EPIC Chandra Cross Calibration with the Perseus Cluster

S. Molendi, F. Gastaldello & A. Tiengo (IASF-MI)
Cross Cal with Clusters

- Has enjoyed some success
- Perseus is the brightest cluster in the X-ray sky
- Lots of photons and no pile-up!
- In the past used to check pn/MOS cross calibration
Example of old vs new pn/mos

Residuals in the form of ratio data/model for PN data on MOS best fitting model
Example of old vs new pn/mos

Residuals in the form of ratio data/model for PN data on MOS best fitting model

![Graph showing residuals in the form of ratio data/model for PN data on MOS best fitting model. The x-axis represents channel energy (keV) and the y-axis represents ratio, with data points plotted across the range.]
ACIS S3 vs EPIC pn

- Same thing, only now we compare Chandra ACIS S3 with EPIC pn
- About $3 \times 10^6$ events for each spectrum extracted from annulus with bounding radii of 1' and 2'
- Used old and new Chandra calibrations (CALDB 4.1.1 with hrmaD1996-12-20axeffaN0008.fits)
- Multi T spectral model (Molendi & Gastaldello 09)
ACIS S3 vs EPIC pn

Residuals in the form of ratio data/model for pn and ACIS data on pn best fitting model.

Renorm applied to match spectra at 1.5 keV
ACIS S3 vs EPIC pn

Residuals in the form of ratio data/model for pn and ACIS data on pn best fitting model.

Renorm applied to match spectra at 1.5 keV
Cross Cal

pn and ACIS S3 spectral shapes are now in much better agreement!

Congratulations calibrators!
Flux cross-cal

- Both figures have renorm factors: 5% for the first; 15% for the second; let's take them out.
Both figures have renorm factors: 5% for the first; 15% for the second; let's take them out.
Both figures have renorm factors: 5% for the first; 15% for the second; let’s take them out.
Flux cross-cal

- The new HRMA calibration impacts on the ACIS/EPIC flux cross calibration.
- Our analysis indicates that the flux cross calibration below $\sim 2$ keV will be shifted by about 10%.
- Although comparing spectra extracted from a given region of a cluster may not be the best way to go, our data indicates that the flux cross calibration change is not for the better.
Summary

• The new HRMA effective area limits ACIS S3 vs pn residual calibration errors to less than 5%

  this is no small achievement!

• The new spectral calibration modifies by about 10% Chandra fluxes below 2 keV, ACIS vs EPIC flux cross calibration will be affected