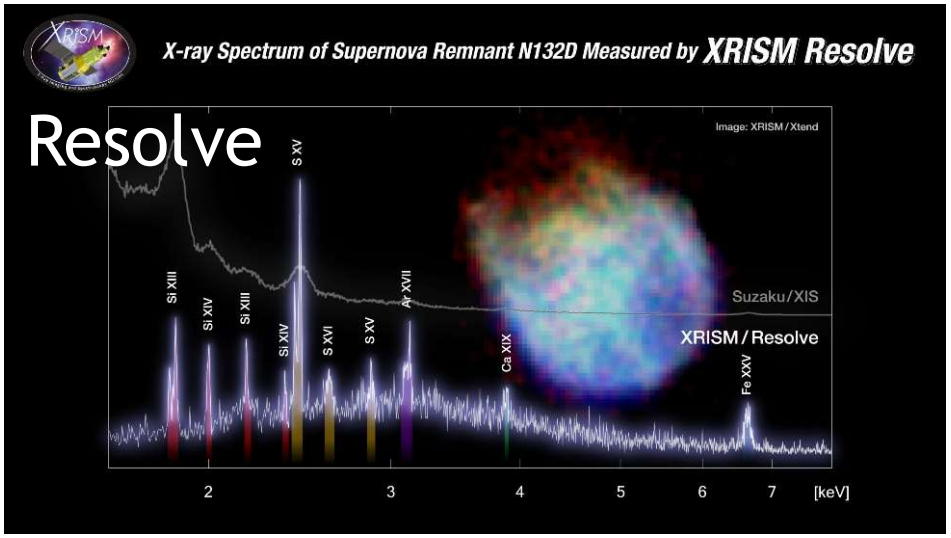
Evolution from SNe to SNRs with XRISM

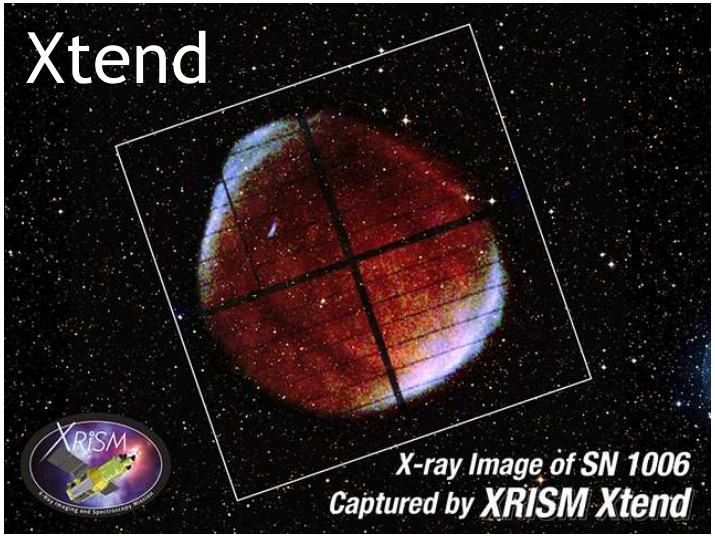
Aya Bamba
(U. Tokyo, Japan)

0. XRISM results in the early phase

XRISM is Japan – US X-ray observatory with two detectors.



X-ray calorimeter
with excellent E resolution
(5 eV @ 6 keV)



X-ray CCD
with large FoV of 38’ x 38’

Publications in high impact journals

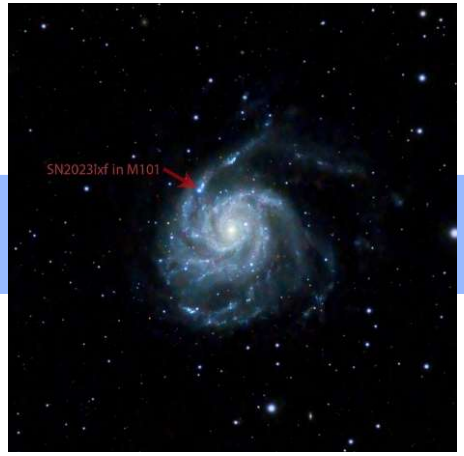
	Gal. compact	Gal. diffuse	ExtraGal. compact	ExtraGal. diffuse
Published	2+0	1+1	1+0	1+4
Submitted	0+0	0+0	2+0	1+0

(Nature/Nature astronomy + ApJL)

1.1. When SNe become SNRs ?

SNe and their remnants: origin of heavy elements
and diversity of the universe

star evolution



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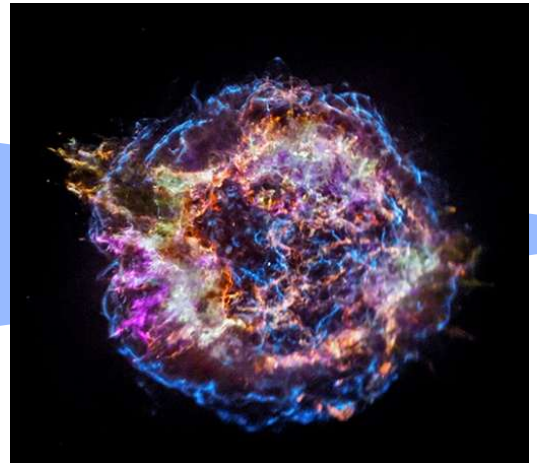

chemical evo.

circumstellar medium
heated by forward shock

high abundance ejecta
heated by reverse shock

When are heavy elements heated ?
and distributed into the space to enrich the space ?

