

Early-Time Observations of the Nearby Type Ia Supernova SN 2025qe

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Miho Kawabata (Kyoto U.), Ichiro Takahashi (Science Tokyo)

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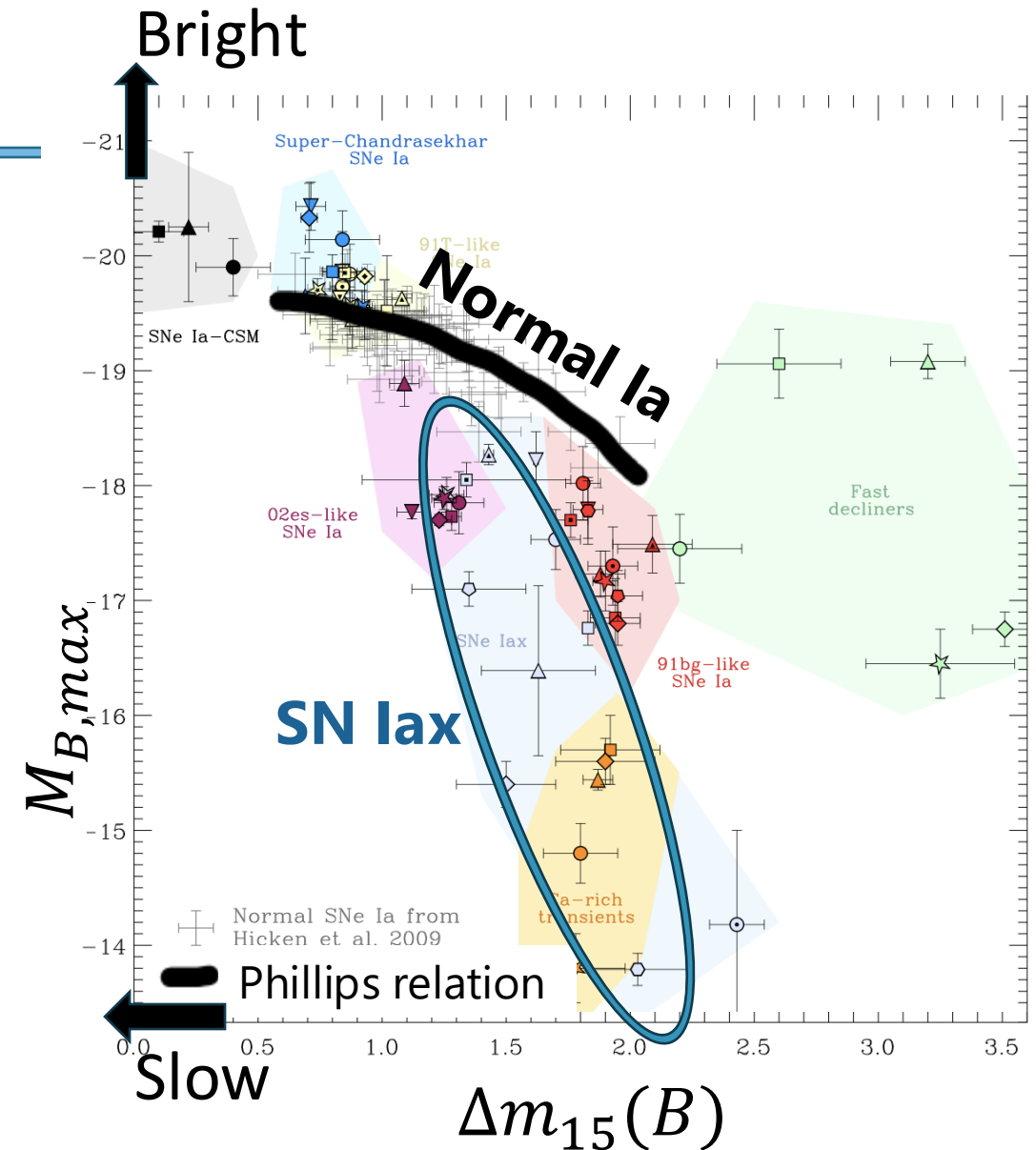
- Introduction
- Observations
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 - Characterization
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What is SN Iax?

- A group of thermonuclear supernovae with
 - lower luminosity
 - lower ejecta velocity
- **“Failed” explosion**
- Late-time spectra never become fully optically thin.
- **Leaves behind a bound remnant.**



