Recent results from XRISM

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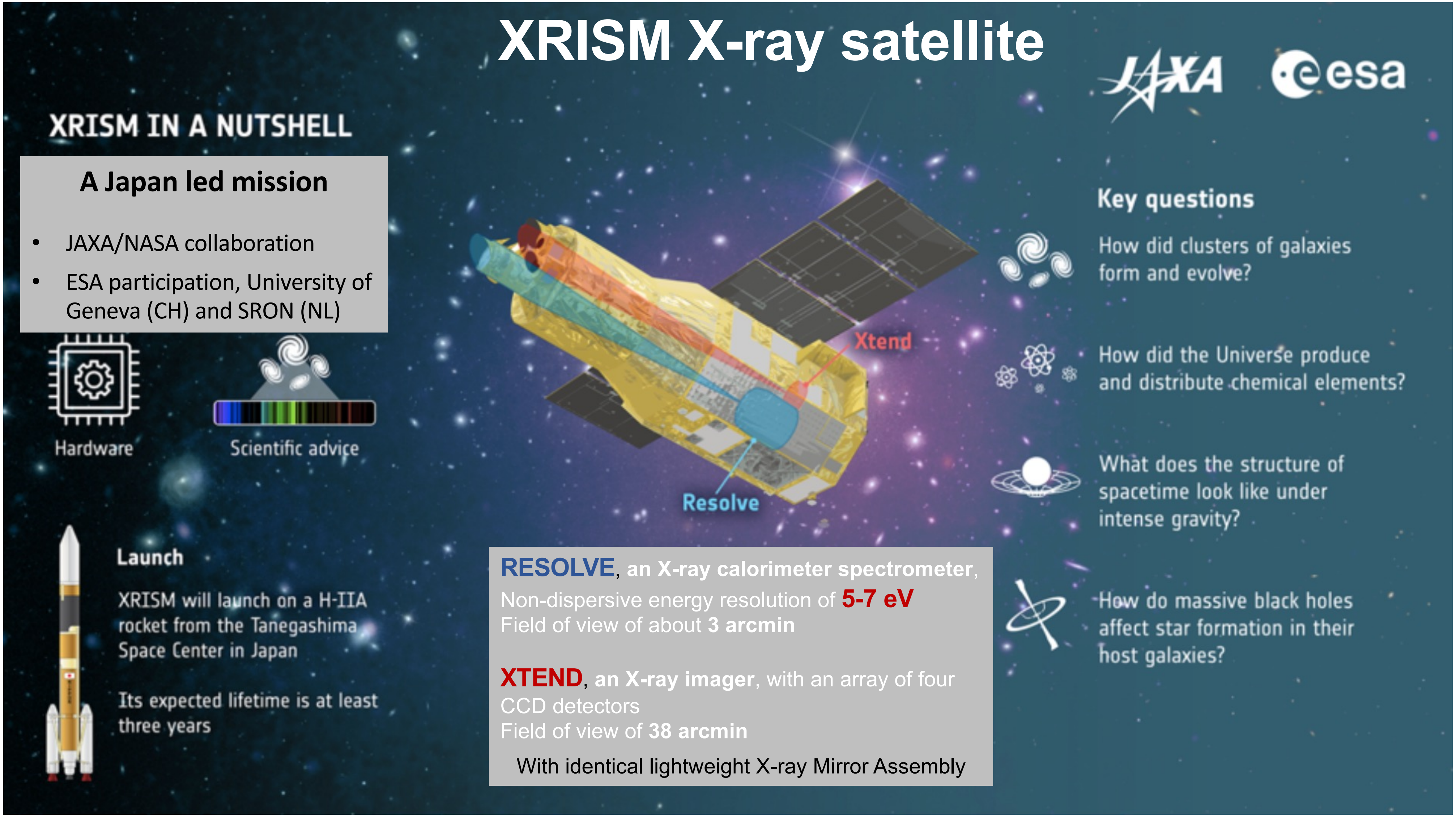
ESA XRISM Guest scientist



XRISM X-ray satellite
XRISM IN A NUTSHELL
A Japan led mission
• JAXA/NASA collaboration
• ESA participation, University of Geneva (CH) and SRON (NL)
Hardware
Scientific advice
Launch
XRISM will launch on a H-IIA rocket from the Tanegashima Space Center in Japan
Its expected lifetime is at least three years
Xtend
Resolve
RESOLVE, an X-ray calorimeter spectrometer,
Non-dispersive energy resolution of 5-7 eV
Field of view of about 3 arcmin
XTEND, an X-ray imager, with an array of four CCD detectors
Field of view of 38 arcmin
With identical lightweight X-ray Mirror Assembly
Key questions
How did clusters of galaxies form and evolve?
How did the Universe produce and distribute chemical elements?
What does the structure of spacetime look like under intense gravity?
How do massive black holes affect star formation in their host galaxies?

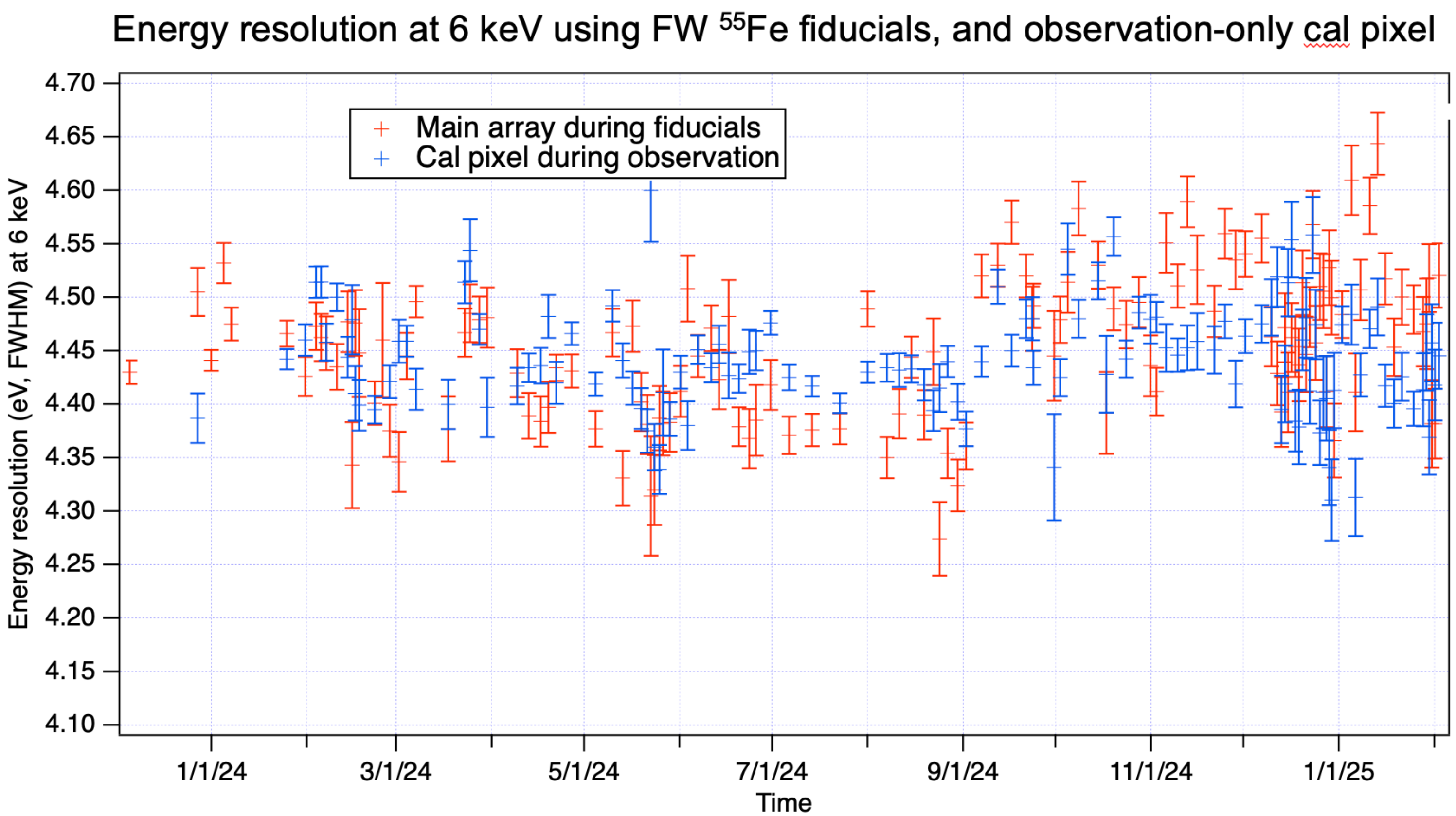
SUCCESSFUL LAUNCH:
7 septembre 2023

- Japanese H-IIA rocket
- from Tanegashima Space Center
- Low Earth orbit (550 km)

ESA has 8 % of the XRISM observing time

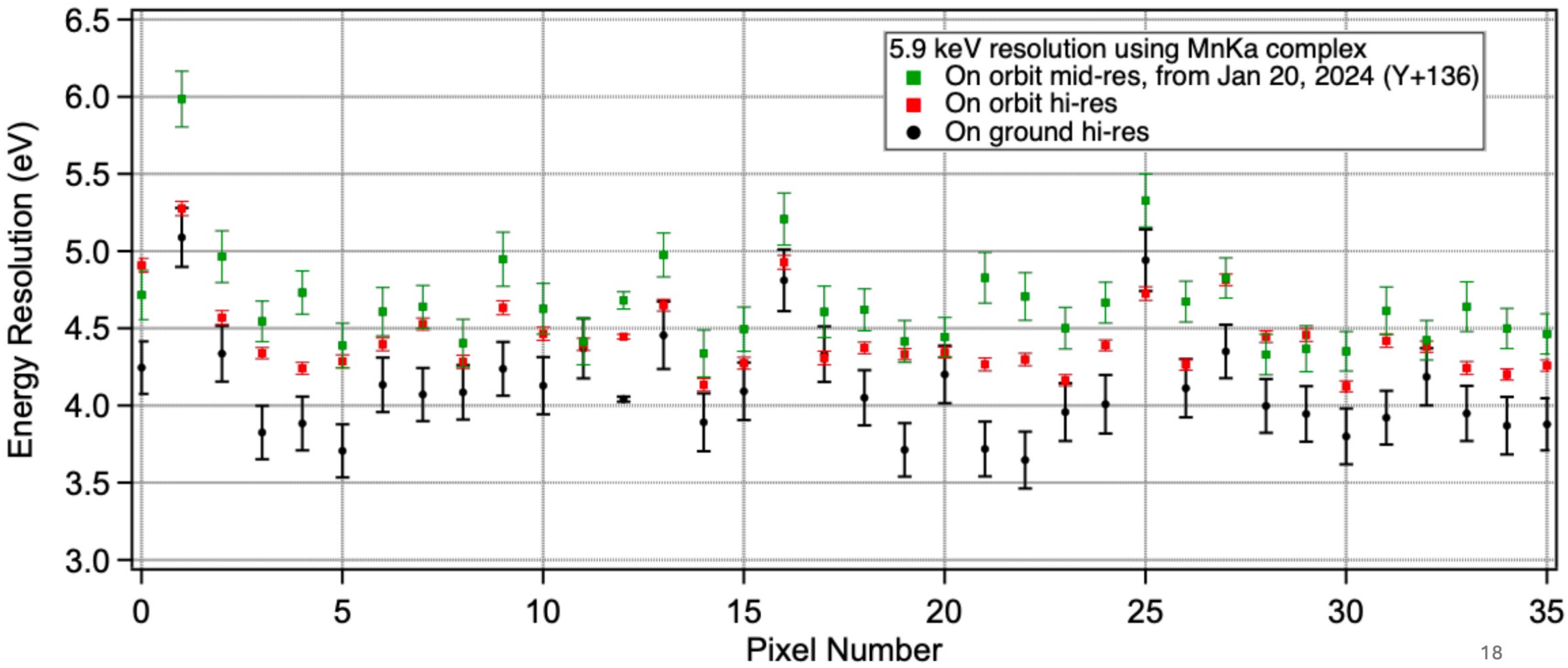
- Access to 5 European Guest scientists to the PV observations
- Cycle 1 of the Guest Observer program (may 2024)
- Cycle 2 of the Guest Observer program (may 2025)
  - Selection announcement: **7 october 2025**
  - Observations: November 1, 2025 – May 1, 2026
- Cycle 3 of the Guest Observer program
  - Open: November 2025 (TBC)
  - Observations: May 2026-April 2027 (TBC)

