IACHEC Thermal SNRs Working Group Meeting

Wednesday May 13th
9:00 JST = 00:00 UT = 2:00 CEST = 20:00 Monday EDT

WG Meeting Agenda

N132D:
- Paul: XMM model for Fe-K region Foster et al. 2025, arXiv:2504.19964
- Hiromasa: compare IACHEC model to XRISM data
- Paul: XRISM paper, XRISM Collaboration et al. 2024, PASJ, 76, 6, 1186, Fe-K complex is broader than the Si & S and the redshifts are different
- Paul: XRISM detects charge exchange in N132D, Gu, L., et al. 2025, arXiv:2504.03223

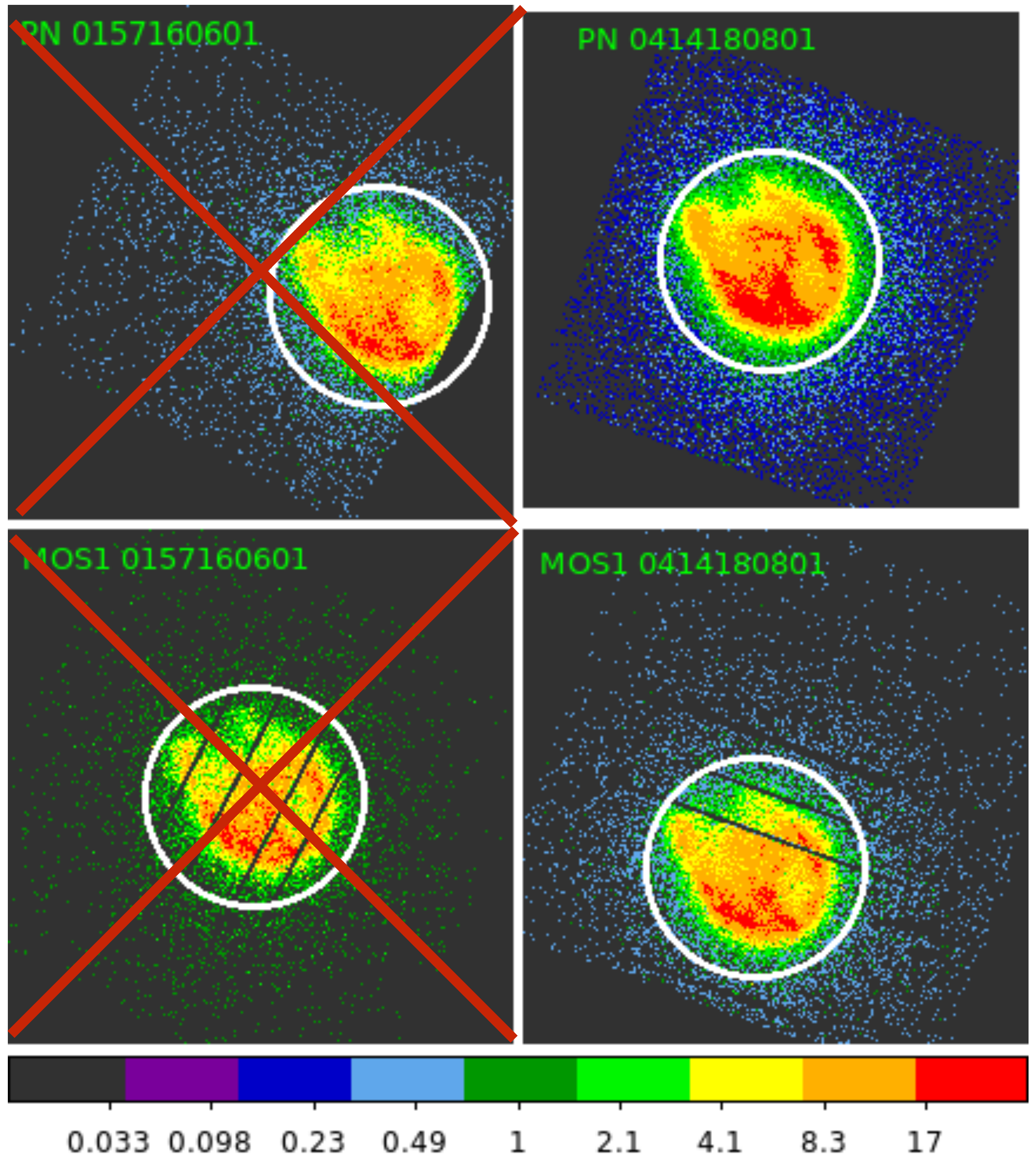
Cas A:
- Paul: XRISM, Fe-K velocities and broadenings, Bamba et al. 2025, arXiv:2504.03268
- Paul: XRISM, Si & S H-like and He-like have different redshifts, Suzuki et al. 2025, arXiv:2503.23640
- Paul: XRISM, Si & S velocities and broadenings, Vink et al. 2025, arXiv:2505.04691
- Paul: XRISM standard spectral models for two regions

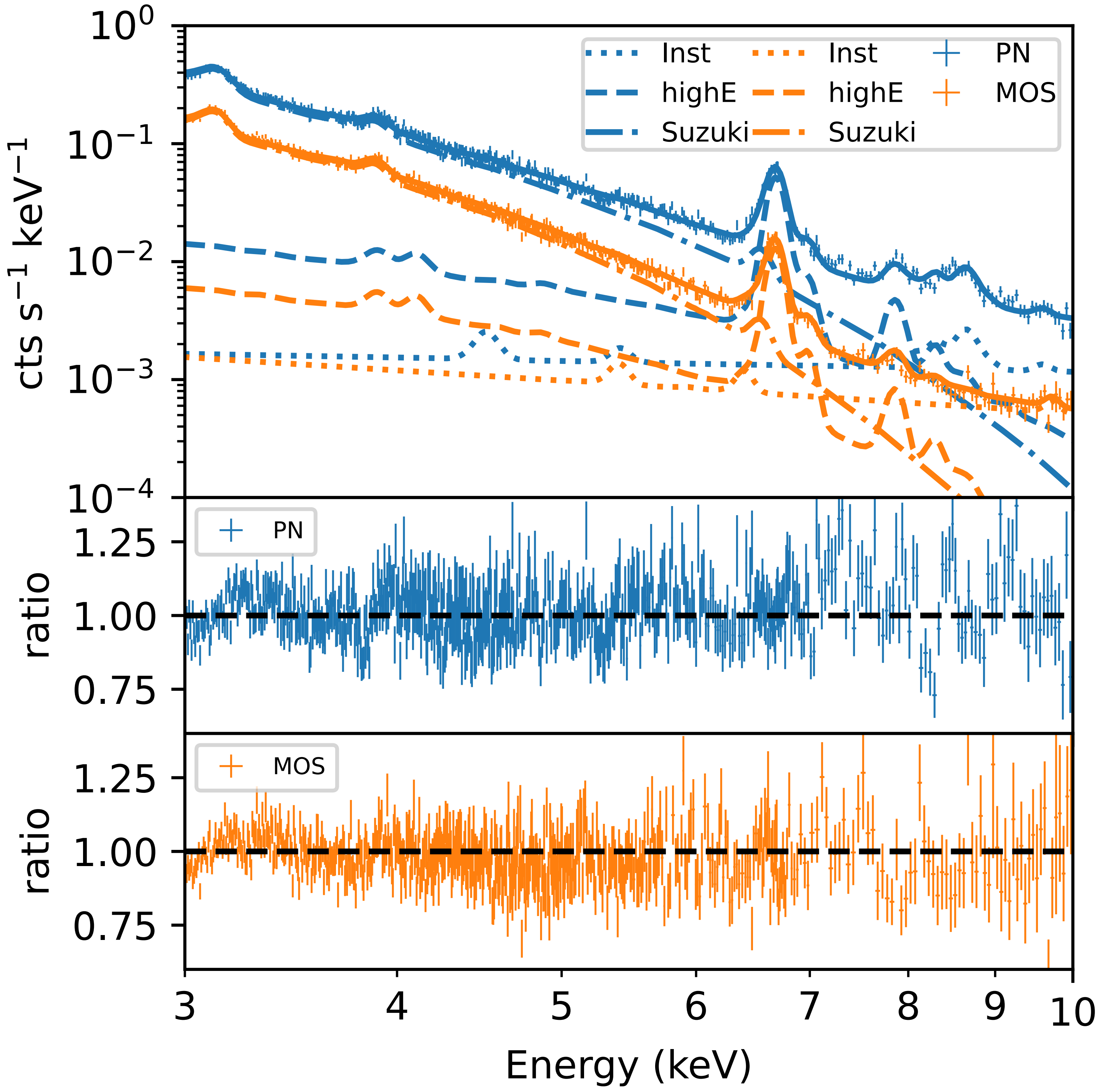
E0102:
- Mayu: XRISM Xtend observations of E0102 to monitor contamination
- Hiromasa: XRISM Resolve spectra of E0102

