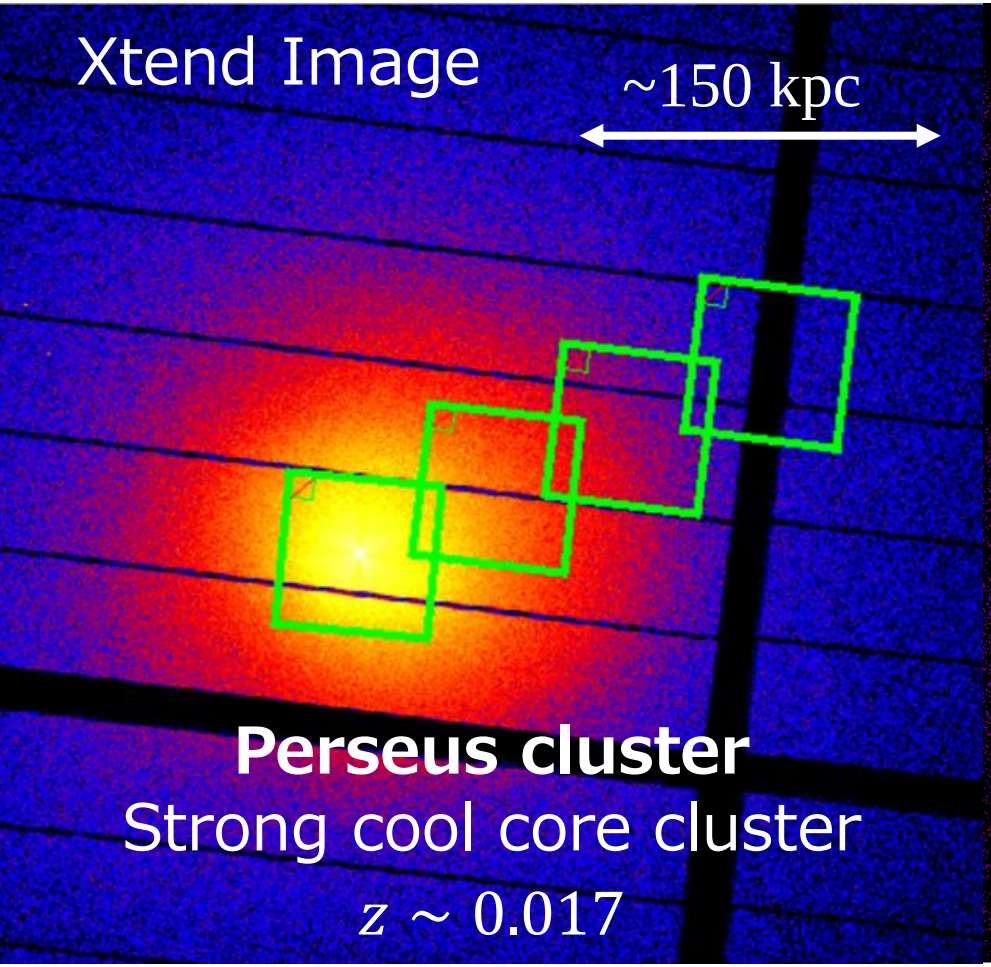
Cross-Calibration of XRISM Resolve and Xtend: I. Temperature Measurements in Nearby Galaxy Clusters

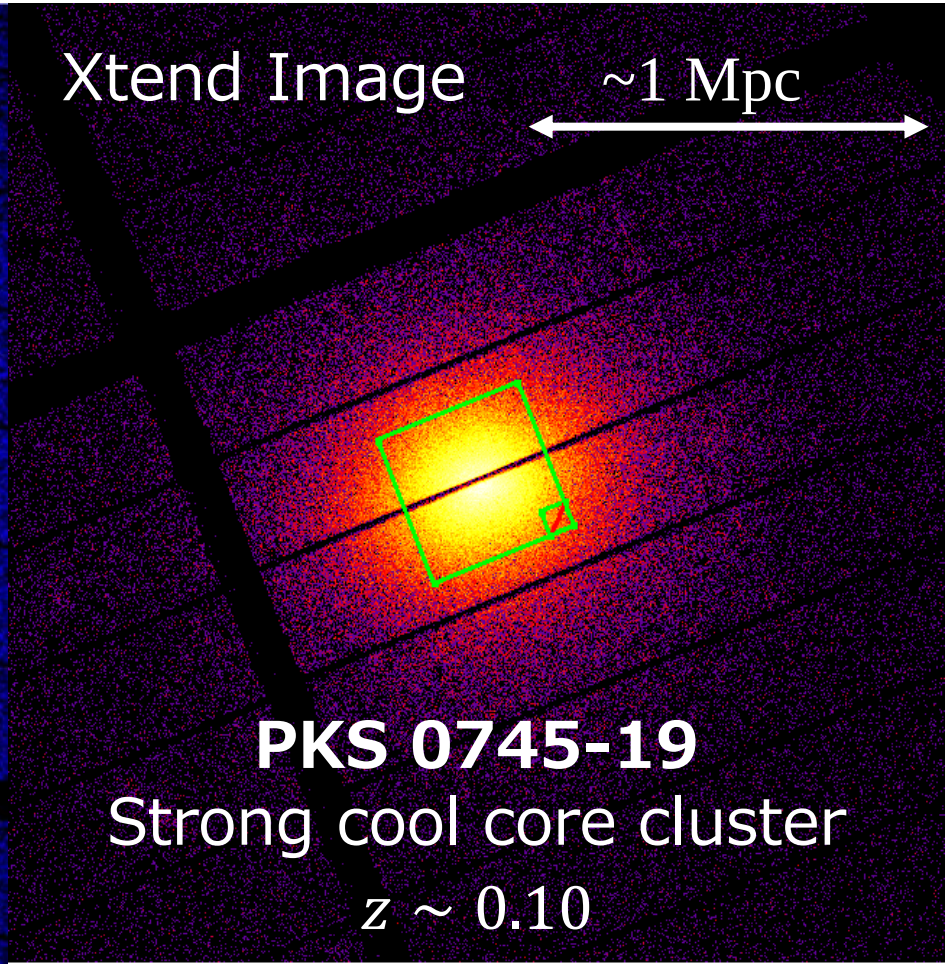
Itsuki Aihara*, Kazunori Suda*

Nie Runqi*, Kyoko Matsushita*, Shogo Kobayashi*

*Department of physics, Tokyo University of Science

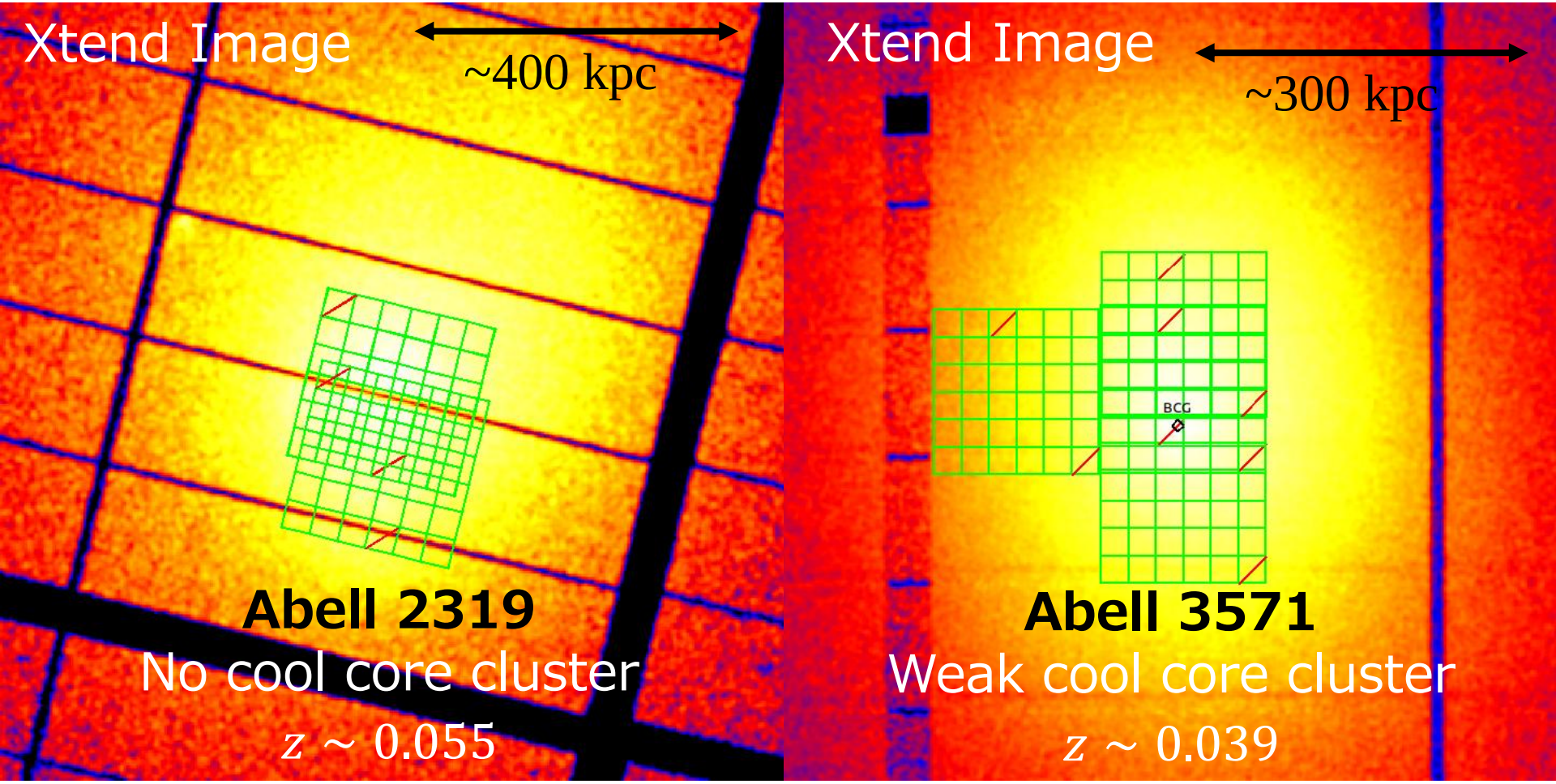
Target overview





These clusters have complex temperature structures.

Target overview



These clusters exhibit simpler temperature structures.