Progenitors & Explosion Mechanisms of SN Iax

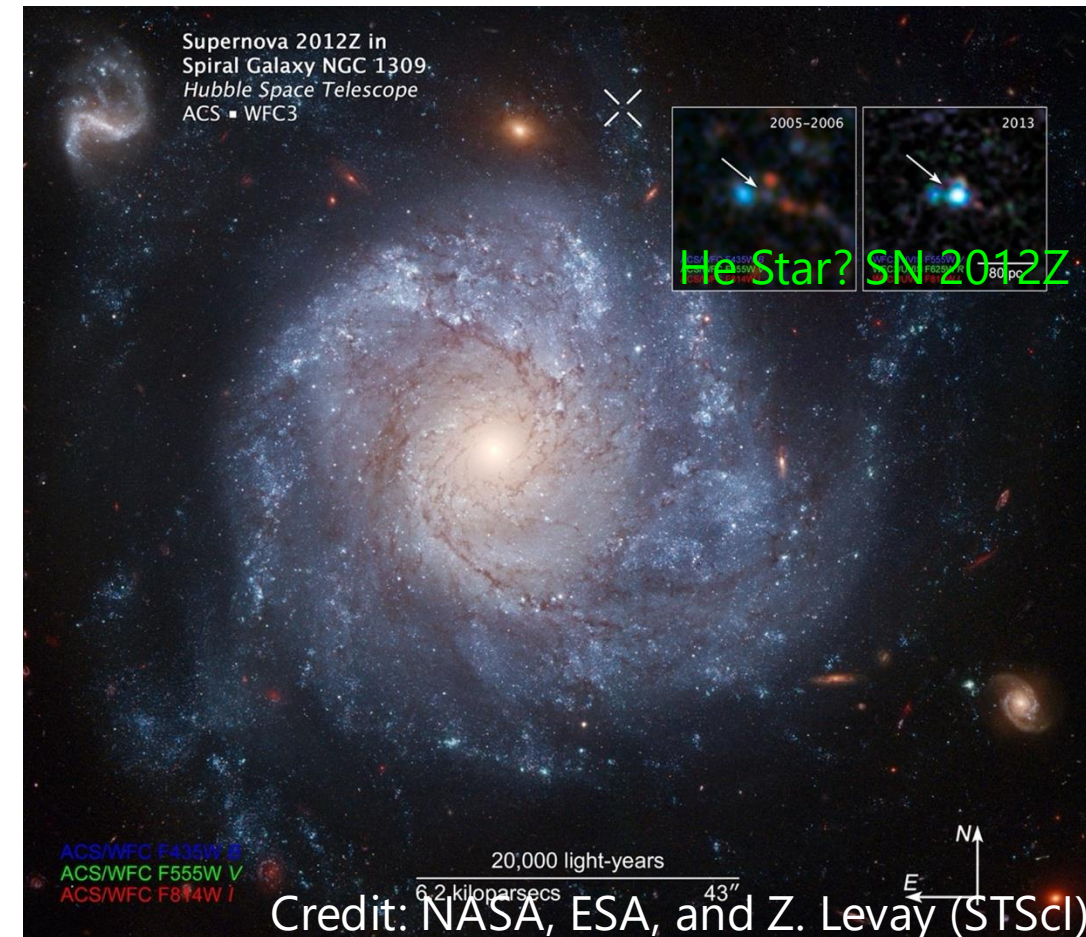
➤ The leading scenario is:

A pure deflagration explosion by helium accretion onto a CO WD.

- To confirm this scenario, we need information on the **outermost layers**.

- **Ejecta velocity**
- **Spatial distribution of Ni** in the ejecta

➤ **Early-time observations** are needed.



A Nearby SN Iax: SN 2025qe

- Discovered on 2025/1/18 by ZTF

Tomo-e Gozen transient survey independently detected the object on 2025/1/18.

Transient Candidates アプリ 13:33
transientId: 8391561, RealProb: 0.760 , SN-Prob: 0.820
AT 2025qe, VSX: Failed

Detail

[Tomo-e_transient_server](#)

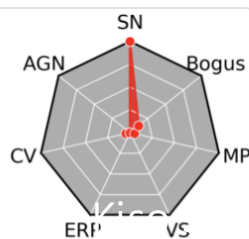
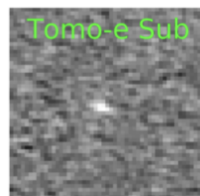
[VSX](#) [SDSS](#) [SIMBAD](#)

