

早期で発見されたII型超新星 SN 2024acnの可視光追観測

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OISTER Workshop

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- Observation of SN 2024acn (24acn) plays a role as
 - A case study of Type II(n) supernovae
 - An example of follow-up observations for transient objects found by the Tomo-e Gozen project
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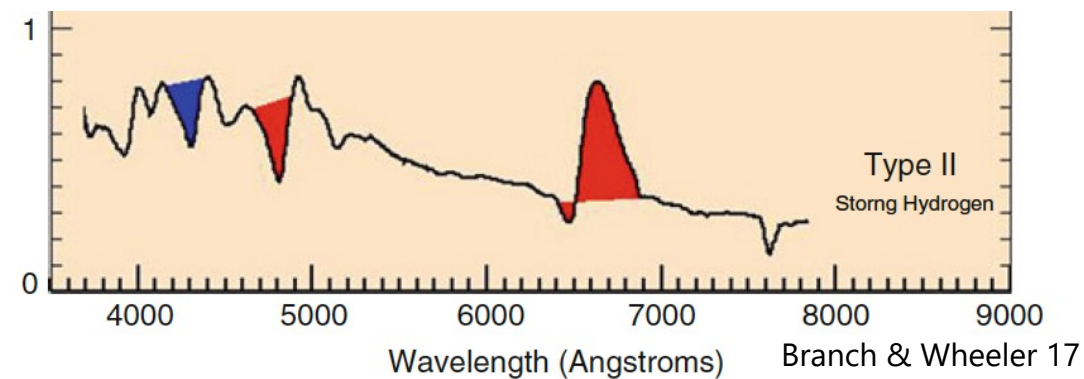
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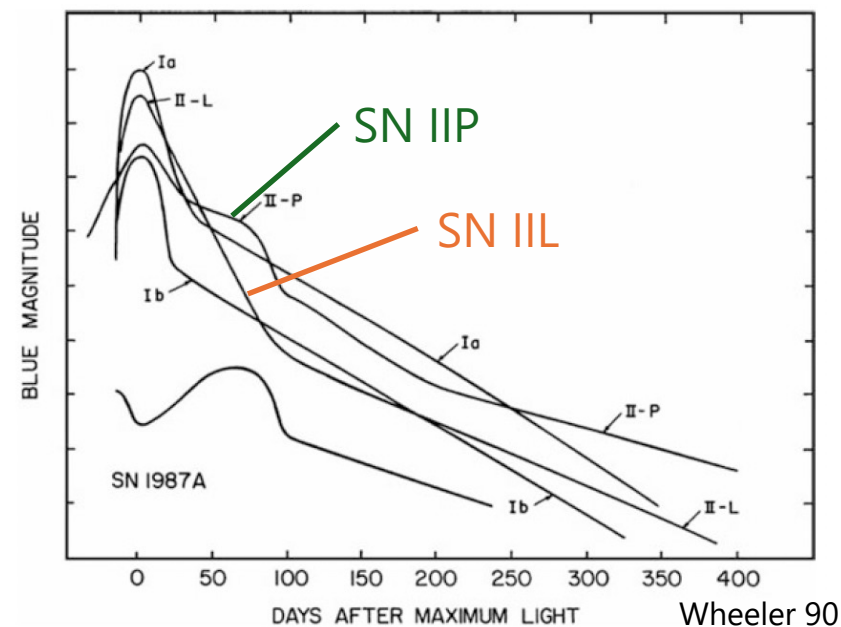
4. Summary

1.1 Type II supernovae (SNe II)

- **SNe II** are supernovae that occur from core-collapse of massive stars ($>8M_{\odot}$)
 - Strong **hydrogen lines** in spectra (progenitor has a hydrogen envelope)
- SNe II can be further classified from their **light curves** / **spectra**
 - SN IIP: **"P"lateau** phase in light curve
 - SN IIL: **"L"inear** decline in light curve
 - SN IIn: **"n"arrow** lines in spectrum
 - ◆ Dense circumstellar material (**CSM**) around the SN → heavy **mass-loss** of progenitor
 - SN IIb: emergence of **He I** in spectrum