Spectral analysis

Model:

tbabs*bapec+NXB

(+ AGN power-law for the Perseus center)

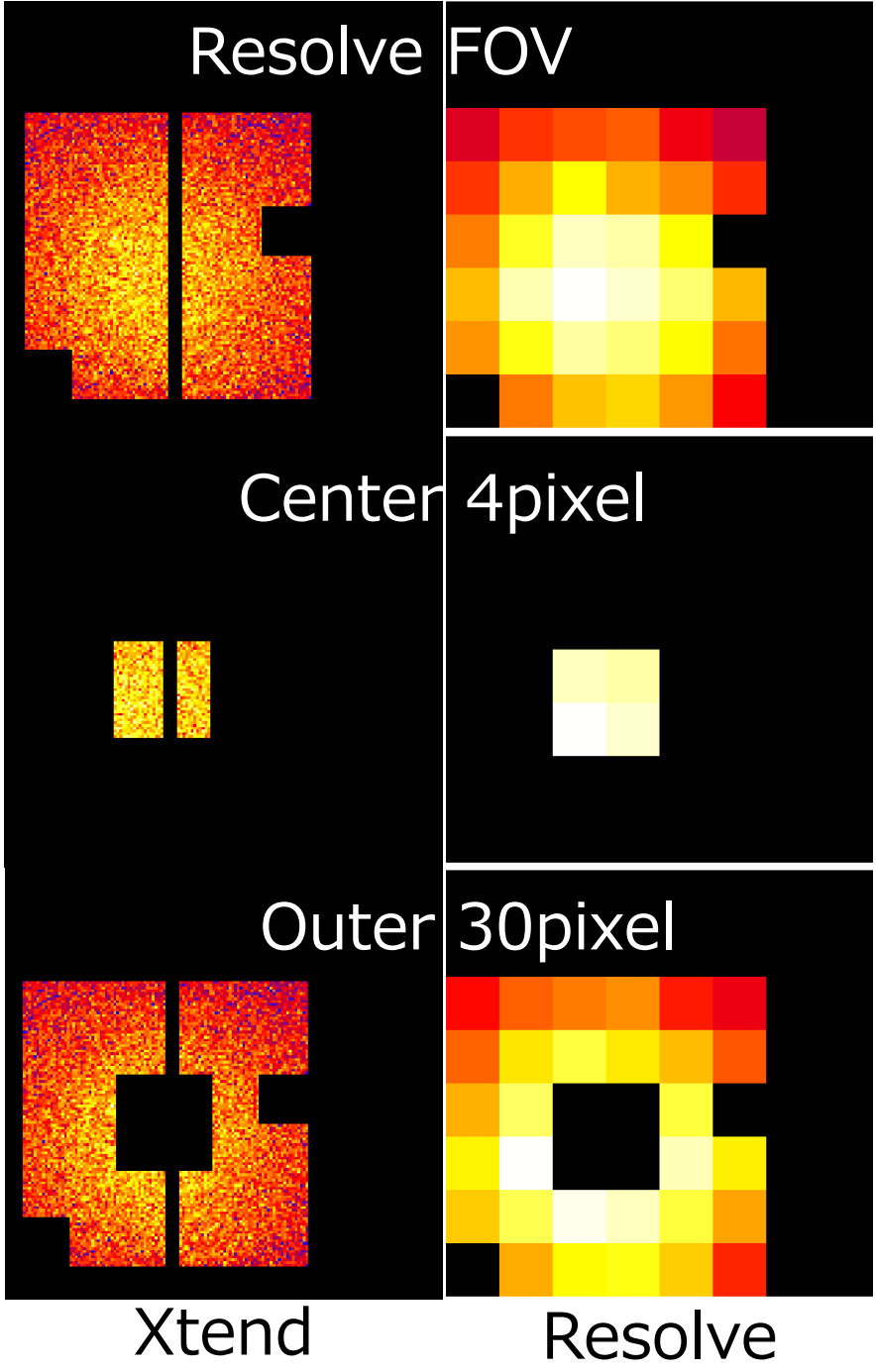
RMFs: Large (Resolve)

ARFs: 6′ Fratcircle

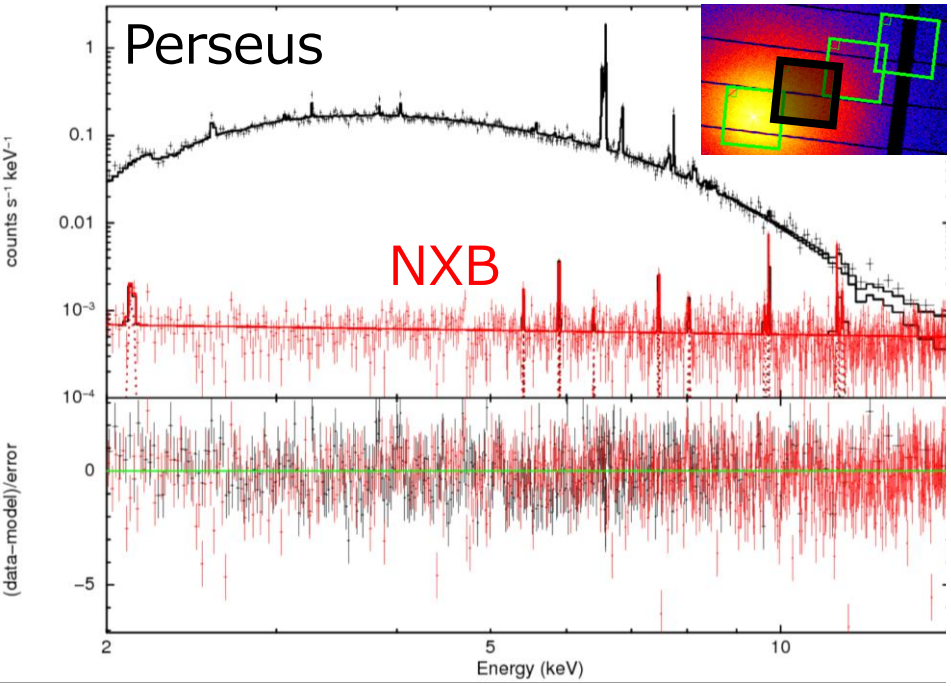
Abund: lpgs

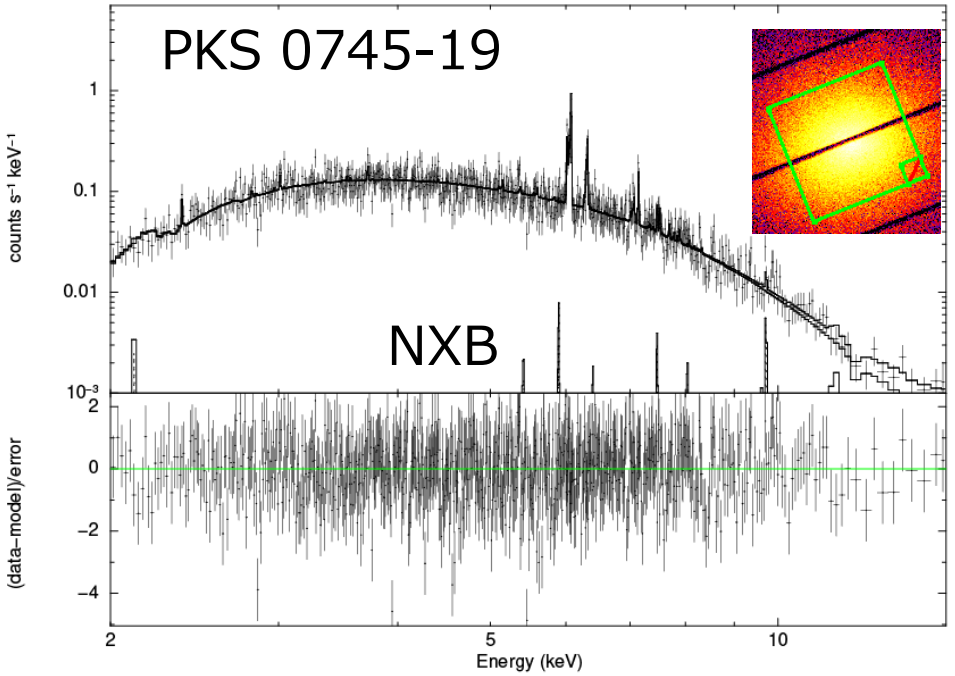
Regions:

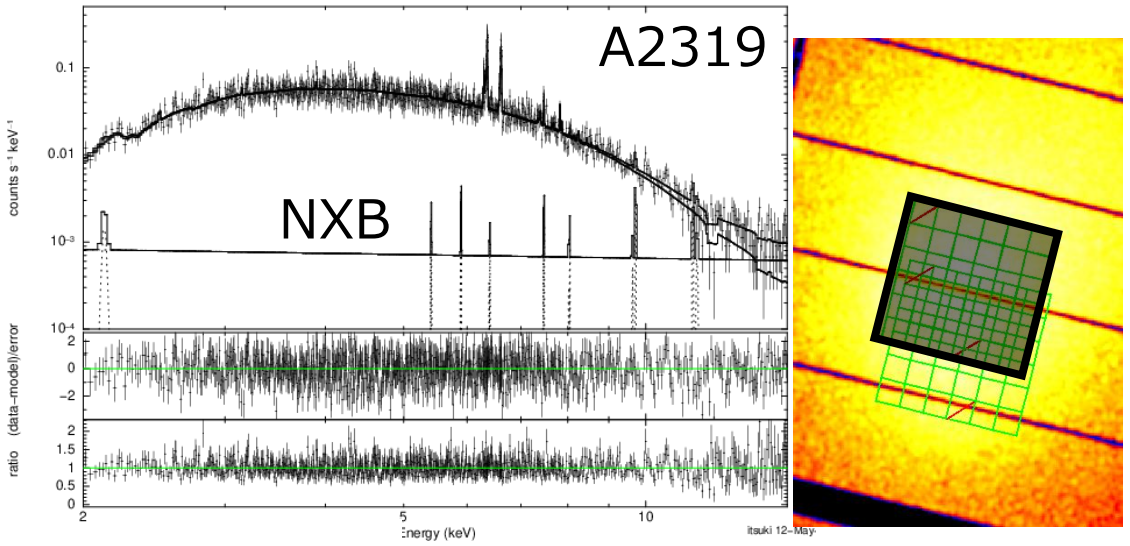
- Pixel 12&27 are excluded.
- Three detector regions were analyzed