! 4

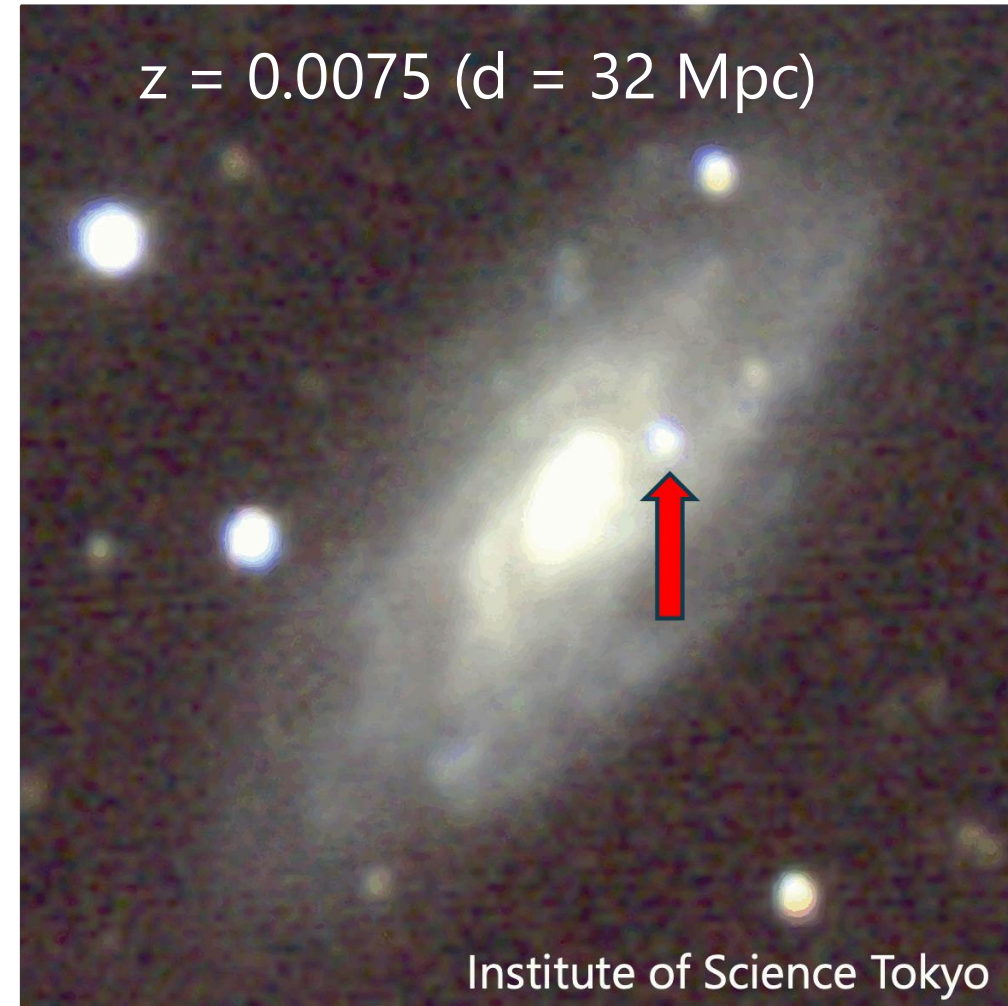


3 件の返信 最終返信: 9日前

Transient Candidates アプリ 13:33
trid_8391561.png ▼



Details in my talk on the
Tomo-e transient alert system,
2.5 hours later!



Institute of Science Tokyo

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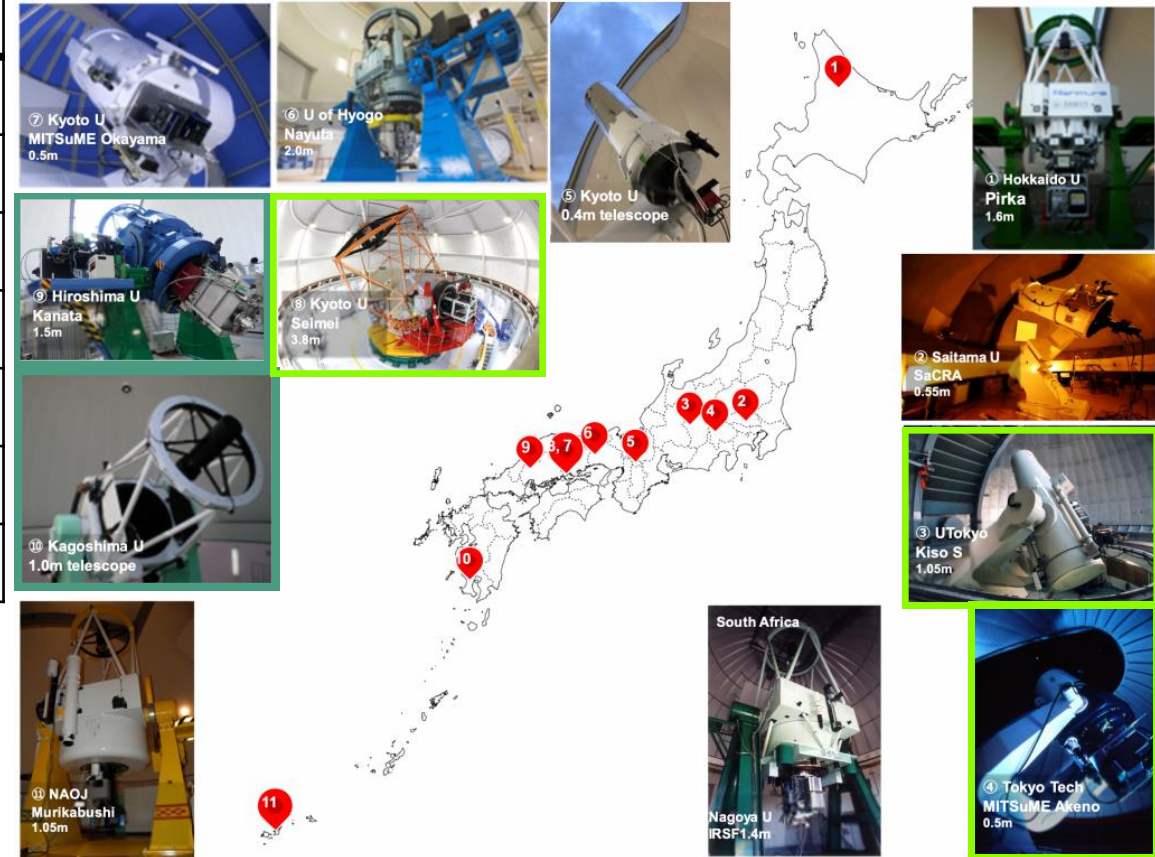
Pre-Peak Observations (Photometry)

Days from disc.	instrument	g mag	r/Rc mag	Ic mag
0	ZTF-g	18.673	-	-
0.103	ZTF-r	-	18.716	-
0.265	Tomo-e	19.285 (clear)	-	-
0.342	Tomo-e	18.901 (clear)	-	-
1.334	MITSuME	17.691	17.196	17.446
2.310	MITSuME	17.147	17.208	17.193
3.298	MITSuME	16.900	17.019	17.012

⋮

+ ZTF, ATLAS, UVOT,
Seimei (Kyoto U.), Kanata (Hiroshima U.),
1.0m telescope (Kagoshima U.)