A typical spectrum of SNe II



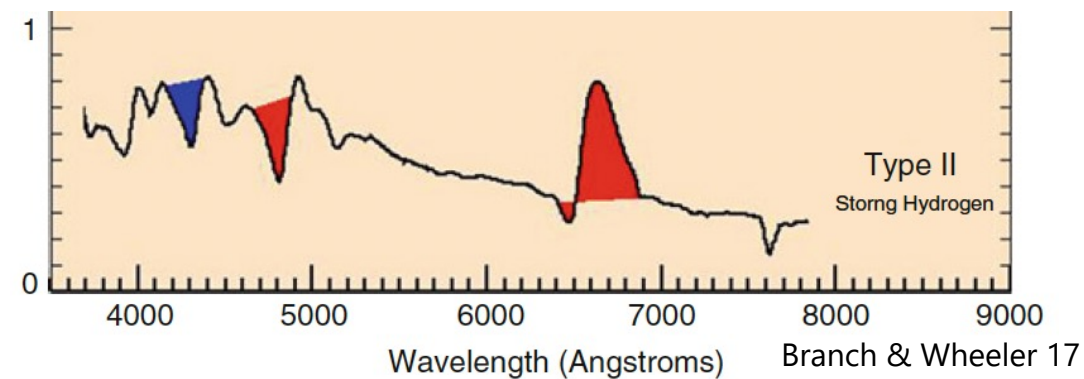
Light curves of SN IIP and IIL

1.1 Type II supernovae (SNe II)

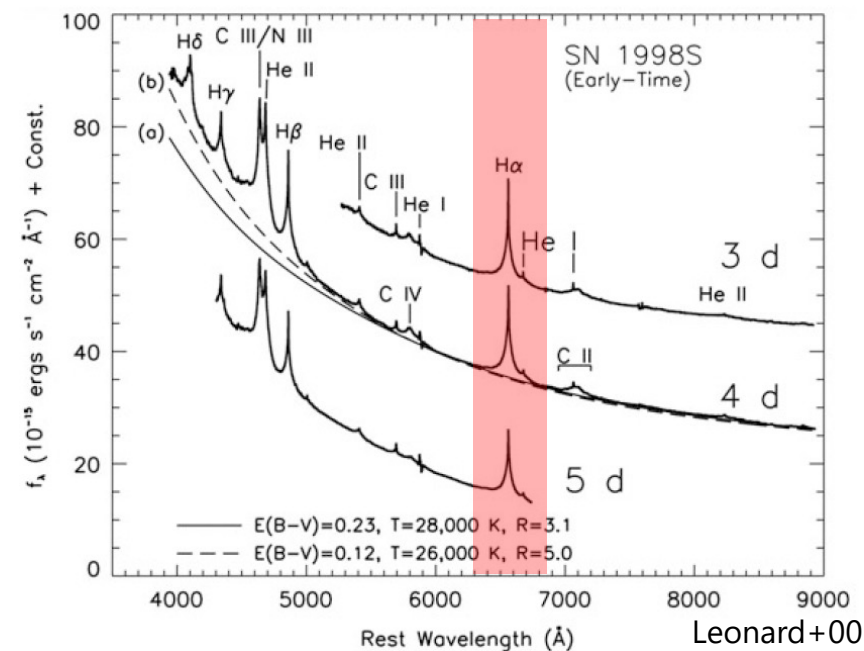
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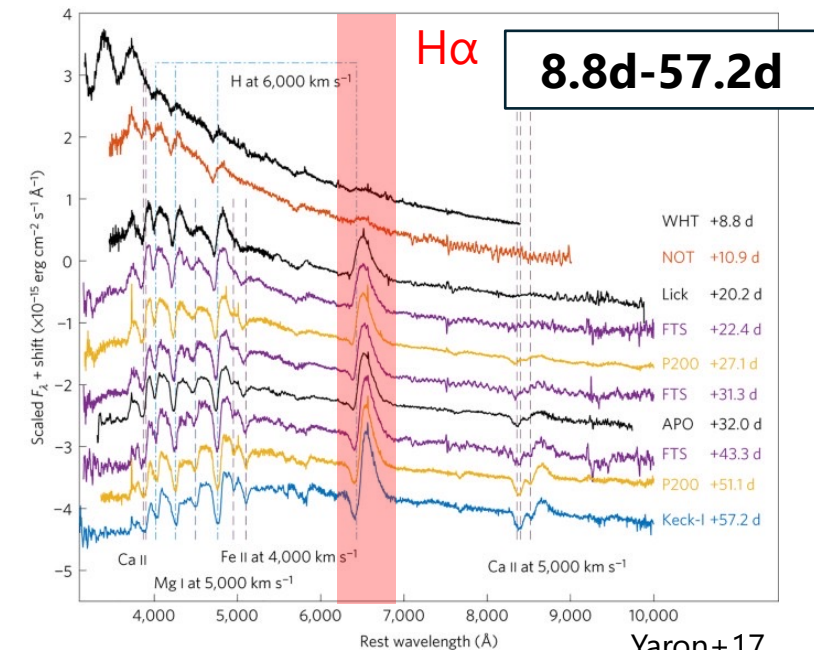
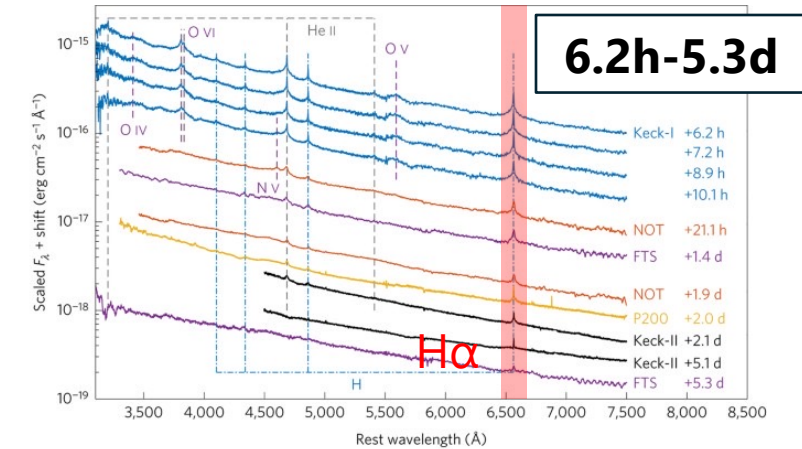
A typical spectrum of SNe II