1.1. When SNe become SNRs ?

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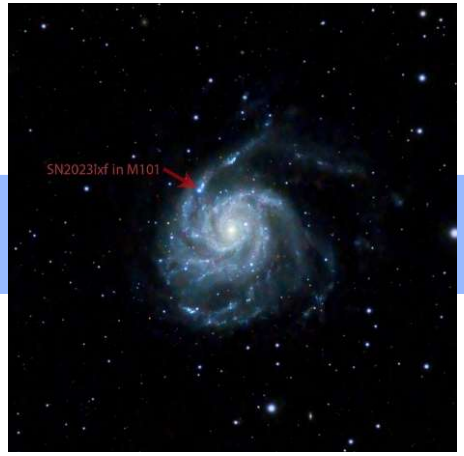
topic 2

star evolution



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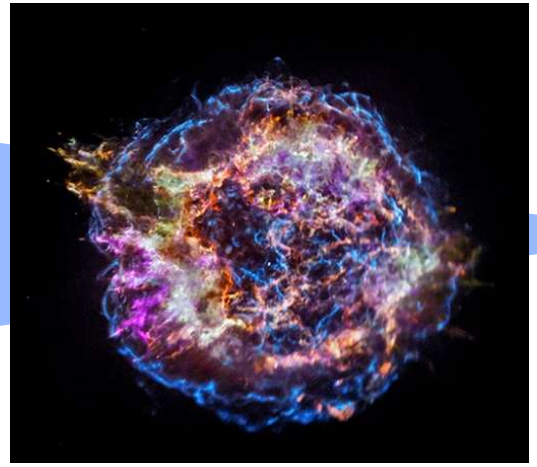
topic 1



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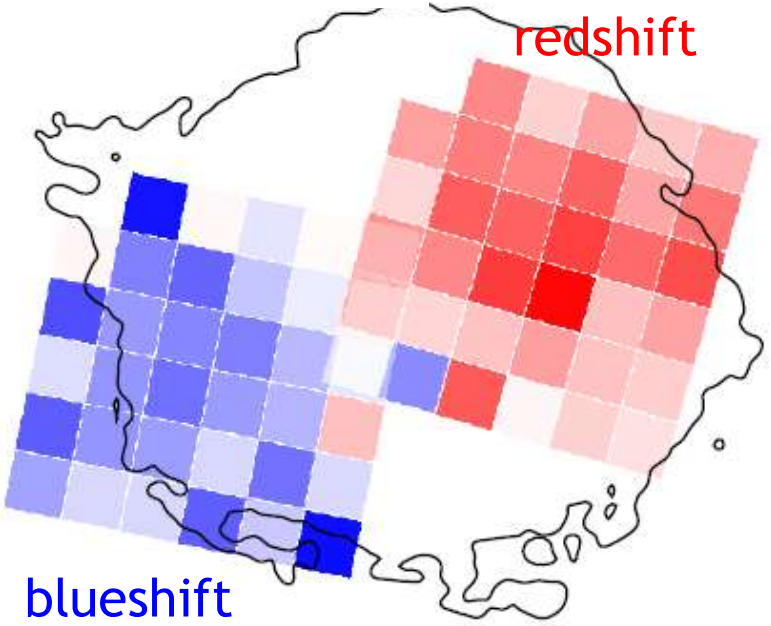
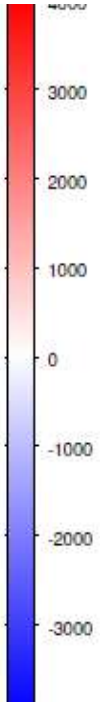
1.2. Topic 1: The expansion structure of Cas A