TELESCOPES OF THE OISTER



[OISTER](#) web page

Pre-Peak Observations (Spectroscopy)

	Days from disc.	telescope	instrument	min λ [Å]	max λ [Å]
[TNS, Public]	0.539	Lijiang-2.4m	YFOSC	~3400	~9000
[TNS, Public]	1.746	Liverpool-2.0m	SPRAT	~4020	~8100
	4.379	Seimei-3.8m	KOOLS-IFU	~4000	~8500
	12.368	Seimei-3.8m	KOOLS-IFU	~4100	~8500

⋮



Seimei Telescope, Kyoto Univ.

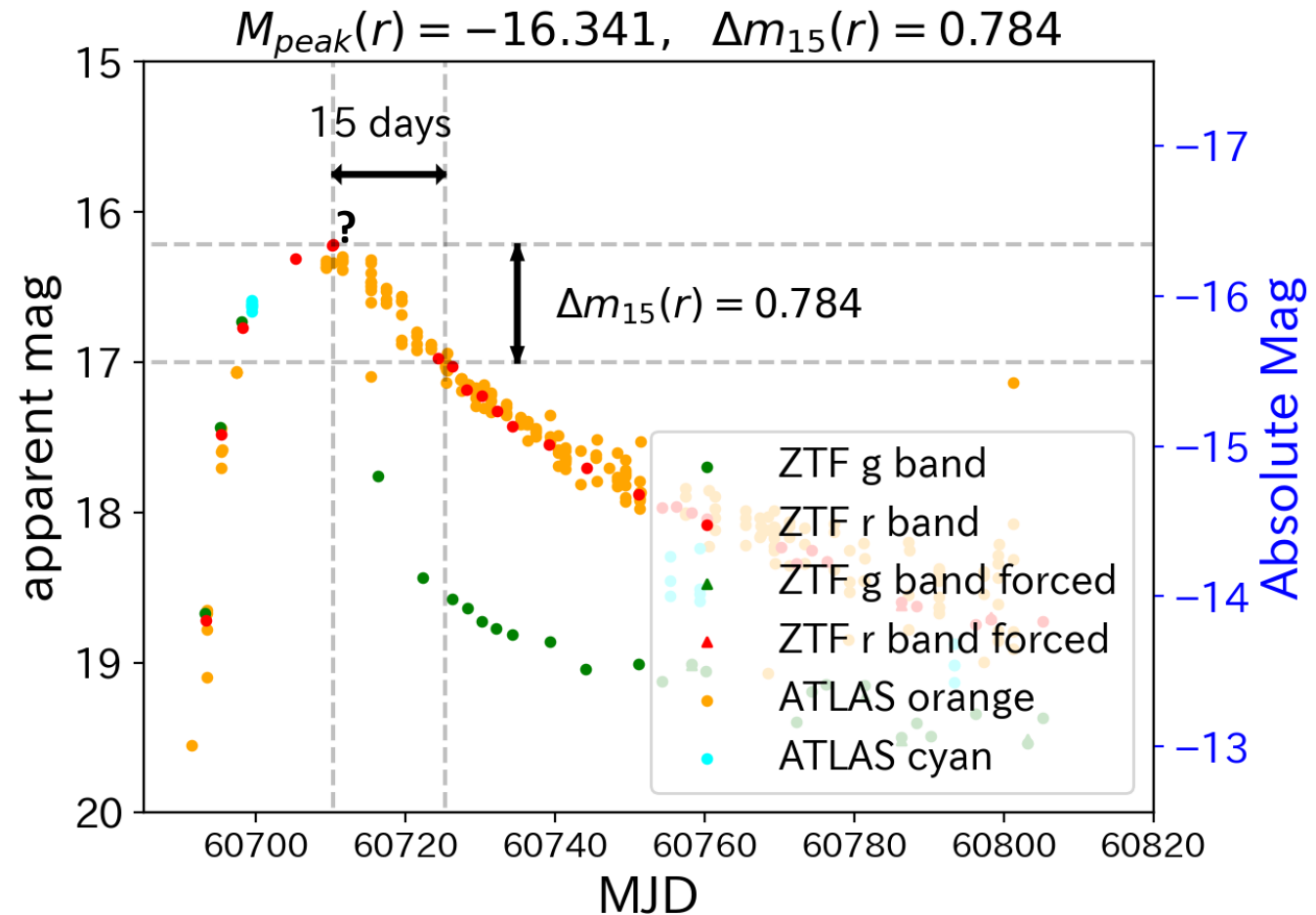
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r -band Peak & Decline Rate (Light Curve)