Spectrum of SN IIn (SN1998S)

1.2 Mass-loss of SN II progenitors

- Wide-field surveys have enabled early SN observations, deepening our understandings
- Many SN II progenitors experience **intense mass-loss** just before explosion (not just SNe IIn)
 - SN 2013fs: a SN IIP showing narrow lines for ~5 days (Yaron+17)
 - Implies the existence of CSM near the SN
- There is a diversity of mass-loss rates within SNe II
 - We need a larger sample (e.g. SNe in between SNe IIP and SNe IIn) to understand this diversity
 - SNe should be observed as early as possible

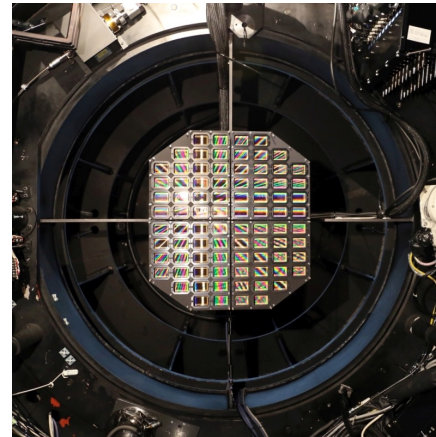


Spectra of SN2013fs

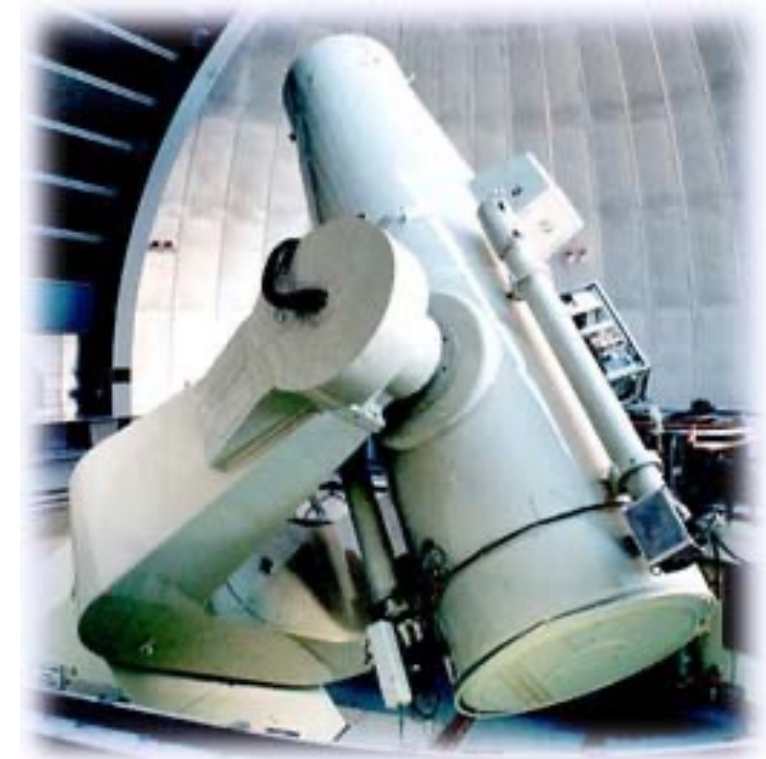
Yaron+17

2.1 The Tomo-e Gozen camera

- The **Tomo-e Gozen** camera is an instrument mounted on the 1.05m Kiso Schmidt telescope
- A wide-field camera consisting of 84 CMOS sensors
 - Field of view of 20 square deg
 - 2 fps images
 - ~10 TB of data per night
 - No filters



The Tomo-e Gozen camera →



東京大学 木曾観測所
Kiso Schmidt telescope

Wide field × high time resolution × quick data handling
= **a powerful tool to study short timescale phenomena**



2.2 Transient surveys with Tomo-e Gozen

- We are conducting survey programs with the Tomo-e Gozen camera to discover short timescale phenomena (e.g. supernovae)

➤ **All-sky survey**

➤ **High-cadence survey**

+ **manual ToO observations**

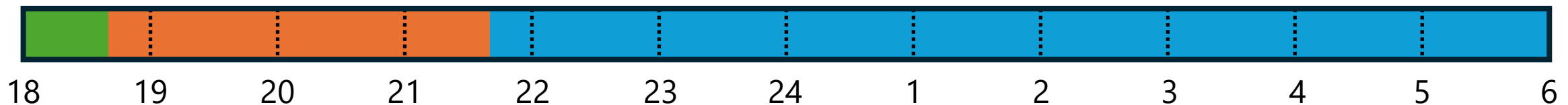
Features	Value
Cadence	1 day
Depth	~ 18 mag
Field coverage per day	13,000 square deg
Exposure time	0.5s * 18 frames

Features	Value
Cadence	0.5 hr
Depth	~ 18 mag
Field coverage per day	3,000 square deg
Exposure time	0.5s * 12 frames

Other surveys

All-sky survey

High-cadence survey




Example of an observation schedule of Tomo-e Gozen

2.3 Recent improvement of transient detection

- Using machine learning, an alert system has recently been developed to discover and notify about new transients



非公開



非公開

2.4 Discovery of SN 2024acn

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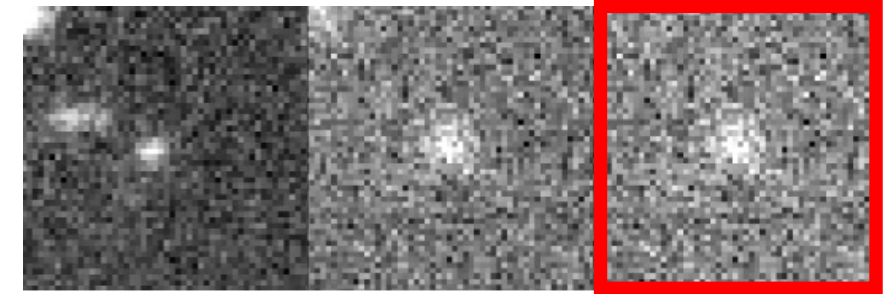
- 24acn was detected at 17.57 ± 0.11 mag (Tomo-e)