Resolve X-ray performance

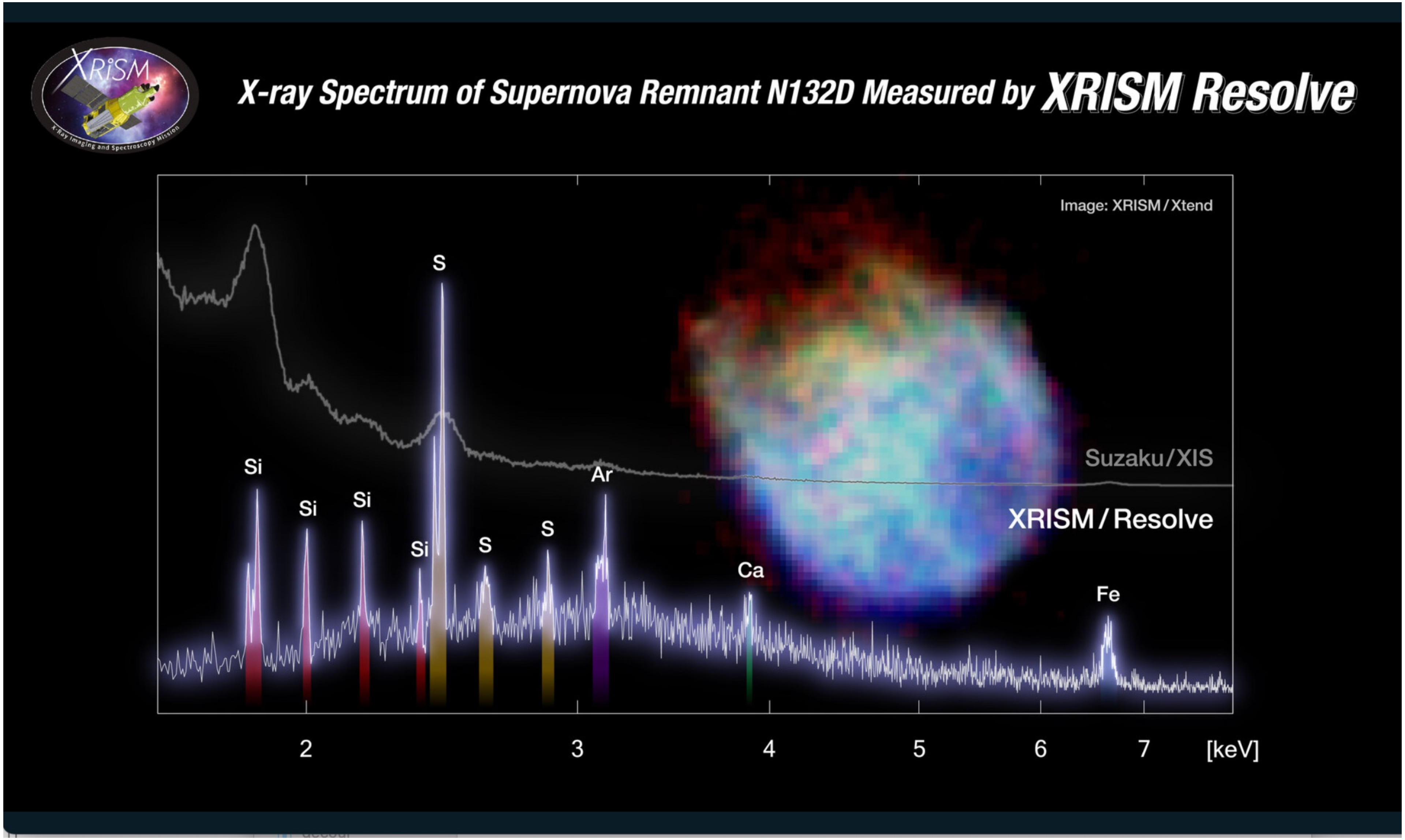


=> Energy resolution better than nominal (<5 eV) and stable

Resolve performance

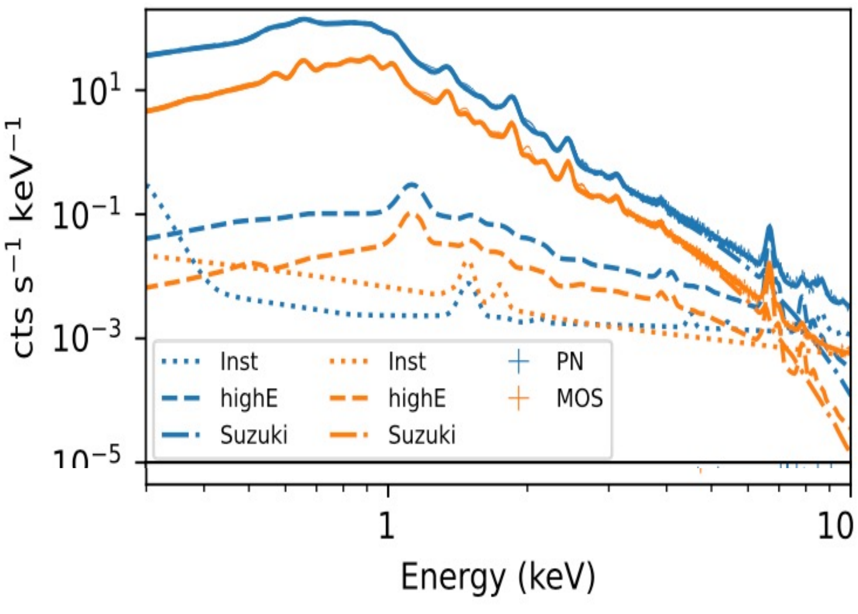


=> The energy resolution is homogeneous across pixels


X-ray Spectrum of Supernova Remnant N132D Measured by XRISM Resolve
Image: XRISM / Xtend
S
Si
Si
Si
Si
S
S
Ar
Ca
Fe
Suzaku / XIS
XRISM / Resolve
2
3
4
5
6
7
[keV]