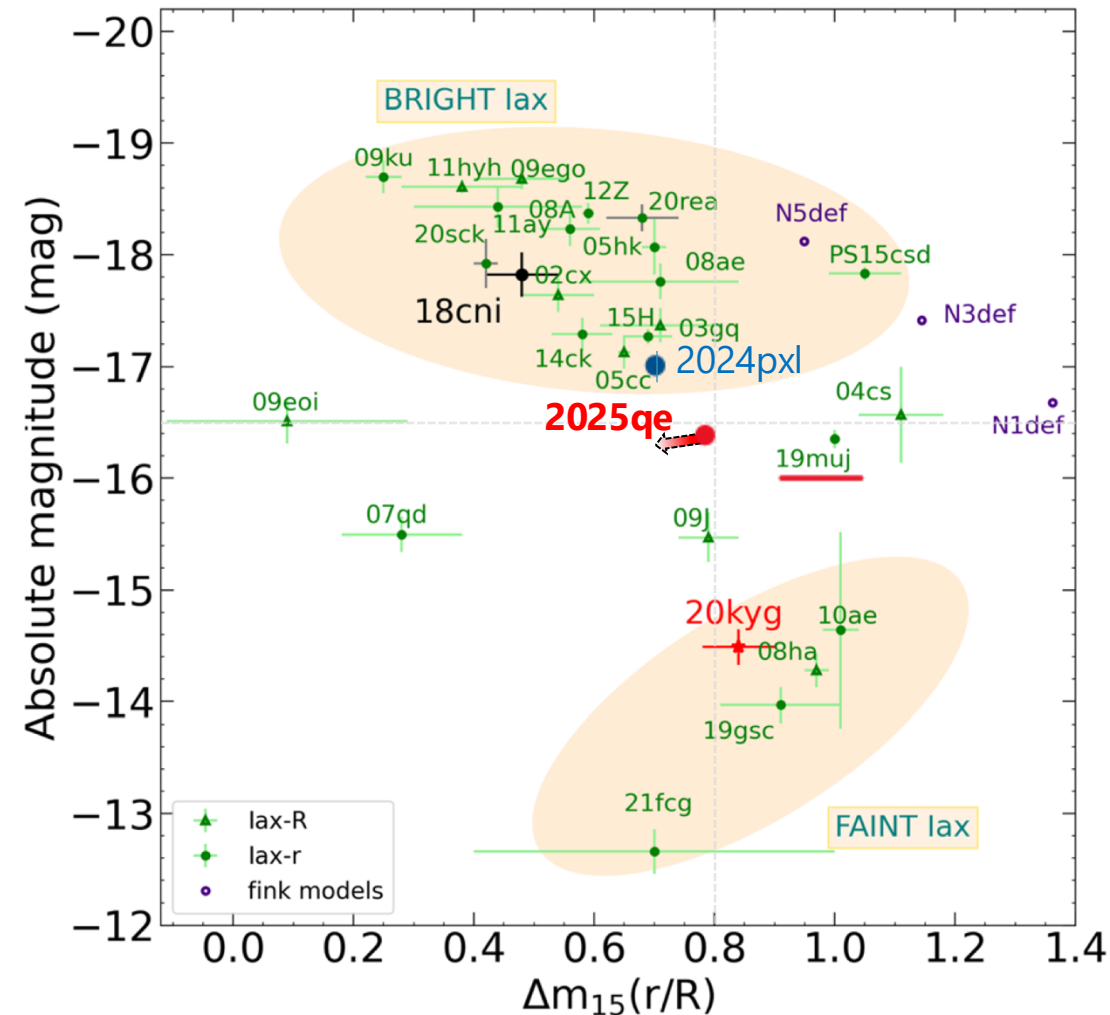
- Extinction by host galaxy
→ negligible (almost no Na ID absorption)
- Extinction by Milky Way
→ $A_r = 0.053$