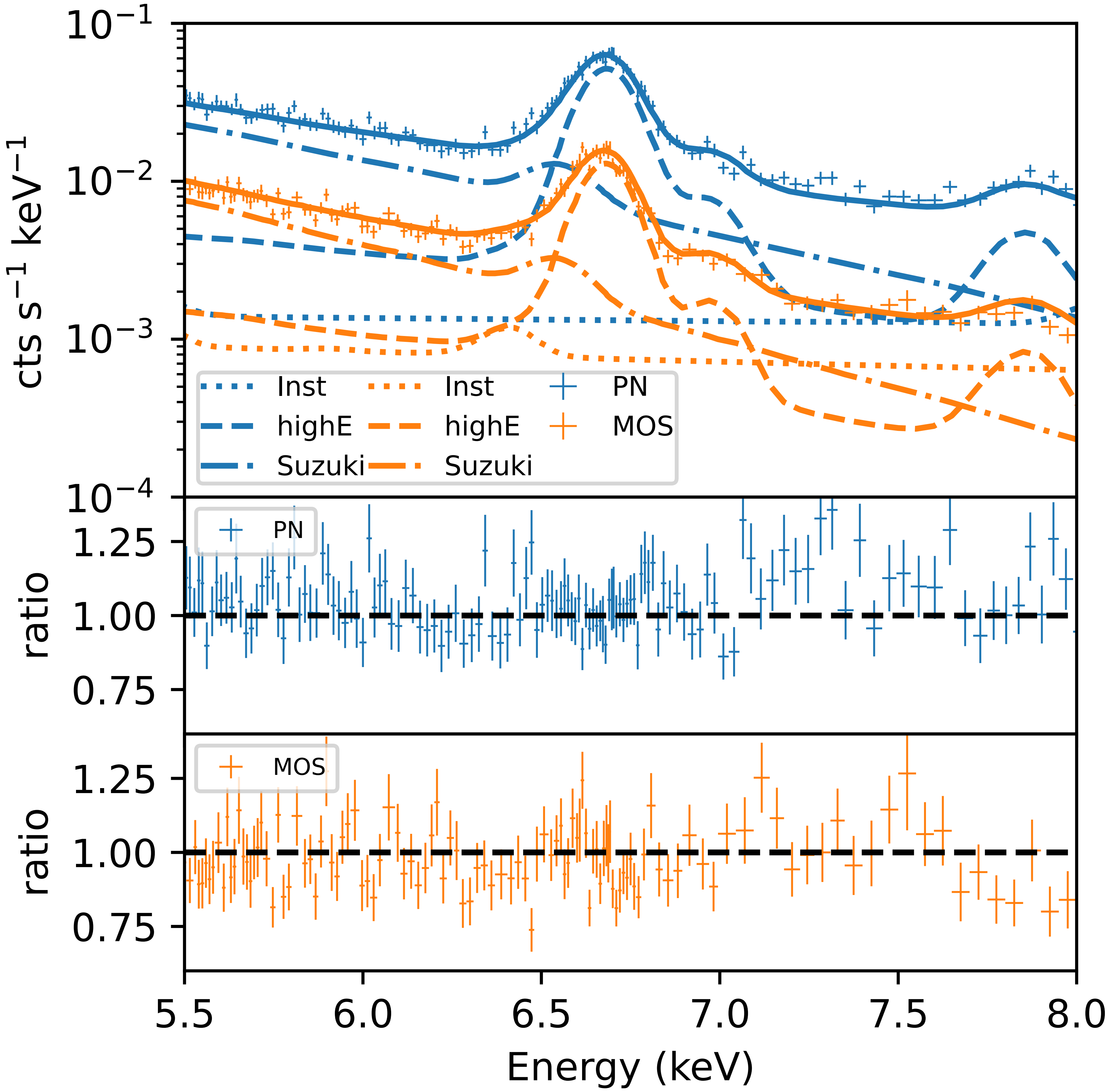
XMM Observations of N132D

- Foster et al. 2025, arXiv:2504.19964, accept only observations in the center of the small window
- fit 17 pn observations in PrimeSmallWindow mode from 2001-2020, 33/34 MOS1/MOS2 observations in Prime Partial W3 from 2000-2020
- Adopt Suzuki et al. 2020 model for energies below 2.0 keV, add a high temperature (kT~4.5 keV) to fit the Fe-K region
- pn and MOS agree quite well at Fe-K, the long term CTI correction works quite well, congratulations Ivan !!
- the pn and MOS data do not agree with the Suzuki model and do not agree with each other

Foster et al. 2025







XRISM Observations of N132D

- Yamaguchi et al. 2024, PASJ, 76, 6, 1186
- Si & S have σ_v = 450 km/s and z~280 km/s, Fe Heα has σ_v = 1670 km/s and Fe Lyα has z~890 km/s

Table 3. Best-fit parameters of the spectral fit in the 1.6–10 keV band.

Parameters	Model A	Model B	
	Low-T_e component	Low-T_e component	
kT_e (keV)	0.79 ± 0.03	$0.81^{+0.05}_{-0.04}$	
kT_{init} (keV)	0.01 (fixed)	0.01 (fixed)	
τ (10^{12} cm^{-3} s)	>0.46	$0.83^{+1.19}_{-0.31}$	
z (10^{-4})	$7.4^{+0.8}_{-0.7}$	7.7 ± 0.8	
σ_v (km s^{-1})	462 ± 24	452 ± 24	
Normalization (10^{-2})	7.8 ± 0.1	7.1 ± 0.7	
	High-T_e (RP) component	High-T_e component	Very-high-T_e component
kT_e (keV)	2.0 ± 0.1	1.8 ± 0.1	10 (fixed)
kT_{init} (keV)	30 (fixed)	0.01 (fixed)	0.01 (fixed)
τ (10^{12} cm^{-3} s)	1.0 ± 0.1	>0.8	10 (fixed)
z (10^{-3})	$1.14^{+0.40}_{-0.31}$	$0.84^{+0.32}_{-0.39}$	2.98 (fixed)
σ_v (km s^{-1})	1700^{+150}_{-140}	1670^{+160}_{-170}	750 (fixed)
Normalization (10^{-3})	9.7 ± 1.5	9.7 ± 1.5	$0.29^{+0.06}_{-0.07}$

Yamaguchi et al. 2024

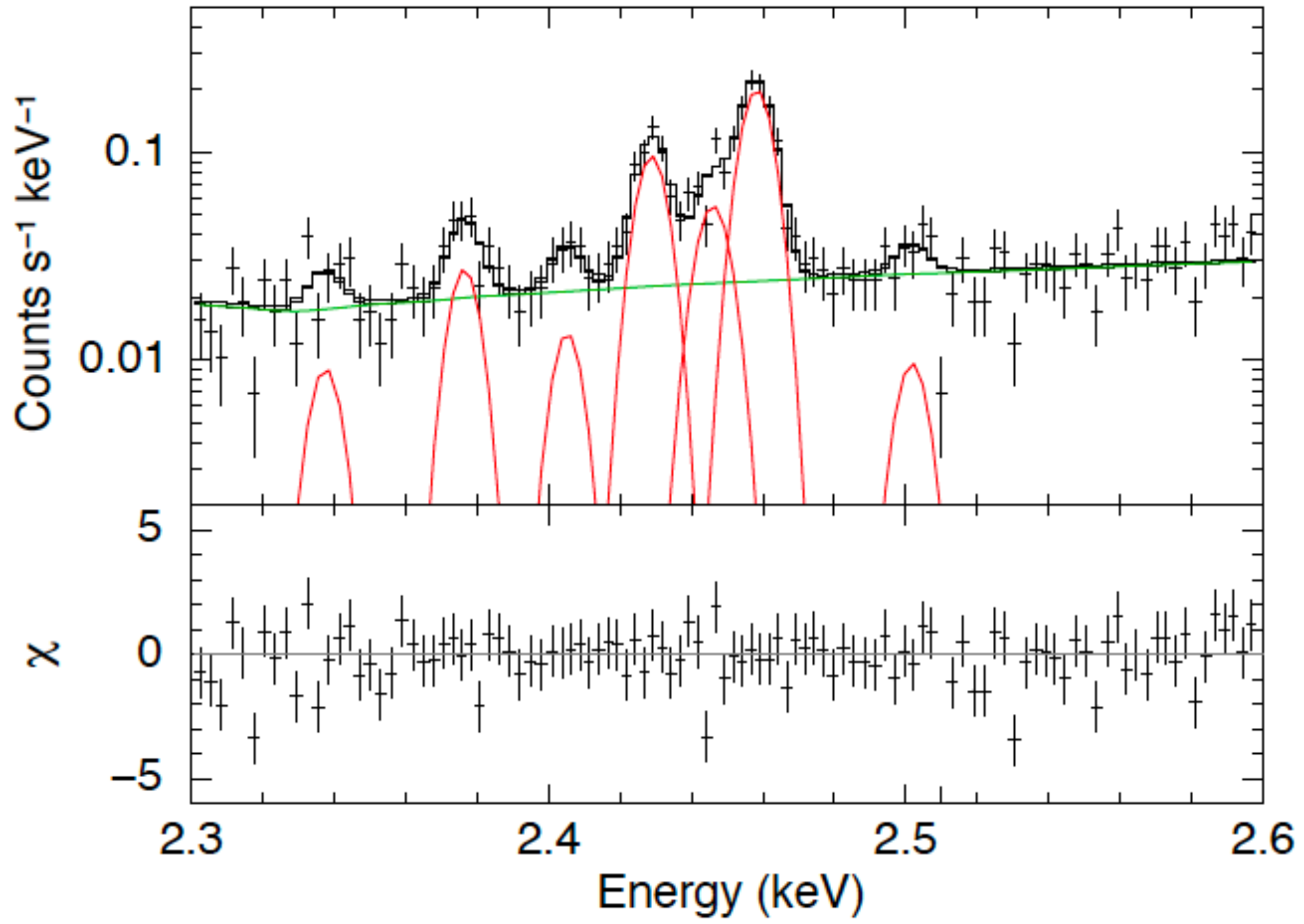


Fig. 3. The Resolve spectrum in the 2.3–2.6 keV band, where the S XV emission is prominent. Red and green are Gaussian functions and the bremsstrahlung continuum component of the ad hoc model, respectively. The NXB contribution is taken into account but is below the displayed flux level.