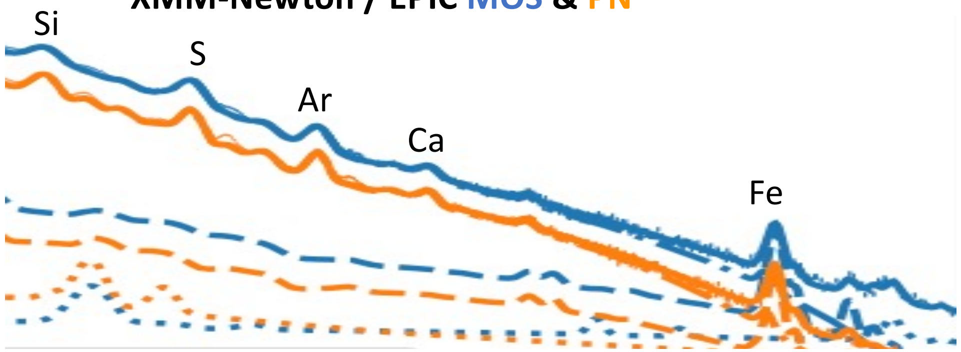
X-ray spectrum of N132D

XMM-Newton / EPIC

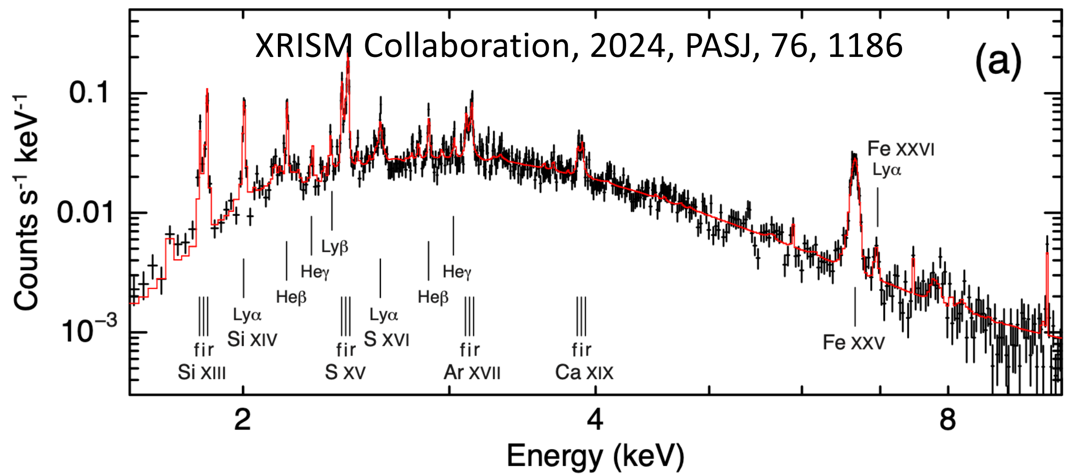


Foster et al., 2025, ApJ 986, 8

XMM-Newton / EPIC MOS & PN

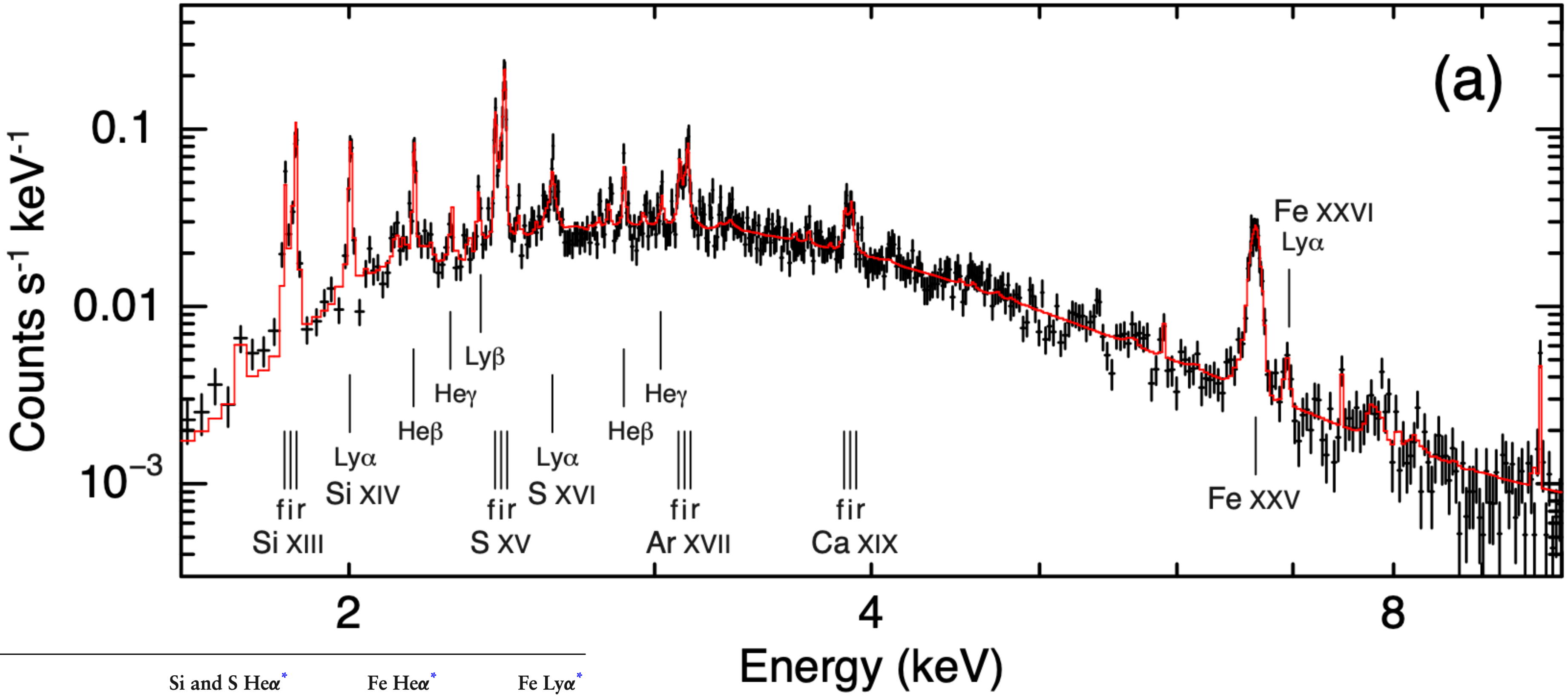


XRISM/RESOLVE



N132D : XRISM Resolve spectrum

XRISM Collaboration, 2024, PASJ, 76, 1186

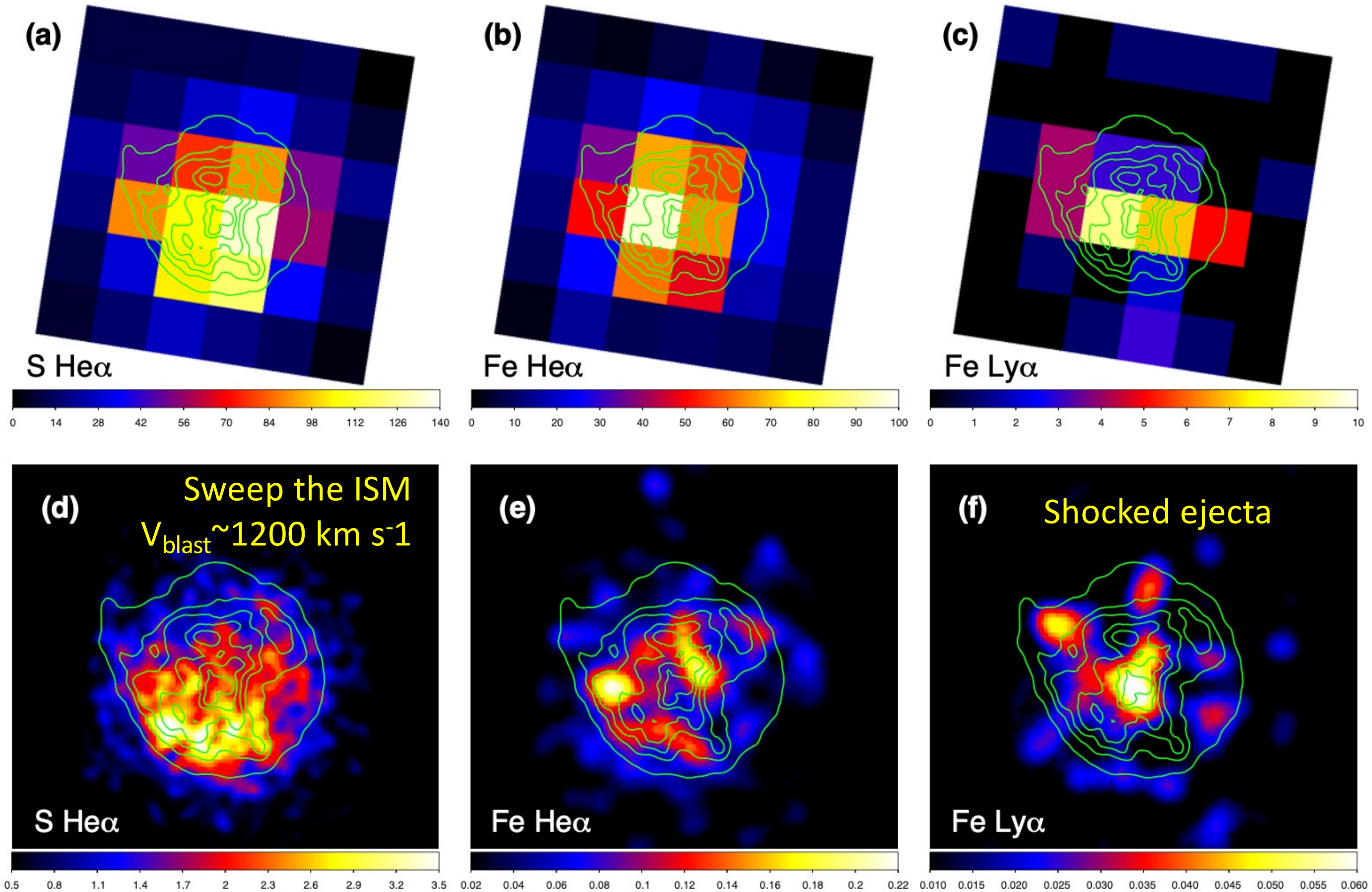


	Si and S Heα*	Fe Heα*	Fe Lyα*
v_{bulk} (km s^{-1})	227 ± 24	249^{+96}_{-117}	891^{+306}_{-315}
σ_v (km s^{-1})	452 ± 24	1670^{+160}_{-170}	749^{+370}_{-512}

v_{bulk}=line-of-sight velocity σ_v=line broadening

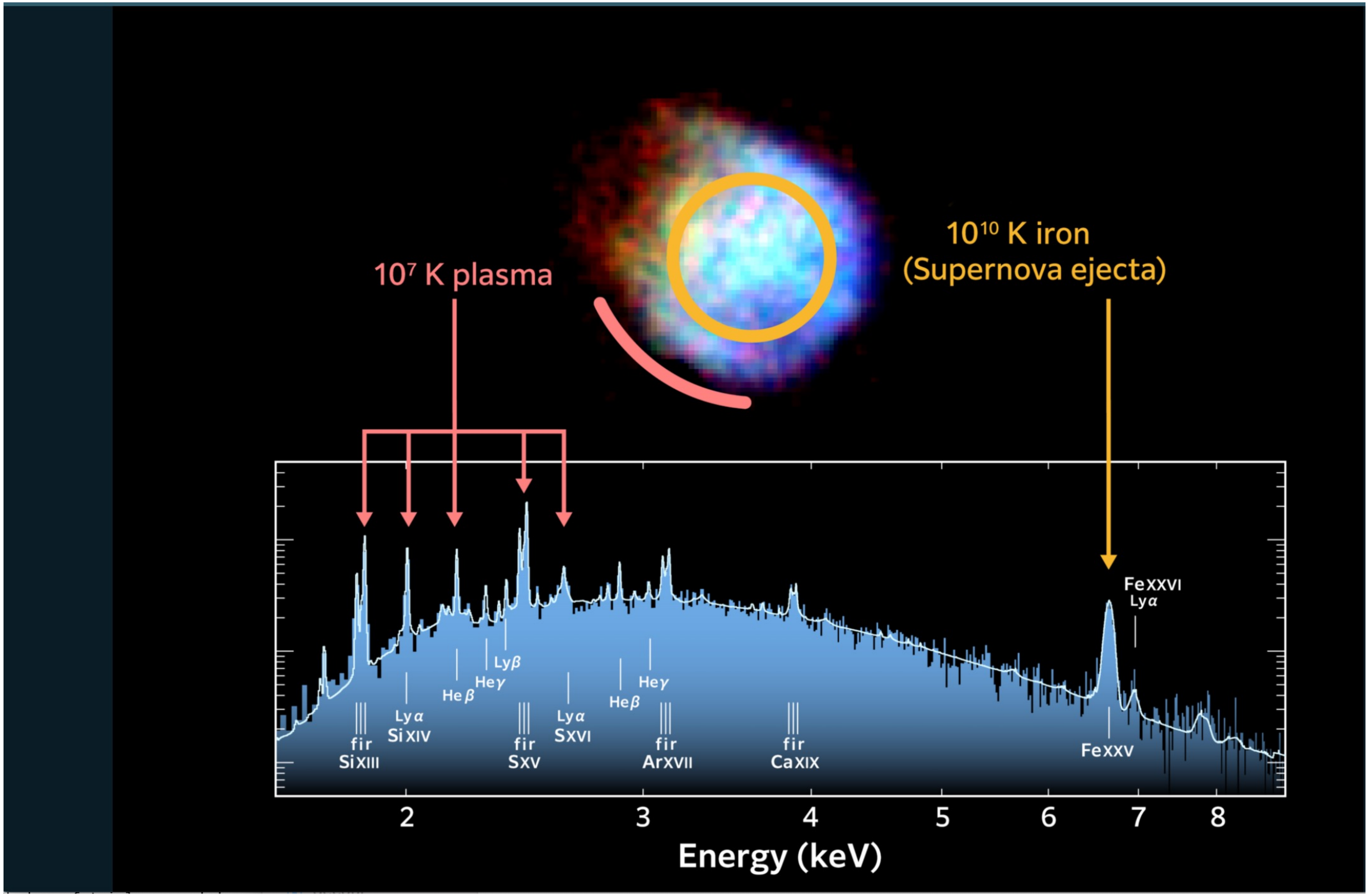
N132D: XRISM narrow-band Spatial distributions