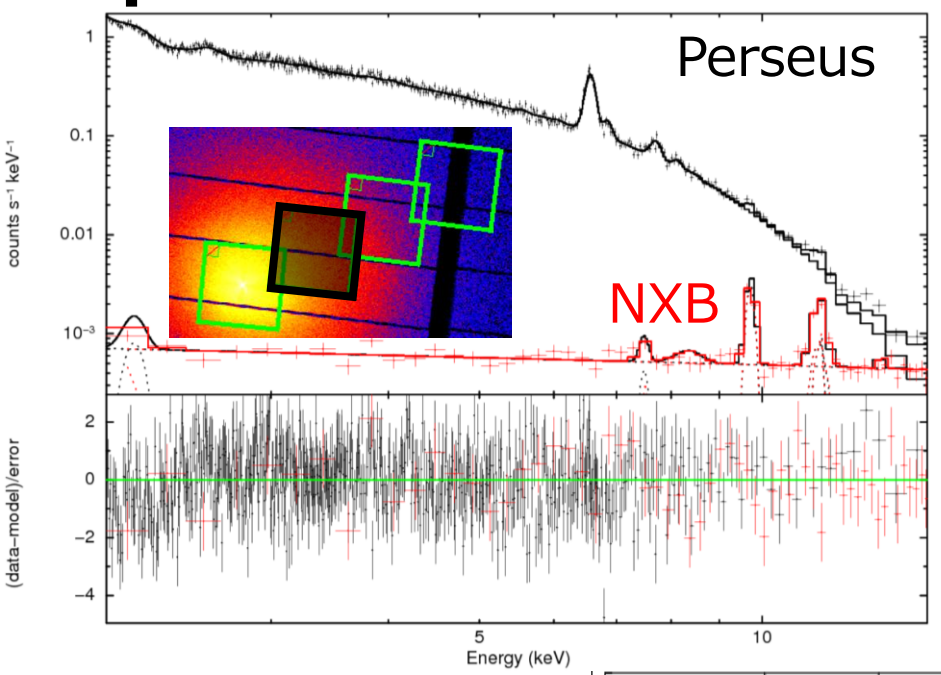
Representative Resolve FOV spectra

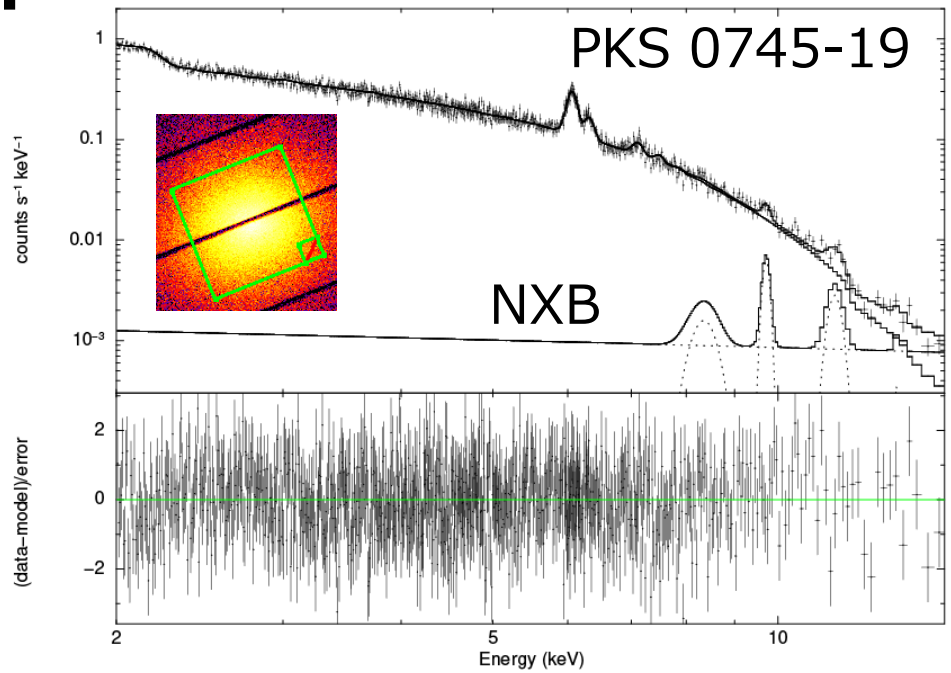


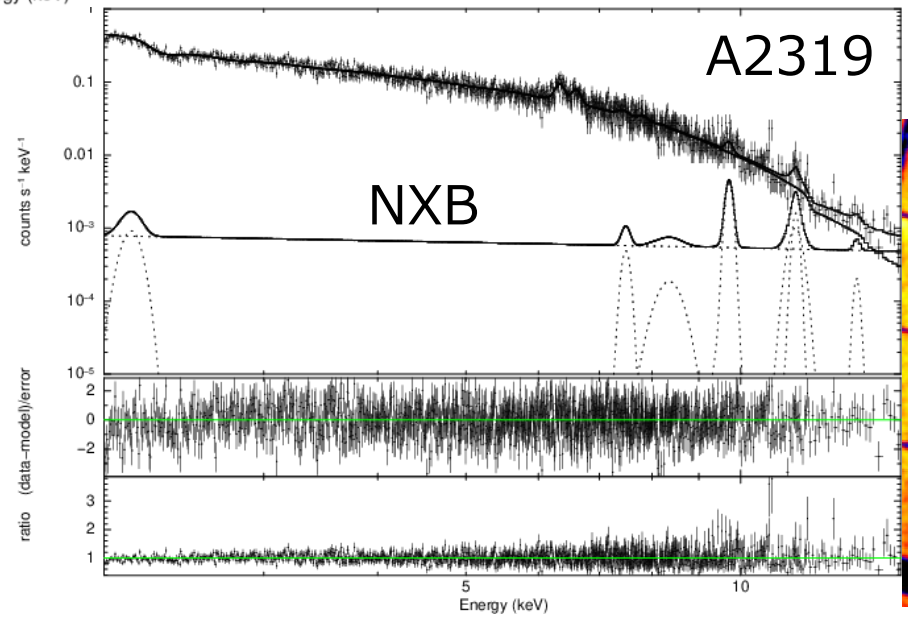


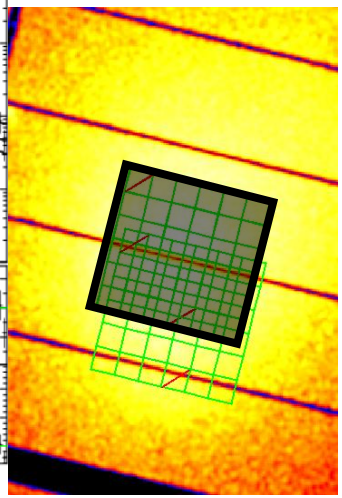


Representative Xtend spectra in Resolve FOV

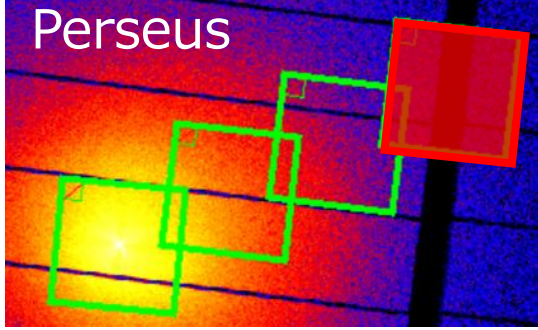


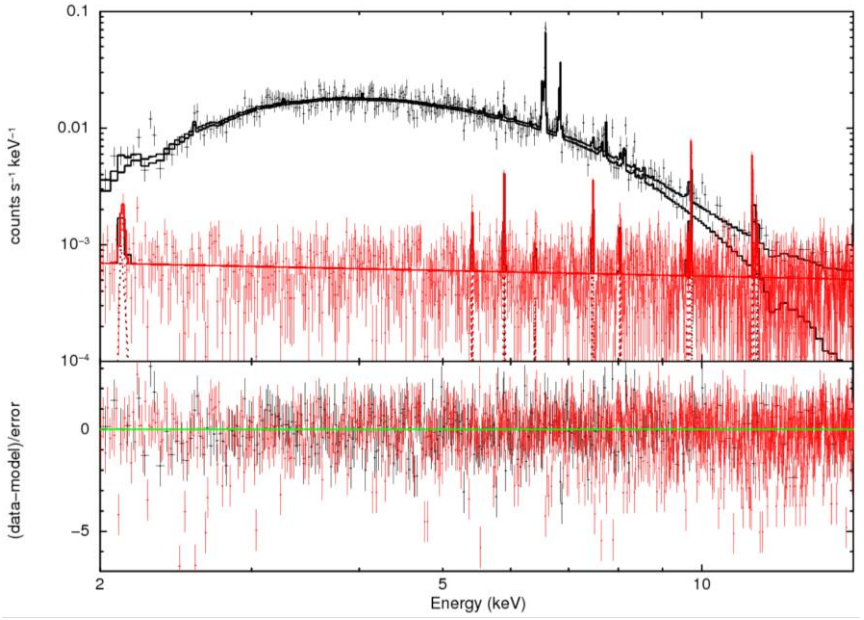






Effect of NXB modelling methods

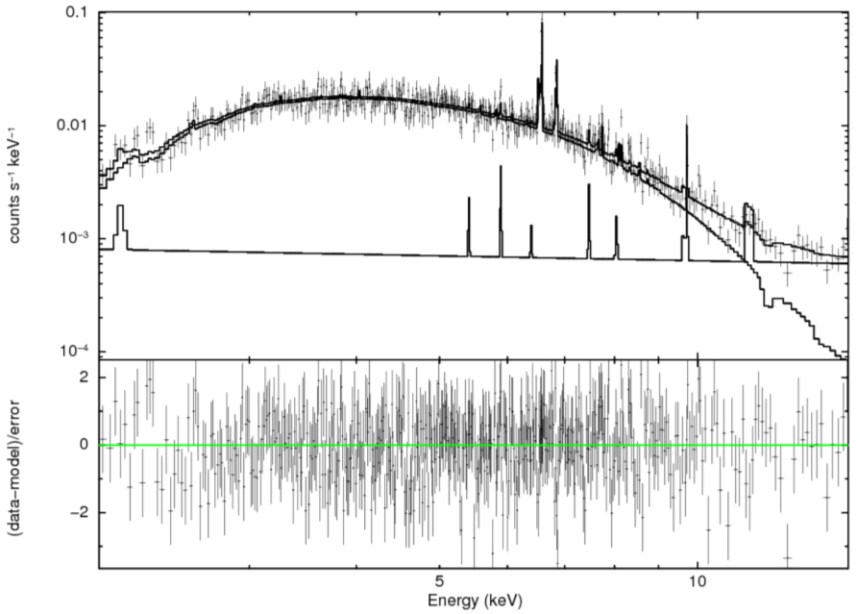




Simultaneous fitting with NXB spectra

$kT = 7.8 \pm 0.3$ keV

$Abund = 0.25 \pm 0.02$ sloar