1/14

- We received an alert
- 2nd observation: detection and brightening was confirmed (MITSuME Akeno)

1/15

- Object was reported to the Transient Name Server (TNS) as AT 2024acn
 - Second object to be reported by Tomo-e Gozen (after SN2019cxx)



Reference New Subtracted
Image of first detection of 24acn

SN 2024acn

RA/DEC (2000)	Type	Redshift
11:10:40.441 +21:06:26.87 167.668505874 +21.1074646977	SN II	0.031

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

Reporting Group	Discovering Data Source	Discovery Date	TNS AT	Public	Discovery Mag
Tomo-e Gozen	Tomo-e Gozen	2024-01-13 19:30:26.000	Y	Y	17.57

Filter
Other-

Reporter/s
Ryotaro Koshi (The University of Tokyo), Ryuichi Hoshino (The University of Electro-Communications), Ichiro Takahashi (Tokyo Institute of Technology), Shigeyuki Sako (The University of Tokyo), Taiga Sasaoka (The University of Tokyo), Nozomu Tominaga (National Astronomical Observatory of Japan), Kenta Taguchi (Kyoto University)

Discovery report of 24acn

3.1 Follow-up observations with OISTER

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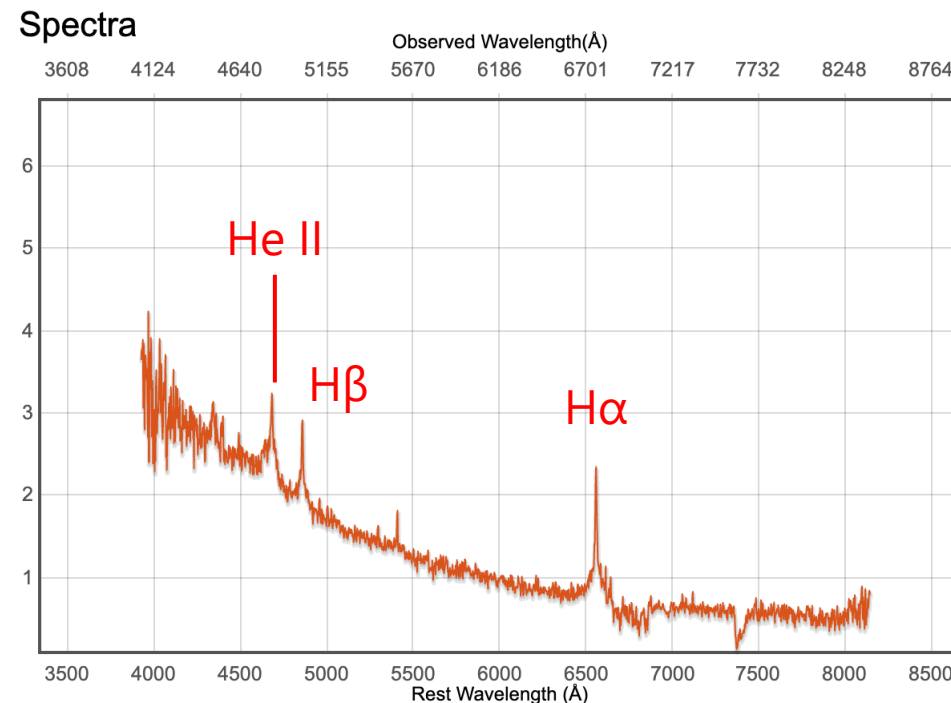
- Spectroscopy and photometry (Seimei)
- 24acn was classified as a SN II at $z=0.031$ (~ 130 Mpc)

1/16

- Spectroscopy and photometry (Seimei)

