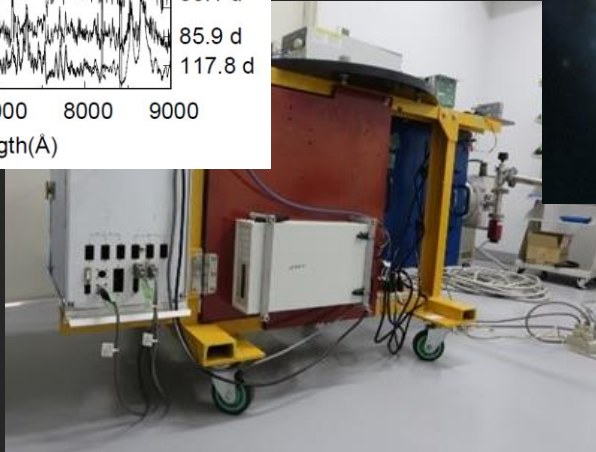
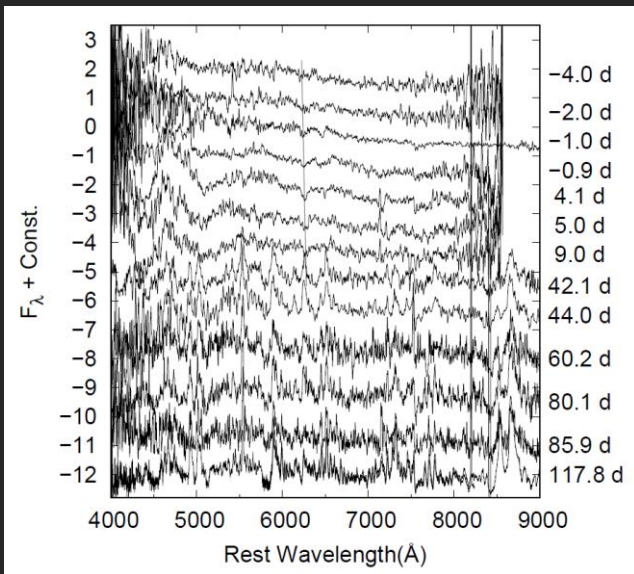


せいめい望遠鏡による 系外突発天体観測プログラム

2023 Seimei UM, 2023.09.12

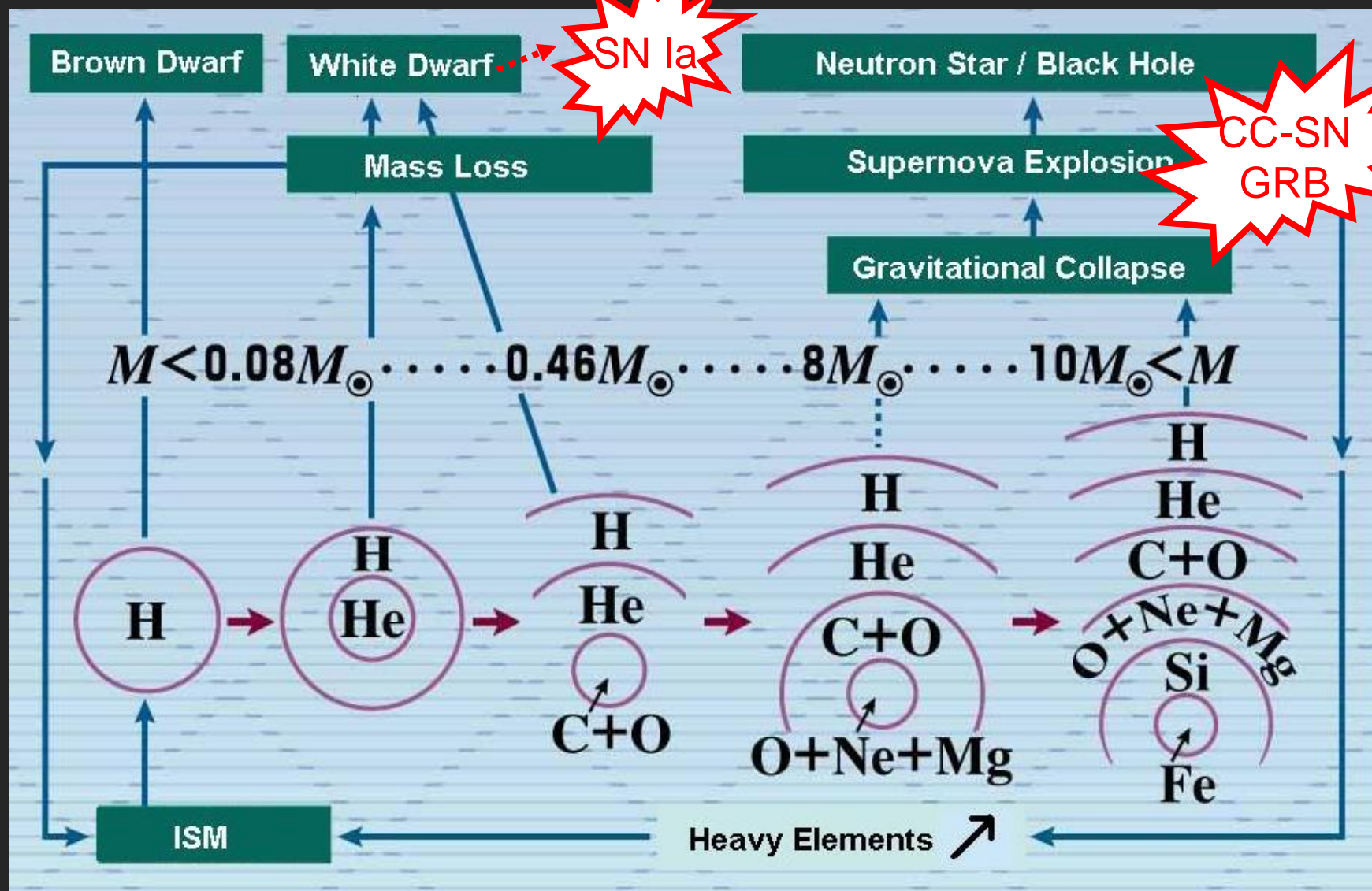


Keiichi Maeda (Department of Astronomy, Kyoto University)