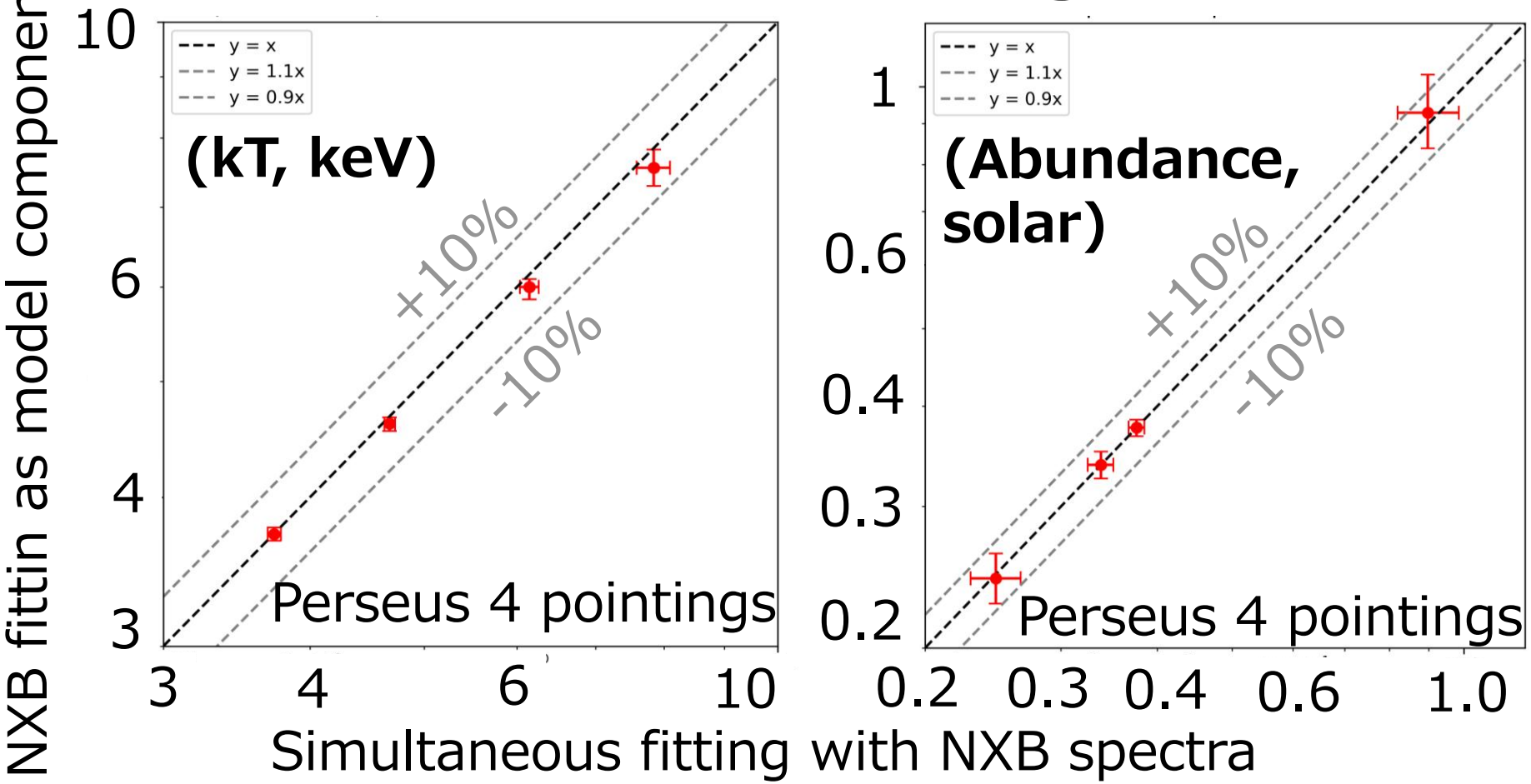
NXB was included as a mode component

$kT = 7.6 \pm 0.3$ keV

$Abund = 0.24 \pm 0.02$ solar

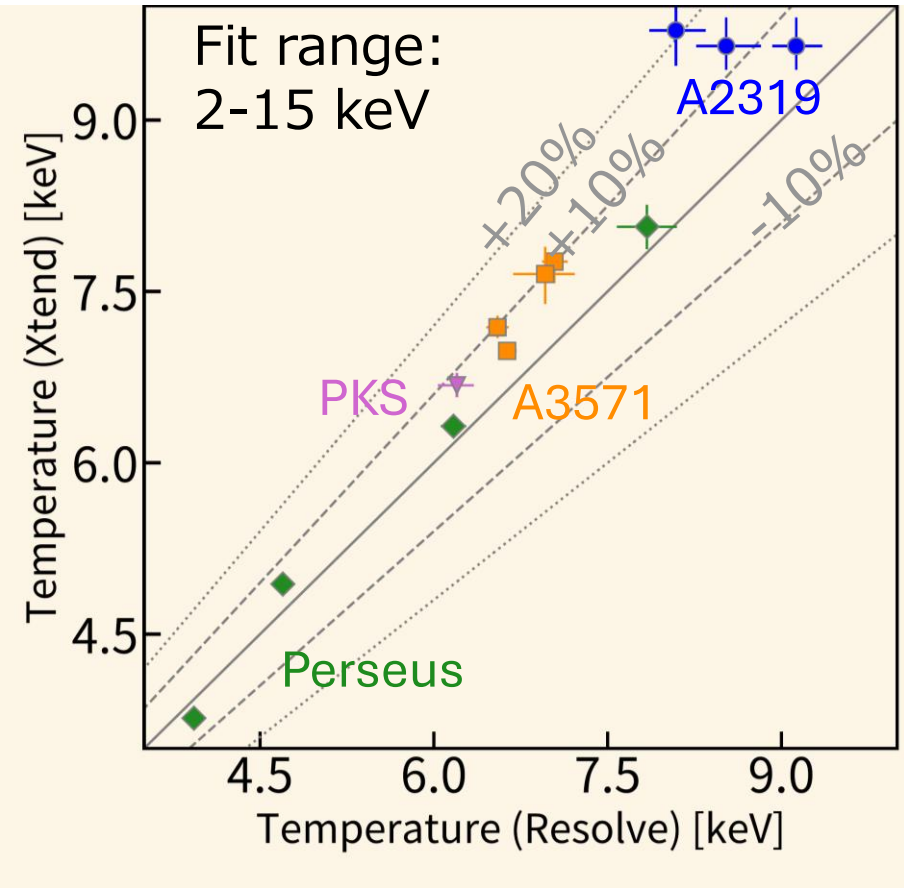
- The effect on the temperature and abundance measurements is small.

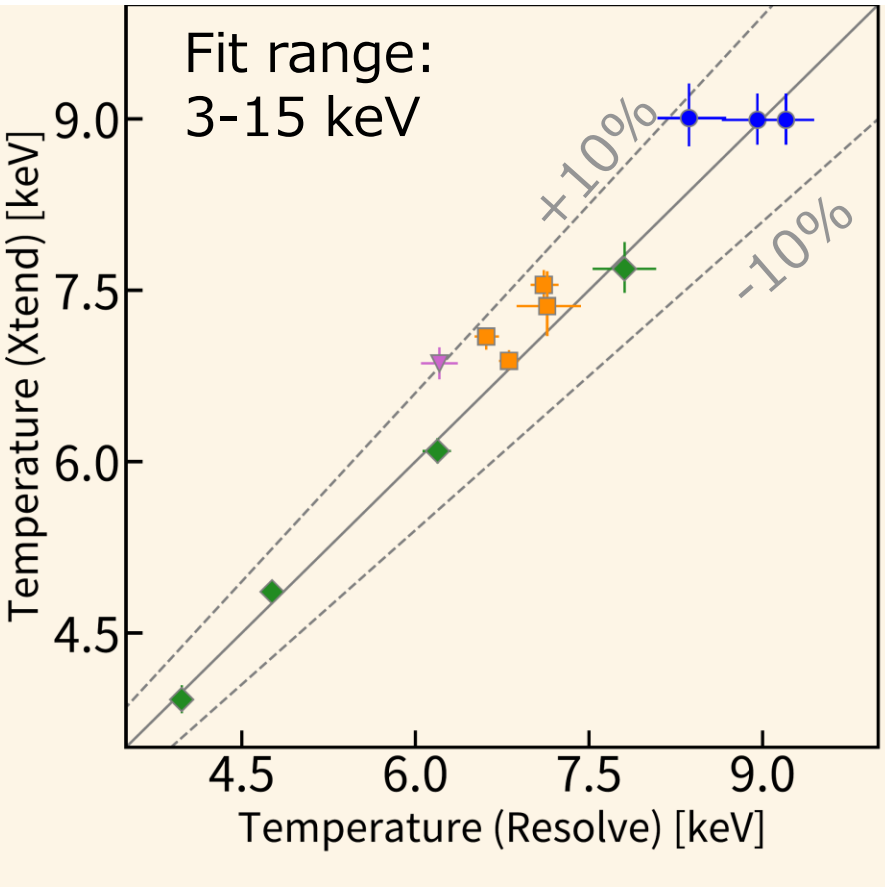
Effect of NXB modelling methods



- The two methods yield almost the same temperatures and abundances.
- In the following analysis, the NXB was modeled as a component for all clusters except Perseus.

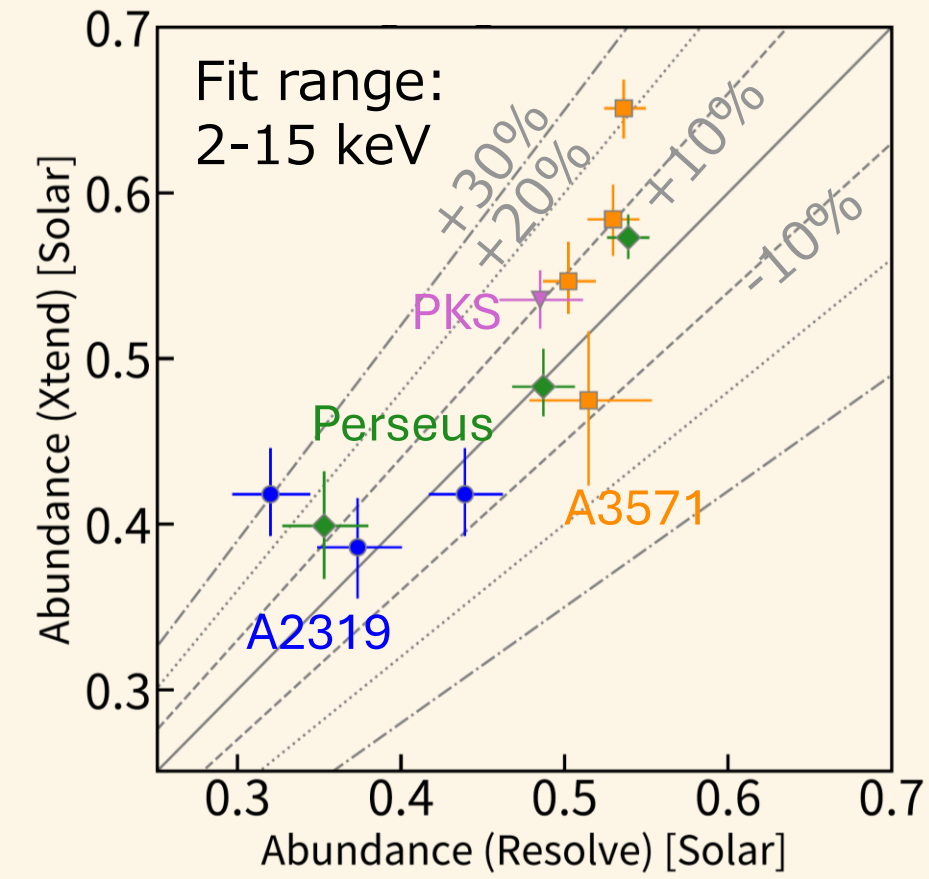
Resolve vs Xtend (kT)