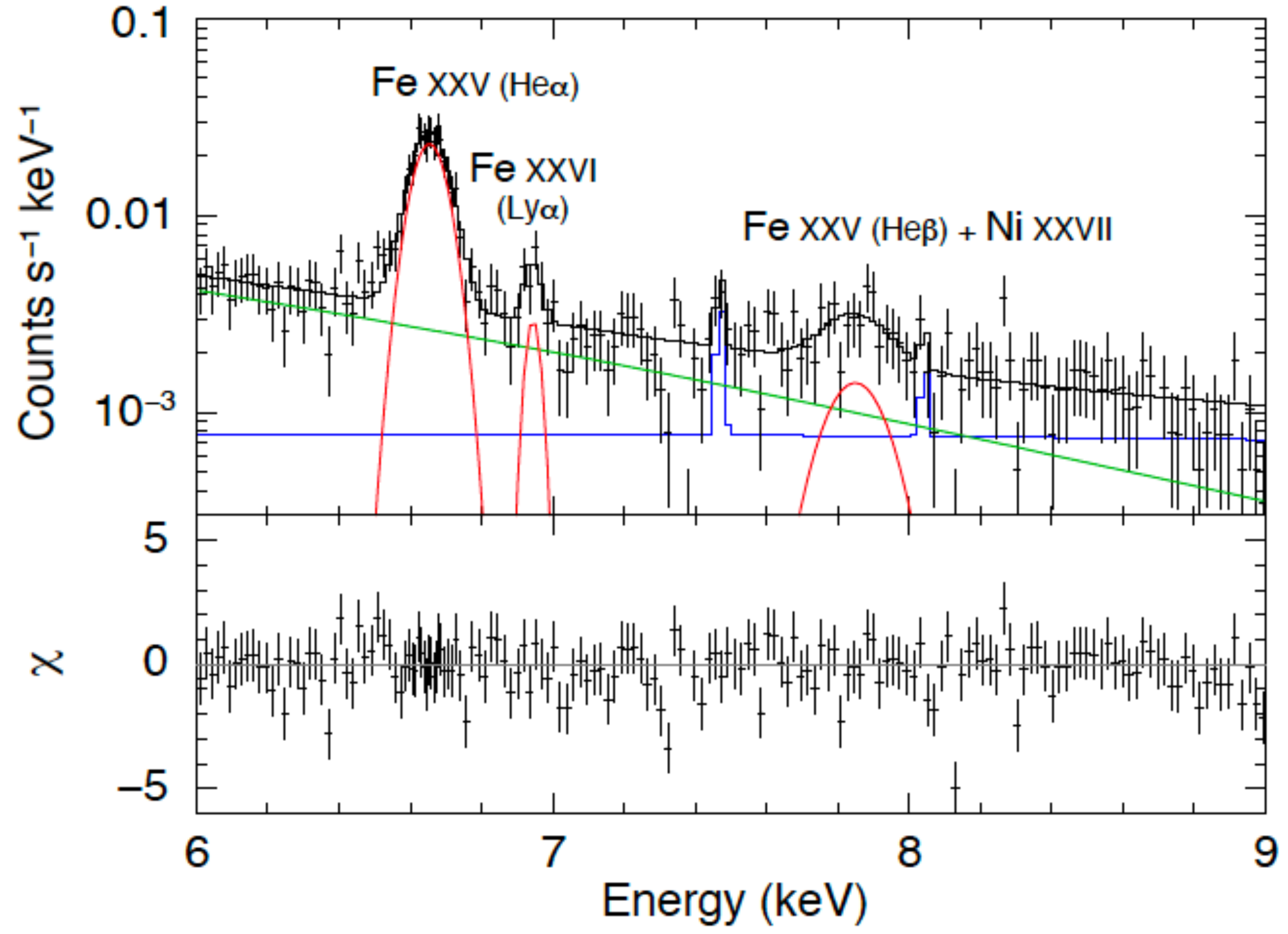
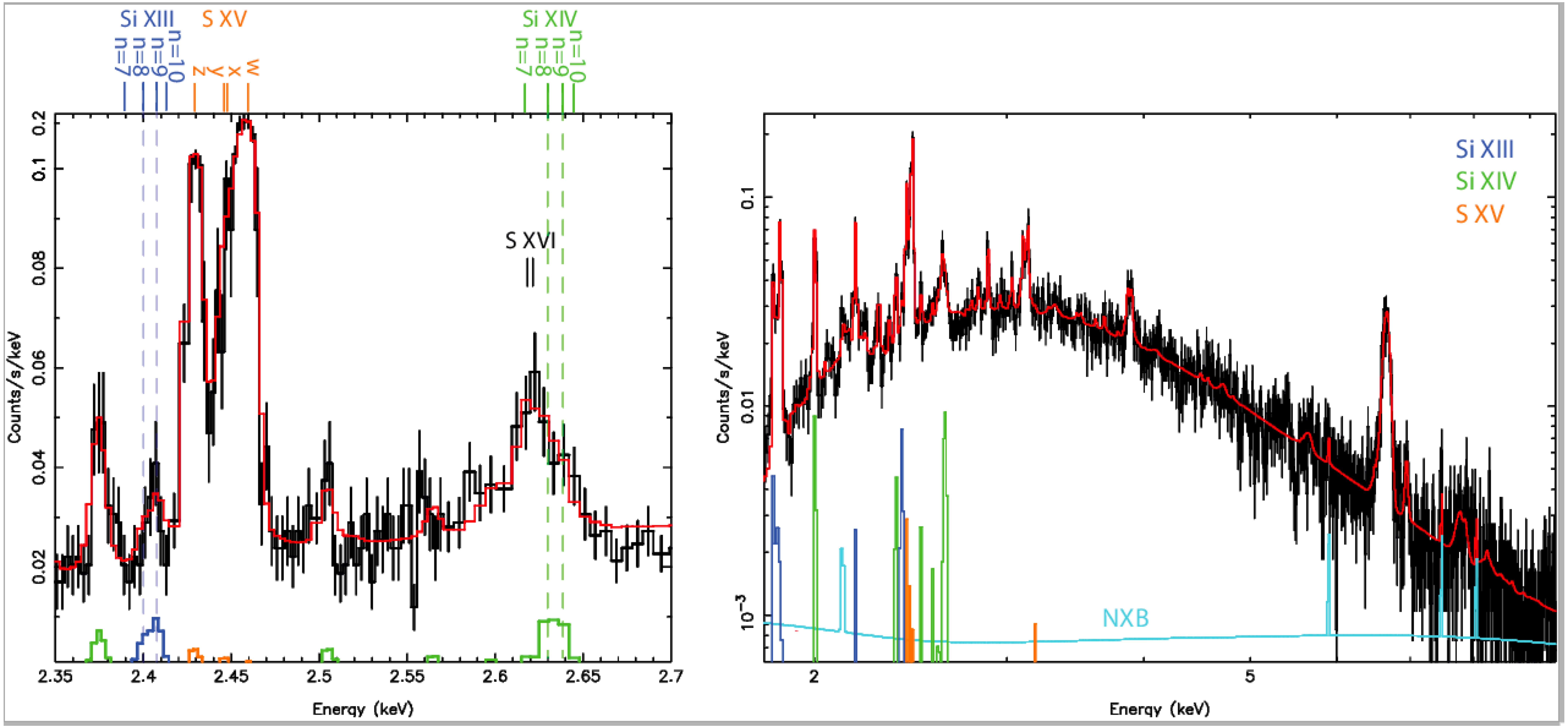


Fig. 4. The Resolve spectrum in the Fe K band. Red and green are the Gaussian functions and bremsstrahlung continuum components of the ad hoc model, respectively. Blue indicates the NXB spectrum.

XRISM Observations of N132D

Gu et al. 2025

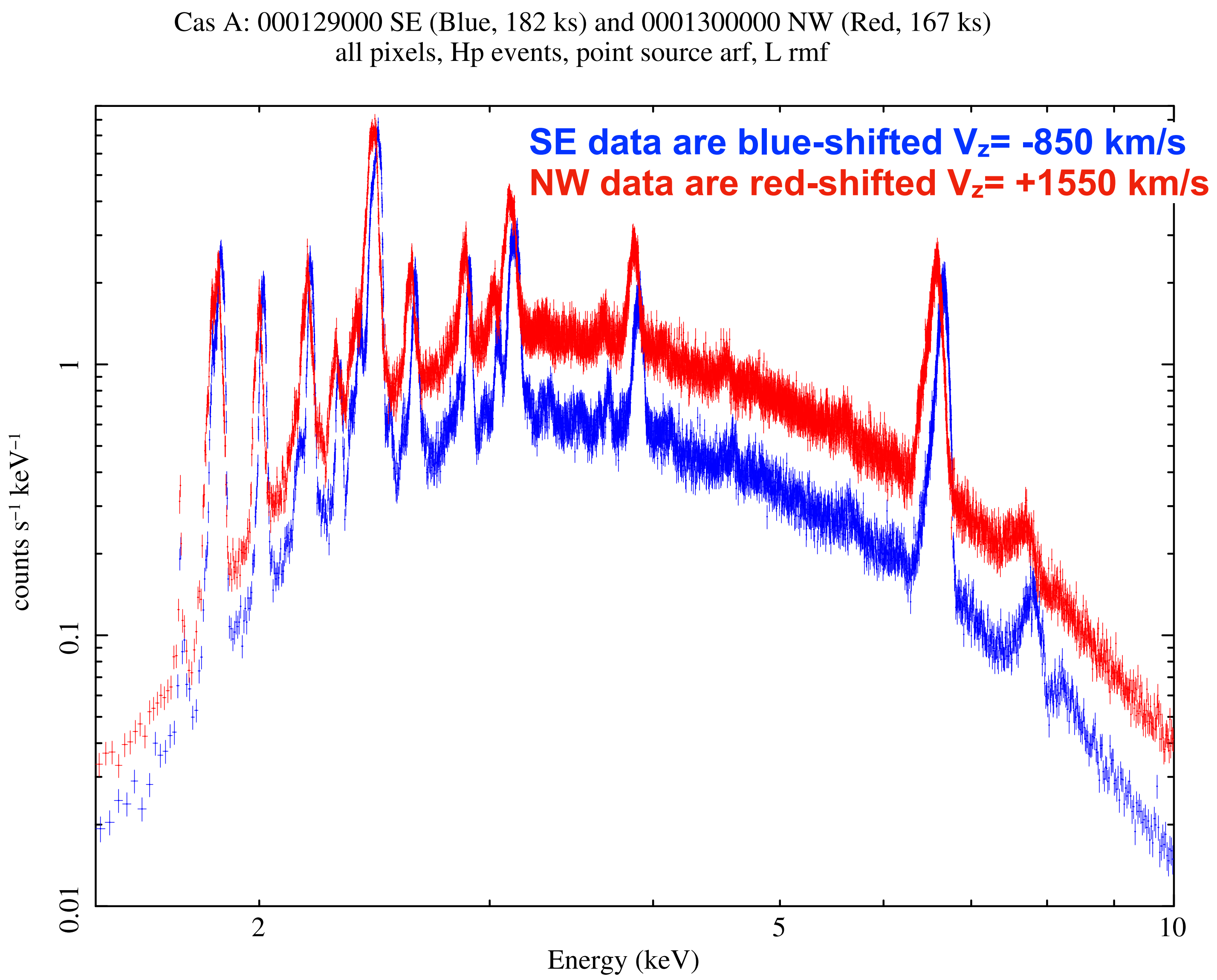
- Gu et al. 2025, arXiv:2504.03223, CX detected from Si
- These features are weak, I suggest they are a low priority to add to the IACHEC model