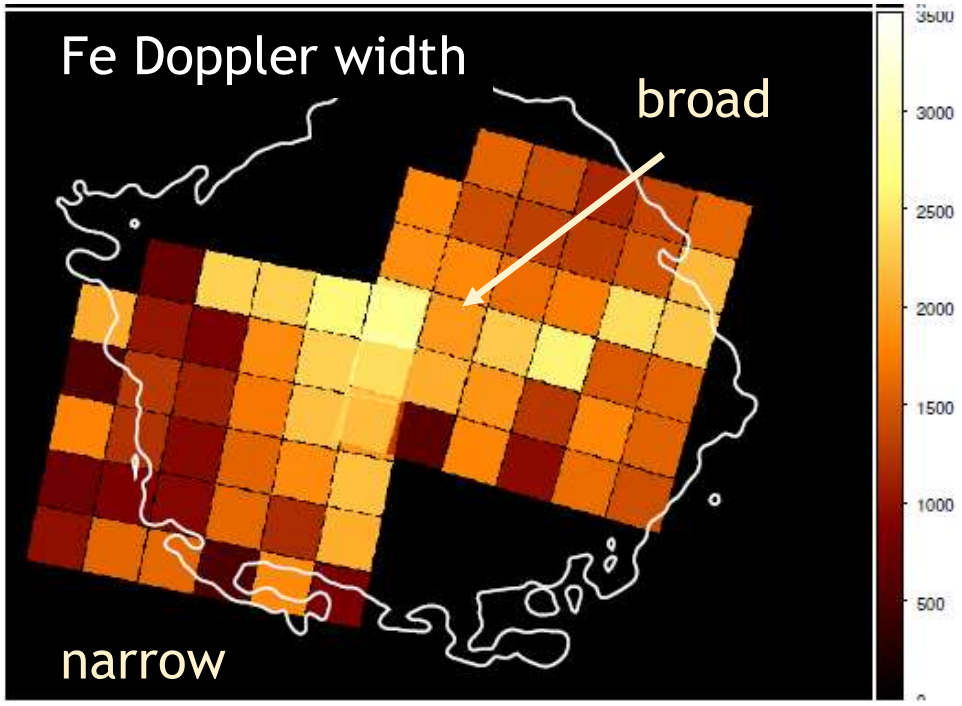
Expansion structure

Bamba+25
Vink+25

Fe Doppler shifts

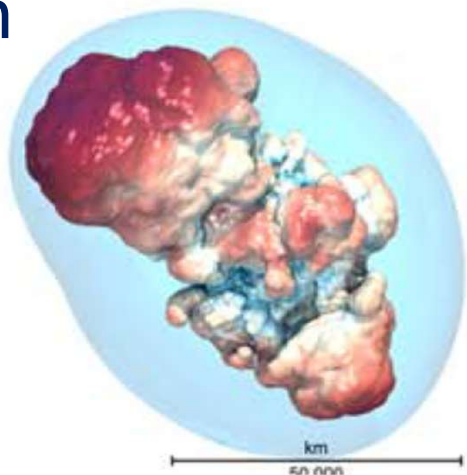






~-2000 – -3000 km/s in SE, ~+2000 km/s in NW -> asymmetric
broad in the center with ~ 3000 km/s dispersion

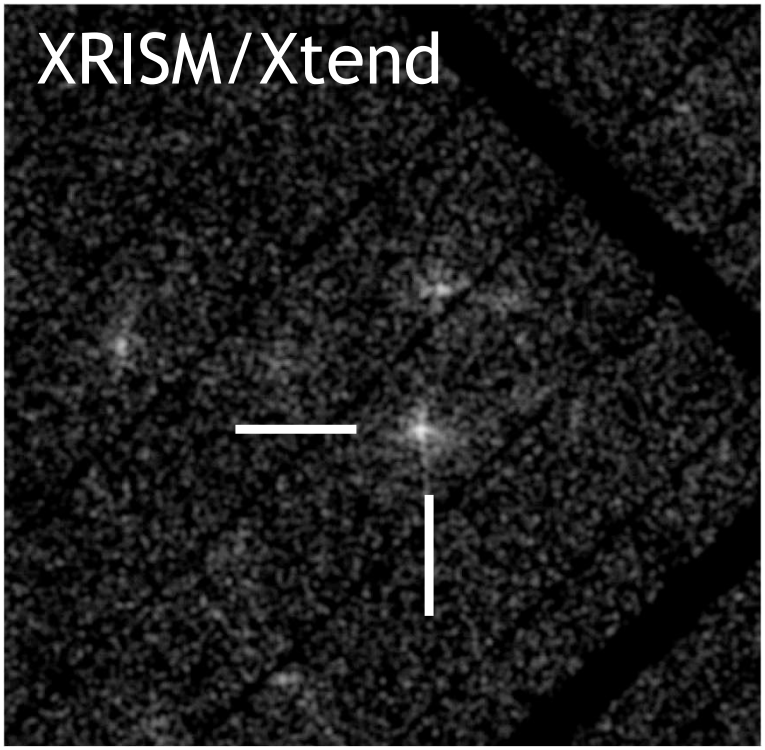
Consistent with incomplete shell structure
Result of neutrino-driven supernova ?