$$M_{peak}(r) = -16.394,$$
$$\Delta m_{15}(r) = 0.784$$



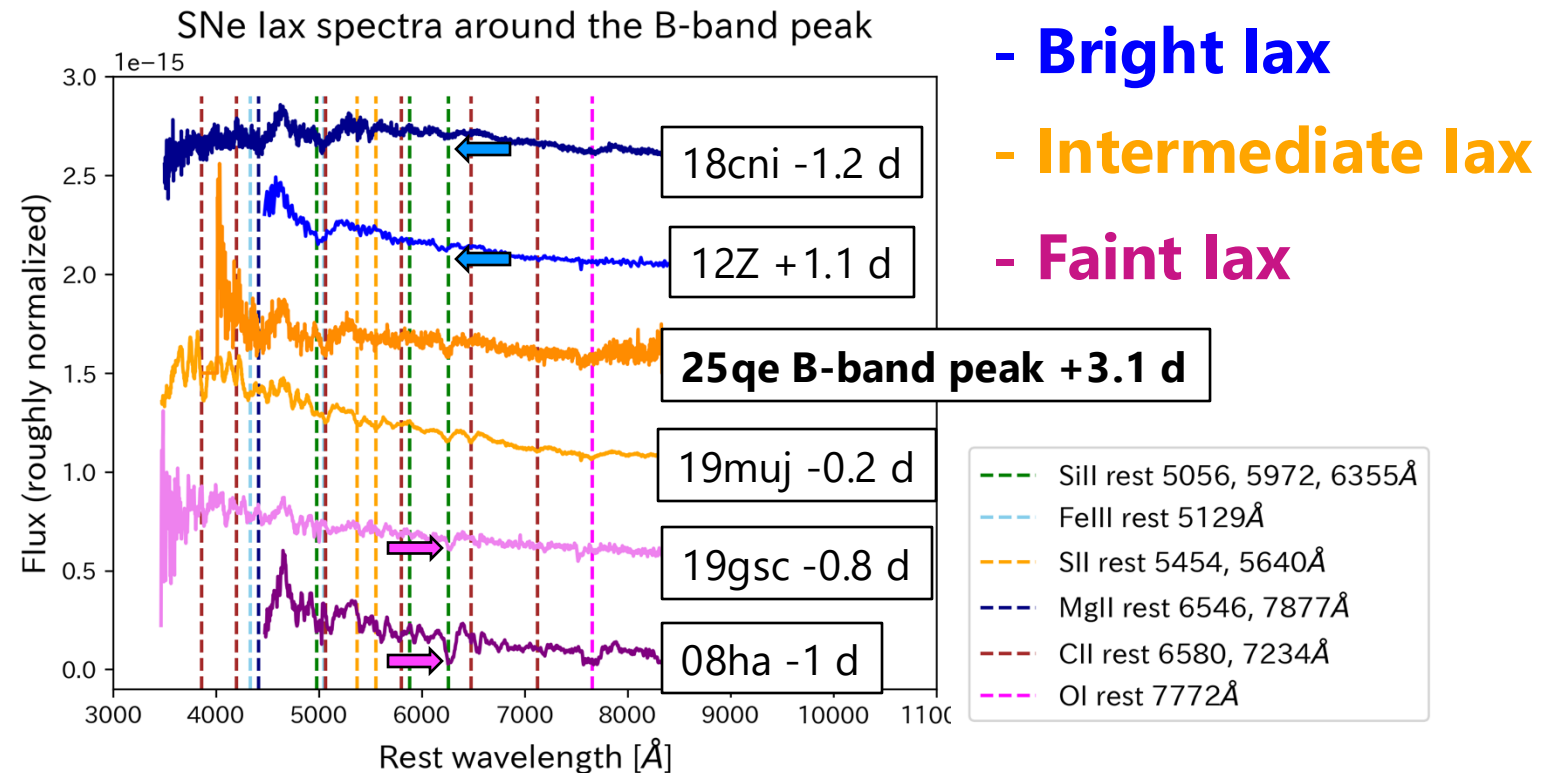
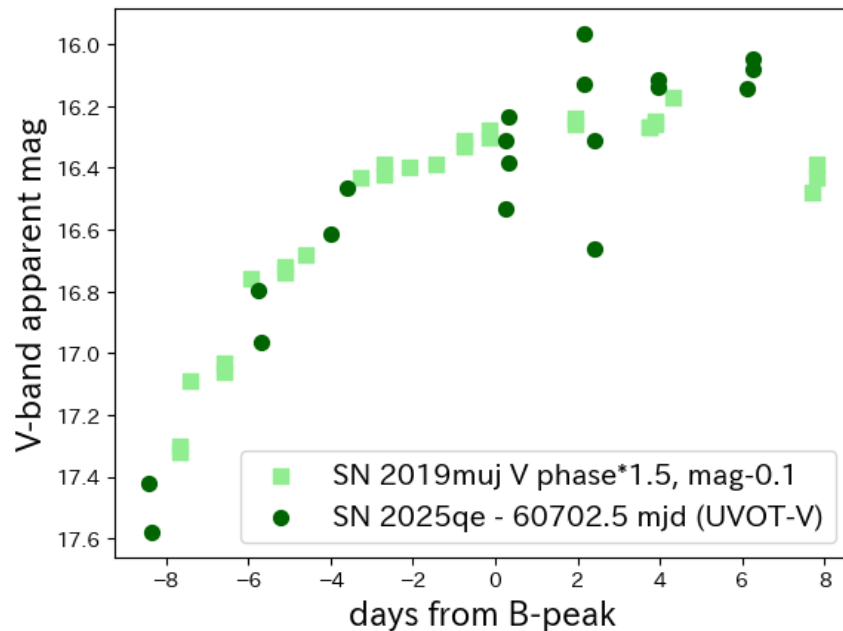
r -band Peak vs Decline Rate Plane

- Plotted **SN 2025qe** on [Singh+23](#) r -band Peak vs Decline Rate Plane.
- **SN 2024pxl** is also plotted.
 - Classified as a intermediate-luminosity SN lax in a recent study. ([Singh+25](#))
- SN 2025qe is an **intermediate-luminosity SN lax** with only a few observational examples.
- Appropriate for comparison with 2019muj (and 2024pxl)



Spectrum at B -band Peak

- B band peak of 2025qe: Estimated in comparison to 2019muj
- $v_{\text{Si II}, \text{max}} \sim 4500 \text{ km/s}$: **intermediate luminosity**



