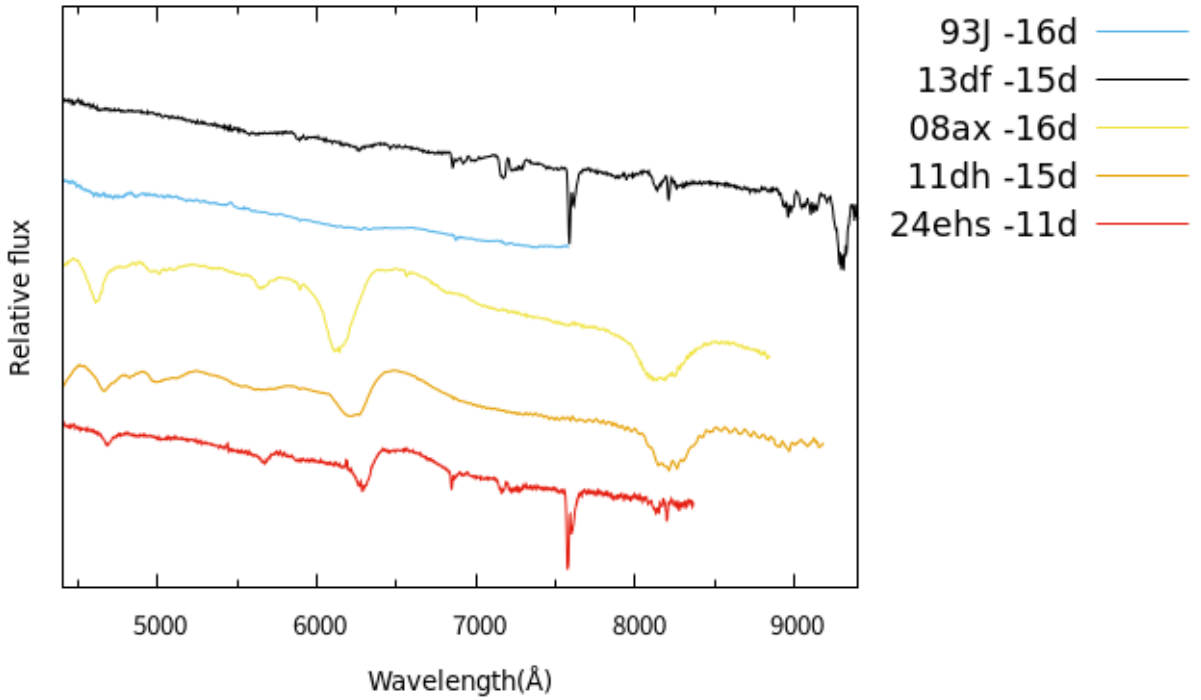


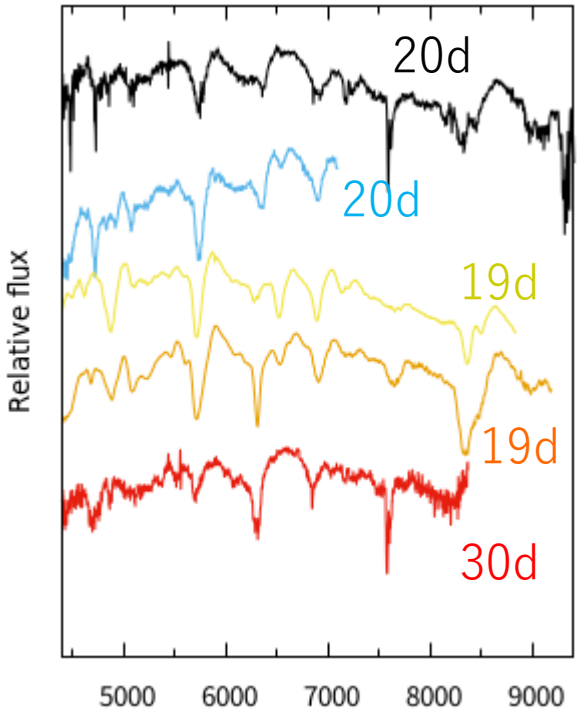


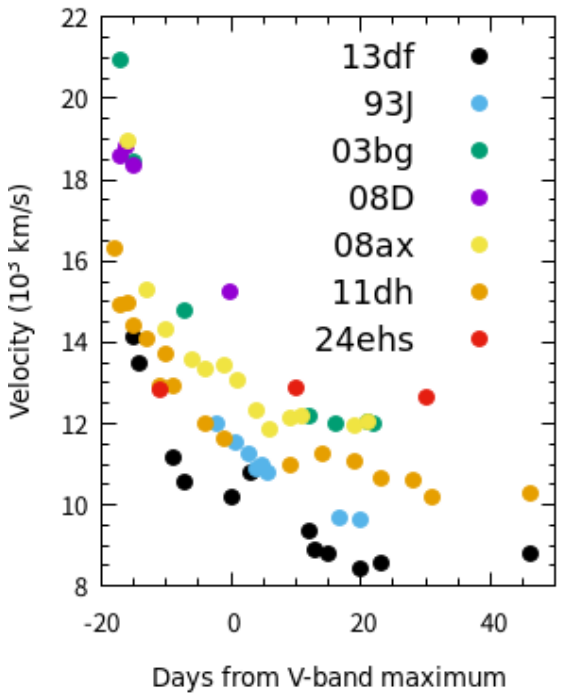


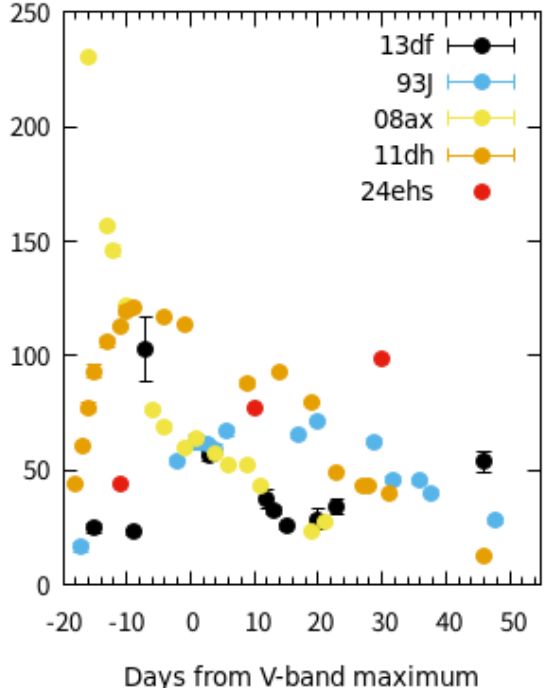
SN 2024ehs

- Spectrum similar to SN 2008ax









まとめと今後

- 近傍で見つかった超新星のフォローアップ観測
  → せいめい望遠鏡だけでも年間50例ほど
  → その中には10例ほど、フォローアップを継続

- 特に面白い超新星に関してはOISTER ToOも検討