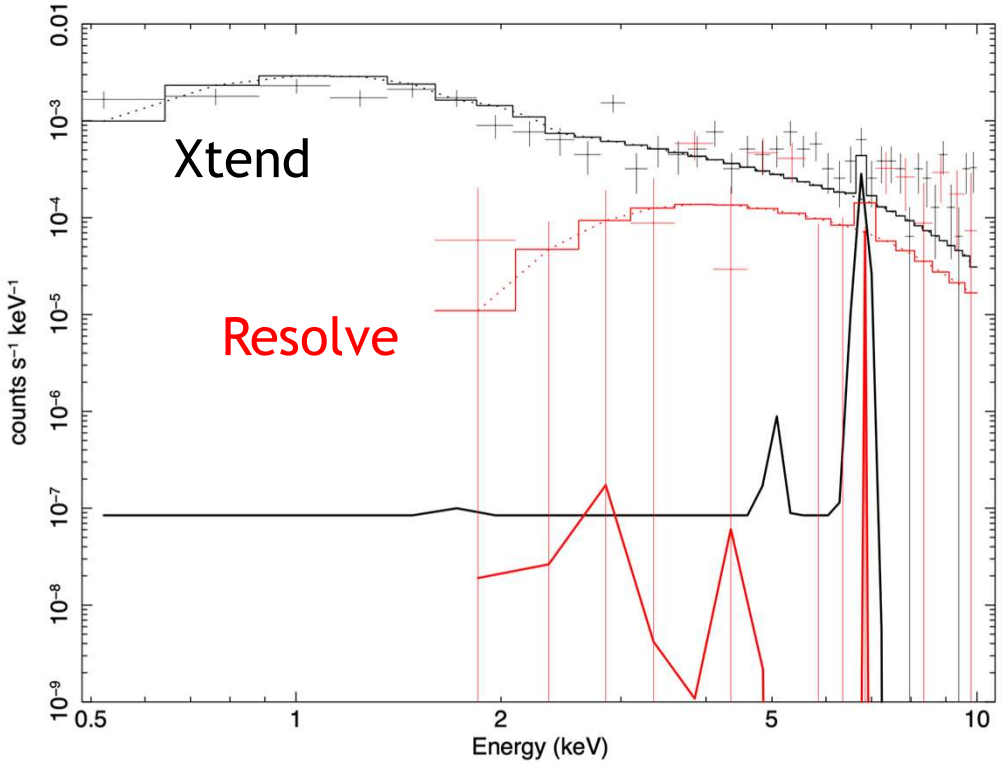


1.3. Topic 2: Time critical observation of SN2024iss (Uchida+)

Discovered on 2024.May 12
Type IIb, 18.67 Mpc

XRISM ToO started on May 24





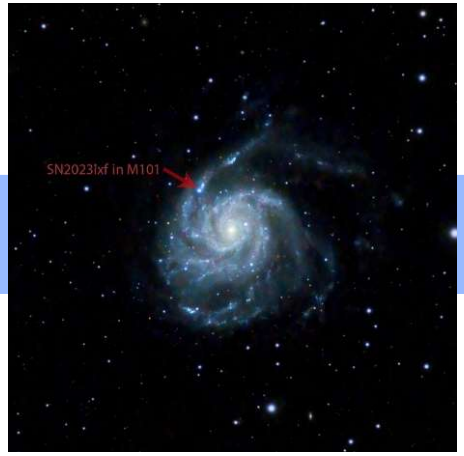
We detected significant emission from SN2024iss.
Possible detection of iron line (2.3sigma). He-like ?
Further ToOs will show us the initial status of ejecta
-> Official collaboration with SK ! (Lead: Uchida)

2.1. When SNe become SNRs ?

SNe and their remnants: origin of heavy elements
and diversity of the universe

topic 2

star evolution



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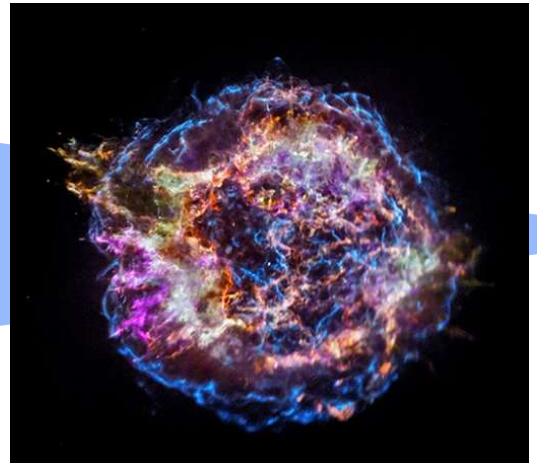

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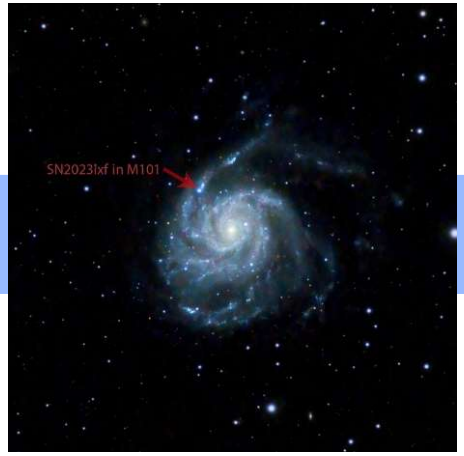