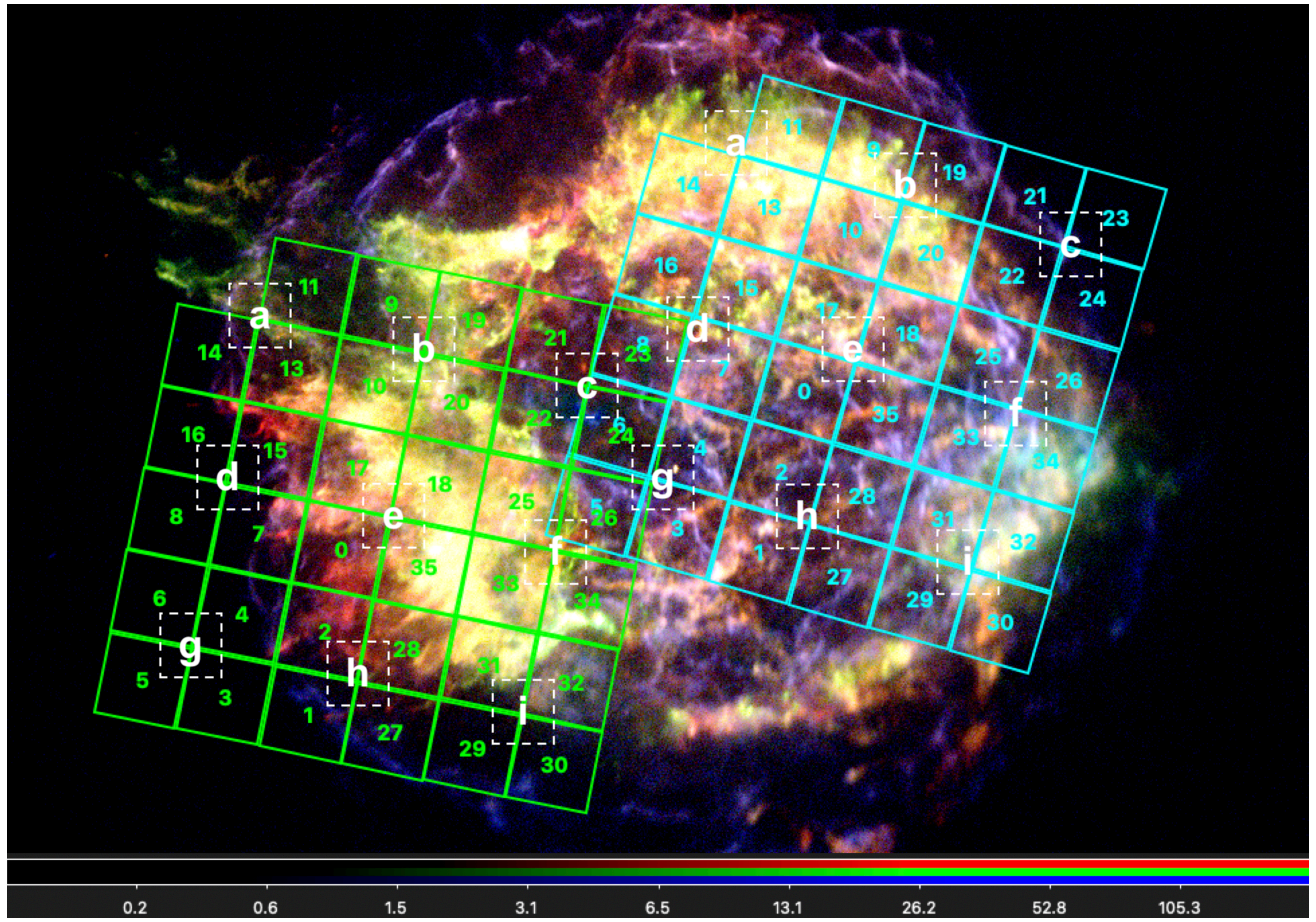
XRISM Observations of Cas A

- XRISM observed Cas A twice in the PV phase

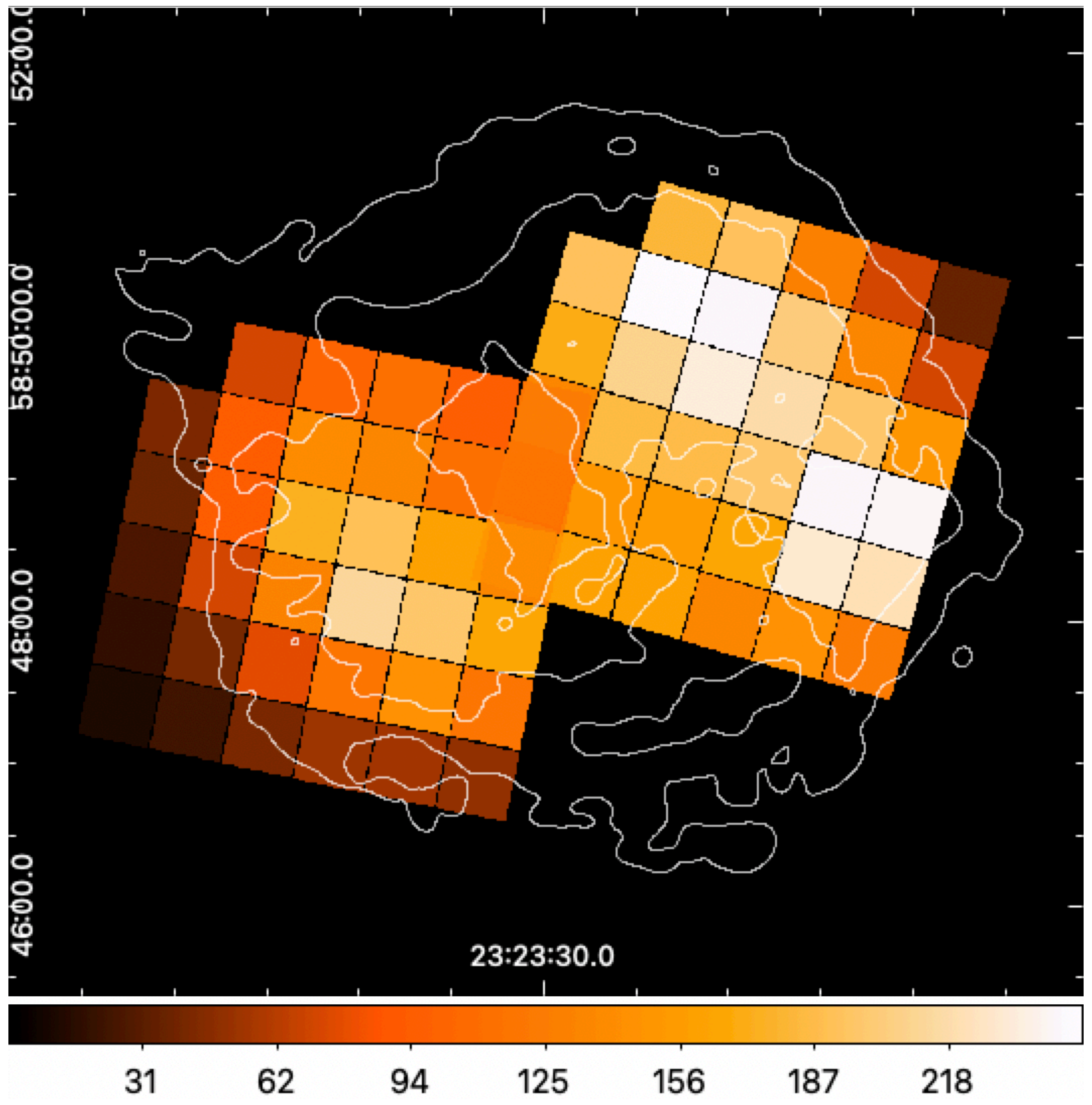
OBSID	Exp(ks)	Events [2-10 keV]	Rate (cts/s)	%Hp events	Peak Pixel	Peak Pixel (cts/s)
000129000	182	609416	3.4	96.6	37517	0.21
000130000	167	968909	5.8	96.2	40023	0.24