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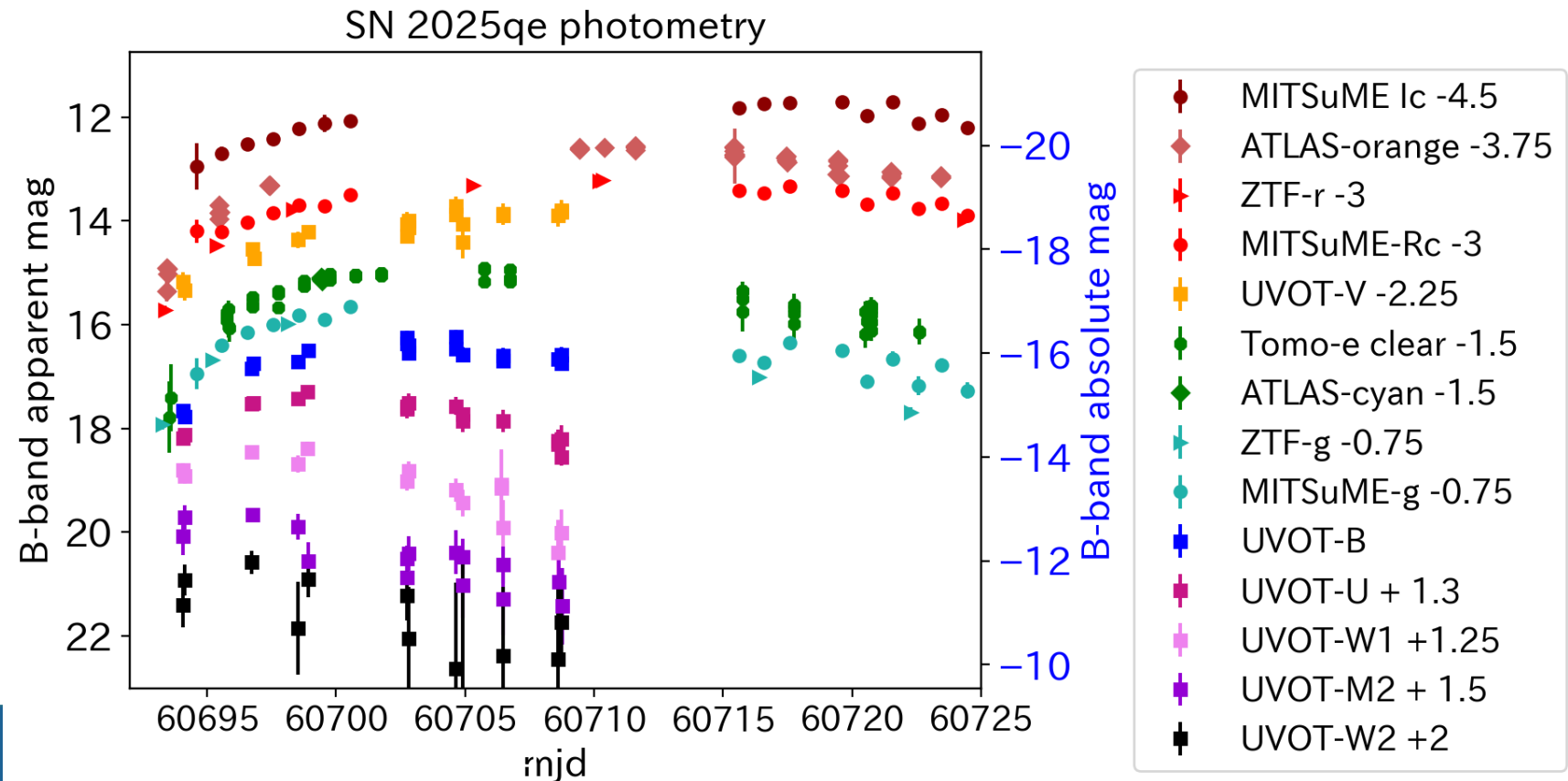
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From NUV to NIR Light Curve of Rising Phase

Filter	W2	M2	W1	U	B	g	cyan	clear	V	Rc	r	orange	Ic
λ_{eff} [Å]	2076	2247	2716	3524	4346	4746	5182	~5000	5412	~6500	6370	6630	~8000