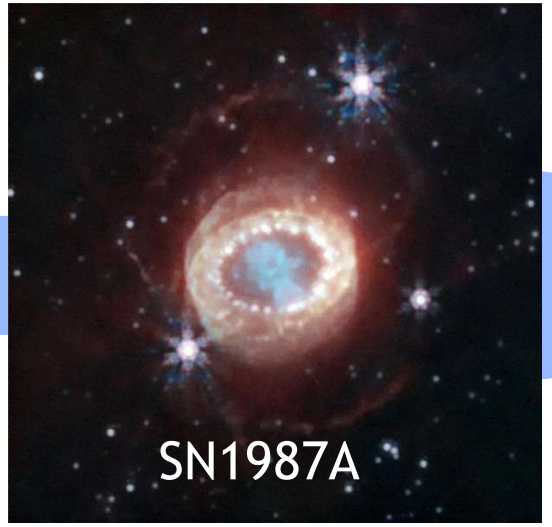

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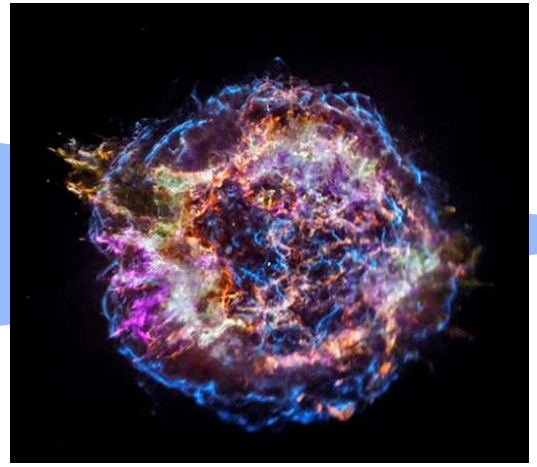

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When are heavy elements heated ?
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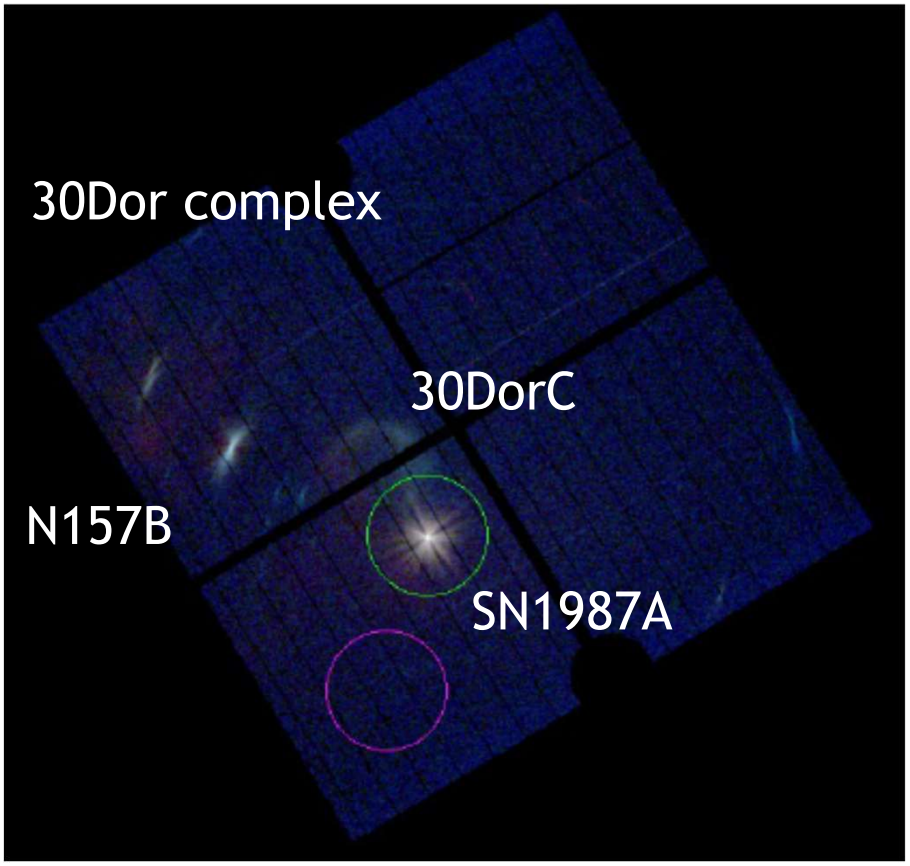
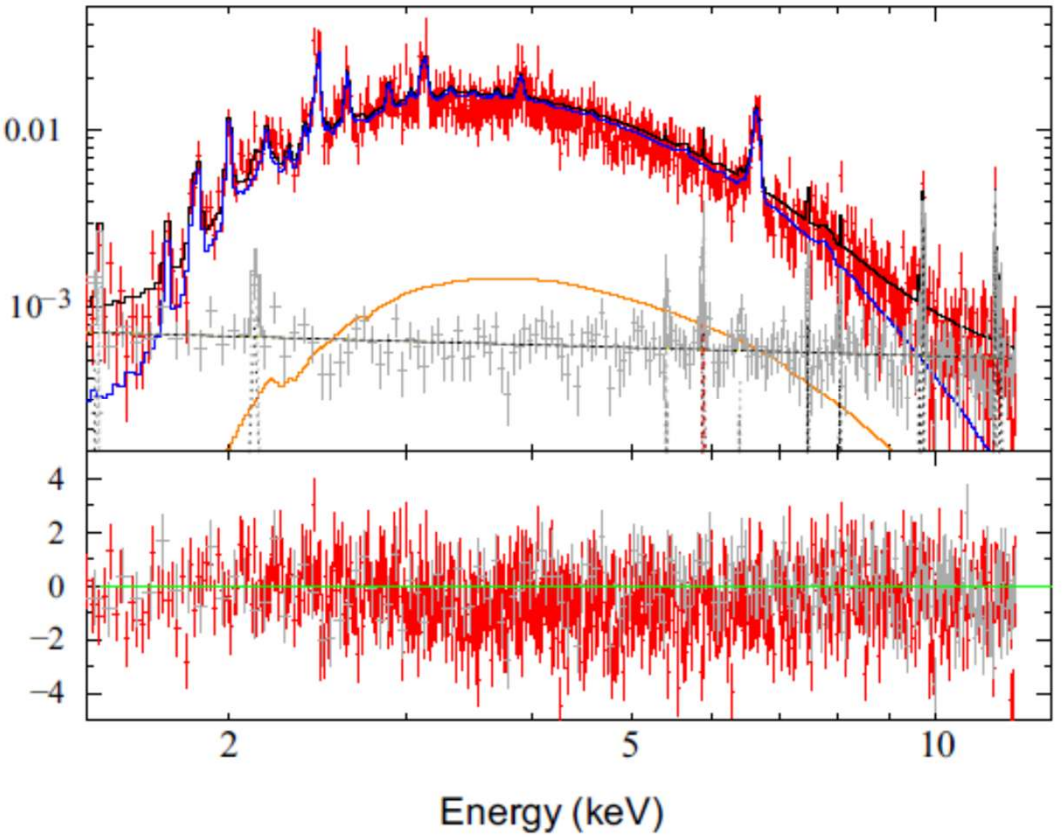
SN1987A is ideal to study this transition
with its age of ~40 years.