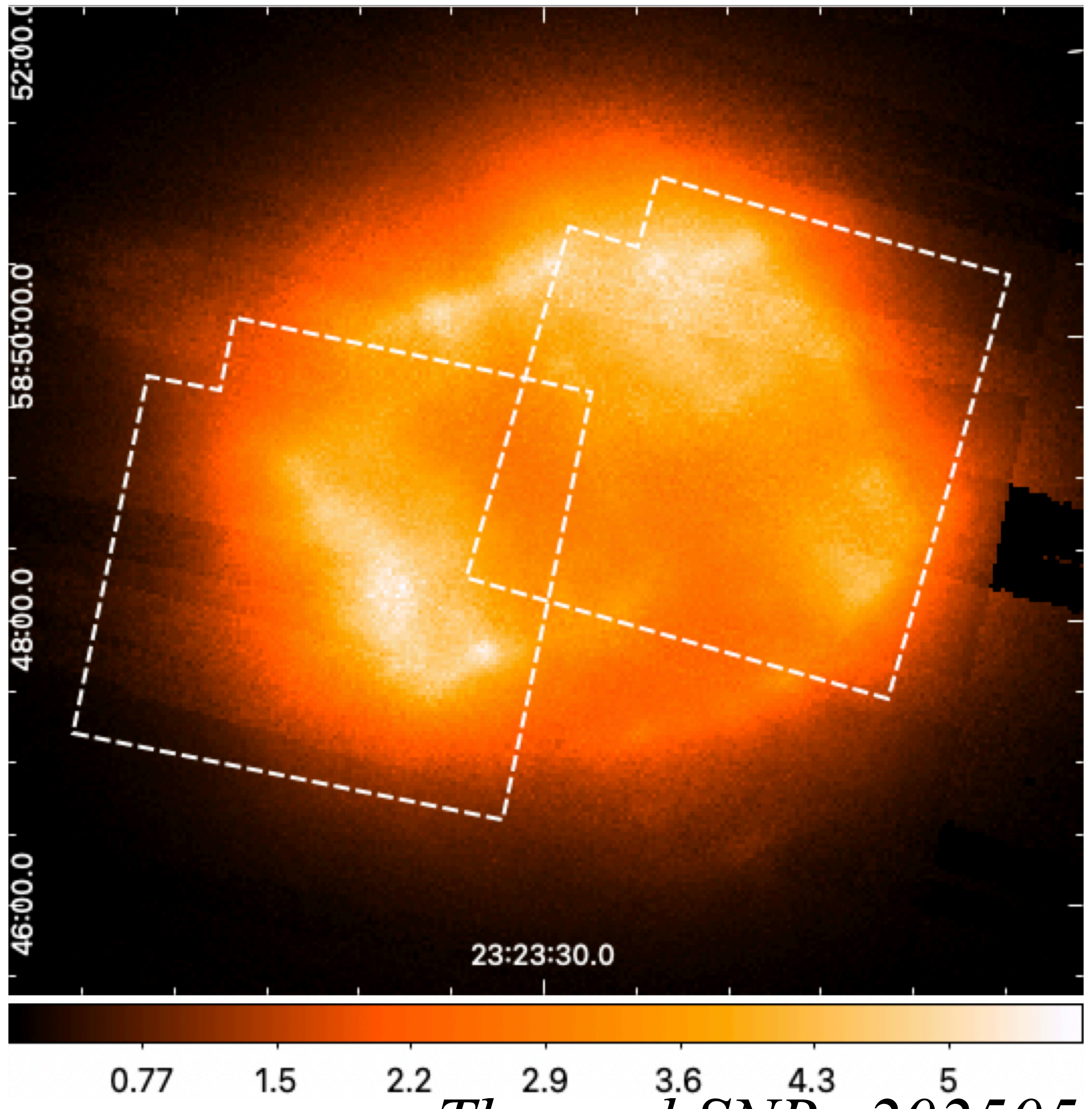
Plucinsky et al. 2025



Resolve



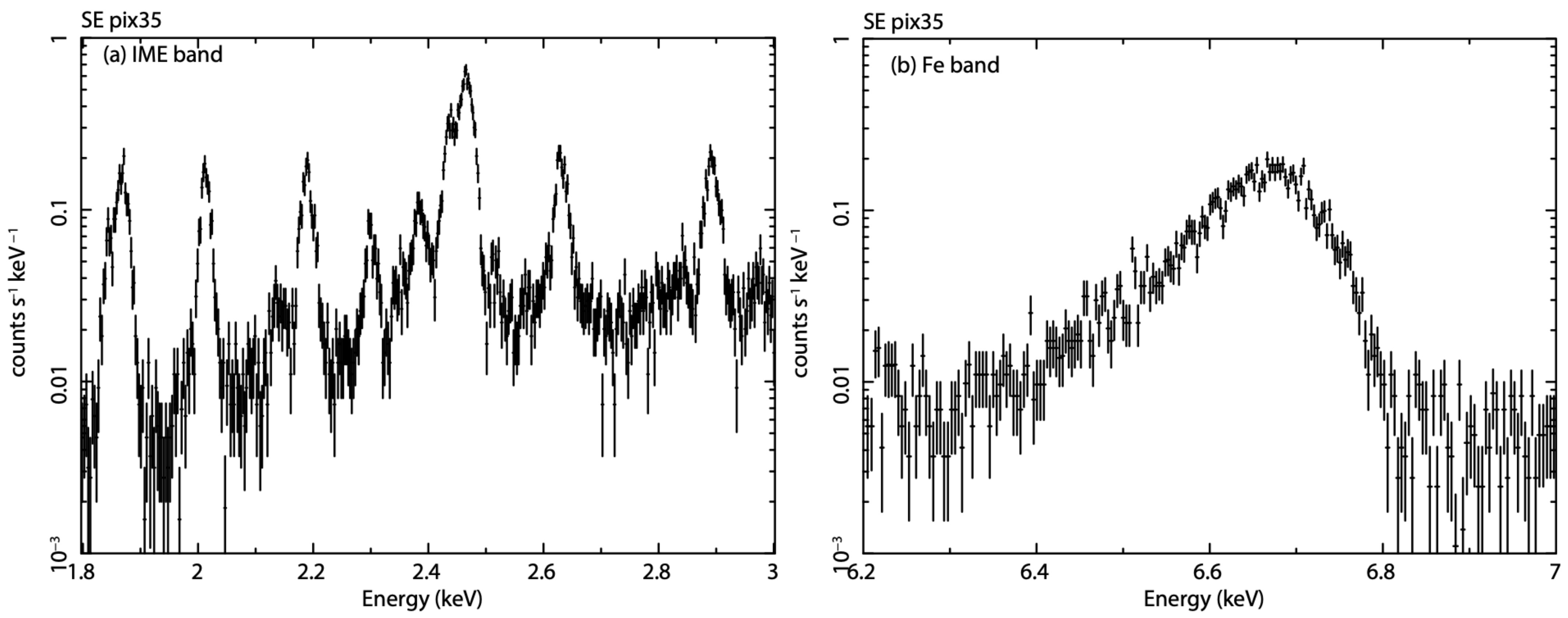
Xtend

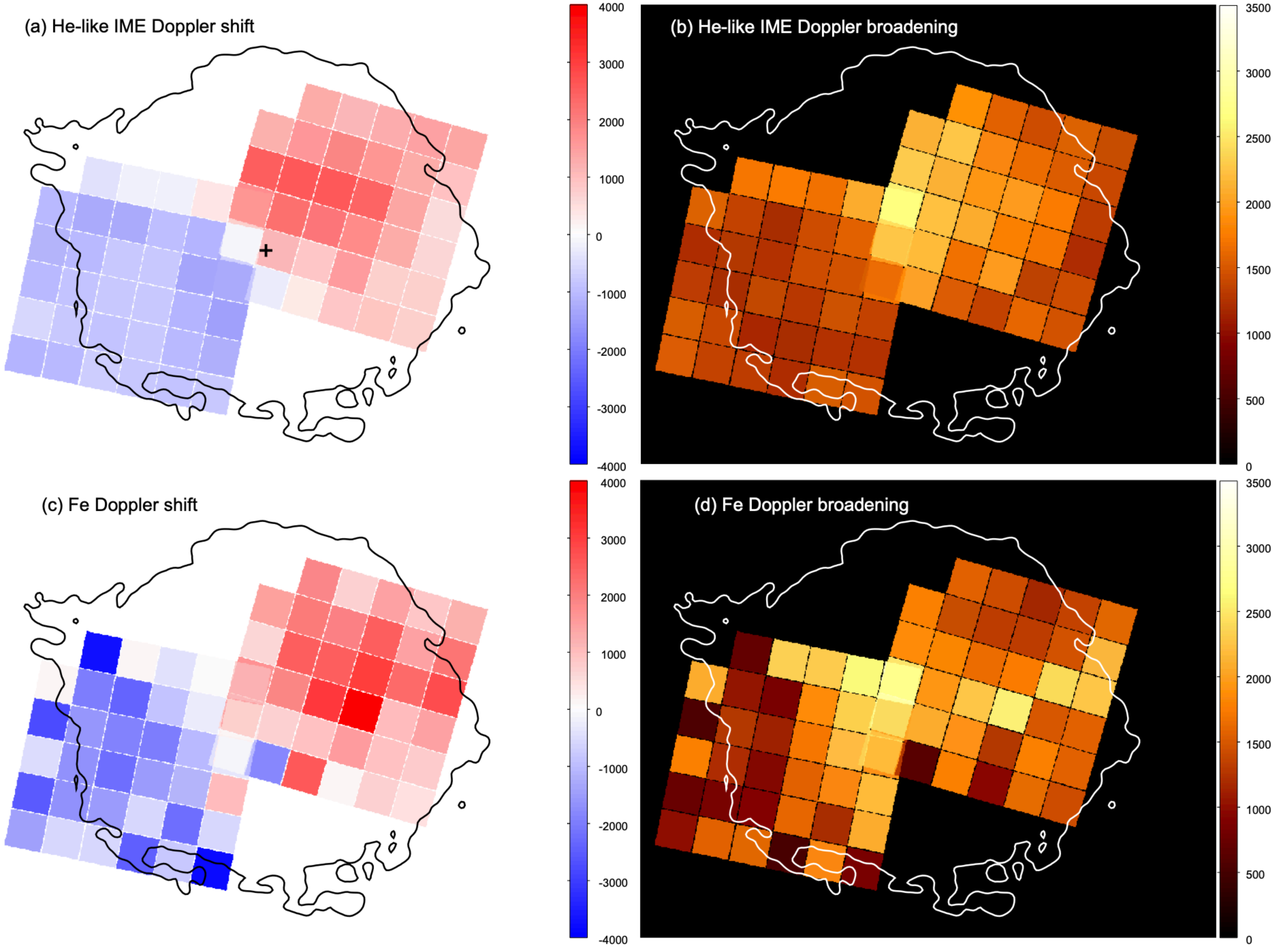


XRISM Observations of Cas A

Bamba et al. 2025

- Bamba et al. 2025, arXiv:2504.03223, velocities and broadenings of Fe-K, blue shifted in the SE and redshifted in the NW
- Fe-K complex is broad





XRISM Observations of Cas A

- Suzuki et al. 2025, arXiv:2503.23640, He-like and H-like lines of Si and S have ***different*** redshifts
- Need calorimeter resolution to measure this effect, CCD resolution is not enough

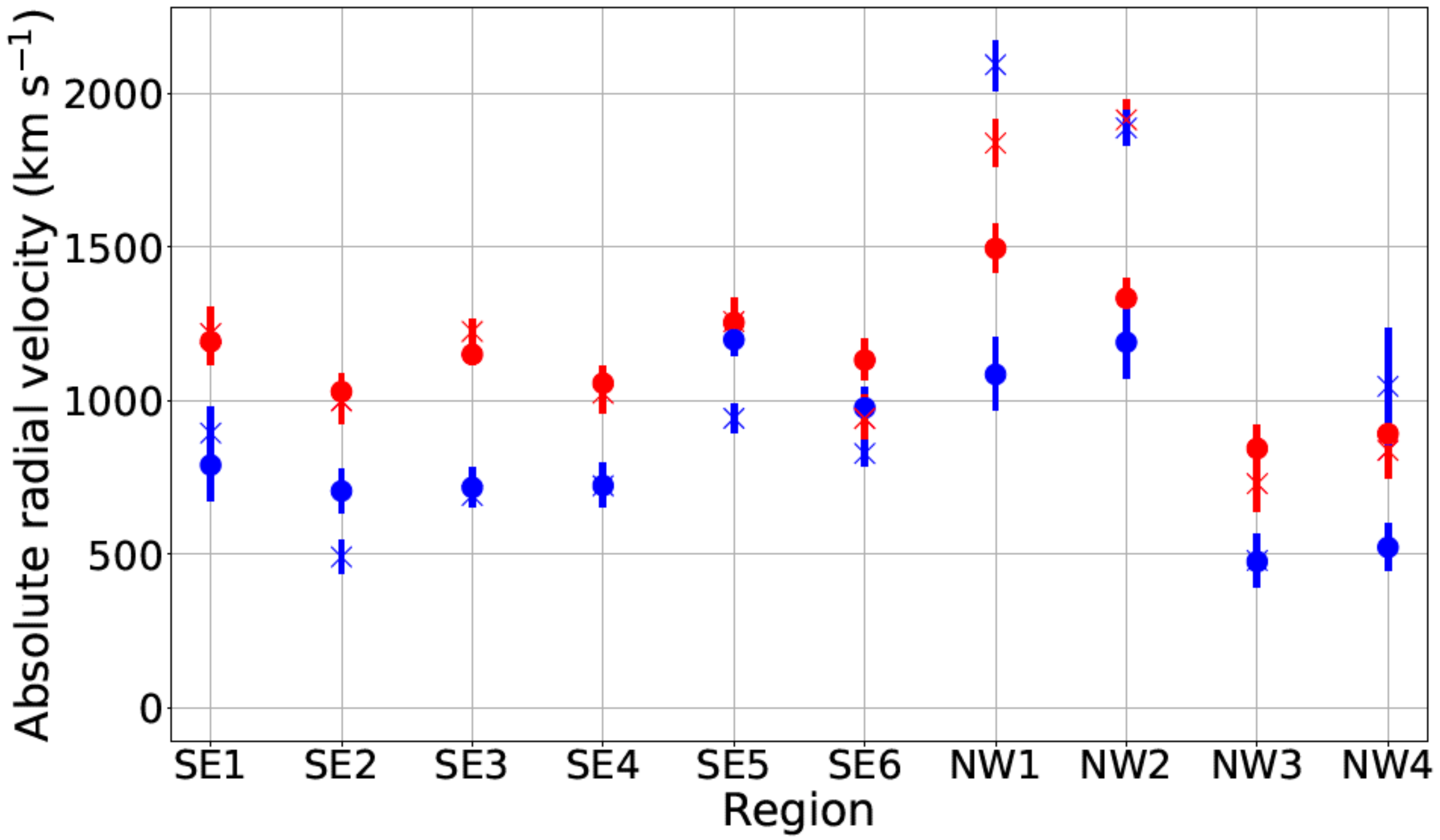
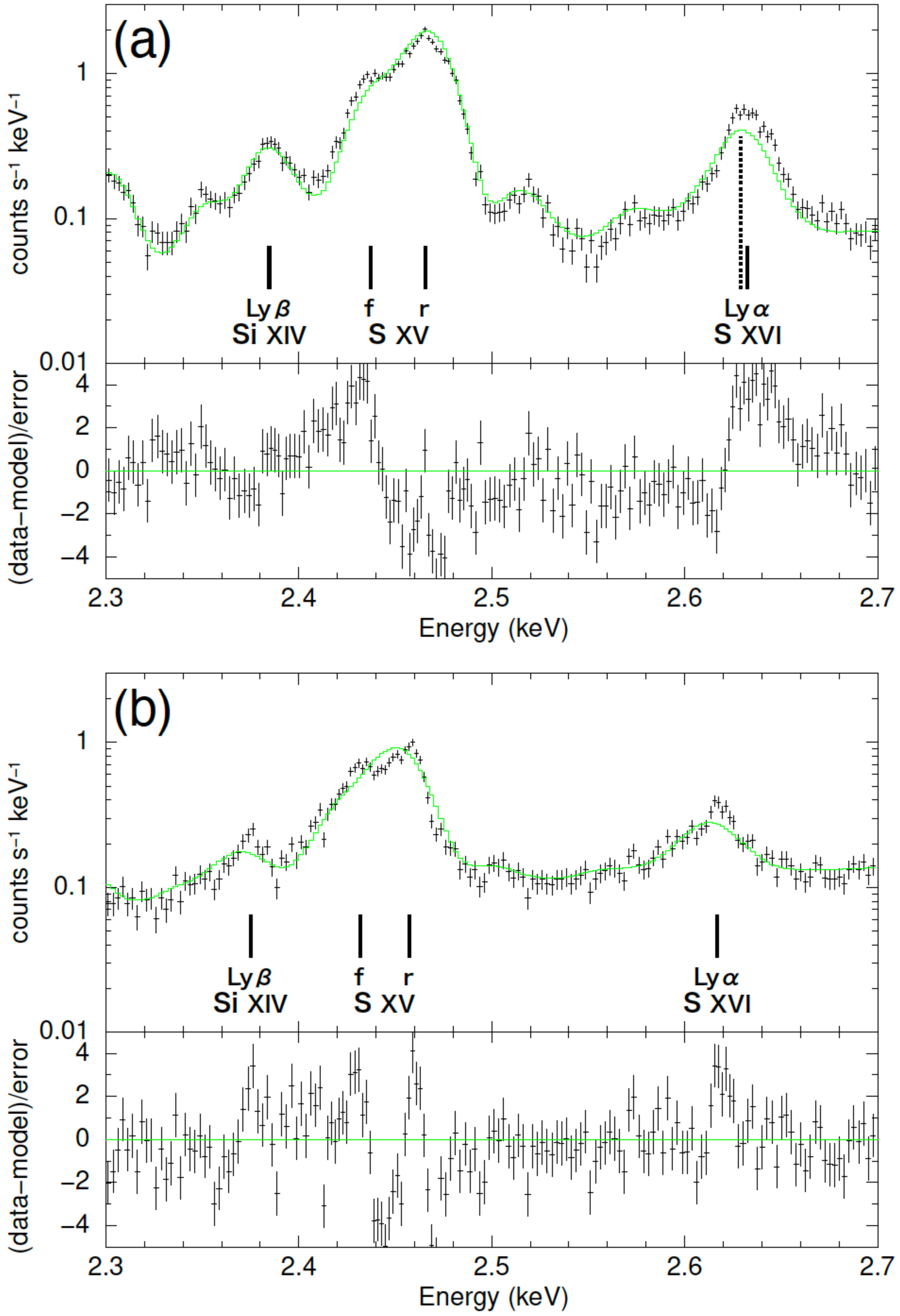