✂ full transmission

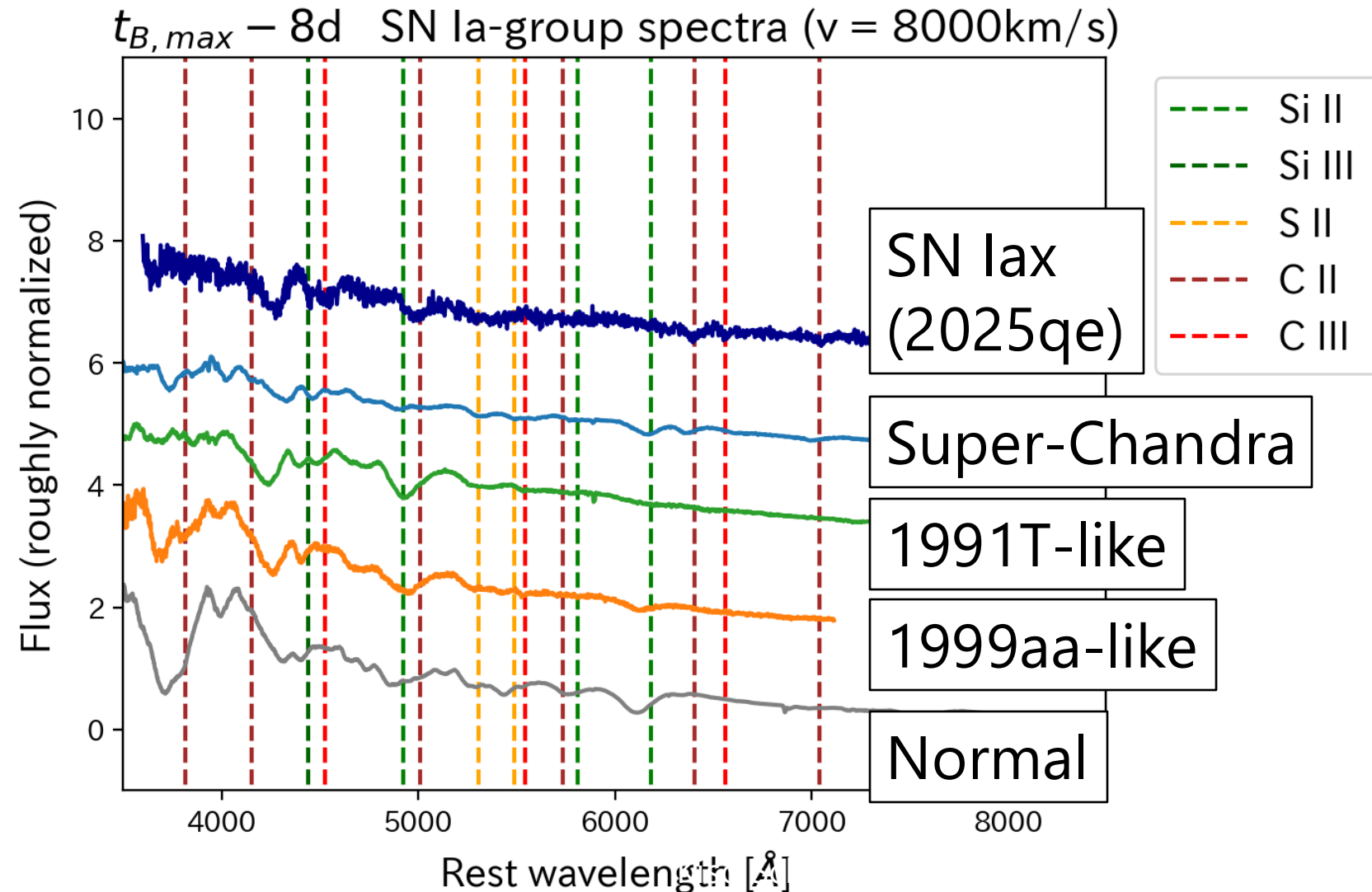
- UVOT covered peak from M2 to V bands.
- J, H, Ks-band plots will be added soon.



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Comparison with Other Early SNe Ia Spectra



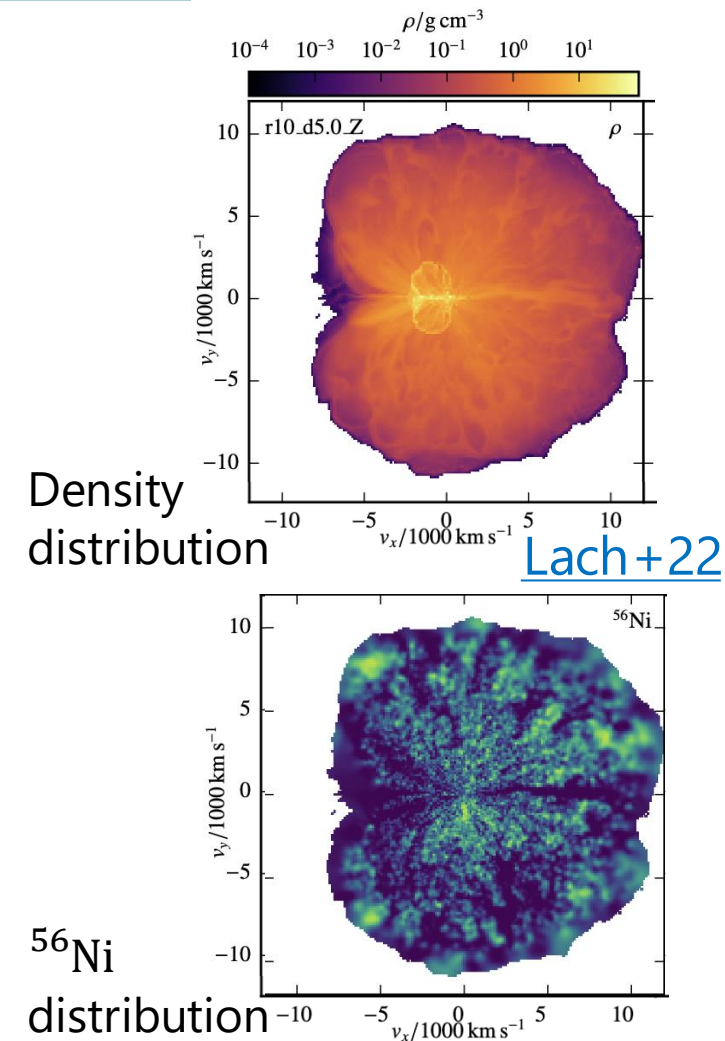
- Showing Ni II absorption, weak Si II feature
→ Similar to 1991T-like

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Discussion

- **Low velocity**
 - Lower kinetic energy
 - Suggests **weak burning (deflagration)**
- **Ni III** absorption lines are detectable
 - Similar to 1991T-like, 1999aa-like
 - Suggests **Ni mixing into the outer ejecta**



Summary

- SN 2025qe is an **intermediate-luminosity SN lax**.
- A very early spectrum similar to that of **1991T-like** (as in previous studies), suggesting **Ni mixing**.
- [Future work] Relate observed features to the occurrence rate of intermediate-luminosity SNe lax.