1/17

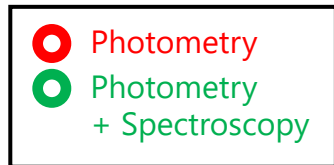
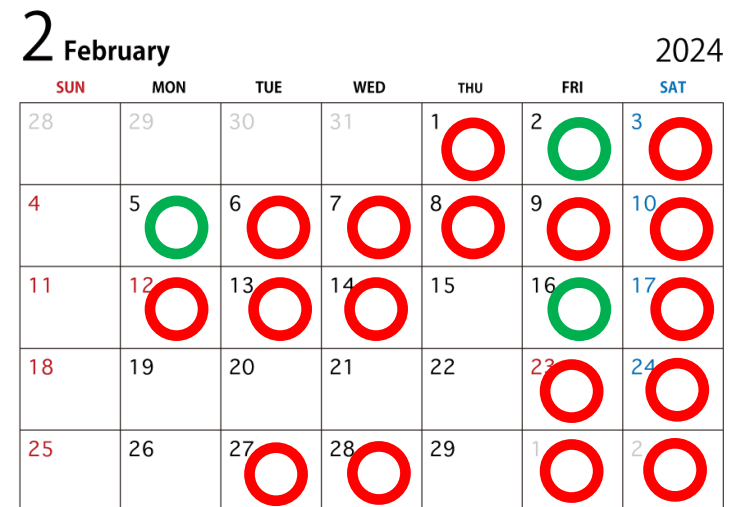
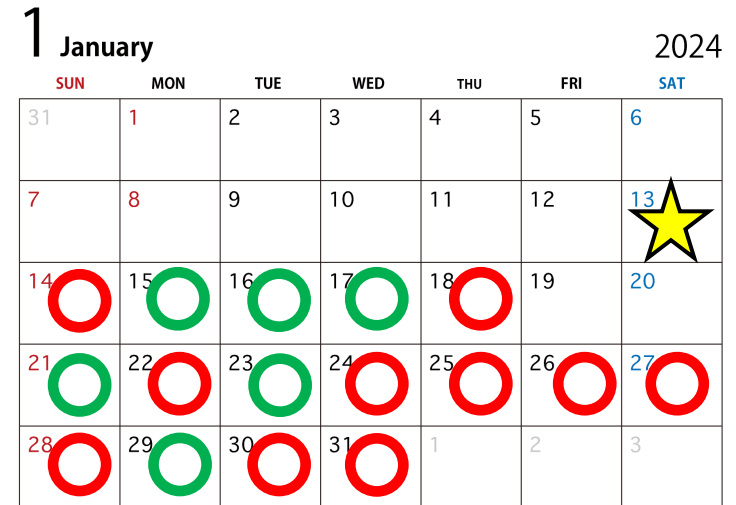