Fig. 4. Doppler velocities of Si XIV Lyα (red dot), Si XIII Heα (blue dot), S XVI Lyα (red cross) and S XV Heα (blue cross), derived by the Gaussian modeling in Section 3.2. Alt text: Scatter plots showing the relationship between Region ID (x-axis) and absolute radial velocity (y-axis) in kilo meters per second.

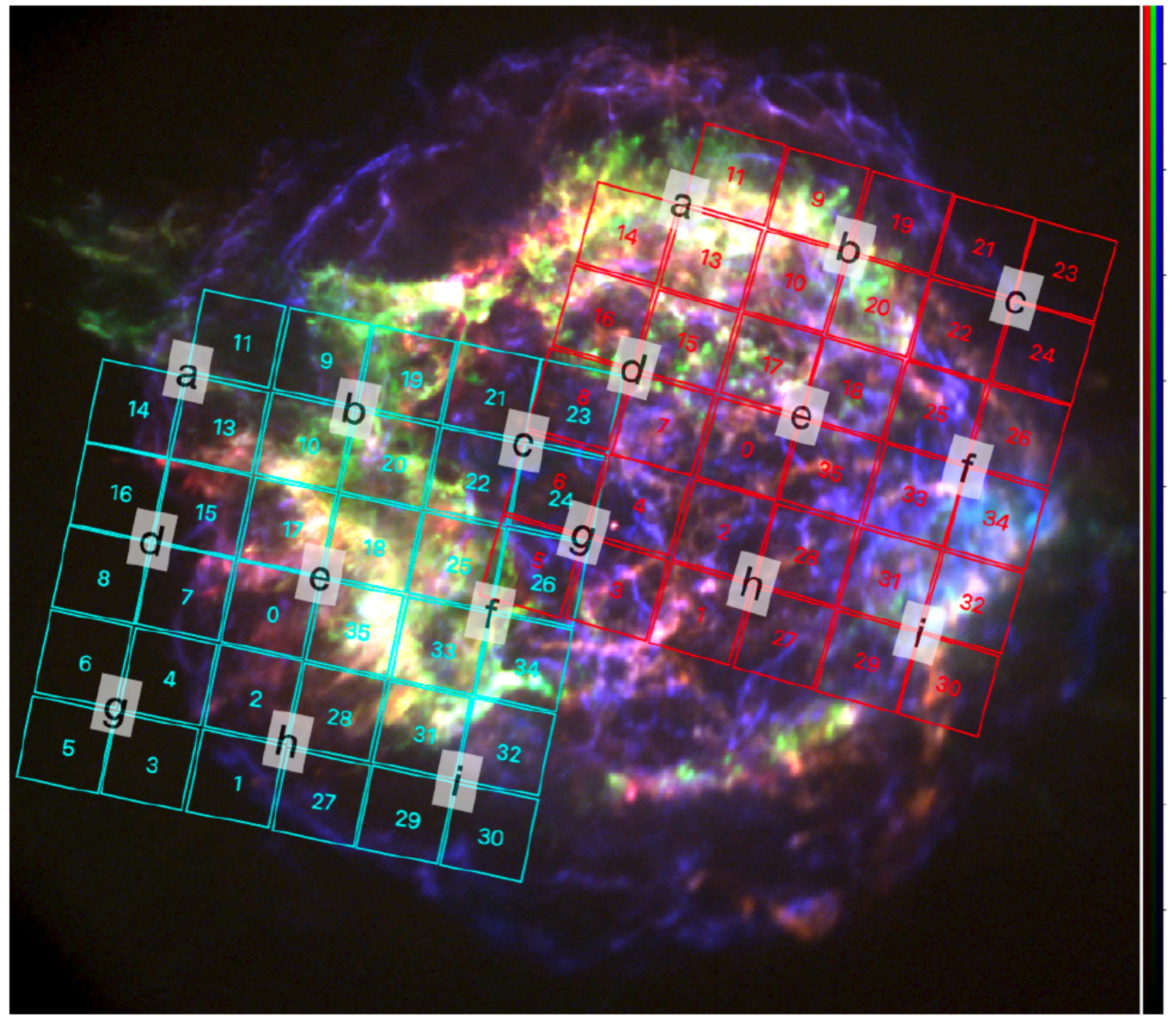
Suzuki et al. 2025



XRISM Observations of Cas A

- Vink et al. 2025, arXiv:2505.04691
- fit the data with a double Gaussian model to represent two components with different redshifts and broadenings