2.2. XRISM observation of SN1987A (XRISM collabo. 2025)





2007: Narrow lines with HETG <- heated CSM (Miceli+19)

2024: XRISM detected broad emission lines

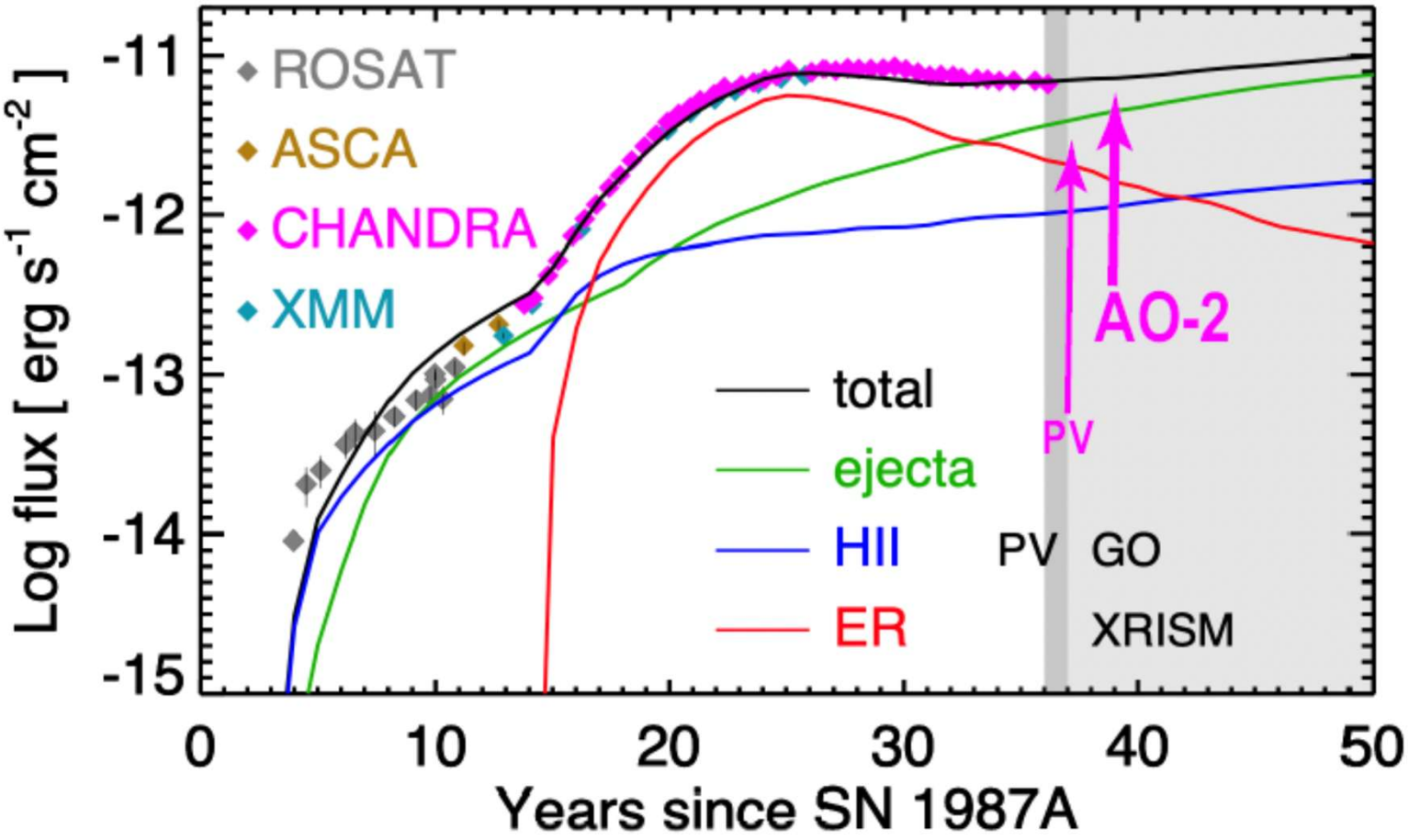
ejecta heated by reverse shock (XRISM collabo.25)