Stellar Evolution and Supernovae (SNe)

Type Ia
supernova

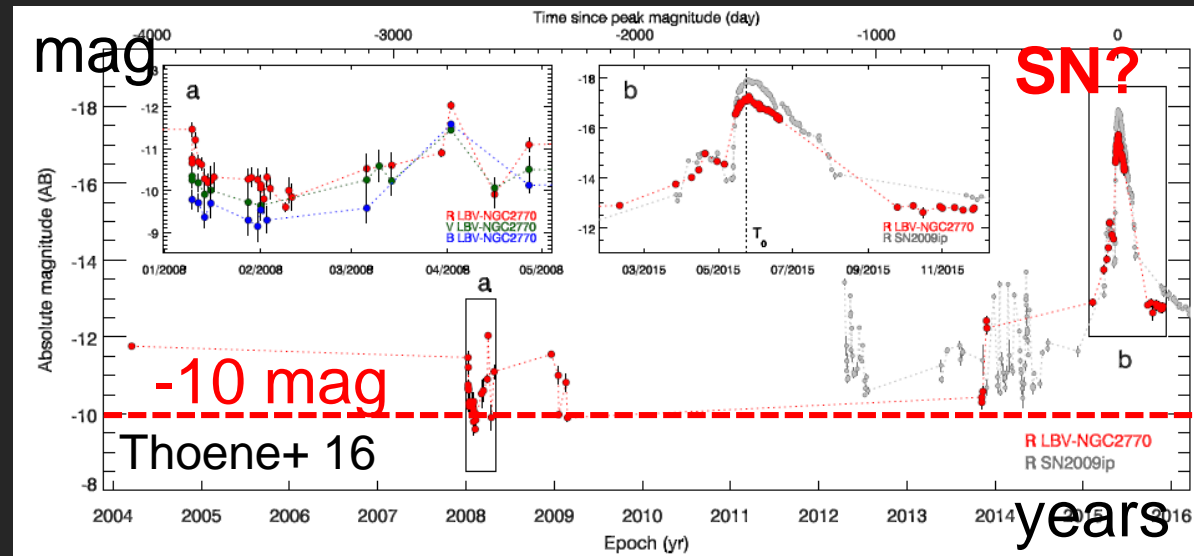
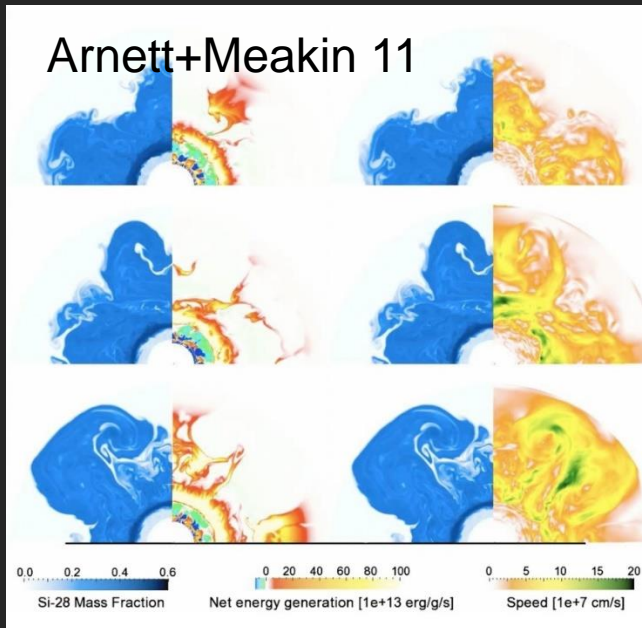
Core-collapse
supernova



Explosions of massive stars at the end of their lives.