XRISM Collaboration, 2024, PASJ, 76, 1186



Resolve
(moderate imaging
superb spectroscopy)

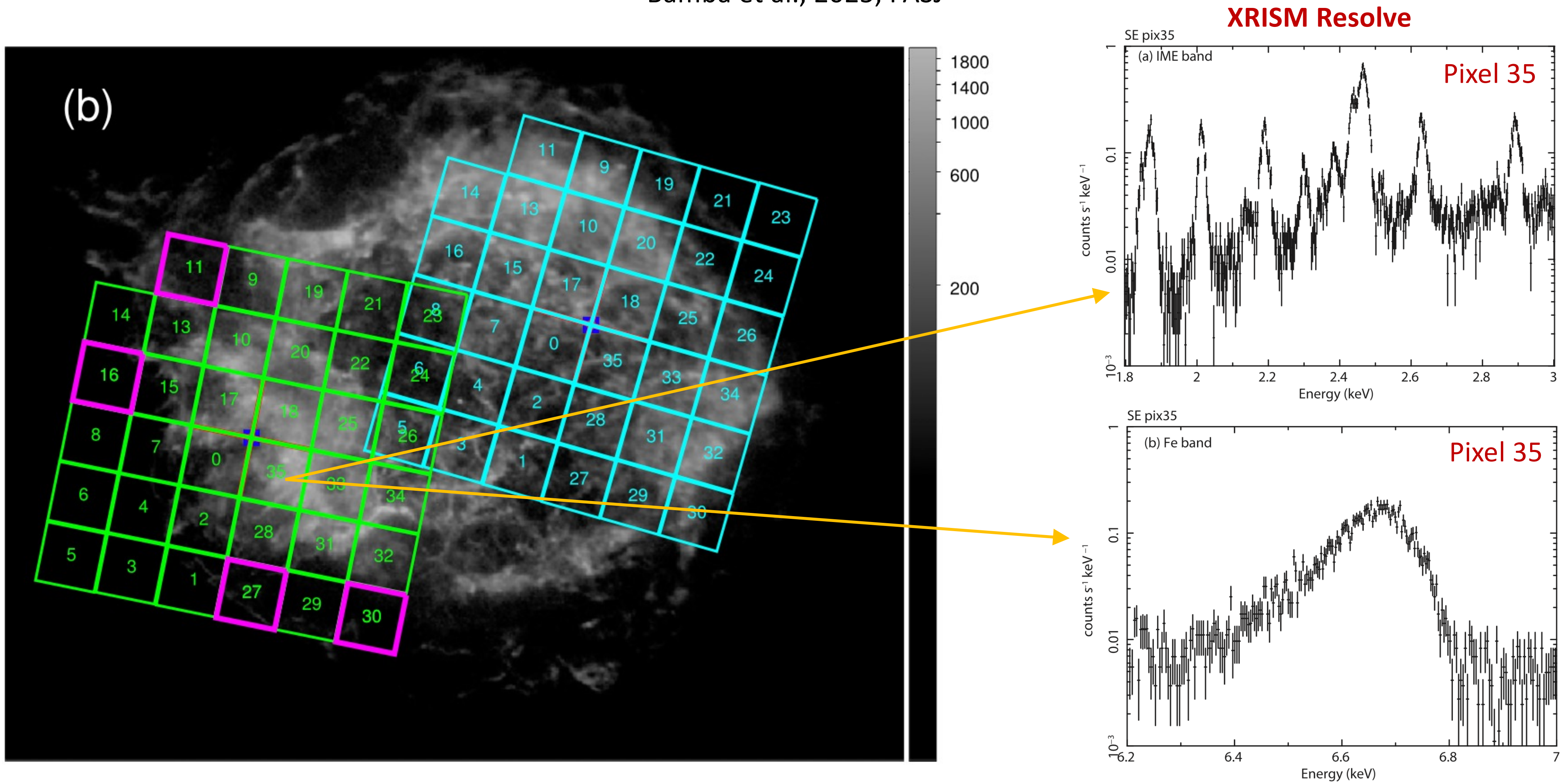
Xtend
(good imaging
moderate spectroscopy)



10⁷ K plasma
10¹⁰ K iron
(Supernova ejecta)
fir
SiXIII
Lyα
SiXIV
Heβ
Heγ
Lyβ
fir
SXV
Lyα
SXVI
Heβ
Heγ
fir
ArXVII
fir
CaXIX
FeXXVI
Lyα
FeXXV
2
3
4
5
6
7
8
Energy (keV)

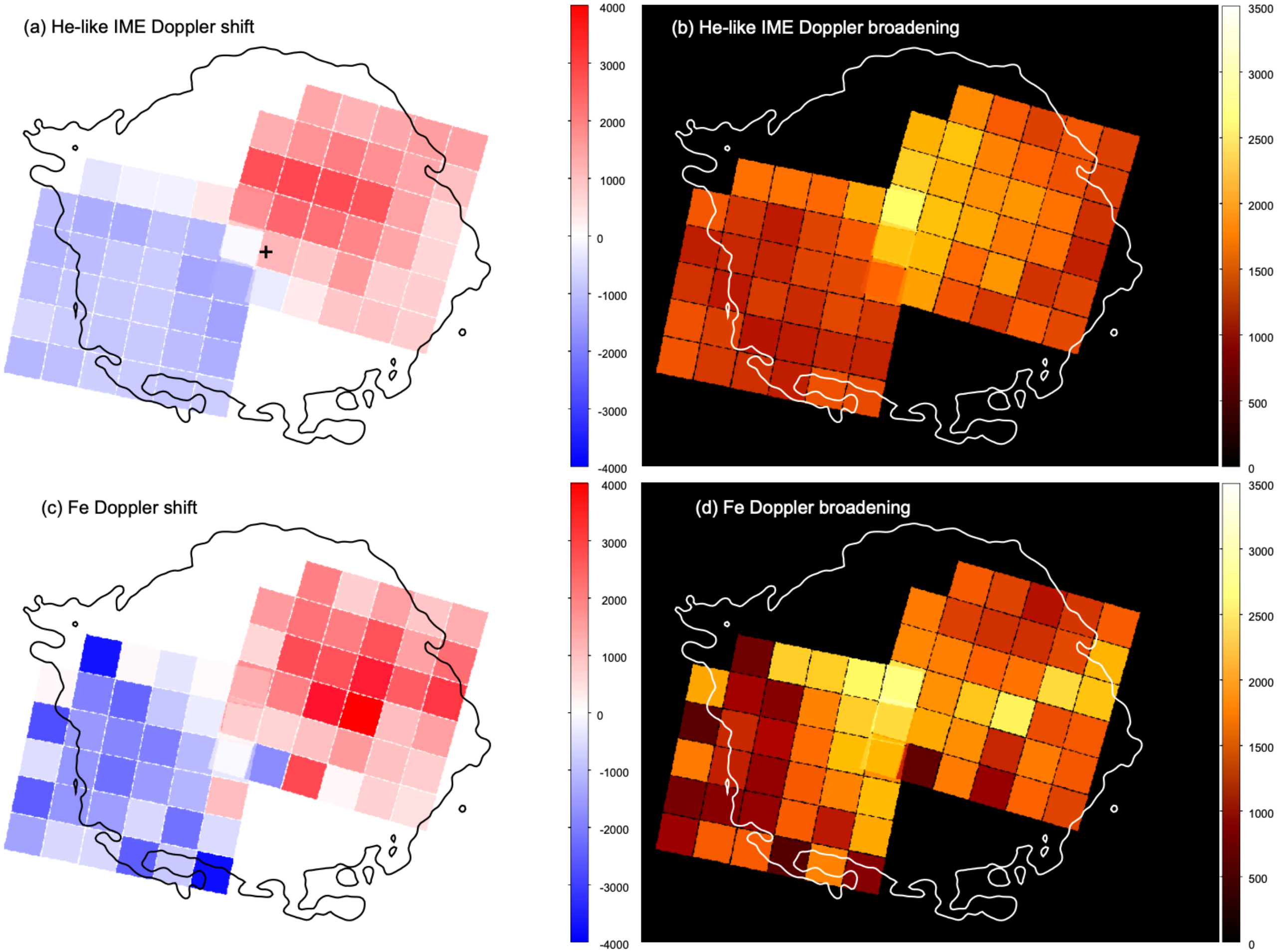
Mapping the dynamics of the core collapse Cas A SN remnant