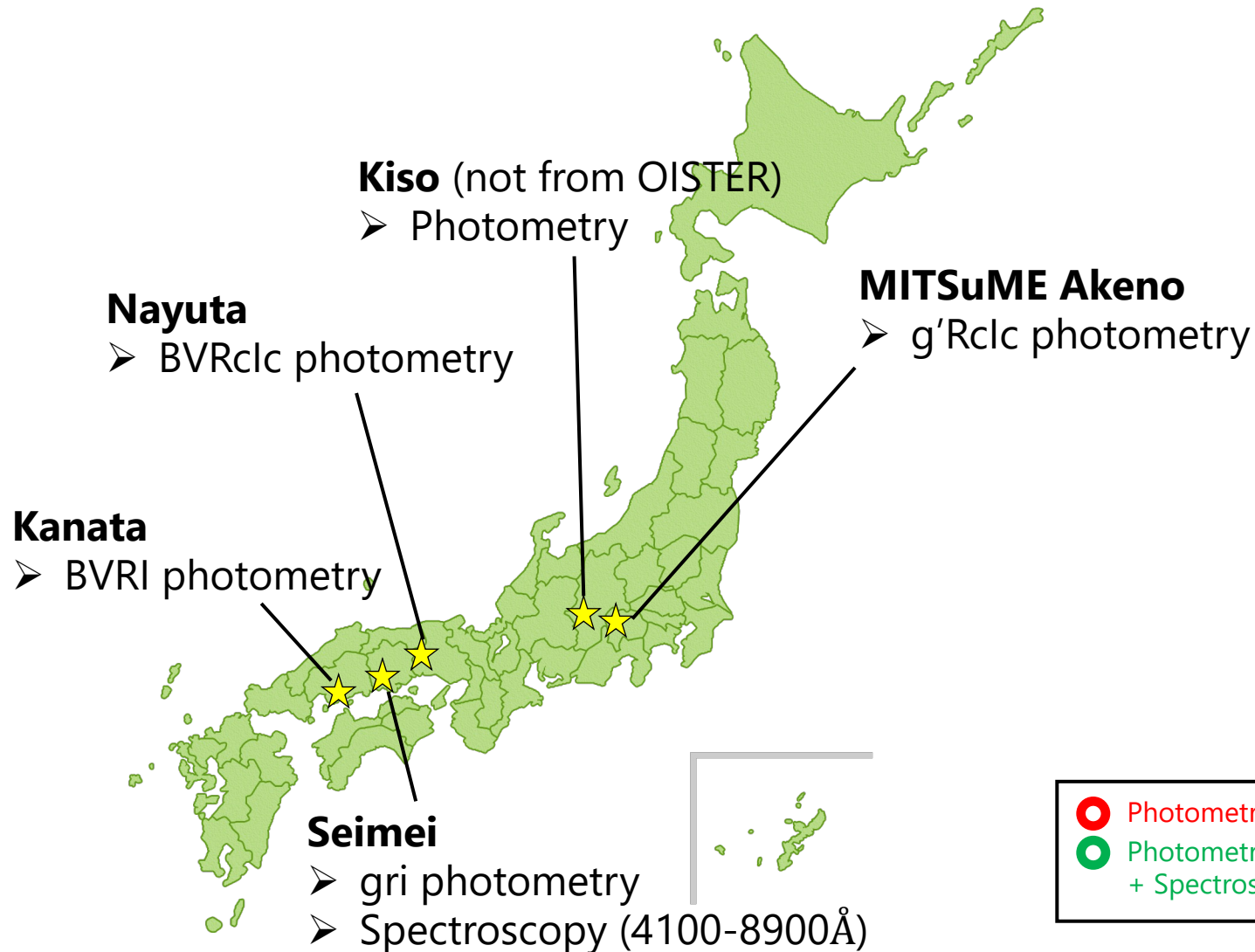
- A proposal was submitted to and accepted by OISTER
- Follow-up observations by OISTER were commenced