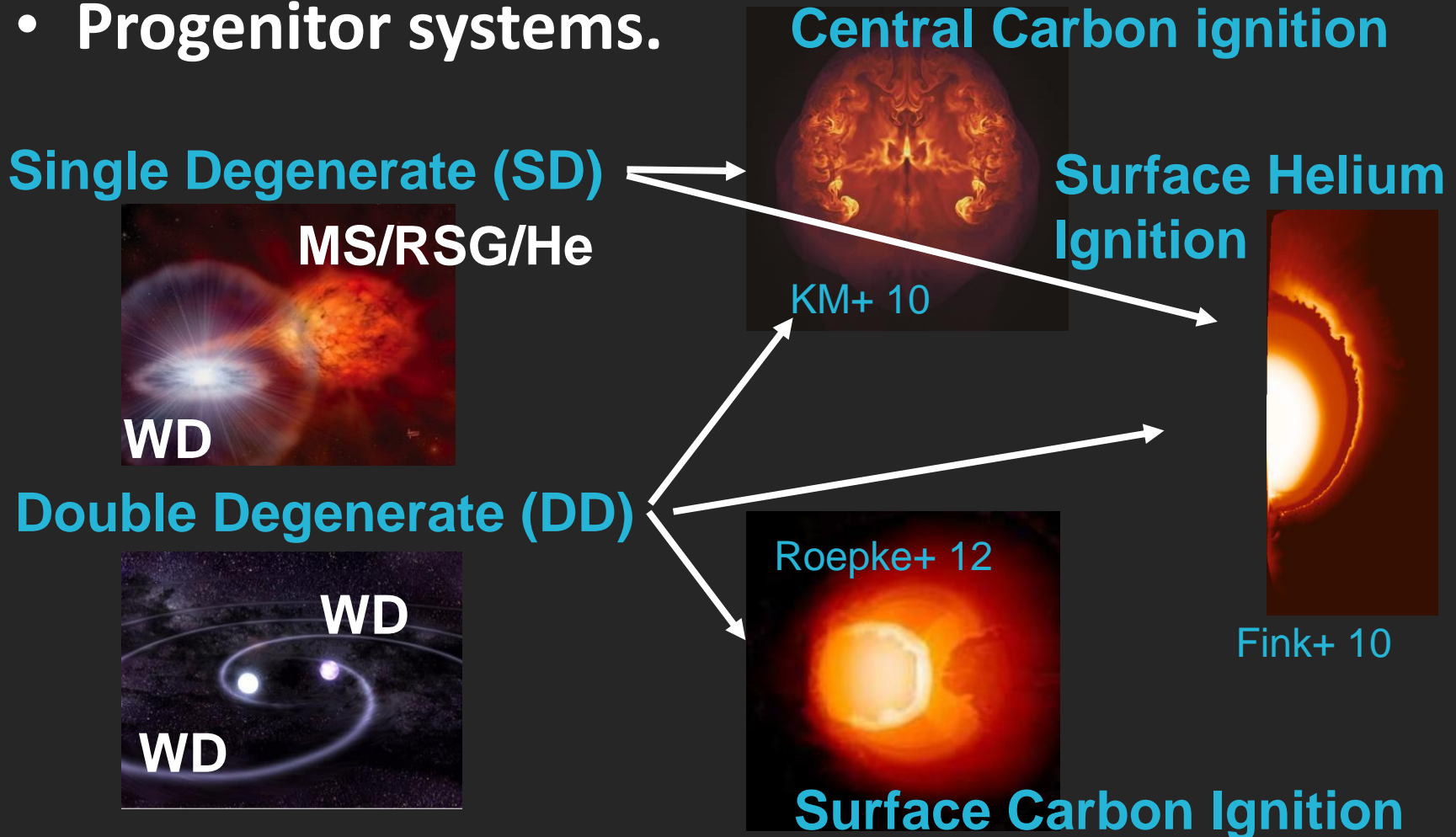
Unresolved problems for Core Collapse SNe (CC SNe)

- Explosion mechanism.
- Final evolution of massive stars (single & binary).
 - Progenitor at the time of the explosion.
 - Mass loss in the final decades.



Unresolved problems for SNe Ia

- Explosion mechanism (multiple paths?).
- Progenitor systems.



Extragalactic Transience w/ Seimei: since 2019

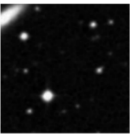
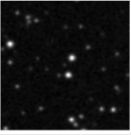
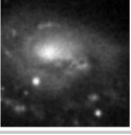
Observing schedule for 3.8-m SEIMEI Telescope (2021A)

	Sun		Mon		Tue		Wed		Thu		Fri		Sat	
Date			1		2		3		4		5		6	
Observer (PROP-ID)			行方(21A-K-0009)	前田(21A-N-CT02)	行方(21A-N-CN03)	前田(21A-N-CT02)	行方(21A-N-CN03)	行方(21A-N-CN03)	行方(21A-N-CN03)	行方(21A-N-CN03)	行方(21A-N-CN03)	行方(21A-N-CN03)	栗田(21A-K-0015)	前田(21A-K-0001)
Grism			B/R/6		B/R/6		B/R/6		B/R/6		B/R/6		B/R/6	
Date	7		8		9		10		11 ●		12		13	
Observer (PROP-ID)	栗田(21A-K-0015)	前田(21A-K-0001)	磯部(21A-N-CN12)	磯部(21A-N-CN12)	磯部(21A-N-CN12)	磯部(21A-N-CN12)	磯部(21A-N-CN12)	磯部(21A-N-CN12)	磯部(21A-N-CN12)	磯部(21A-N-CN12)	磯部(21A-N-CN12)	磯部(21A-N-CN12)	前田(21A-K-0001)	前原(21A-K-0013)
Grism	B/R/6		B/R/6		B/R/6		B/R/6		B/R/6		B/R/6		B/R/6	
Date	14		15		16		17		18		19		20	
Observer (PROP-ID)	前田(21A-K-0001)	前原(21A-K-0013)	前原(21A-N-CN10)	前原(21A-N-CN10)	前原(21A-N-CN10)	前原(21A-N-CN10)	前原(21A-N-CN10)	前原(21A-N-CN10)	前原(21A-N-CN10)	前原(21A-N-CN10)	前田(21A-K-0001)	前原(21A-K-0013)	前田(21A-K-0001)	前原(21A-K-0013)
Grism	B/R/6		B/R/6		B/R/6		B/R/6		B/R/6		B/R/6		B/R/6	
Date	21		22		23		24		25		26		27 ○	
Observer (PROP-ID)	前原(21A-K-0013)	前原(21A-K-0013)	栗田(21A-K-0015)	Engineering (TriCCS)	栗田(21A-K-0015)	Engineering (TriCCS)	Engineering (Tel.)	Engineering (TriCCS)	Engineering (Tel.)	前田(21A-K-0001)	Engineering (Tel.)	前田(21A-K-0001)	前原(21A-K-0013)	前原(21A-K-0013)
Grism	B/R/6		B/R/6		B/R/6		B/R/6		B/R/6		B/R/6		B/R/6	
Date	28													
Observer (PROP-ID)	前原(21A-K-0013)	前原(21A-K-0013)												
Grism	B/R/6													

ToO: rapid classification, high-cadence especially at the beginning. Fill in the gap of the classical nights.

Classical: (half x 2) / a week, long monitoring.