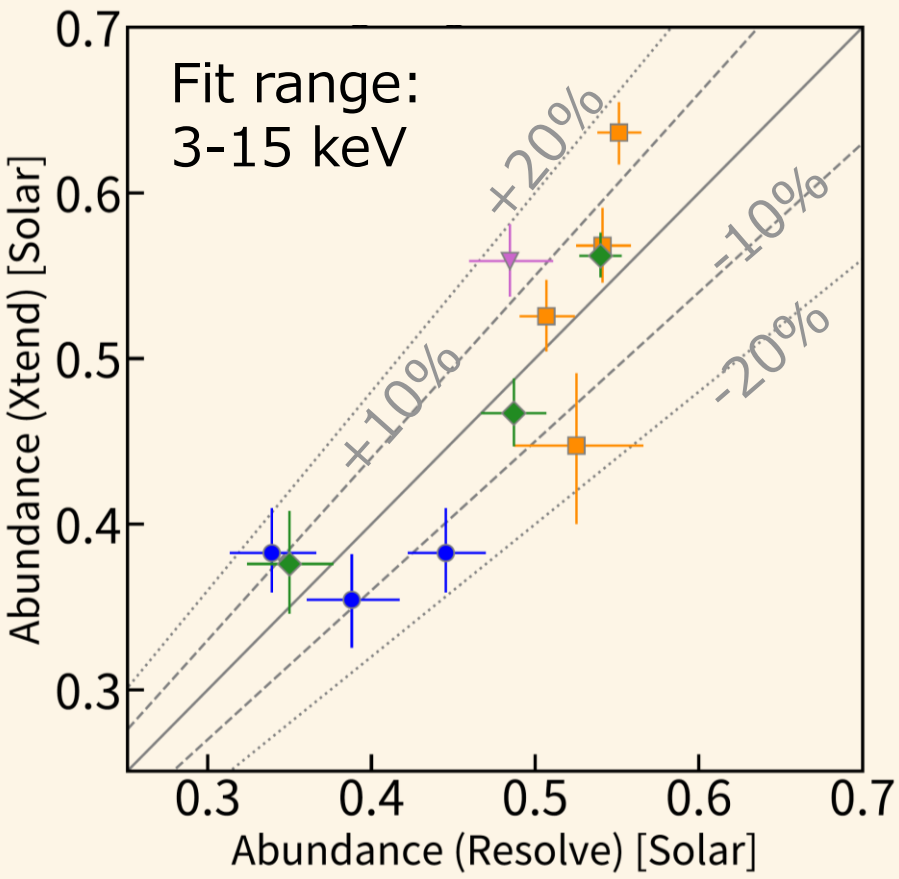




- Using the 3–15 keV band reduces temperature discrepancies between Resolve and Xtend.
- The Resolve and Xtend temperatures are consistent within±10%.

Resolve vs Xtend (Abundance)



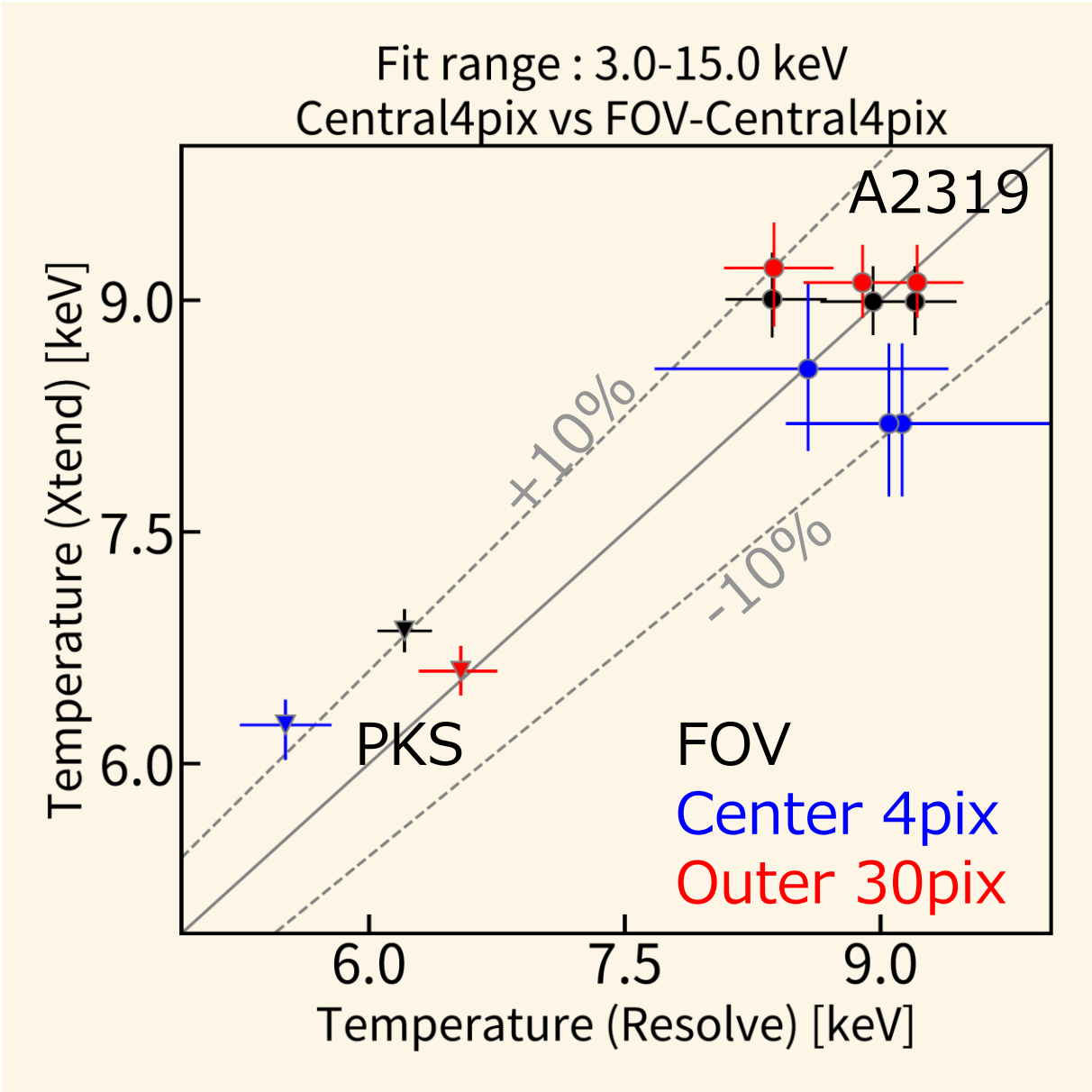


- Abundance measurements are more consistent when using the 3-15 keV band.
- However, differences about 20% remain in some cases.

Evaluation of the spatial variation across detector regions (kT)

Energy Band:
3-15 keV

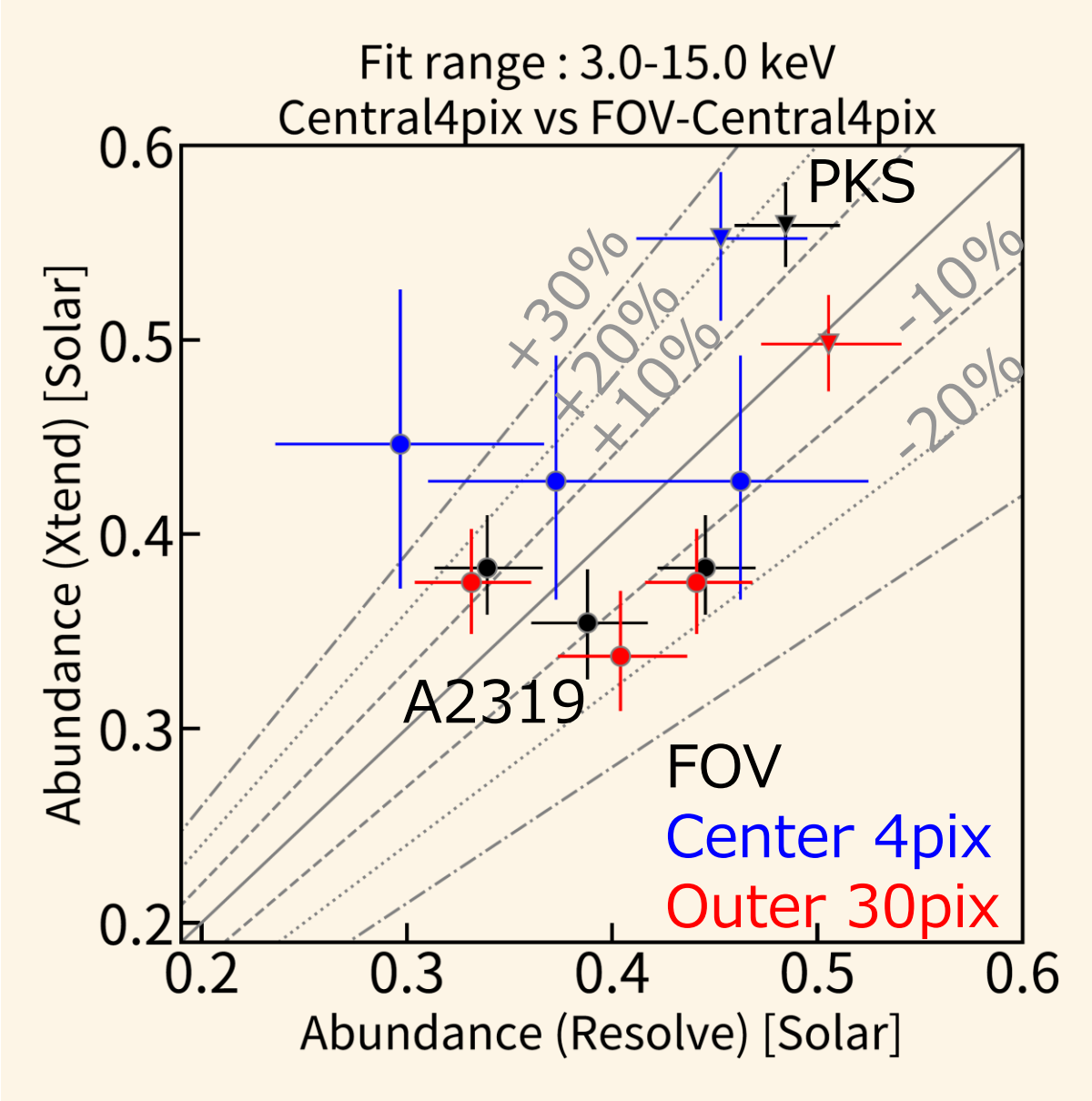
- We compared temperatures from three detector regions.
- The measurements agree within about **±10%**.
- **No significant differences** are found across different regions.