low abundance -> ejecta from outer layers of progenitor ?

First detection of low abundance ejecta

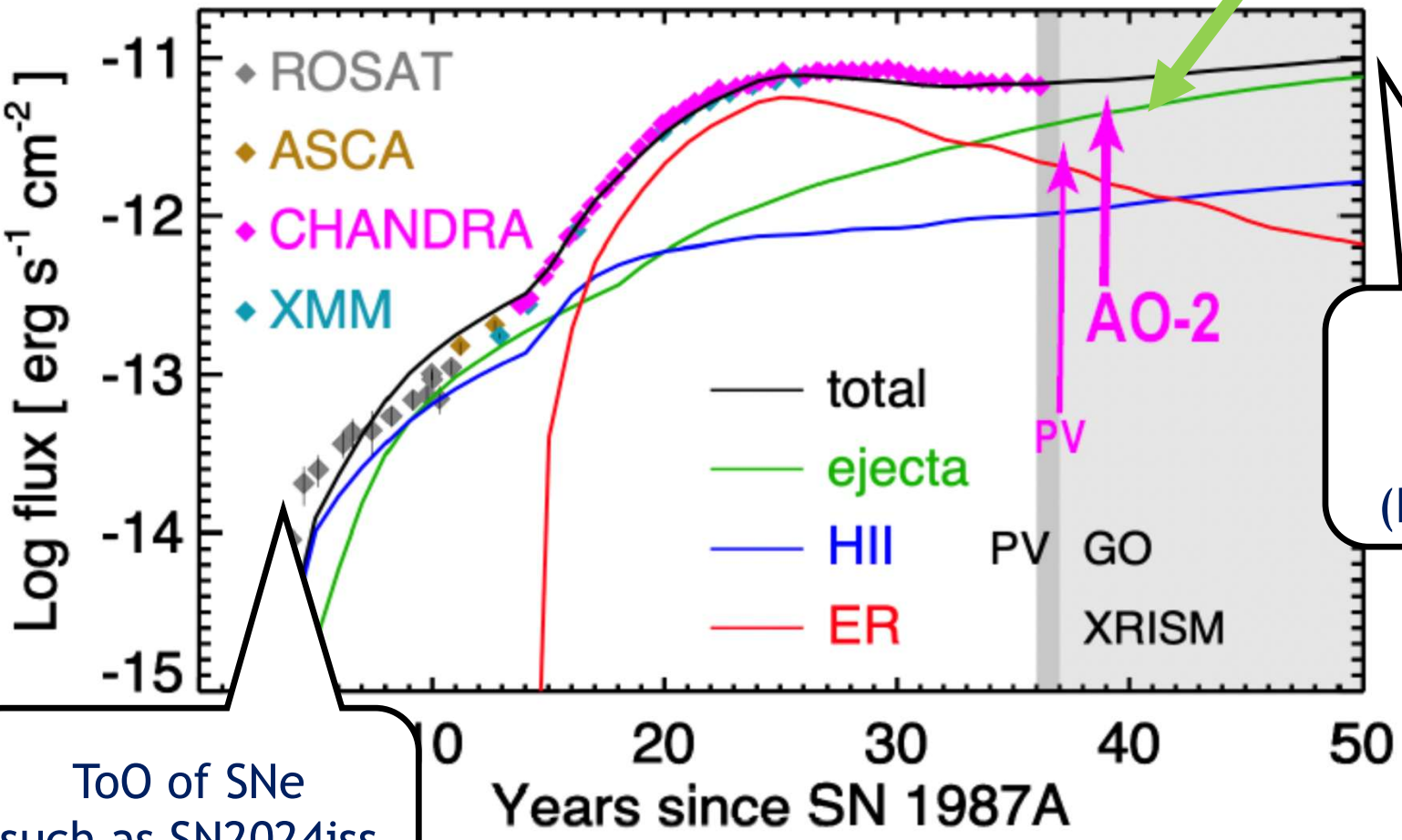
2.3. How does 1987A evolve ?