Candidate selection for Seimei

2021vbb		discovered: 2021-07-09 11:03:50.400 R.A. = 20:33:37.531, Decl. = -11:22:53.98 Mag: 21.97 Host: null (z=0.0) Remark: (References: INS Tomo-e)	NGC6931	20h33m41.3s	-11d22m08s	3549	0.011838
2021vba		discovered: 2021-08-05 09:45:21.000 R.A. = 04:38:19.090, Decl. = +60:16:51.20 Mag: 16.7 Host: null (z=0.0) Remark: Hostless transient at galactic latitude 08.8 deg (References: INS Tomo-e)	WISEAJ043833.65+601628.0	04h38m33.6s	+60d16m28s	22024	0.075165
2021vaz		discovered: 2021-08-05 18:30:05.000 R.A. = 05:42:01.760, Decl. = +69:22:36.10 Mag: 17.5 Host: NGC1961 (z=0.0) Remark: (References: INS Tomo-e)	NGC1961	05h42m04.6s	+69d22m42s	3934	0.013122
			CGCG329-011	05h43m23.0s	+69d25m51s	4108	0.013703

Own interface
(Kawabata,
Nakaoka)

ToO

Selection
(host galaxy, luminosity...)

TRANSIENT NAME SERVER SEARCH ASTRONOTES NOTS LIGO SW

Transient Name Server (TNS)

SN 2021vaz

Tomo-e transient server List Object TNS Object GW Galaxy Account Logout

page 1 / 145444

transientid (variableid) project (event) (rawid)	Name	Ra, Dec Date (magnitude)	Ref	New	Sub	SDSS DR15 Ref	PS1 gri 3-color Ref	paramcand cncncand	mark
7662831 (68643235) All-Sky Survey (SN) (34089171)	202106aaacq	176.20479, 19.79675						2	2
7662830	202106aaacp	176.22761, 19.77695						2	2
7662827 (49809413) All-Sky Survey (SN) (34088035)	202106aaaco	155.36763, 36.45247						2	2
7662820 (38094051) All-Sky Survey (SN)	202106aaacn	185.48311, 1.38298						2	2

RA/DEC (J2000) Type Redshift
05:42:01.760 +69:22:36.10 SN II 0.013122
85.507333 +69.376694

Discovery Report Classification Report

Reporting Group Discovering Data Source Discovery Date

Discovery Mag Filter

Reporters

NEED SIMBAD DECAL.S
PanSTARRS-1 SkyMapper VizieR
WISE DSS ADS

ZTF, PS, ATLAS, ...

Papers

Refereed Journals (published + nearly accepted)

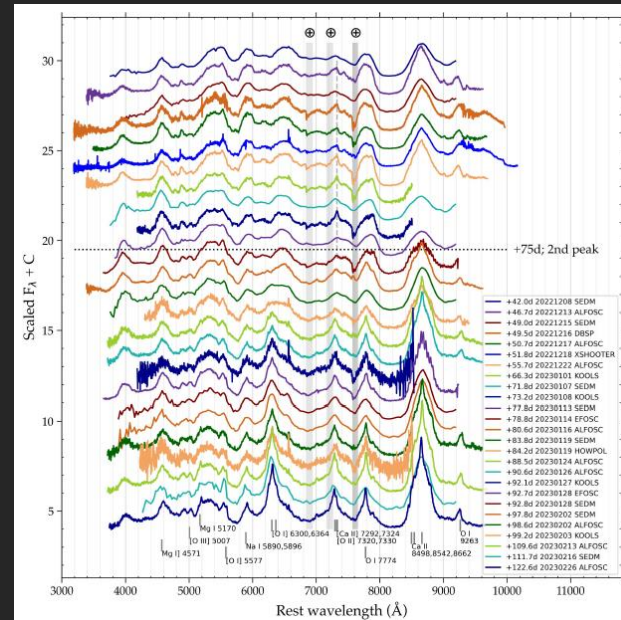
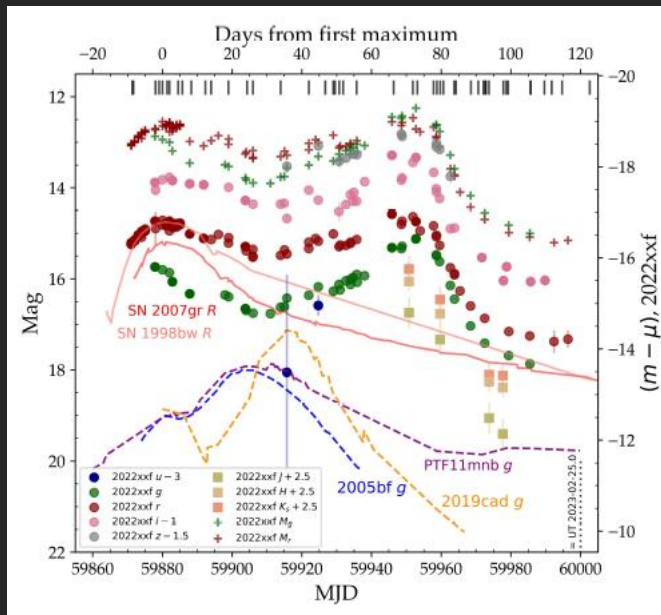
- Gangopadhyay, Maeda, Singh et al. 2023, ApJ, (almost) accepted (SN Iib/Ib 2022crv); talk
- Kuncarayakti, Sollerman, Izzo, Maeda, et al. 2023, A&A, in press (SN “Ic-CSM” 2022xxf)
- Uno, Nagao, Maeda, et al. 2023, ApJ, 944, 204 (SN Ia-CSM 2020uem); talk
- Uno, Maeda, Nagao, et al. 2023, ApJ, 944, 203 (SN Ia-CSM 2020uem); talk
- Jiang, Maeda, Kawabata, et al. 2021, ApJL, 923, L8 (over-luminous SN Ia 2020hvf)
- Kawabata, Maeda, Yamanaka, et al. 2021, PASJ, 73, 1295 (SN “Iax” 2019muj)
- Nakaoka, Maeda, Yamanaka, et al. 2021, ApJ, 912, 30 (Ca-rich transient 2019ehk)
- Kawabata, Maeda, Yamanaka et al. 2020, ApJ, 893, 143 (“infant” SN Ia 2019ein)
- Singh, Sahu, Anupama, et al. 2019, ApJL, 882 L15 (SN1987A-like 2018hna)

+ a number of classification reports (mostly Taguchi et al.)