Bamba et al., 2025, PASJ



Mapping the dynamics of the expanding shell in Cas A

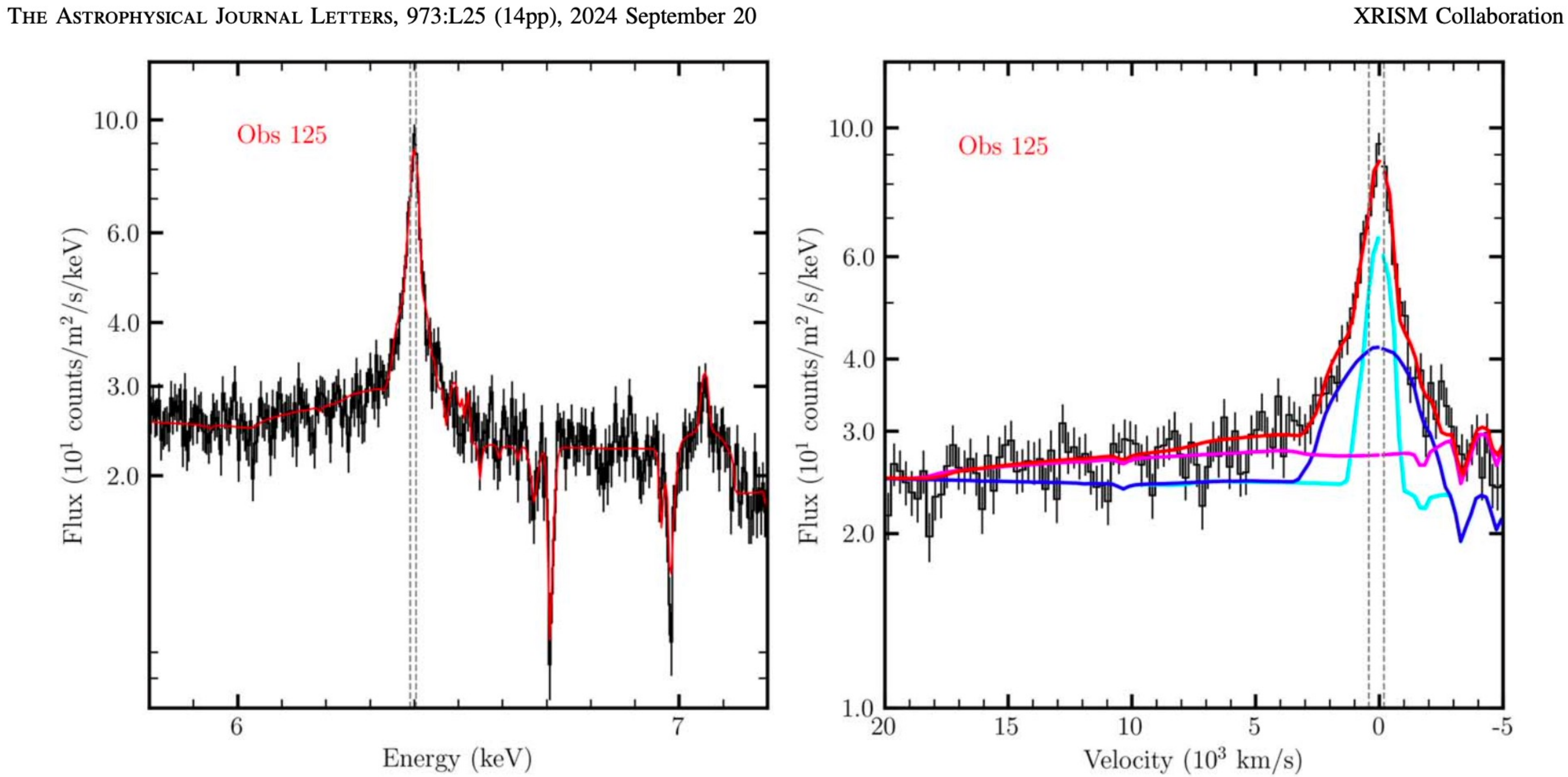
Bamba et al., 2025, PASJ



- Blueshift (redshift) dominates the dynamics in the SE (NW)
- Little Fe broadening – compared with strong broadening of Intermediate Mass Elements (IME; Si and S)
- Asymmetric expansion of the ejecta
- Possibly mirroring large-scale asymmetries in the supernova explosion
- Predicted by models of neutrino-driven explosions

AGN environment tomography in NGC 4151: neutral Fe Kα line

XRISM et al. 2024, ApJL 973, L25



=> Reveals: Disk, Broad-line Region, and Torus

AGN environment tomography in NGC 4151: neutral Fe Kα line

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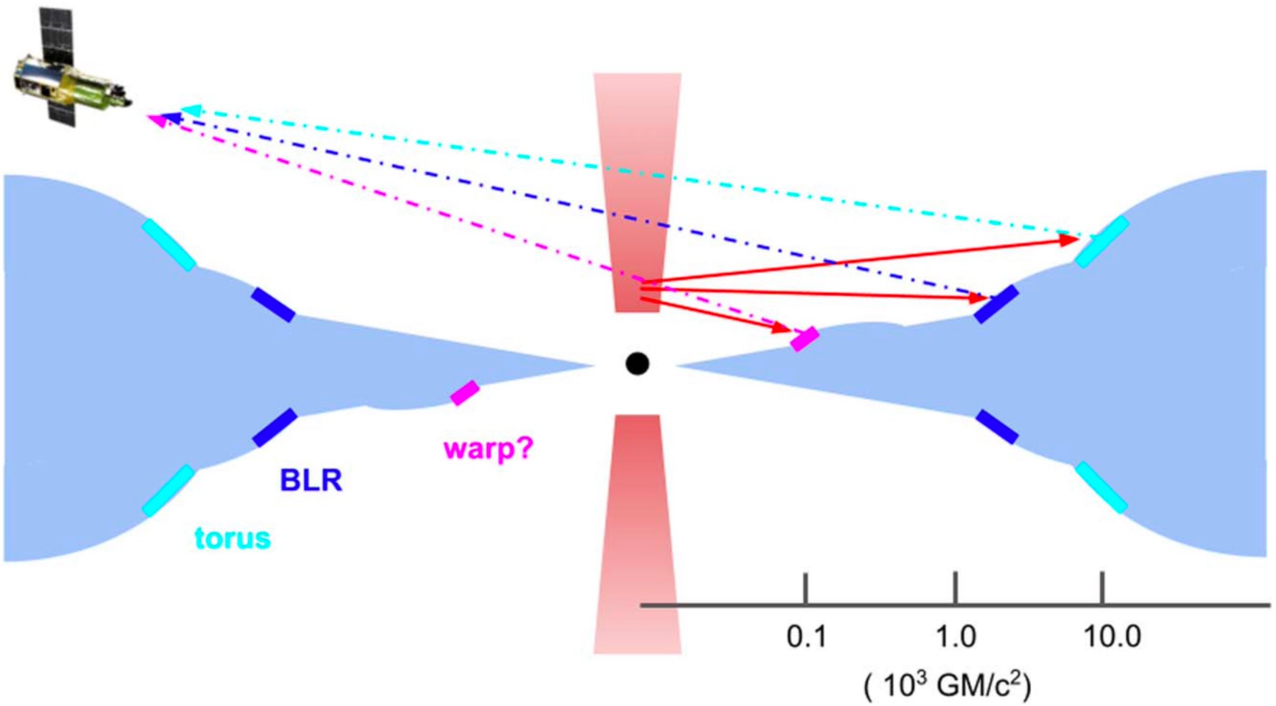
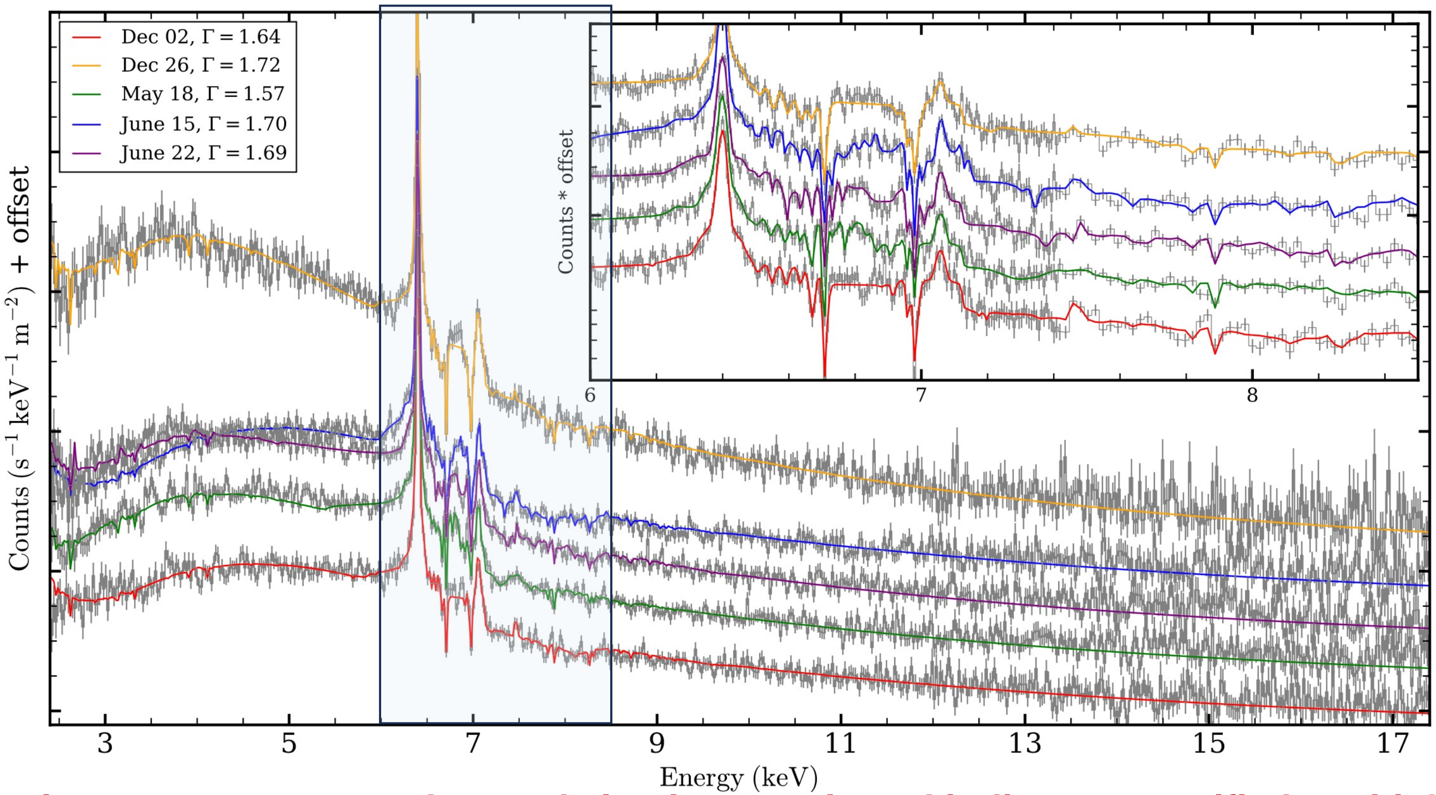


Figure 5. Simple cartoon giving a possible geometrical interpretation of the Fe K_α line observed in NGC 4151 with XRISM. The geometry is depicted in cross section, with light blue indicating the disk (and disk atmosphere). Vertical scale heights and angles are figurative, not quantitative. The corona is depicted here as the base of an outflow, though other possibilities exist. Hard X-rays from the corona irradiate all parts of the inflow, but the face of those regions with extra local vertical extent are irradiated more and contribute specific line-flux components. These are the magenta, blue, and cyan regions associated with a potential warp, the inner extent of the BLR, and the inner extent of the torus are indicated; these colors match the line components in Figure 1. For simplicity and clarity, irradiation and Fe K_α emission are only depicted from the "far" side of the central engine, though the full 2π cylinder must be illuminated. This diagram also neglects winds that are observed in absorption in NGC 4151. Please see the text for details and alternative explanations of the component associated with a warped disk in this diagram.