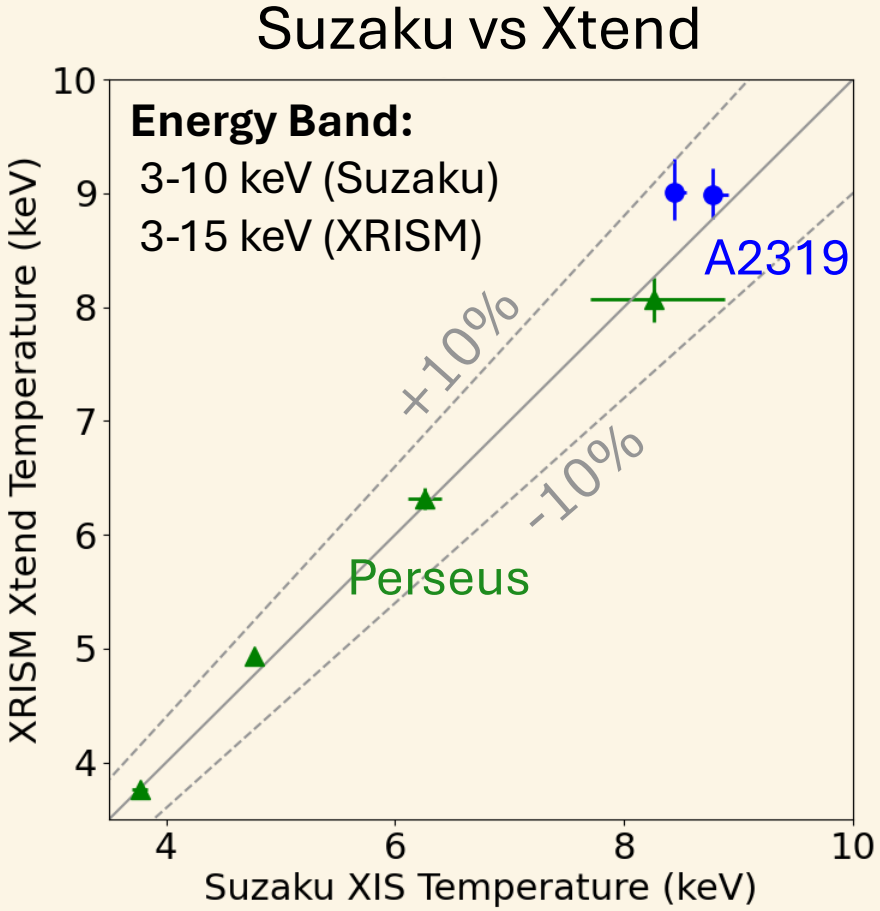
Evaluation of the spatial variation across detector regions (Abundance)

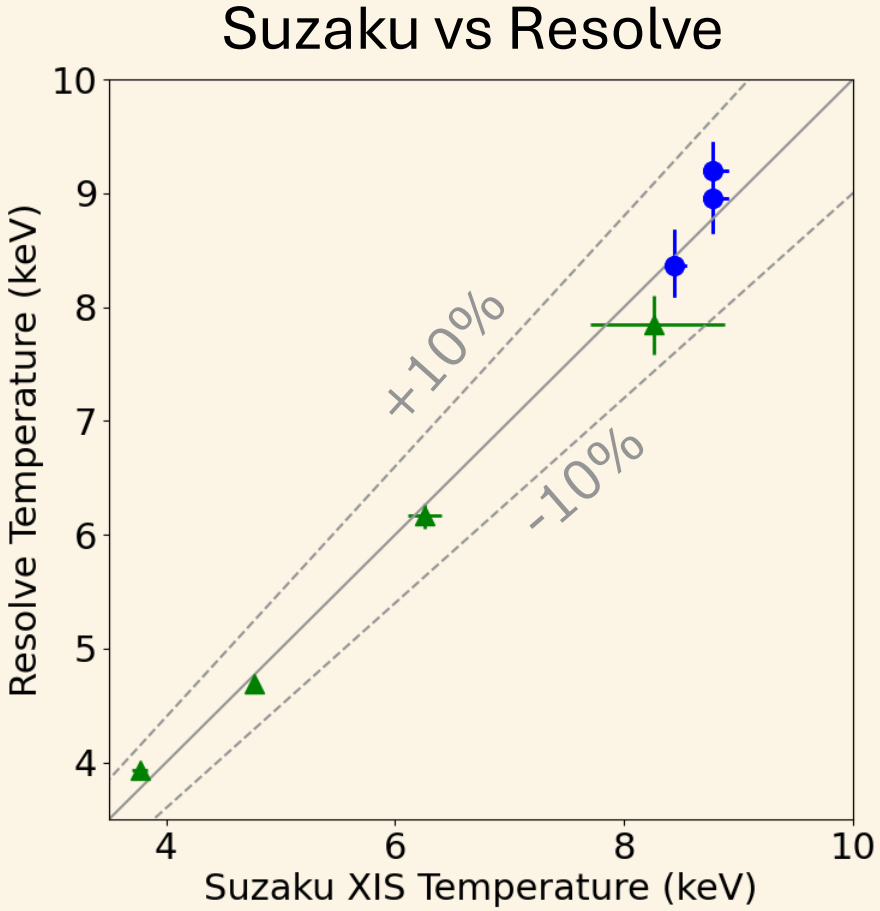
Energy Band:
3-15 keV

- The differences fall within the error range, approximately **±20%**.
- **No significant differences** are found across different regions.



Suzaku vs XRISM (Resolve FOV kT)

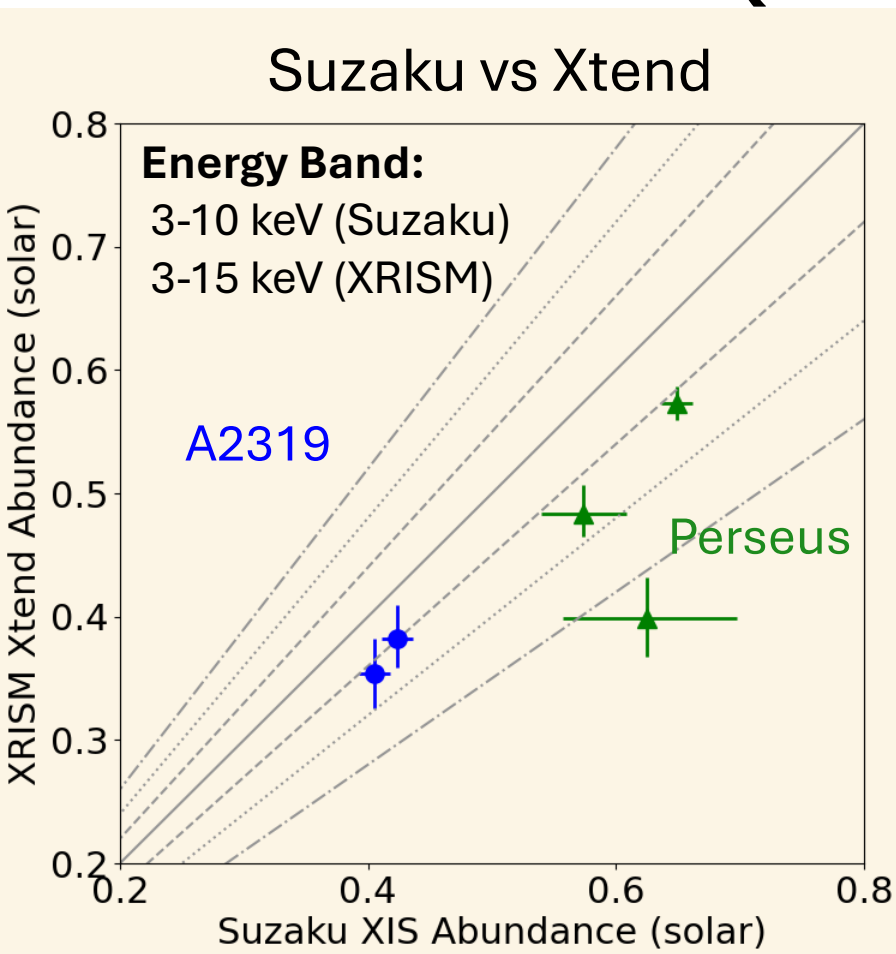


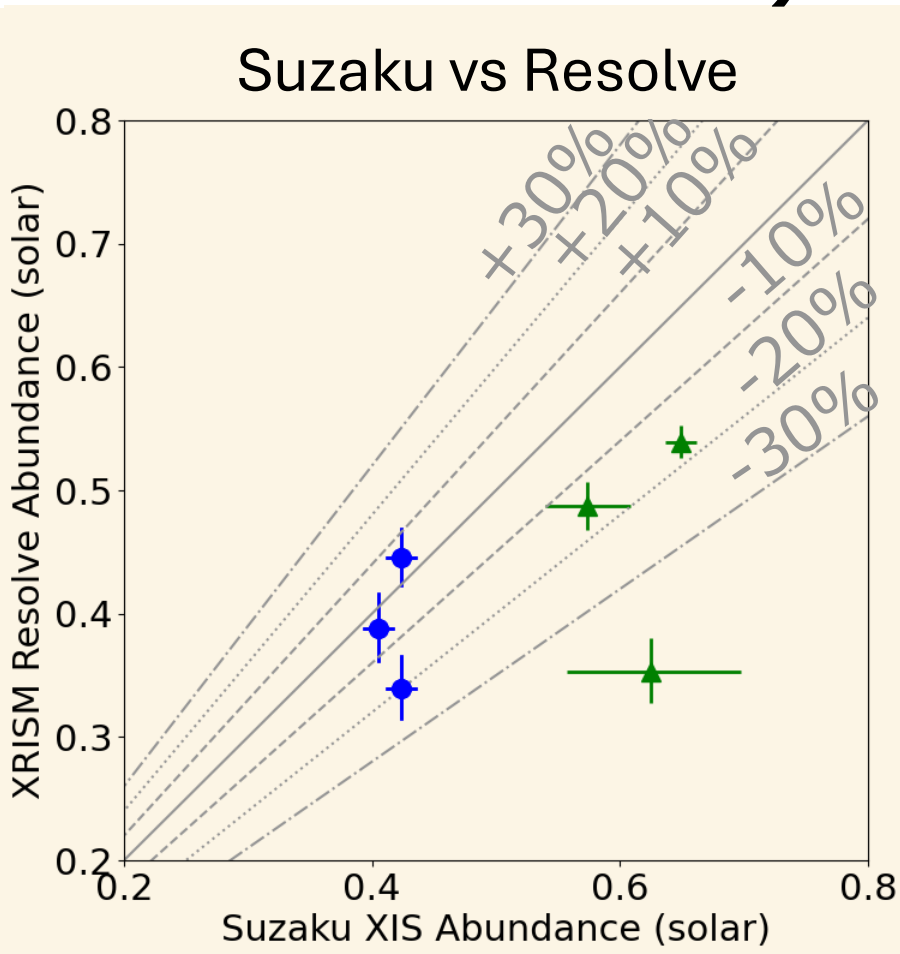


Suzaku Model: Tbabs*(bapec+pow) (NXB subtracted)