- Taguchi, Maeda, Uno, TNS Class. Rep. 15501 (SN II within 7 hrs of the discovery).
- Taguchi, Uno, Nagao, Maeda, TNS Class. Rep. 14478 (TDE)

One highlight: A new population of SNe within C/O-rich CSM

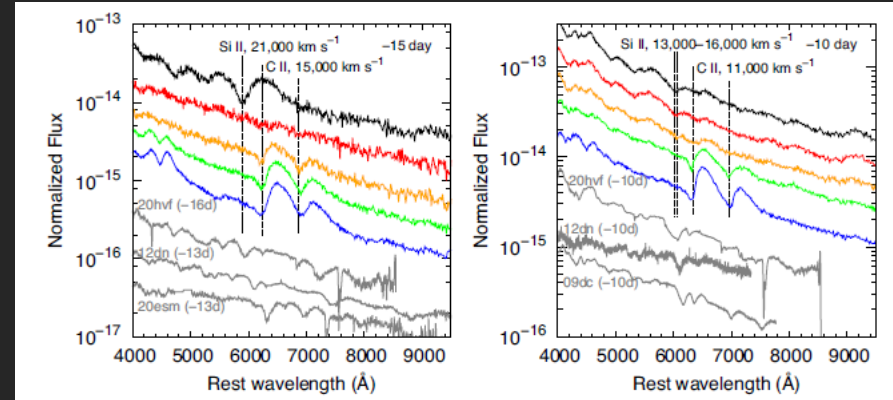
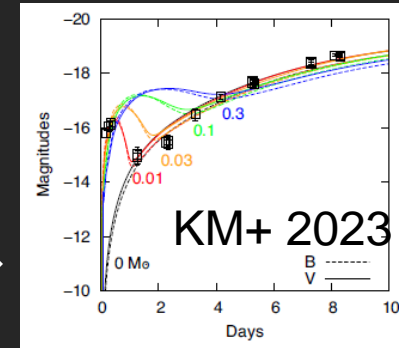
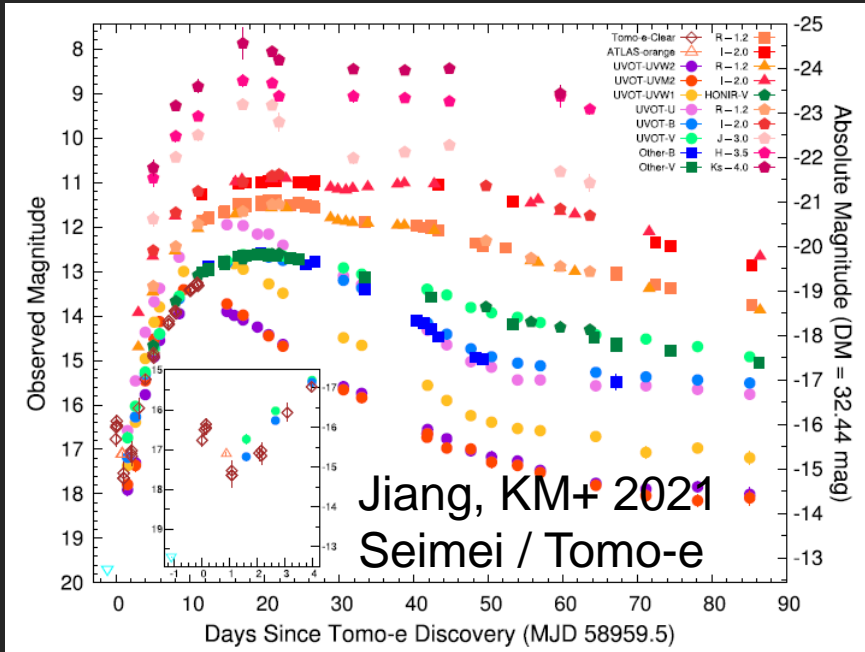
- Peculiar SN Ic 2022xxf (Kuncarayakti, Izzo, Sollerman, KM+ 2023).
- Double-peaked light curve (few examples known).
- Global observation network, in multi-wavelength.
- Explosion of a C+O star, surrounded by C/O-rich CSM (huge mass-loss... challenge to stellar evolution).



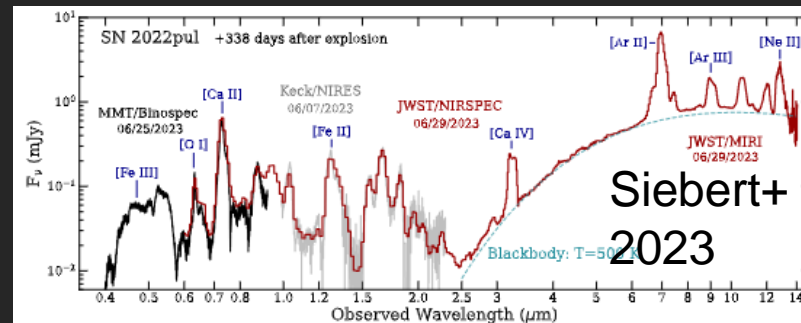
Another example to come; KM+ in prep., w/ Seimei data