Vink et al. 2025



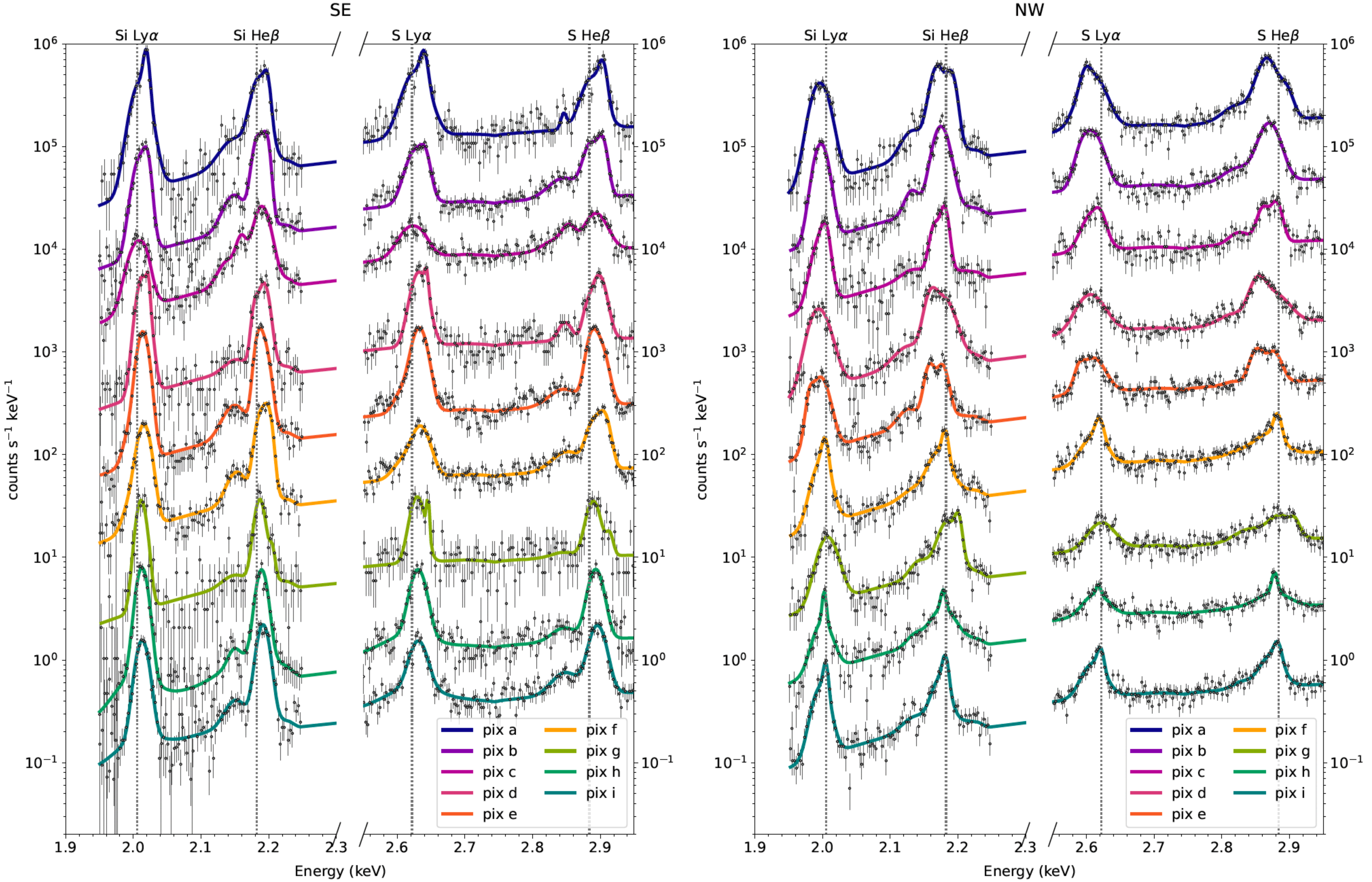
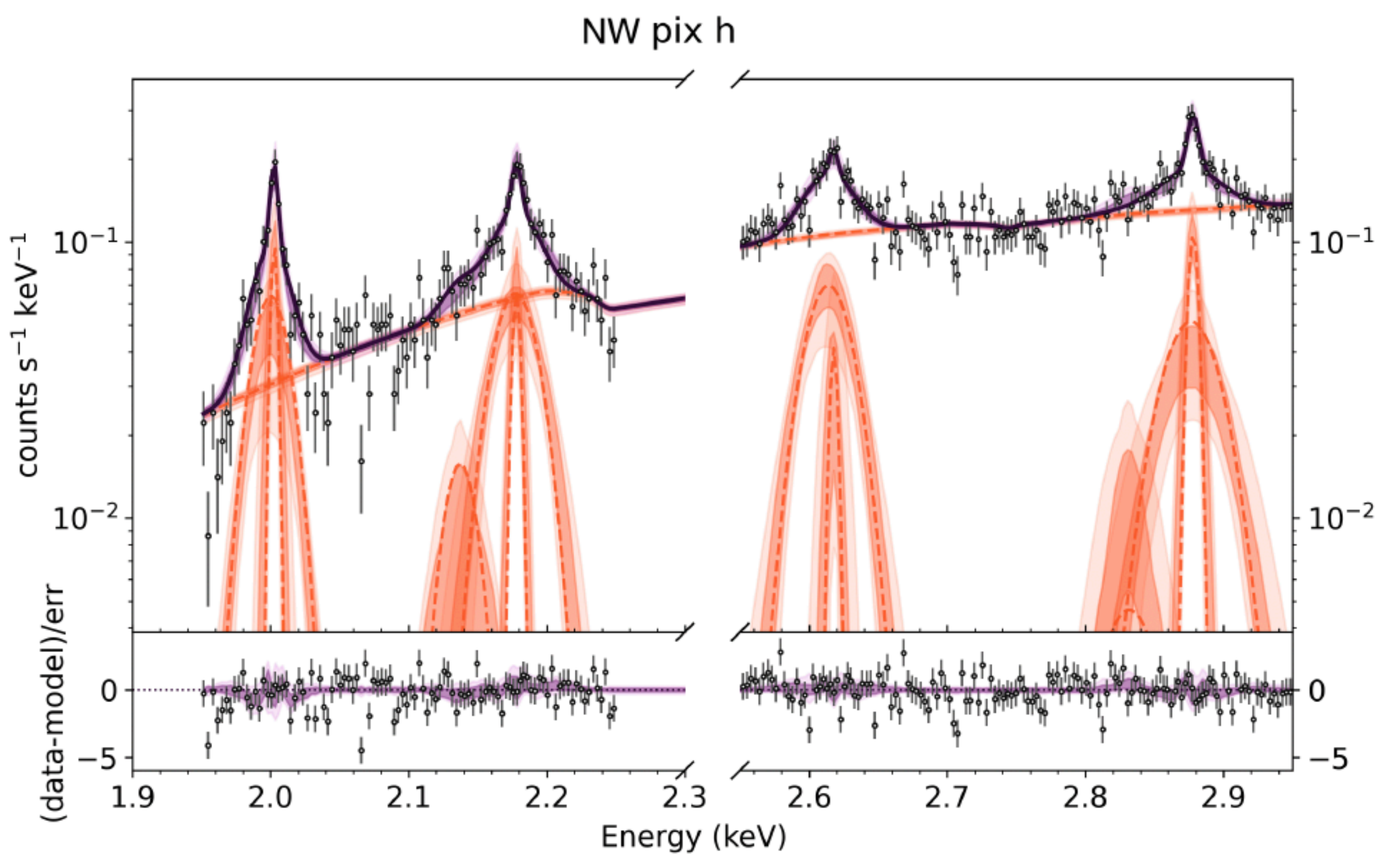


Fig. 6. Line profiles of Si Lyα, Si Heβ, S Lyα and S Heβ as fitted using two gaussians. The fits are for the binned 2×2 pixels (a,...,i). See Fig. 5 for a detailed look of two examples.

XRISM Observations of Cas A

- Vink et al. 2025, arXiv:2505.04691, fits with a narrow component and a broad component can reproduce the “spiky” profile for pixel “h”
- The two components can have significantly different broadenings

Vink et al. 2025



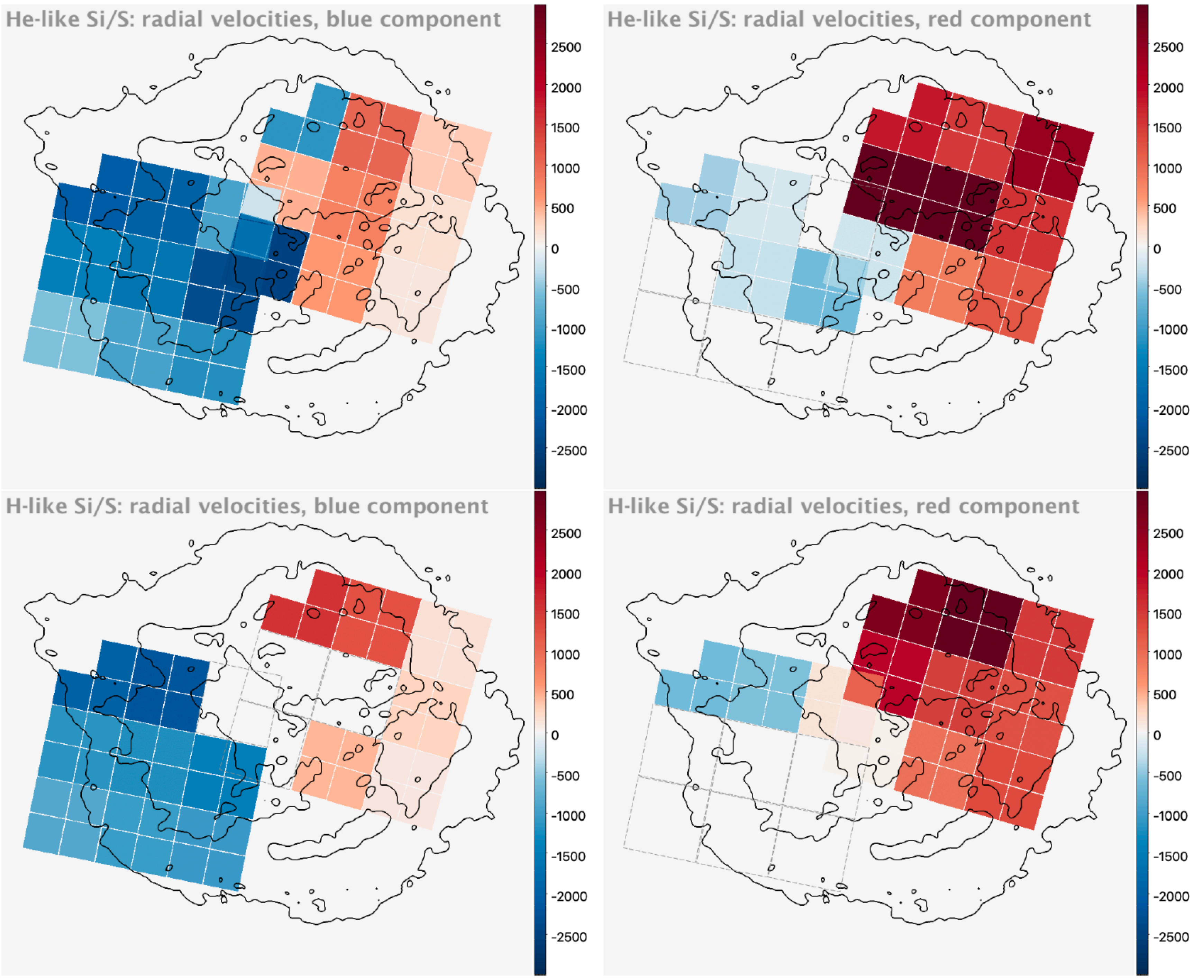
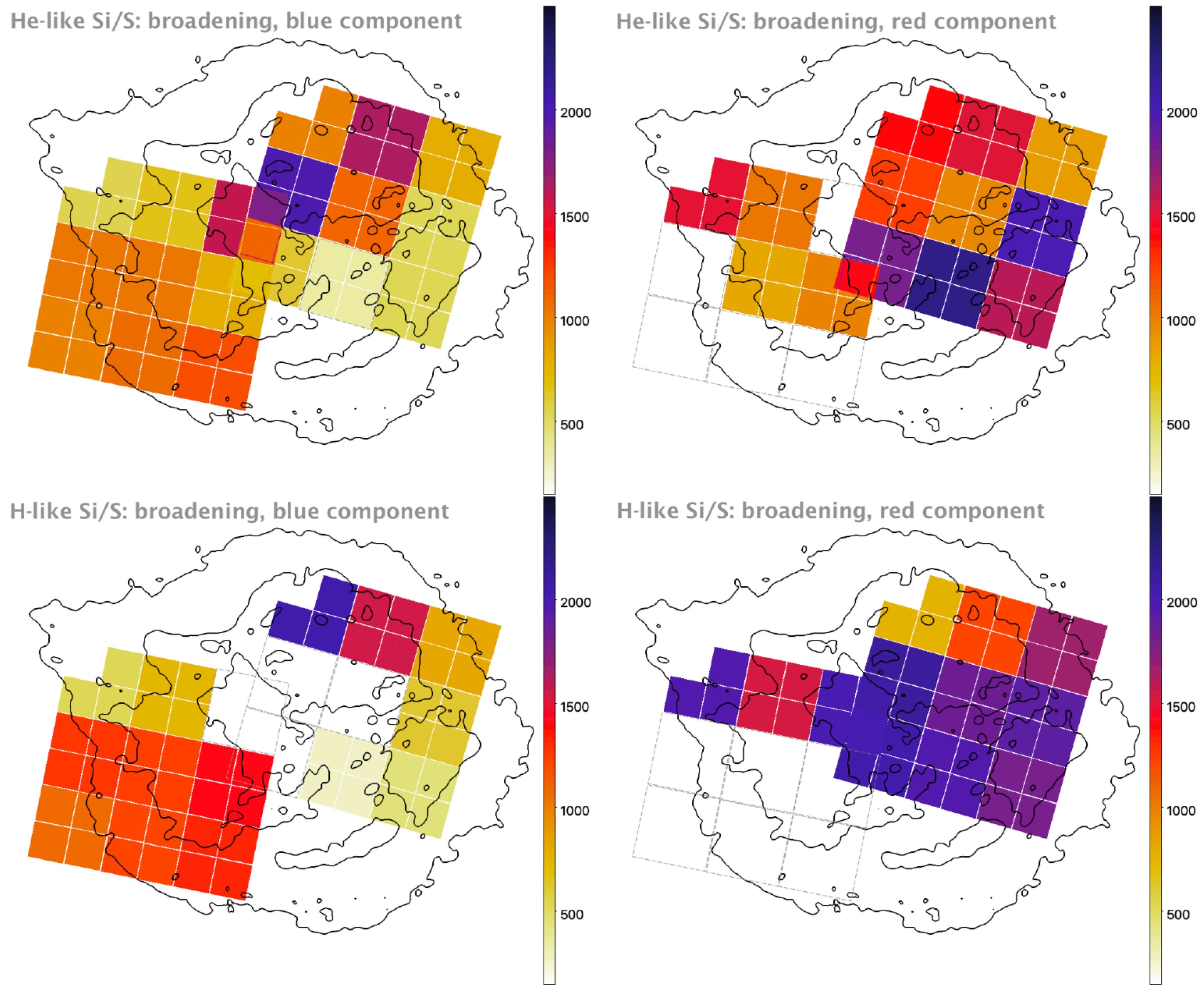