- We compare XRISM measurements with archival Suzaku data.
- Resolve and Xtend temperatures are consistent with Suzaku within ±10%

Suzaku vs XRISM (Resolve FOV Abundance)

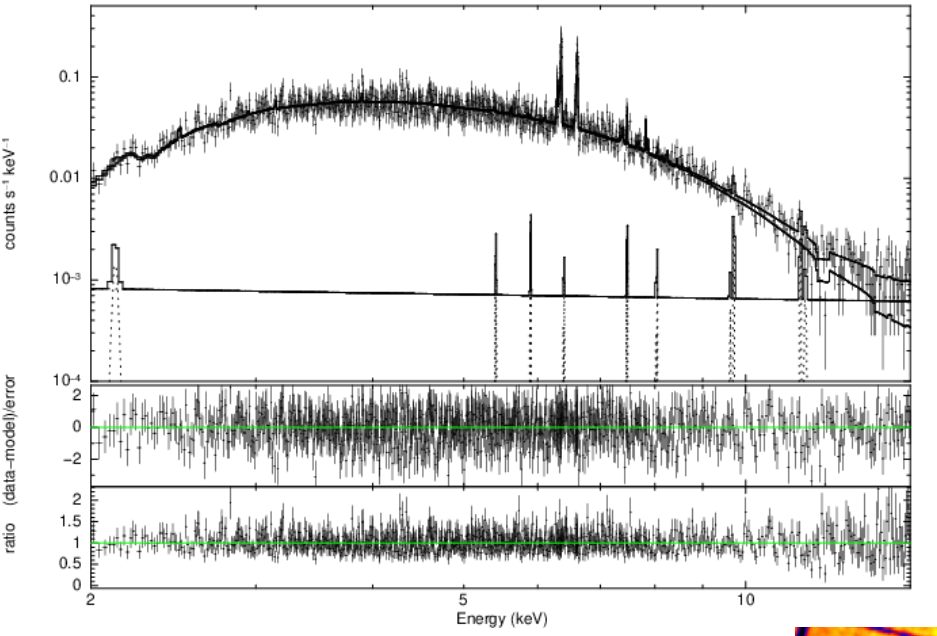


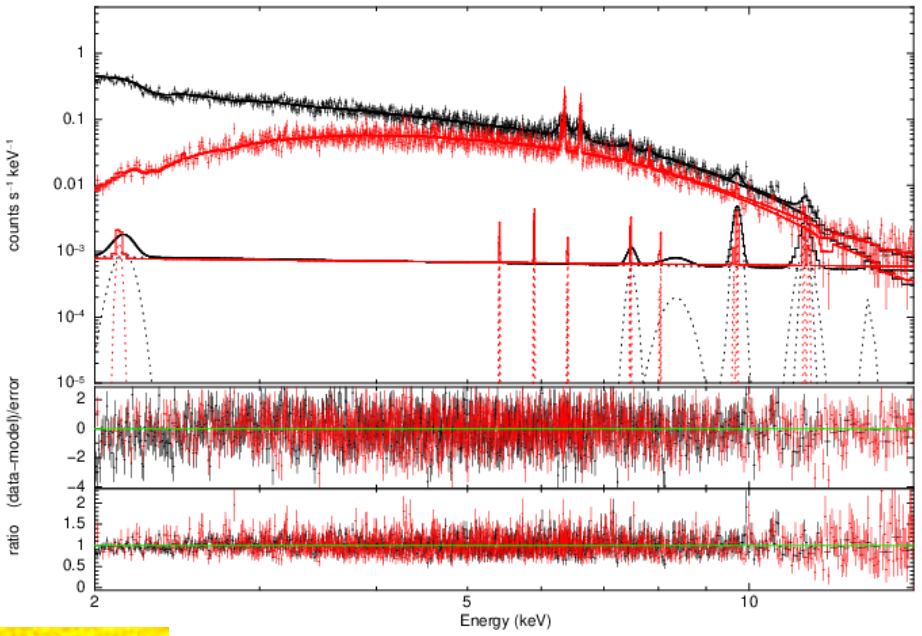


Suzaku Model: Tbabs*(bapec+pow) (NXB subtracted)

- Abundances from XRISM generally agree with Suzaku within ±20%, except for one notable deviation.

Simultaneous fitting (A2319)

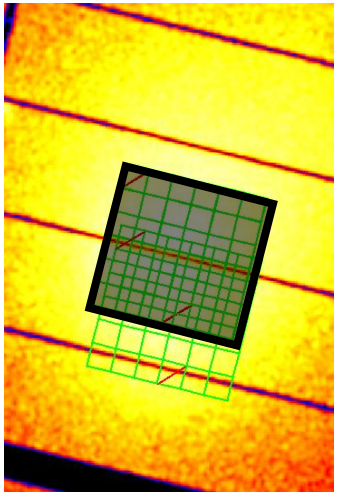




Resolve only

$kT = 9.1 \pm 0.2$ keV

$Abund = 0.44 \pm 0.02$ solar

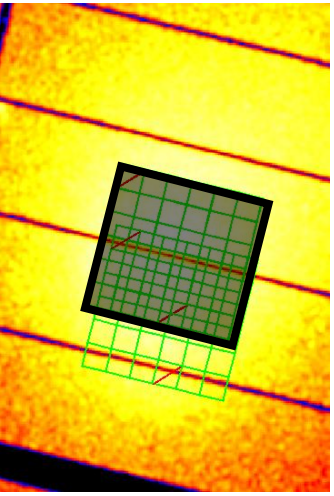


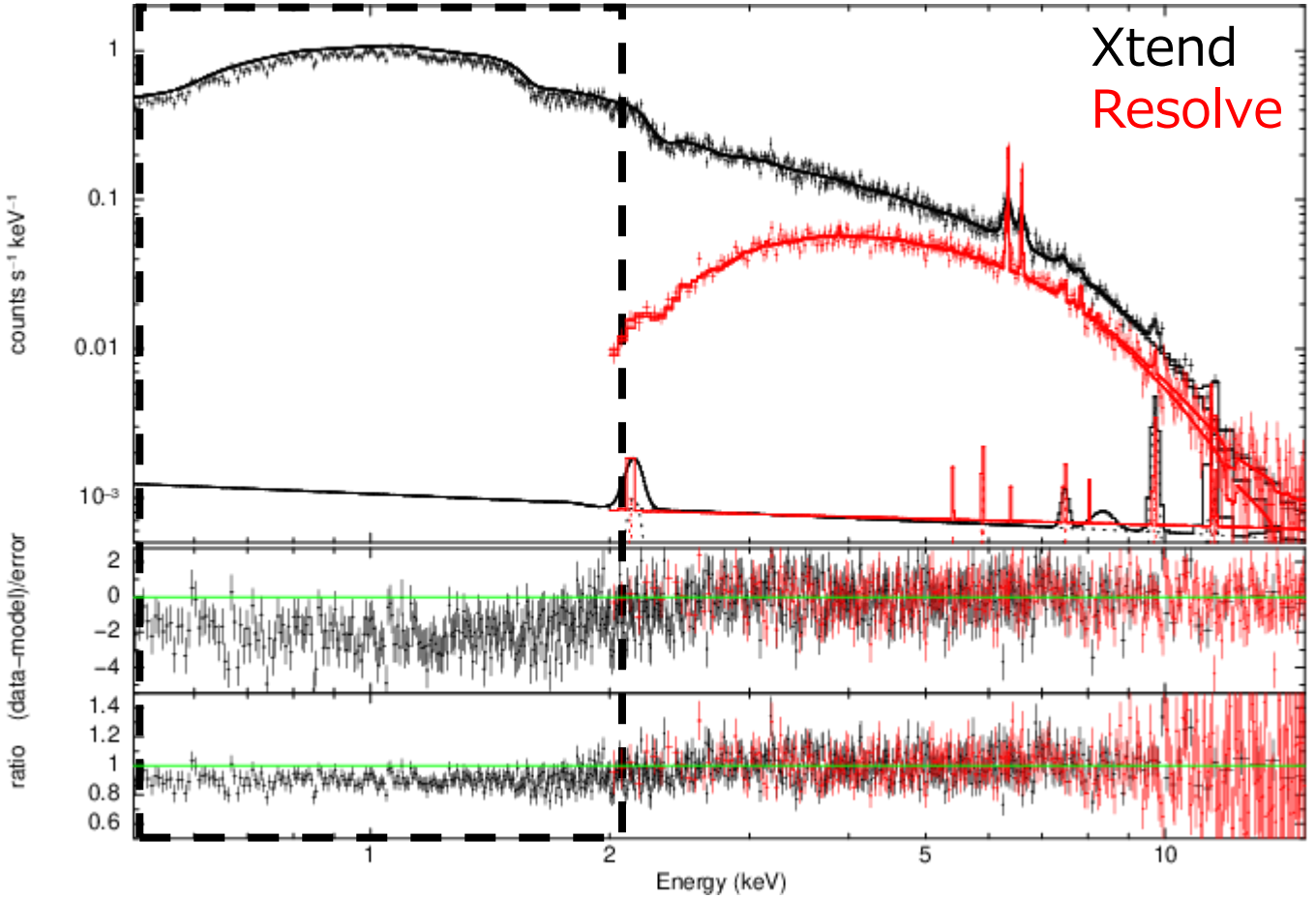
Resolve+Xtend

$kT = 9.4 \pm 0.1$ keV

$Abund = 0.44 \pm 0.02$ solar

Simultaneous fitting (A2319)