Model ↔ data development

Model for
overluminous SNe Ia



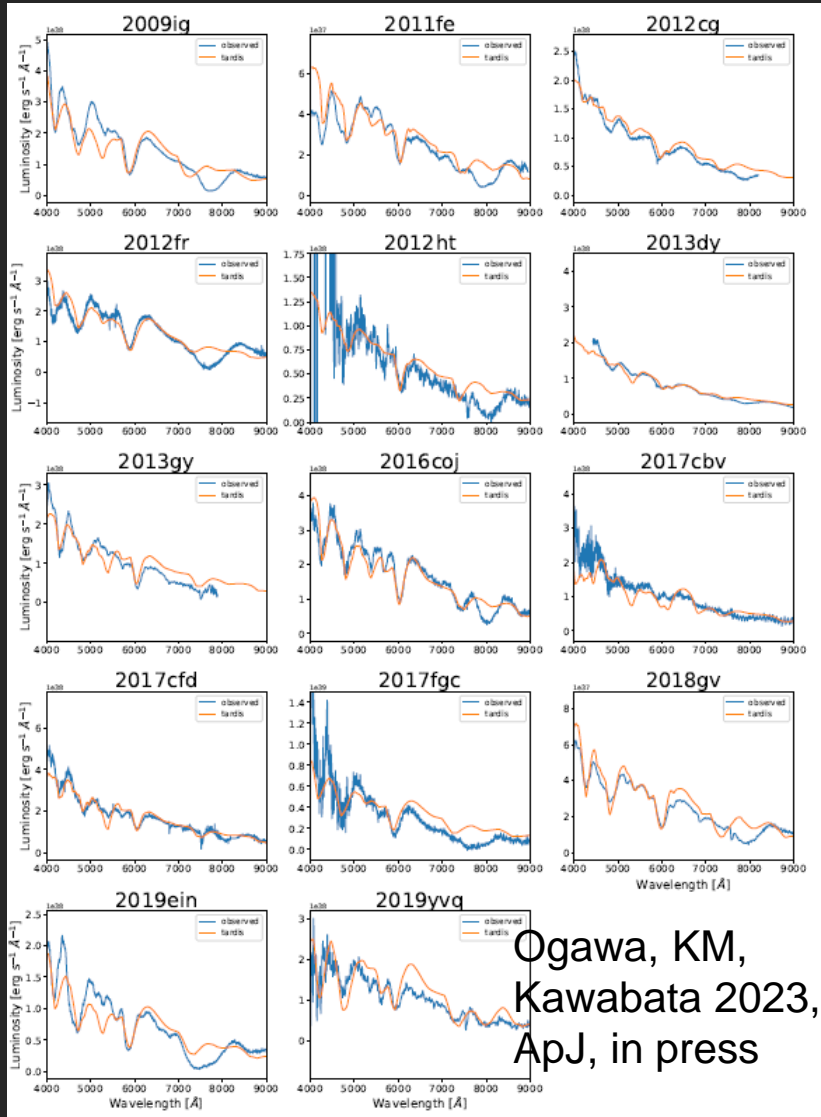
Subaru. JWST [O I] as a coolant
Dust formation



Siebert+ 2023

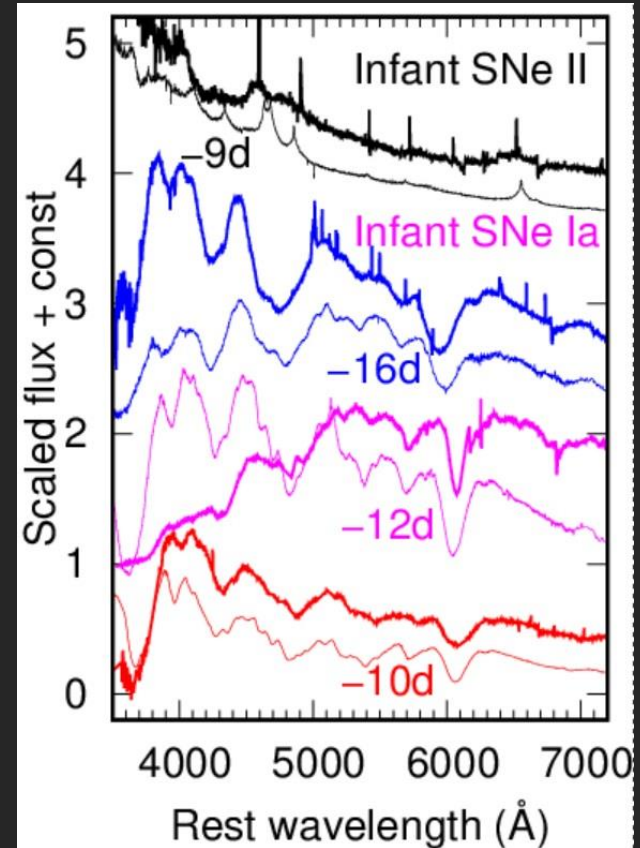
Siebert+
2023

Model ↔ data development



Ogawa, KM,
Kawabata 2023,
ApJ, in press

Ready to apply
to new data



Infant SNe (by GMOS: KM+)

Siebert+ 2023

New direction: TDE & related objects

- Nearest “TDE” classified by Seimei (Taguchi, Uno, Nagao, KM+ 2023).
- Seimei \Rightarrow Subaru (polarization).
- Strong polarization level, with interesting behaviors.
- Probably a “faked” TDE (identifying a new population of AGN?).

RA/DEC (2000) Type Redshift
11:40:09.397 +15:19:38.54 TDE
176.0391524 +15.3273735

[Discovery Report](#) [Classification Report](#)

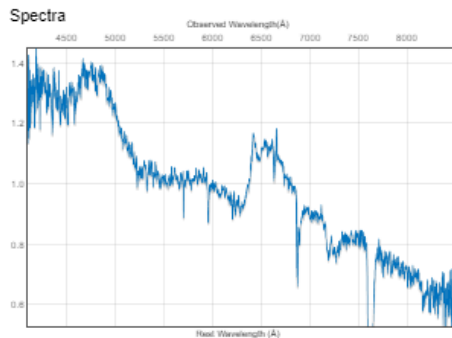
Related AstroNotes: [2023-51](#)



Reporting Group	Discovering Data Source	Discovery Date	TNS AT	Public	Host Name
A 8A 8-BN	A 8A 8-BN	2023-02-22 05:02:24.000	Y	Y	NGC 3788