NGC 4151 : accretion-driven wind feedback

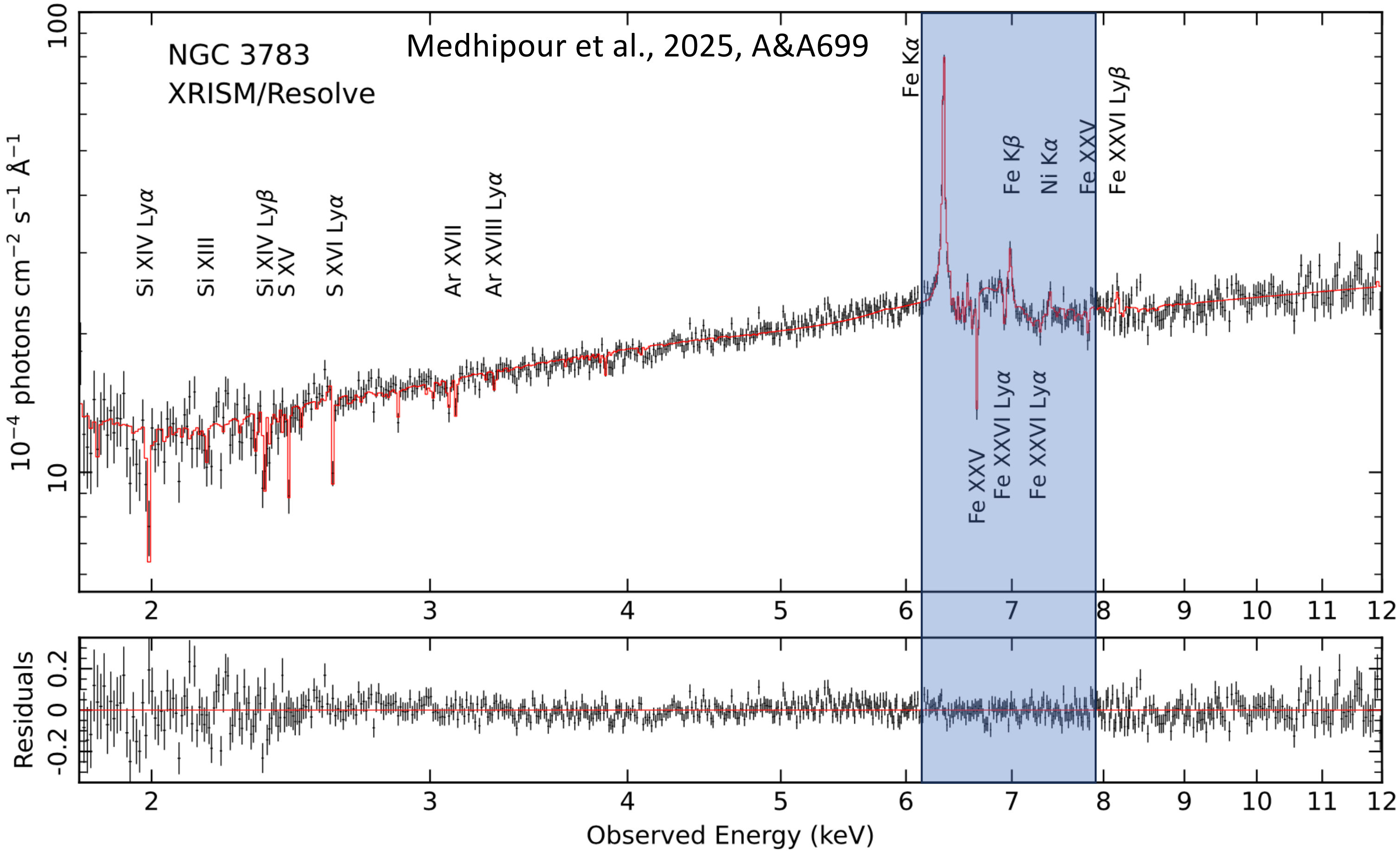
Xiang et al. 2025, ApJ L 988:L54



Six wind absorption components are detected simultaneously and indicate a stratified, multiphase wind:

- slow warm absorbers WAs; v_{out} ~100–1000 km/s
- very fast outflows VFOs; v_{out} ~103–104 km/s
- ultrafast outflows UFOs; v_{out} ~104–105 km/s (or 0.033–0.33c)

NGC 3783: kinematic and ionization structure of the highly ionized outflows



NGC 3783: kinematic and ionization structure of the highly ionized outflows

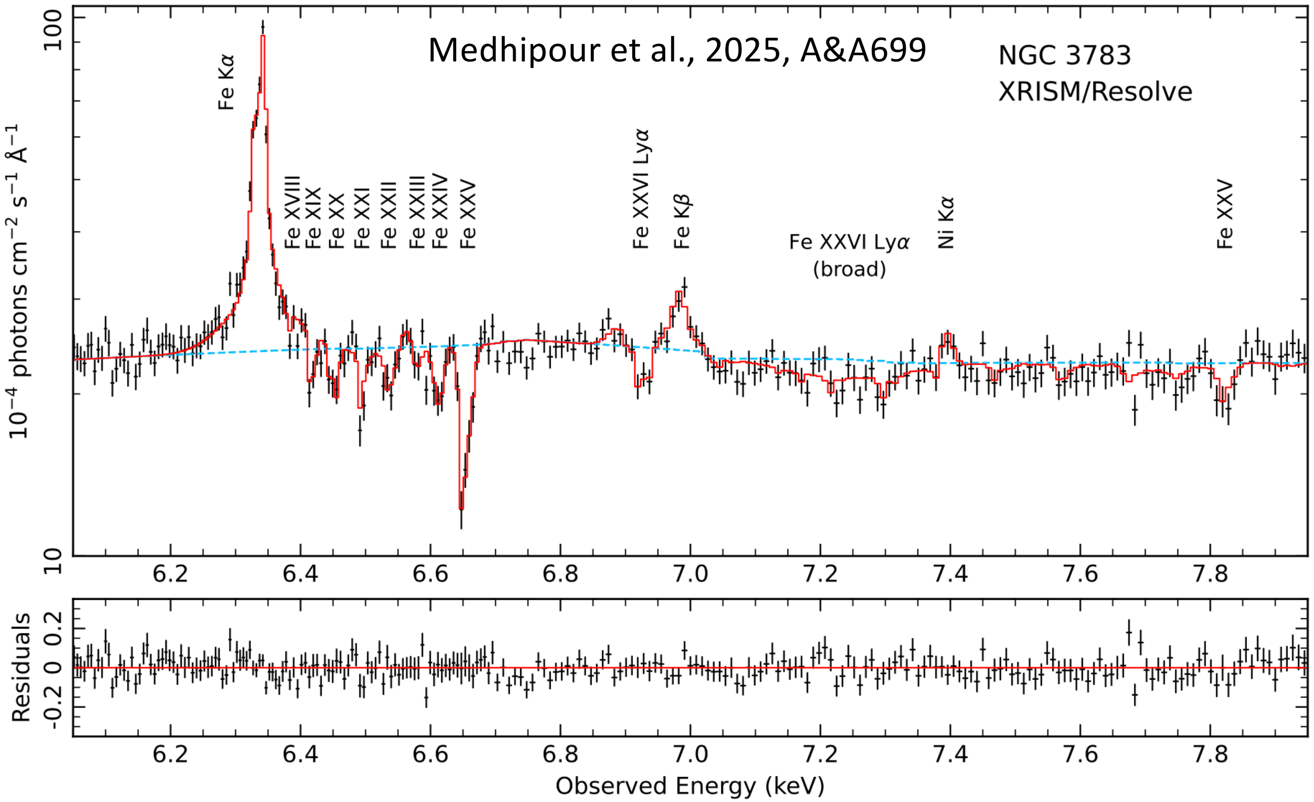


Fig. 1. XRISM/Resolve spectrum of NGC 3783 with our best-fit model. The top two panels show the full spectrum and the corresponding fit residuals. The bottom two panels provide a close-up view of the Fe K band and its fit residuals. For clarity of display, the spectrum is additionally binned up. The strongest emission and absorption features are labeled. Our best-fit model (Table 1) is shown in red. The fit residuals are defined as (data – model)/model. For comparison, the dashed blue line in the third panel represents the continuum plus the broad Fe K emission, excluding any absorption lines.

reveals

- multicomponent, highly ionized outflows in this AGN.
- Six absorption components:
  - five with relatively narrow absorption lines and moderate outflow velocities (560−1170 km/s)
  - one broad absorption component outflowing at sub-relativistic speeds (0.05 c).
- Higher-ionization absorption lines (such as Fe xxvi and Fe xxv) generally broader than those of lower-ionization species, suggesting that the gas closer to the black hole is more highly ionized and more turbulent, likely due to increased Keplerian motion in the deeper gravitational potential.

Cyg X-3: a high-mass X-ray binary (HMXB)