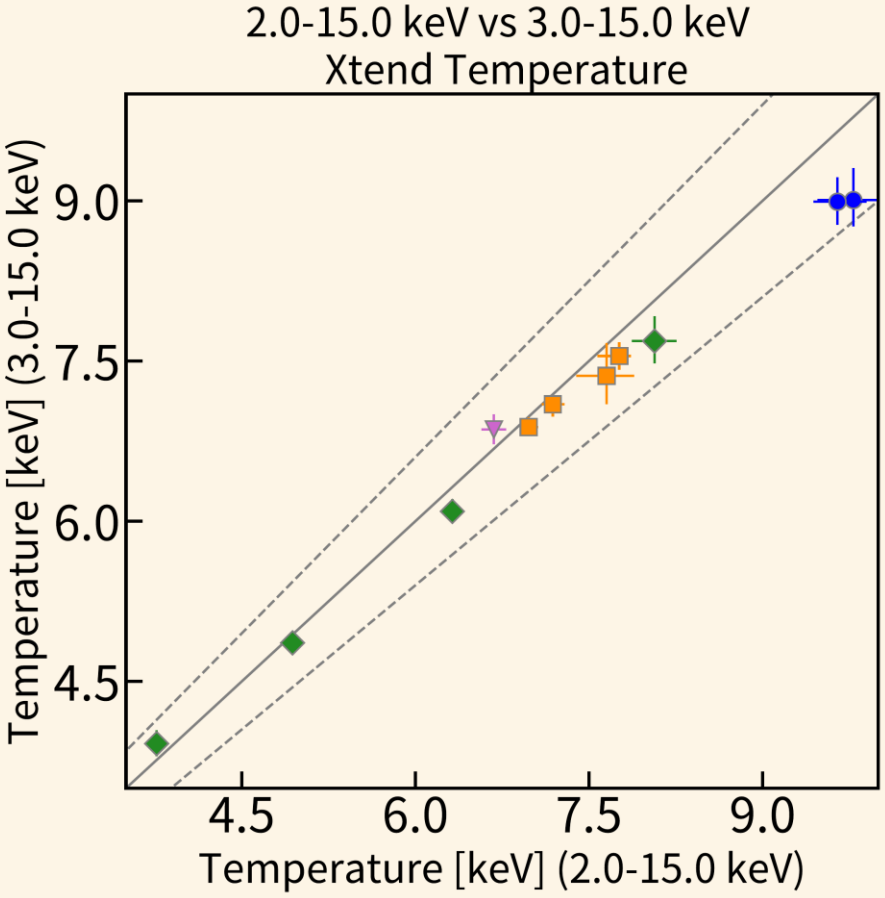


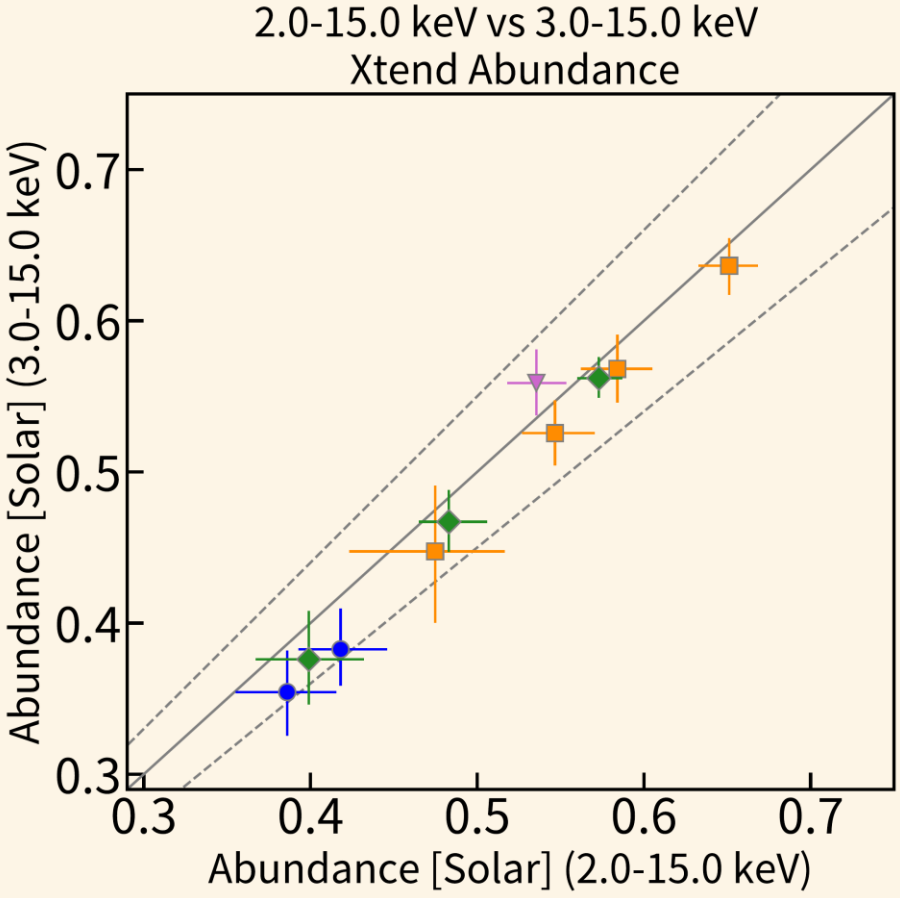
- After fitting in the 3–15 keV band, we unignored the 0.5–3.0 keV range to inspect the model behavior.
- The model clearly overestimates the soft-band flux below 2 keV in Xtend by 10%.

Summary

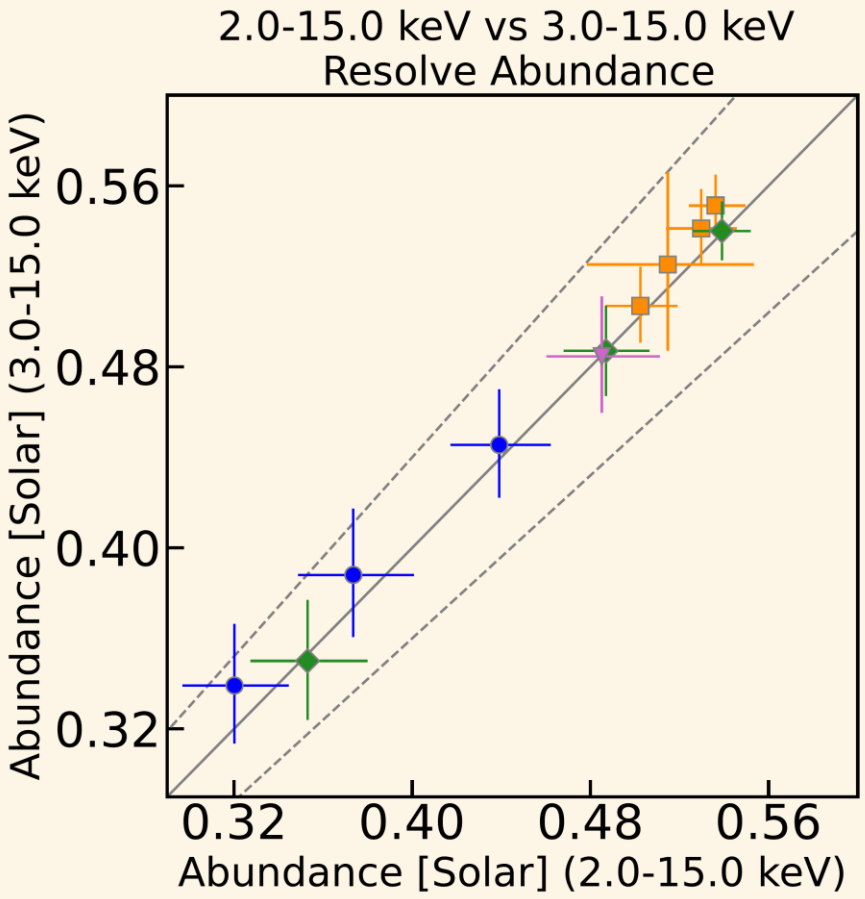
- We analyzed **12 observations** of **four clusters**: A2319, A3571, Perseus, and PKS0745-19 for compere kT & abundance between Xtend & Resolve.
- With 2–15 keV, the temperature difference is within **±20%** and the abundance difference within **±30%**.
- Using **3–15 keV reduces the difference** between Xtend and Resolve compared to using 2–15 keV.
- With 3–15 keV, the temperature difference is within **±10%** and the abundance difference within **±20%**.
- **No significant differences** were found depending on the region: Resolve FOV, central 4 pixels, or the surrounding 30 pixels.
- The results are consistent with Suzaku observations within **±10%** for temperature and **±20%** for abundance.

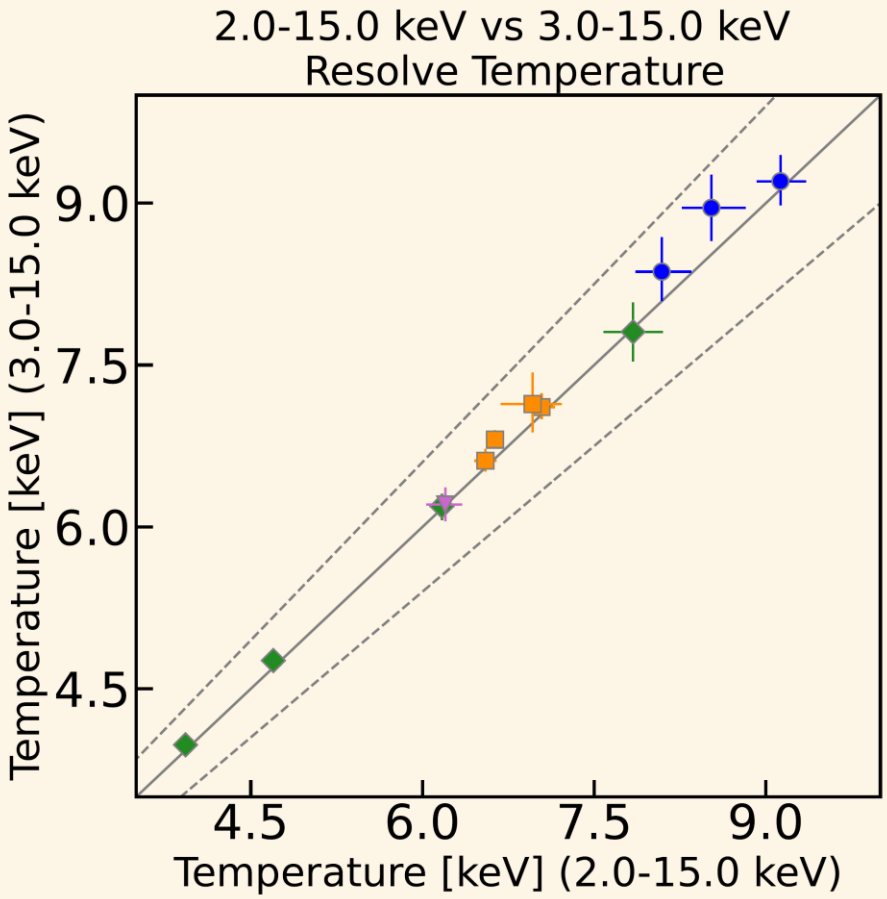
Appendix


2.0-15.0 keV vs 3.0-15.0 keV
Xtend Temperature
Temperature [keV] (3.0-15.0 keV)
9.0
7.5
6.0
4.5
4.5
6.0
7.5
9.0
Temperature [keV] (2.0-15.0 keV)


2.0-15.0 keV vs 3.0-15.0 keV
Xtend Abundance
Abundance [Solar] (3.0-15.0 keV)
0.7
0.6
0.5
0.4
0.3
0.3
0.4
0.5
0.6
0.7
Abundance [Solar] (2.0-15.0 keV)

Appendix


2.0-15.0 keV vs 3.0-15.0 keV
Resolve Abundance
Abundance [Solar] (3.0-15.0 keV)
0.56
0.48
0.40
0.32
0.32
0.40
0.48
0.56
Abundance [Solar] (2.0-15.0 keV)


2.0-15.0 keV vs 3.0-15.0 keV
Resolve Temperature
Temperature [keV] (3.0-15.0 keV)
9.0
7.5
6.0
4.5
4.5
6.0
7.5
9.0
Temperature [keV] (2.0-15.0 keV)