Host Redshift	Discovery Mag	Filter
0.01107	18.3	g-Sloan

Reporters
K. Z. Stanek, for the A 8A 8-BN team



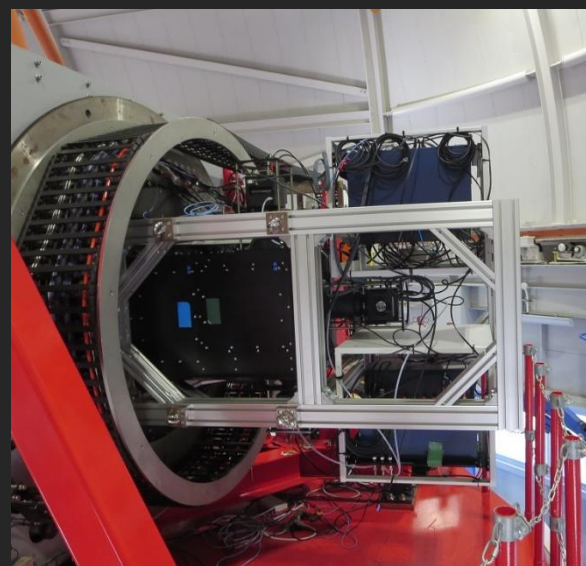
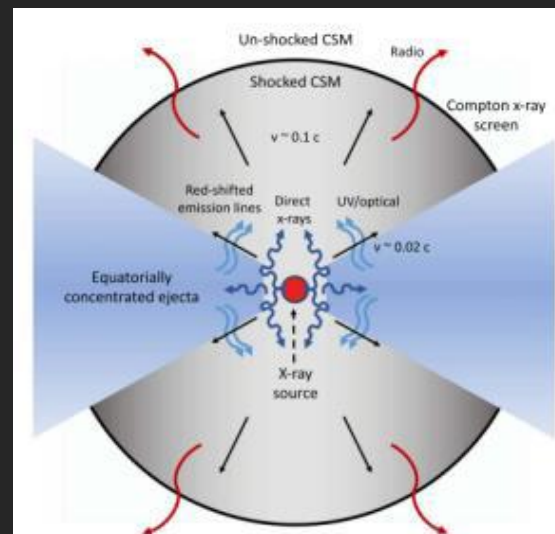
All 2023-01-2023-02-26 13:56:55 Other / Other (None)

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<input type="checkbox"/> Show H β at	<input type="text" value="z=0"/>	<input text"="" type="text" value="km/s"/>	
<input type="checkbox"/> Show H γ at	<input type="text" value="z=0"/>	<input text"="" type="text" value="km/s"/>	
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<input type="checkbox"/> Show N V at	<input type="text" value="z=0"/>	<input text"="" type="text" value="km/s"/>	
<input type="checkbox"/> Show O at	<input type="text" value="z=0"/>	<input text"="" type="text" value="km/s"/>	
<input type="checkbox"/> Show O II at	<input type="text" value="z=0"/>	<input text"="" type="text" value="km/s"/>	
<input type="checkbox"/> Show O III at	<input type="text" value="z=0"/>	<input text"="" type="text" value="km/s"/>	
<input type="checkbox"/> Show O IV at	<input type="text" value="z=0"/>	<input text"="" type="text" value="km/s"/>	

Uno, KM+, in prep.

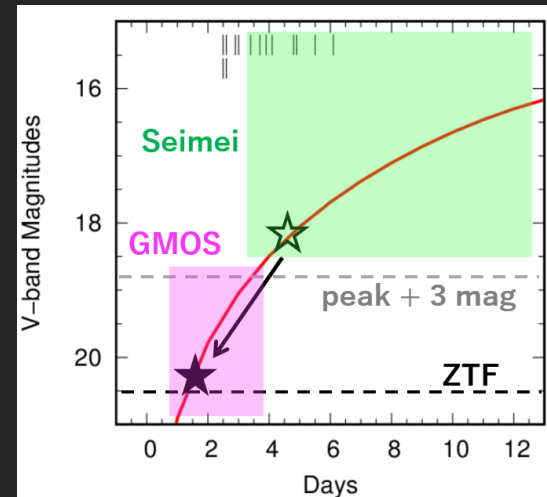
New Direction: Time-resolved obs.

- 23B-N-CT10 / 23B-K-0015.
- Search for short-timescale variabilities for “extragalactic” transients w/ TriCCS.
- Central engine, newborn NS.
- Targets:
 - Luminous-fast-blue-optical transients (LFBOTs, AT2018cow).
 - TDEs (and TDE-like transients).
 - (very) nearby SNe, NS-NS, NS-BH.
 - GRBs?

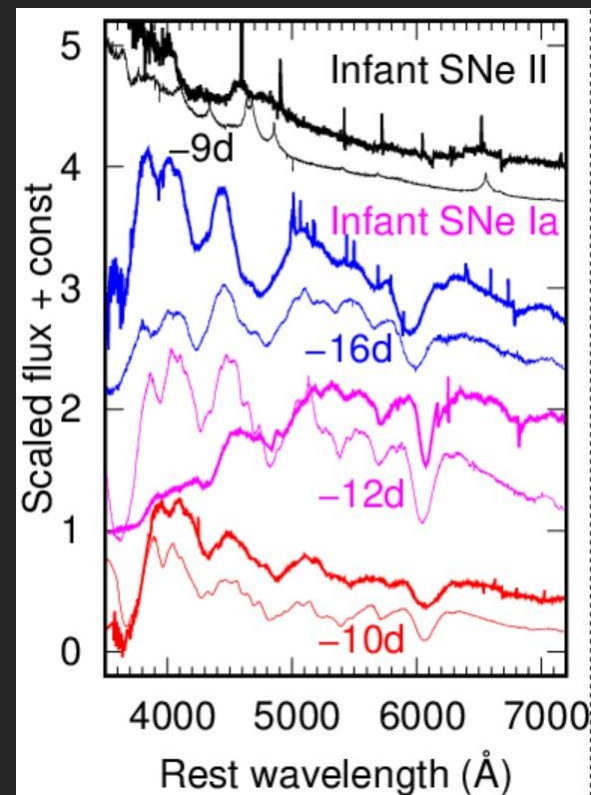


New Direction: 8m to Seimei

- Initial “dark” phase by 8m (e.g., GMOS).
- ⇔ Later follow-up by Seimei.