XRISM et al., 2024, ApJ L 977:L34

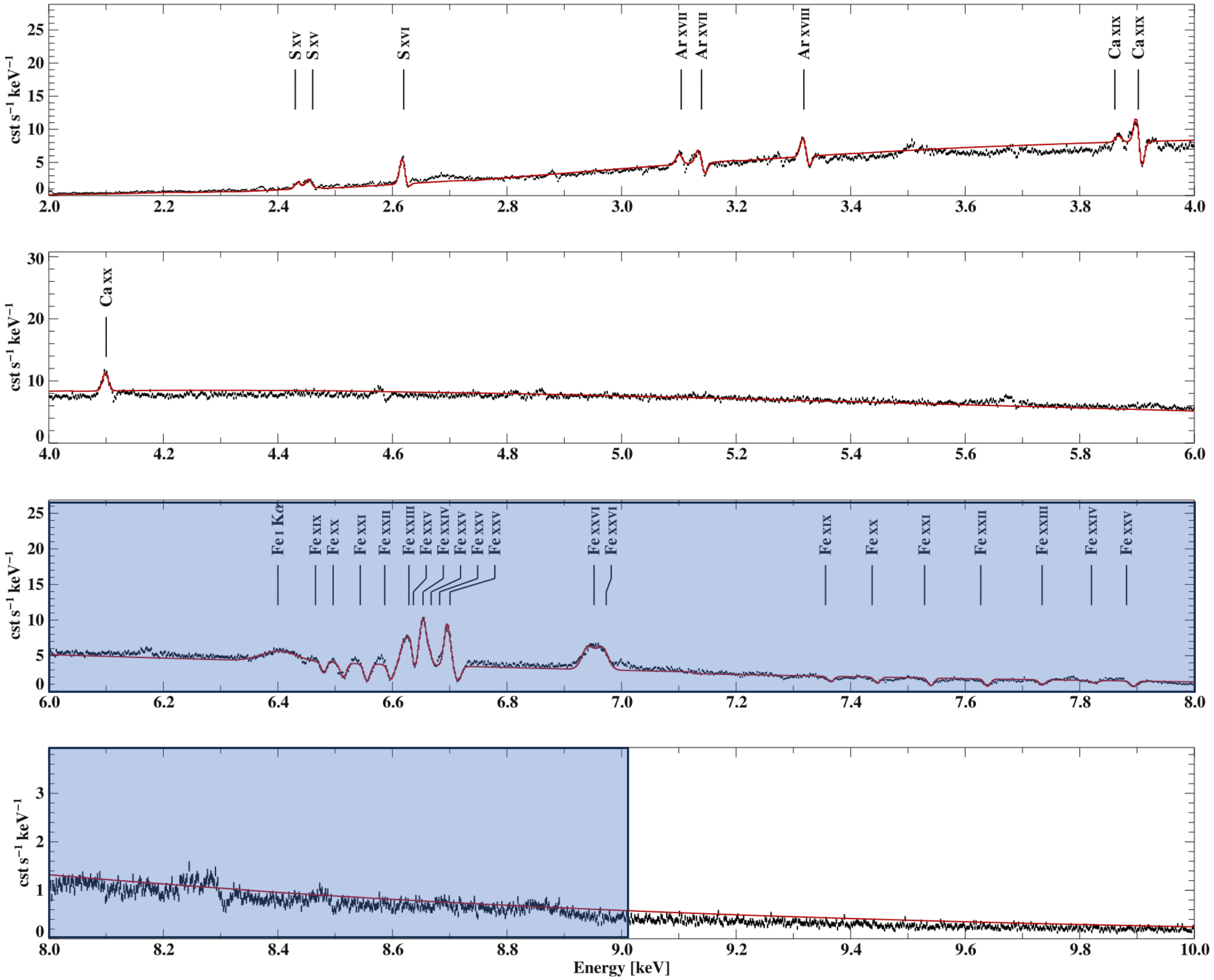


Figure 1. The 2–10 keV XRISM/Resolve spectrum of Cyg X-3, modeled with an absorbed disk blackbody and several Gaussian emission and absorption lines. Black labels are lines that are included in the model and listed in Table 1.

Cyg X-3: a high-mass X-ray binary (HMXB)

XRISM et al., 2024, ApJ L 977:L34

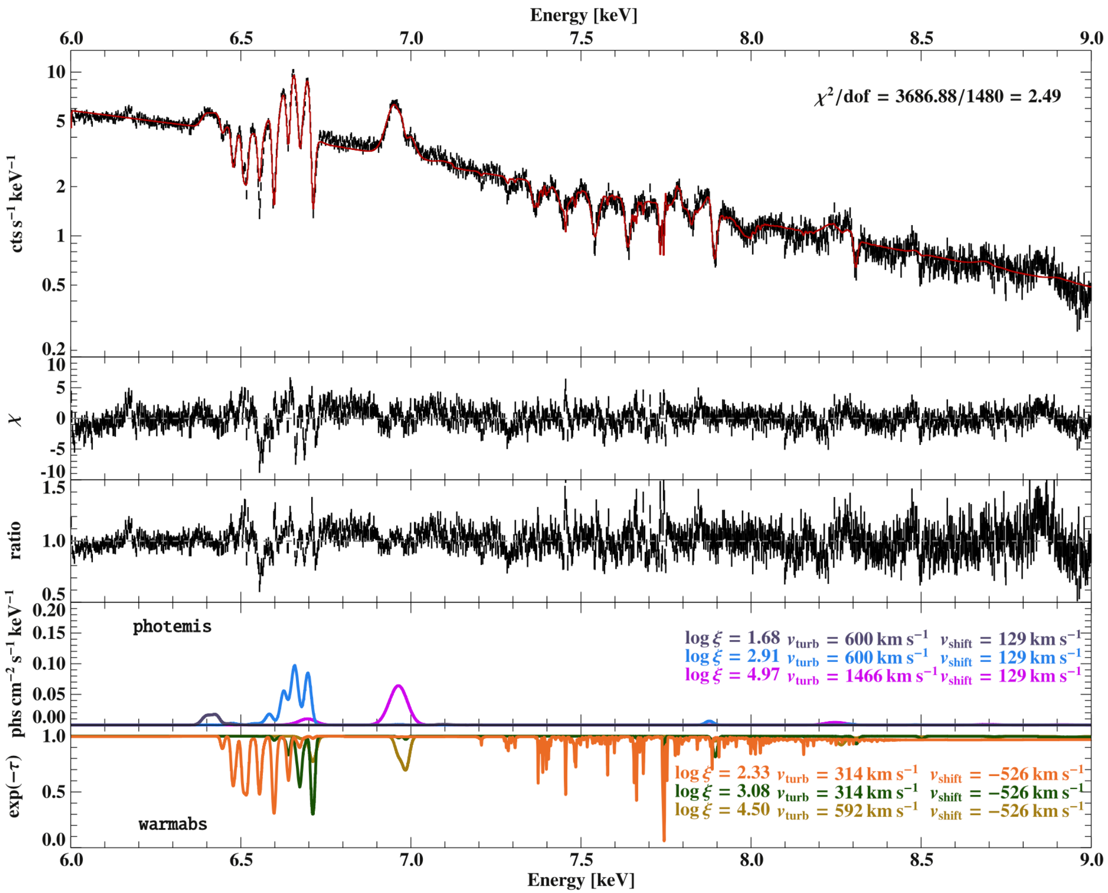
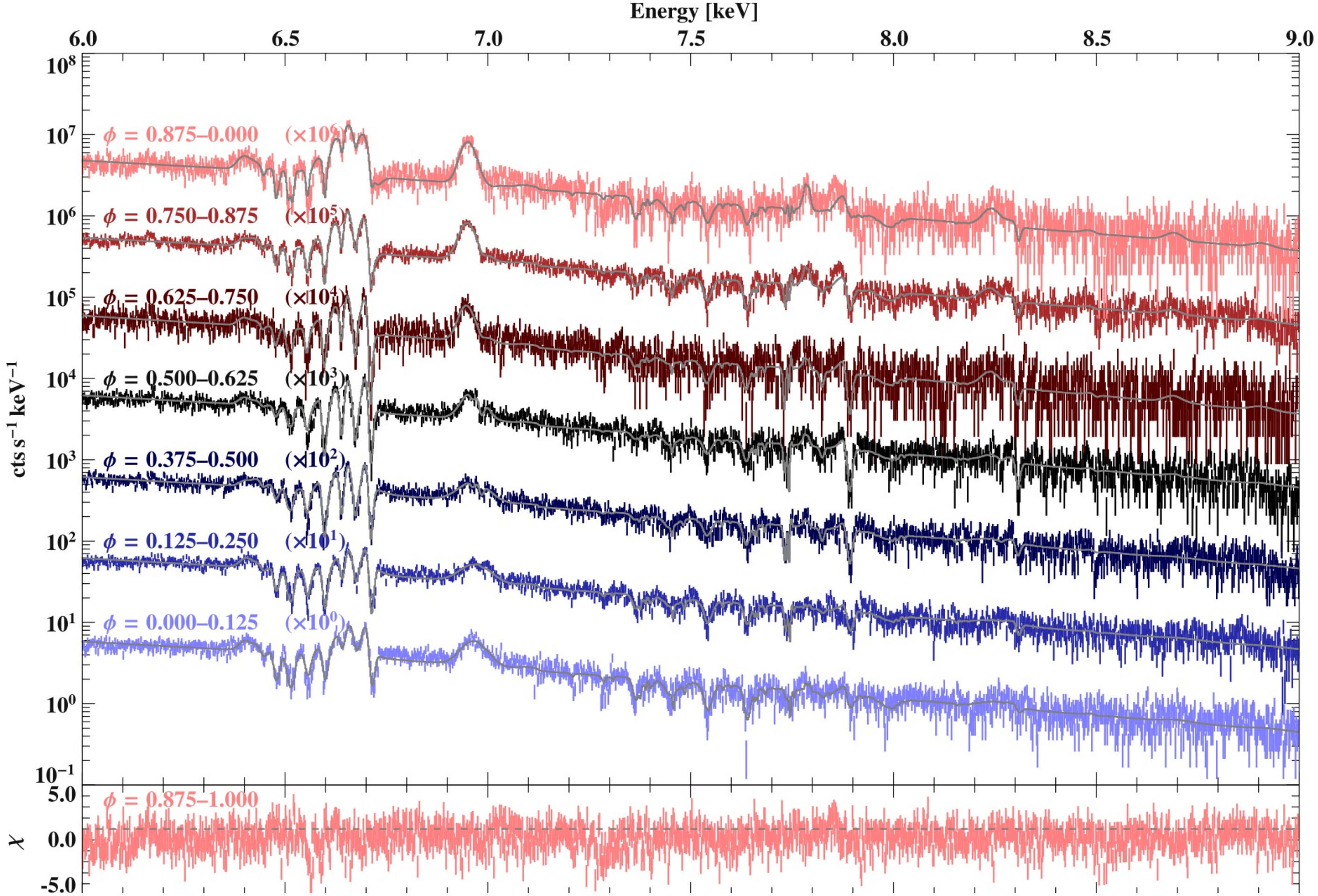


Figure 2. The XRISM/Resolve spectrum in the Fe K region showing the observed data and our best-fit model using multiple photoionized absorption and emission components as described in the text. The top panel shows the observed count data (black) together with the best-fit model. The second and third panels show the contributions to χ^2 vs. energy and the ratio of the best-fit model to the observed counts. The final two panels show the models for line emission and absorption, respectively. Note the energy offset between the emission and absorption.

- Multiple kinematic and ionization components in absorption and emission whose superposition leads to complex line profiles, including strong P Cygni profiles on resonance lines.
- The prominent Fe XXV Heα and Fe XXVI Lyα emission complexes are clearly resolved into their characteristic structure transitions.

Cyg X-3: a high-mass X-ray binary (HMXB)

XRISM et al., 2024, ApJ L 977:L34



Phase-resolved spectroscopy

- Self-consistent photoionization modeling => disentangle the absorption and emission components and measure the Doppler velocity of these components as a function of binary orbital phase.
- Significantly higher velocity amplitude for the emission lines than for the absorption lines.
- Absorption lines generally blueshifted by~−500–600 km/s.
- The wind decomposes naturally into a relatively smooth and large-scale component, perhaps associated with the background wind itself, plus a turbulent, denser structure located close to the compact object in its orbit.