A quicklook spectrum of 24acn taken on 1/15 by Seimei (KOOLS-IFU, VPH-blue)

3.2 Follow-up status of SN 2024acn

Follow-up observation is currently in progress with 5 observatories



3.3 Photometry of SN 2024acn

Koshi et al., in prep.

3.4 Spectroscopy of SN 2024acn

Koshi et al., in prep.

3.5 Comparison with other SNe

Koshi et al., in prep.

3.6 Future observation plans

Koshi et al., in prep.

4. Summary

- SN 2024acn is a Type II supernova that was found in its early phase by Tomo-e Gozen

Koshi et al., in prep

- Observation with several telescopes enables obtainment of good data
- More SNe is expected to be found by Tomo-e
 - Follow-up with OISTER will maximize the values of these discoveries

SN 2024ahe

[Bookmark](#)

RA/DEC (2000)	Type	Redshift
23:02:37.851 +41:13:57.51	SN Ia-91T-like	0.014
345.6577109 +41.232641		

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

Reporting Group	Discovering Data Source	Discovery Date	TNS AT	Public	Discovery Mag
Tomo-e Gozen	Tomo-e Gozen	2024-01-12 09:49:23.000	Y	Y	18.94

Filter
Other-

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Ryotaro Koshi (The University of Tokyo), Ryuichi Hoshino (The University of Electro-Communications), Ichiro Takahashi (Tokyo Institute of Technology), Shigeyuki Sako (The University of Tokyo), Taiga Sasaoka (The University of Tokyo), Nozomu Tominaga (National Astronomical Observatory of Japan), Kenta Taguchi (Kyoto University)

Discovery report of SN 2024ahe, a SN Ia