- GMOS-N rToO accepted in S23A.
 - 10 hrs in July-August (maintenance...).
 - Infant SNe “入れ食い” 状態.
 - Our system for the infant SN search and ToO has worked perfectly.
 - Peculiar rapid transient (KM+, in prep.).
 - Unfortunately Seimei in the maintenance...
 - **Proven to be very powerful.**
- Submitted for Subaru⇔Gemini S24A.



New Direction: multi-wavelength

2022.1.00115.T	Rapid ToO Observations of Nearby Supernovae: Probing The Final Evolution of Massive Stars	Keiichi Maeda	EA	50	
COIs	2023.1.00305.T	First Light of Nearby Supernovae: Disclosing the Massive Stars' Final Activities	Keiichi Maeda	EA	50
Abstr	COIs	Tomoki Saito; Takashi Moriya; Rieko Momose; Kenta Fujisawa; Stuart D Ryder; Poonam Chandra; Dan Patnaude; Hanindy Kuncarayakti; Shiu-Hang Lee; Gaston Folatelli; Tomoki Matsuoka; Esha Kundu; Ji-an Jiang; Tomonari Michiyama; Anna Y. Q. Ho;			
	Abstract	Recent observations of core-collapse supernovae (CCSNe) have led to a surprising picture that the massive stars are much more dynamic in the last few years than widely accepted previously; dense circumstellar matter confined in the vicinity of the progenitor (confined CSM) has been inferred. However, the optical emission is biased to pick up extreme CSM with large uncertainty in the interpretation. A quick ALMA ToO will yield unique and unbiased diagnostics. There are only three previous examples for which the nature of the confined CSM has been derived, using the ALMA data within ~5 days since the explosion. Contrary to the previous expectation that the confined CSM is common, a striking diversity has been emerging, but the very small sample does not allow further investigation. Inspired by this proof-of-concept, we propose ToO observations of two CCSNe at Bands 1, 3 and 6; one SN from a compact He or C+O star and another SN from a yet-unclarified progenitor. This will allow us to study whether the final activity is dependent on the nature of the stars. This project will bring us new and robust information on the yet-unclarified final evolution of massive stars.			

- (As an example) ALMA proposal accepted for infant SNe (one of only 3 ToO proposal accepted for cycle 10).
- So far three papers from the ALMA infant SN program.
- To coordinate w/ Seimei (North vs. South...)
- New SN just triggered in the north hemisphere (and the queue for Seimei).

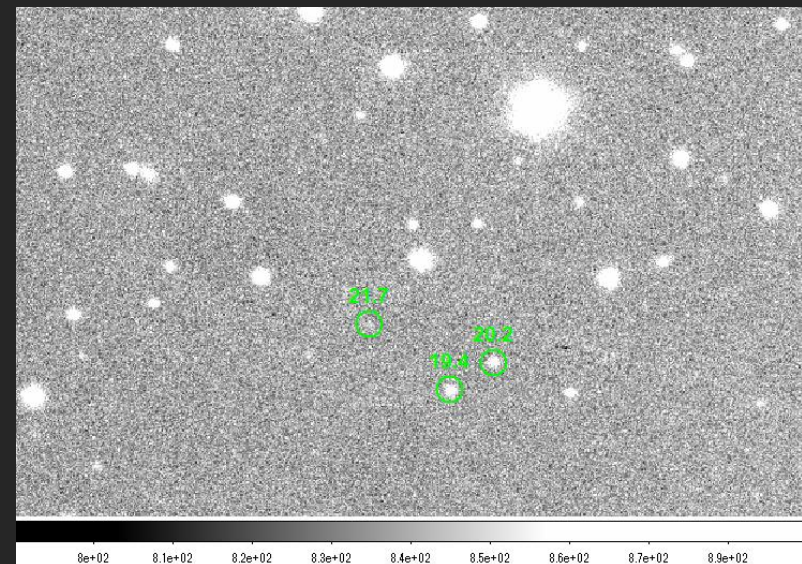


GW counterpart search with TriCCS

- Developing a system for GW counterpart search/follow-up triggered by LIGO/Virgo alerts (through J-GEM).
- Observing flowchart:
 - J-GEM:
 - Compute the 3D likelihood map for a LIGO/Virgo GW alert.
 - Pickup possible host galaxies from the GLATE catalog, and put ranks.
 - Seimei:
 - Continuously monitor the J-GEM server.
 - Trigger ToO for “good” events (e.g., <100 deg², NS involved).
 - Execute a automatic-observation script.
 - Observing in the queue mode, visibility vs. association ranking.
 - Reduction pipeline (next page).
- Currently Virgo offline, so few good events.

TriCCS imaging reduction pipeline

- A new PC installed for the on-site reduction.
- Current features.
 - Dark, Flat, WCS, stacking
 - ⇒ Science image.
 - For GW counterpart search, the data are sent to the J-GEM server
 - ⇒ difference image
 - ⇒ photometry.



Summary

Accelerated publications for the SN/transient program.

Coupled with the model/theory activities.

New directions/functions:

- **TDEs and related phenomena.**
- **Time-resolved observations for extragalactic transients.**
- **Seimei \Rightarrow 8 m, but also 8m \Rightarrow Seimei.**
- **Multi-wavelength, e.g., coordinated with ALMA.**

Preparing for multi-messenger:

- **GW counterpart search pipeline (Taguchi+).**
- **TriCCS reduction pipeline (Kawabata+).**