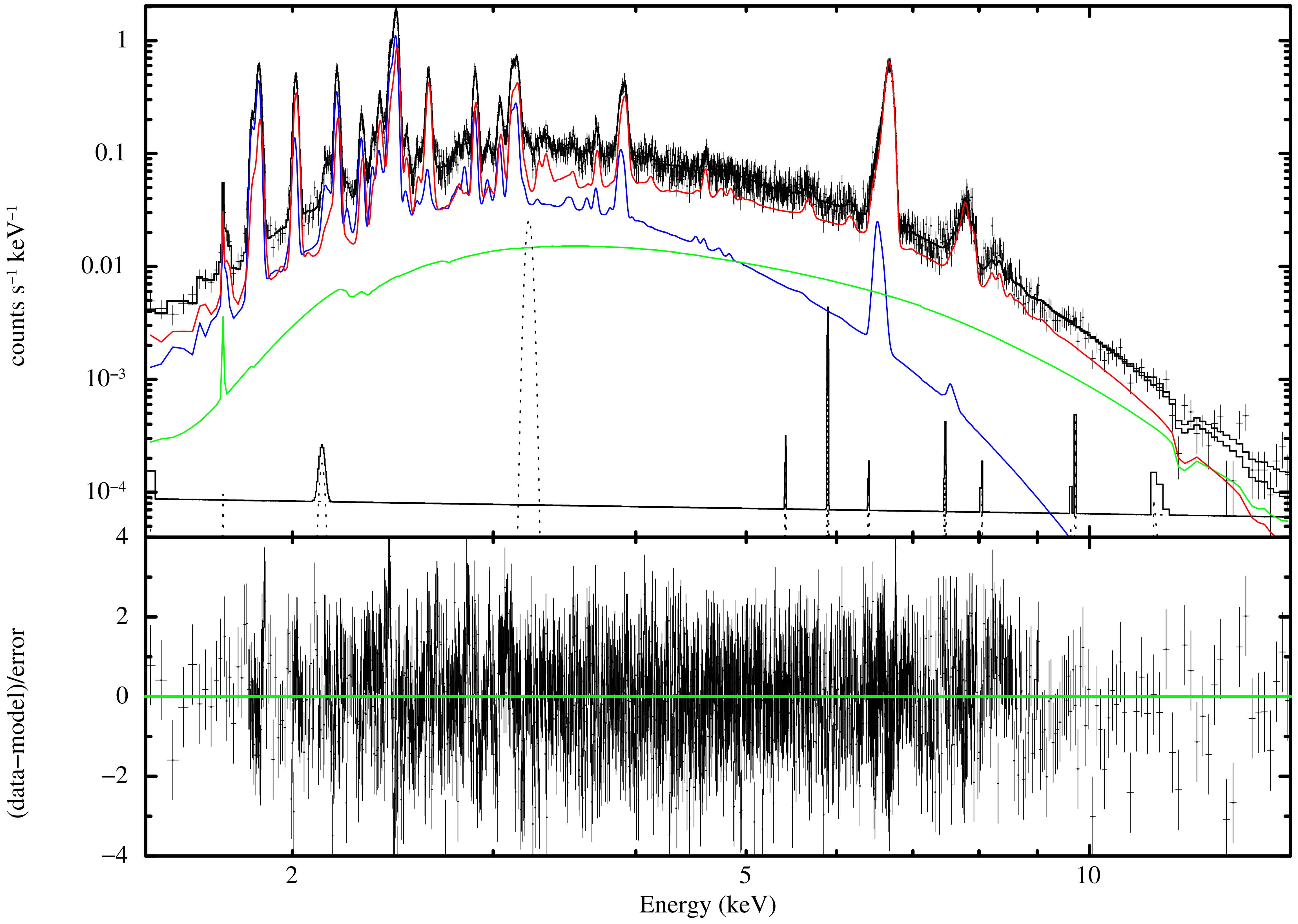
Fig. 7. Radial velocity ($v_{\rm rad}$) maps of the two gaussian components for the Heβ lines (top) and Lyα (bottom) lines Si and S. On the left are the blueshifted components on the right the redshifted components. $v_{\rm rad}$ is only displayed for those components significantly contribute—see text. The colorbars are identical to those of the $v_{\rm rad}$ maps in Fig. 3 and the values correspond to ${\rm km\,s^{-1}}$.



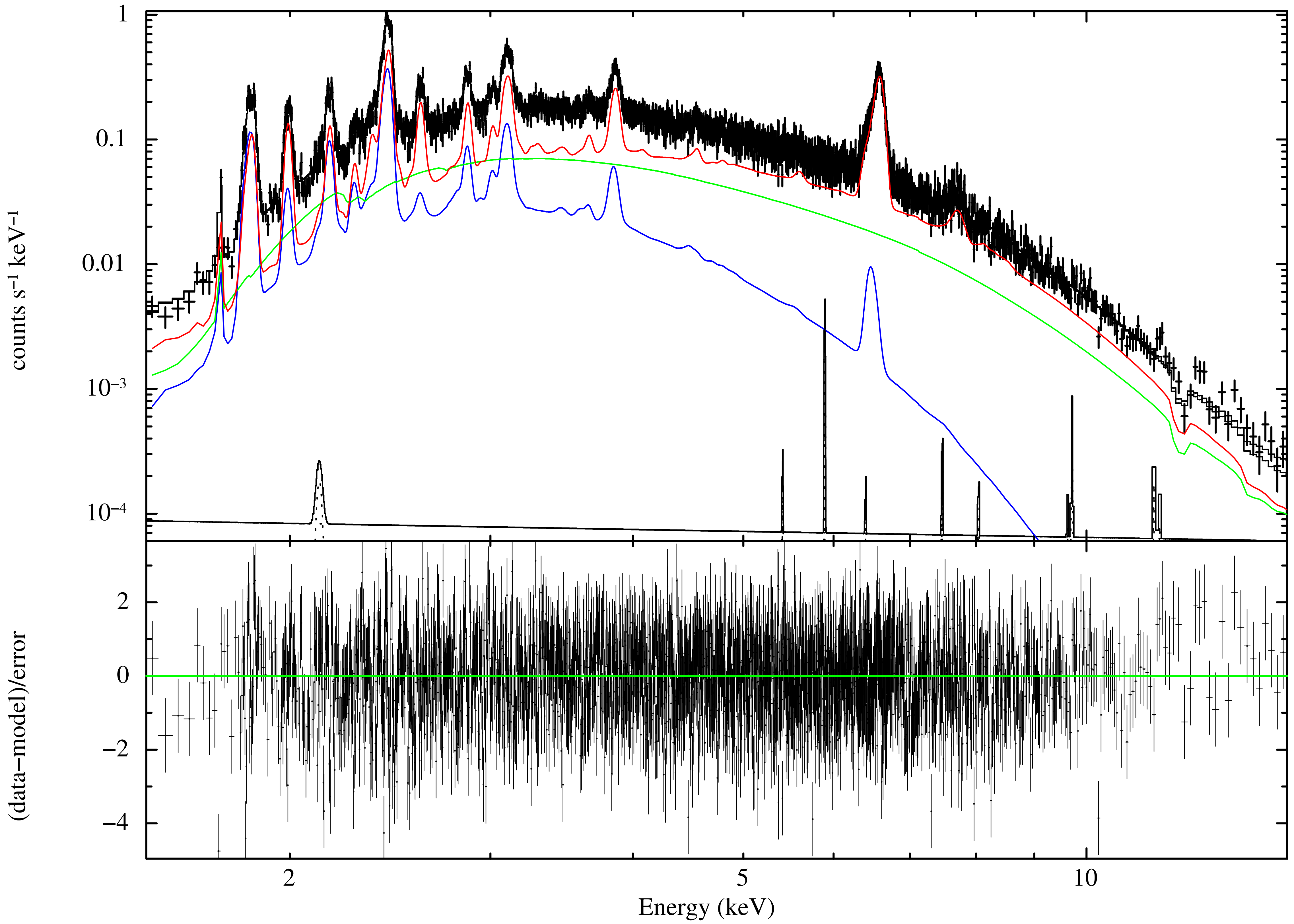
XRISM Observations of Cas A

- Plucinsky et al. 2025, arXiv:2505.04691, superpixel “e” spectra from the SE and NW pointings fit with a phabs+bvvrnei+bvvpshock+pow
- A reasonable fit can be achieved for the broad band of 1.5-10.0 keV

Cas A SE: xa000129000rsl_Hp_2x2pixe−rbopt, CStat=3821.5, DOF=3350, Chi=3761.5
bvvrnei+pow+zgauss+bvvpshock, kT1=1.041 keV, kT2=2.848 keV, AtomDB 3.0.9, corarf



Cas A NW: xa000130000rsl_Hp_2x2pixe−rbopt.pi, CStat=4002.17, DOF=3425, Chi=4074.
bvvrnei+pow+zgauss+bvvpshock, kT1=1.09 keV, kT2=3.81 keV, AtomDB 3.1.0 public



XRISM Observations of Cas A

- Plucinsky et al. 2025, arXiv:2505.04691, superpixel “e” spectra from the SE and NW pointings fit with a phabs+bvvrnei+bvvpshock+pow
- The model is good but there are deficiencies around some of the bright lines
- A more complicated model or a fit in a narrower energy range is necessary to get a better fit