Multi-Mission Study

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IACHEC meeting 2013, Theddingworth
Chandra/XMM

There are cross-correlation problems between XMM-Newton/EPIC and Chandra/ACIS (Nevalainen et al., 2010):

- ACIS 2-7 keV band flux ~10% higher
- 2-7 keV band effective area shape calibration OK
- At 2.0- 1.0 keV pn effarea underestimated or ACIS effarea overestimated by 20%

ACIS-S subsample

Clusters PN stack residuals

ACIS-S/EPIC-pn

EPIC-pn: flag==0 & single+double

Energy (keV)
New cans of worms

- We included now Swift/XRT, Suzaku/XIS and ROSAT/PSPC into the comparison work
- We use 3-6 arcmin annulus for the extraction of the spectra, so that
  - we minimise the scatter from the cool core (we are wasting data, but this enables the comparison with Suzaku which has a larger PSF)
  - we minimise the PSF scatter from and to our extraction region (again, dictated by Suzaku)
  - we stay in the bright part of the clusters and thus minimise background systematics (background a few% of the cluster emission)
New cans of worms

★ Would be ideal to use a combined mask using the info of the bad pixels and CCD gaps of all instruments, but complicated. At this point areas vary somewhat btw the instruments

★ Point sources are variable. We exclude from each instrument the minimal number of point sources required to minimize the point source emission in the 3-6 arcmin annulus
For selecting the observations common with the above five missions, we used these criteria:

- The total exposure time must be at least 10 ks to obtain good enough statistics.
- The center of the cluster must not be too much offset (< 3 arcmin) from the center of FOV so that we don't fold in instrument effects which are different between the central and outer regions of the FOV (e.g. vignetting).
## Sample info

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*PKS0745-19 also observed by all, but XMM obs badly flared and needs extra care*
Method

🔹 Stack residuals:

🔹 We use EPIC-pn as a reference

🔹 For instrument I we calculate the median and the mean absolute deviation of the ratio

\[ R_{I \text{ over } pn} = \frac{\text{data}_I}{\text{model}_pn \otimes \text{resp}_I} \times \frac{\text{model}_pn \otimes \text{resp}_pn}{\text{data}_pn} \]

🔹 The latter term corrects for deviations btw. pn model and pn data which cannot be produced by the model (no point in comparing other data with a model which does not fit pn data)
Preliminary results

(ROSAT and Suzaku not yet done, sorry)
Swift/pn similar as ACIS/pn:

- XRT 2-7 keV band flux ~10% higher
- 2-7 keV band effective area calibr. OK
- At 0.5 keV pn effarea underestimated or Swift effarea overestimated by 10-20%
Is pn a freak?

ACIS / EPIC-pn (flag==0)

SWIFT-XRT / EPIC-pn (flag==0)
Not quite: Suzaku-XIS / pn soft band

* XIS/pn do not show the steep feature btw 1 and 2 keV (Kettula et al, 2013)
Conclusions

- XMM-Newton-EPIC and Suzaku-XIS in rough agreement
- Chandra-ACIS and Swift-XRT in rough agreement
- The two pairs in clear disagreement
- Grand Calibration Scheme (M. Guainazzi)