Orlando+25



2.3. How does 1987A evolve ?

ejecta emission becomes more and more dominant



Asymmetric expansion of young SNRs (Bamba+, Vink+)

ToO of SNe such as SN2024iss (Uchida+)

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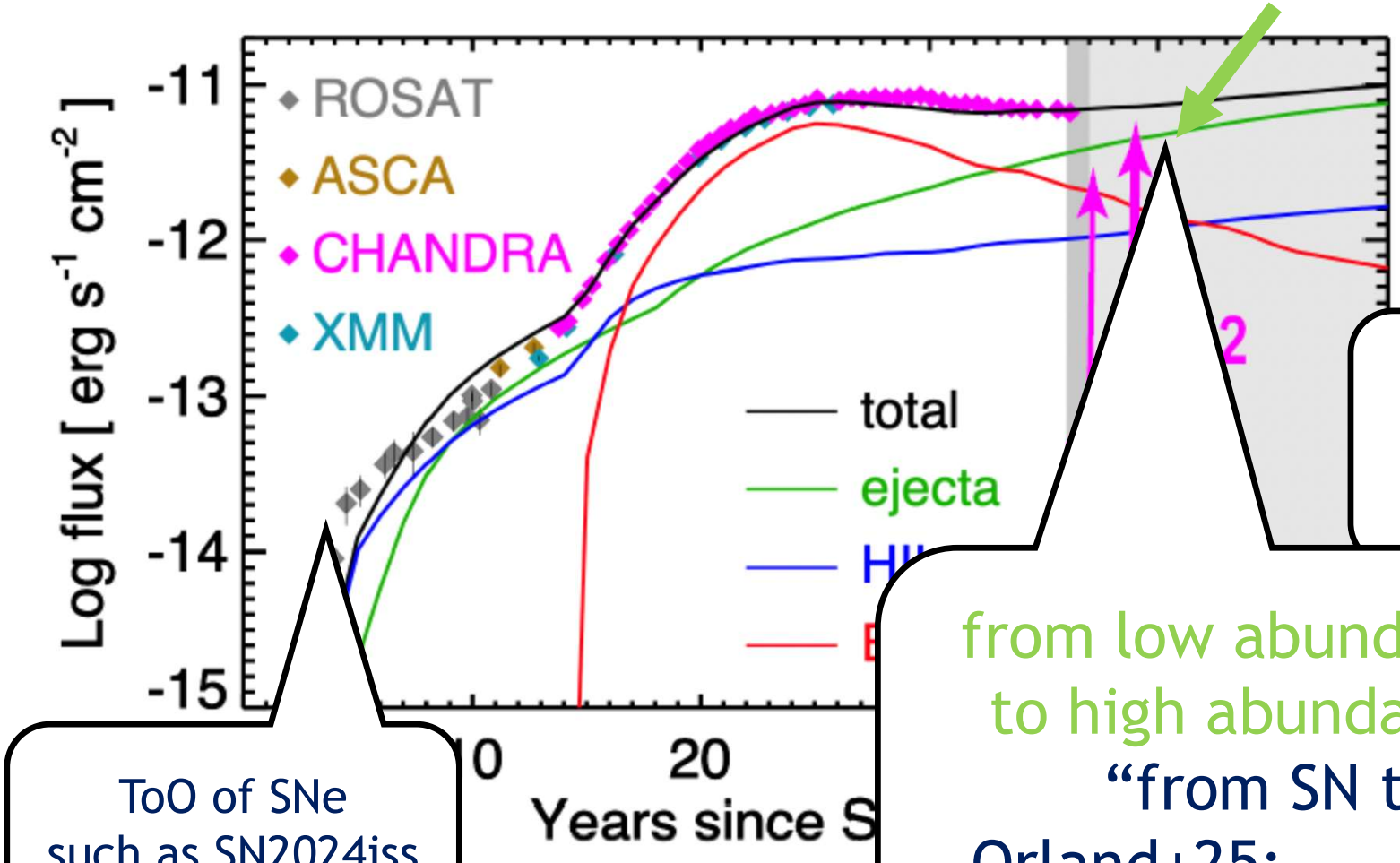

Asymmetric expansion of young SNRs (Bamba+, Vink+)

ToO of SNe such as SN2024iss (Uchida+)

from low abundance ejecta to high abundance ejacta
"from SN to SNR"
Orland+25:
happen between 2027-2035?

We can cover the entire story of chemical evolution for the first time with high resolution spectroscopy of XRISM

3. Summary

- Chasing the evolution from SNe to SNRs is important to understand the chemical evolution of the universe.

- XRISM found important clues of heavy element distribution in three phases of the evolution.

- XRISM will cover the entire story of the evolution of SN1987A.