Galaxy clusters: Centaurus

XRISM et al., 2025, Nature 638, 365

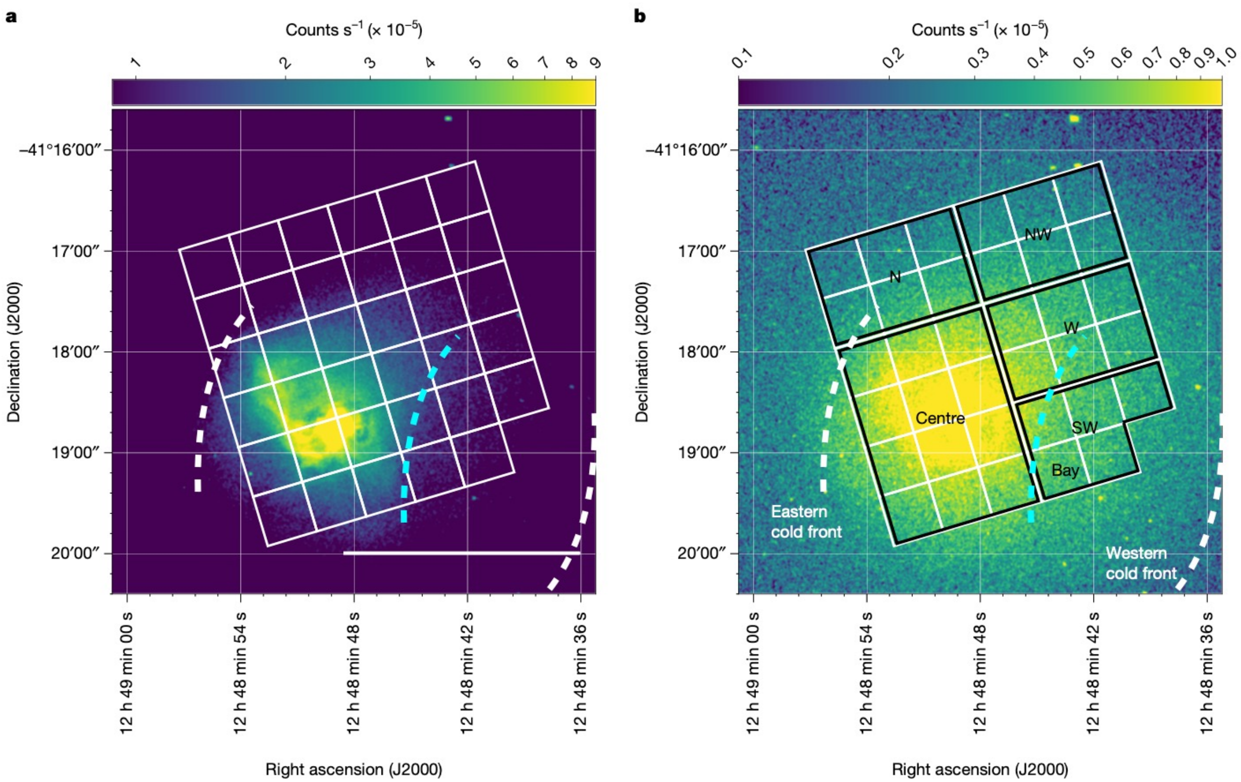


Fig. 1 | Resolve FOV superimposed on the Chandra X-ray images. a, Resolve FOV for 0.5–1.2 keV Chandra. **b**, Resolve FOV for 2–8 keV Chandra. The letters correspond to the regions extracted in the spectral analysis. The cyan dashed line indicates the 'bay' structure, whereas the white dashed lines show the eastern and western cold fronts, respectively, as indicated in ref. 6. Scale bar, 30 kpc (**a**,**b**).

Galaxy clusters: Centaurus

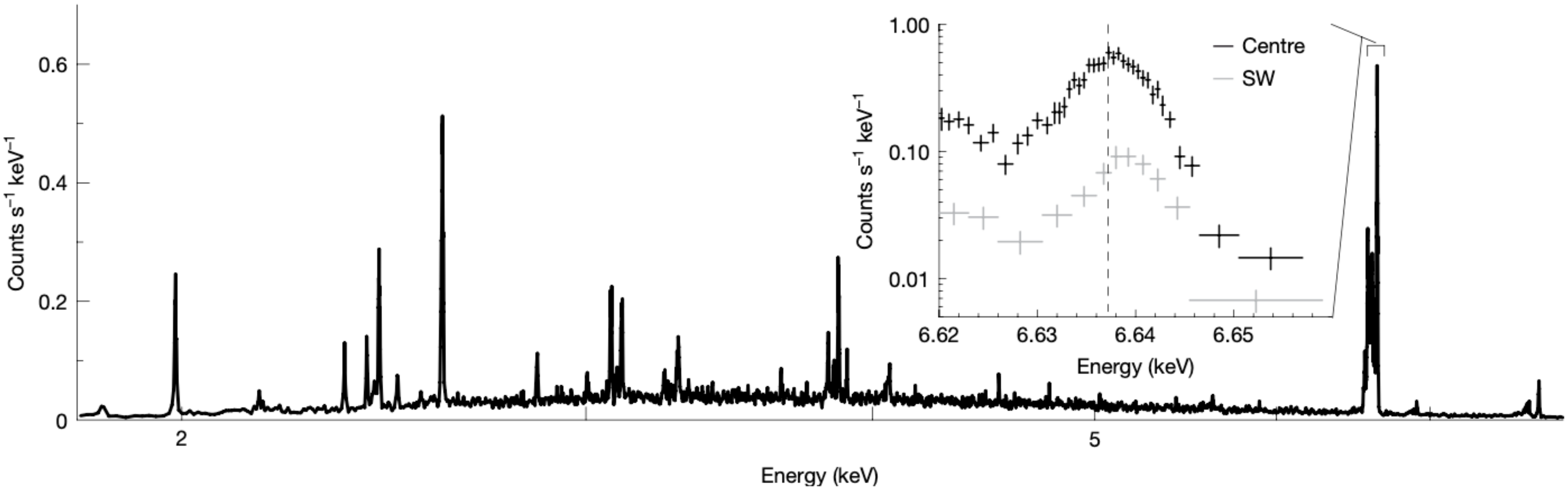


Fig. 2 | Resolve spectrum observed for the FOV in the 1.8–8.0 keV band. Resolve spectra around the He-α Fe lines (inset) in 6.62–6.66 keV of the Central and SW regions are shown in black and light grey, respectively. The vertical dotted black line indicates the central energy of the redshifted He-α Fe resonance line for the Central region obtained in the SSM analysis. The peak of the SW spectrum is blueshifted with respect to the line.

Galaxy clusters: Centaurus

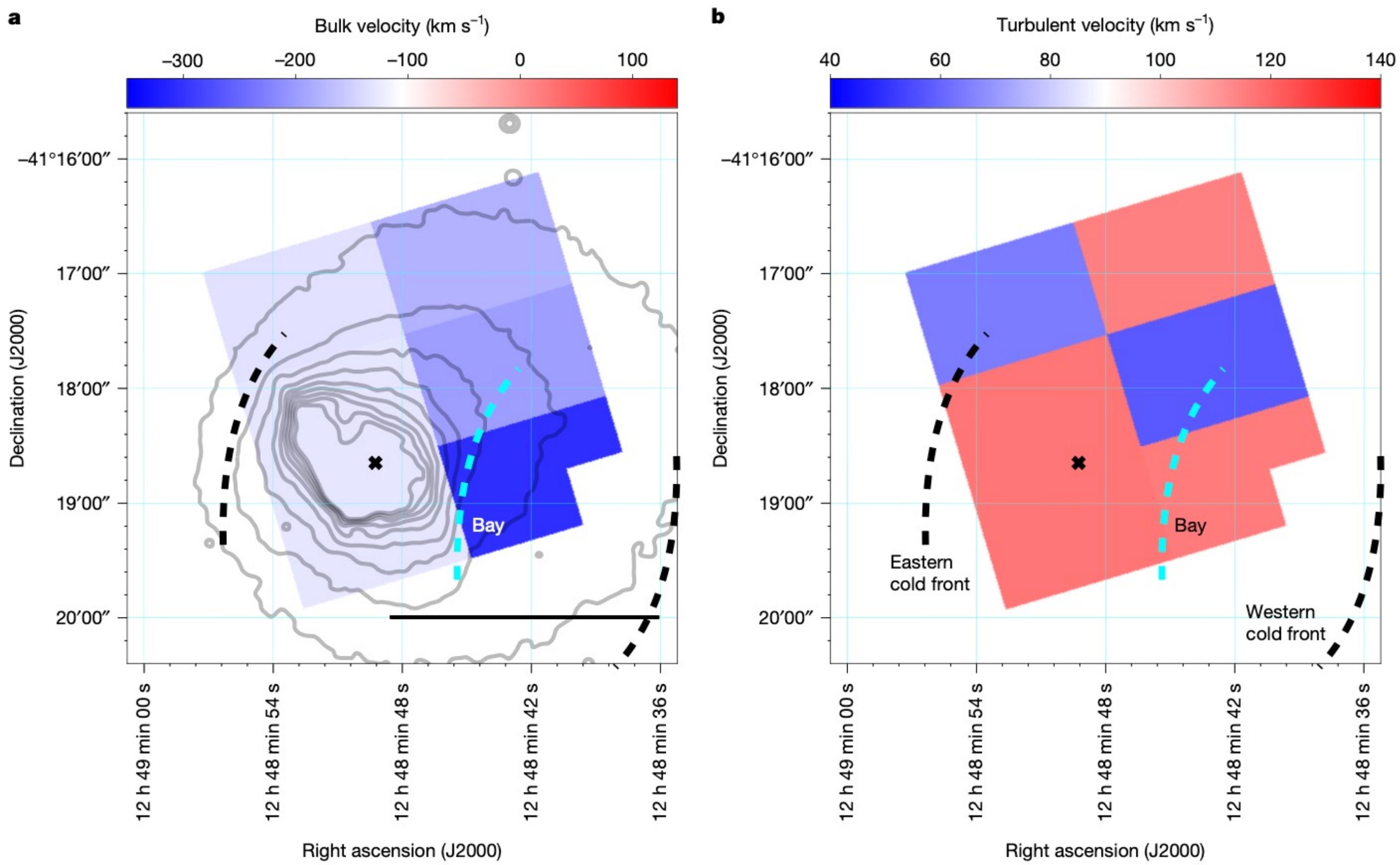


Fig. 3 | Maps for bulk and turbulent velocities. a, Bulk velocity. **b**, Turbulent velocity. The positions of the AGN (marked by X) and the bay are shown. The contour map of the Chandra X-ray image in 0.5–1.2 keV is overlaid on the velocity map in **a**. The black and cyan dashed lines show the cold fronts and the bay, respectively, as in Fig. 1.

Conclusions

Exceptional scientific results with XRISM on many subjects

- More are coming (PASJ XRISM special issue,…)
- First XRISM International Conference
  20-24 October 2025 (Kyoto, Japan)

=> Prepare the path to NewAthena/X-IFU science