# *Update on science with Suzaku HXD*

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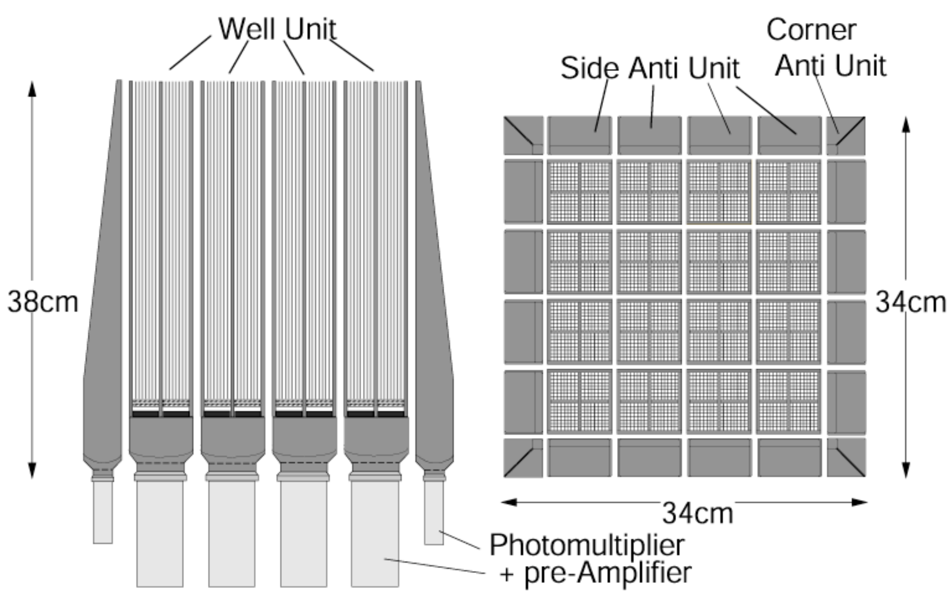
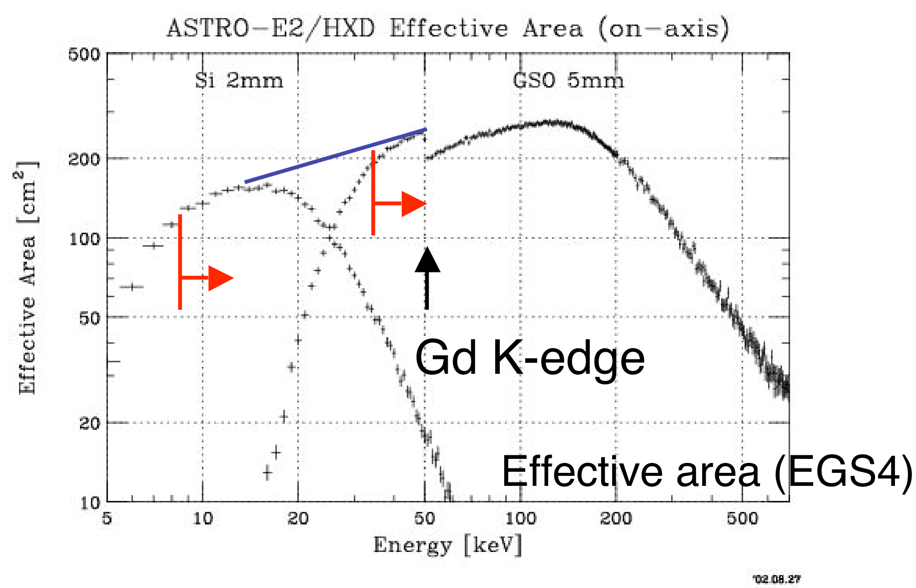
# HXD:  Detector design

- The Hard X-ray Detector is a non-imaging, collimated instrument sensitive from ~7 keV to ~600 keV
- It consists of the GSO/BGO scintillator counter (~30 - 600 keV), and the Si PIN diode (~7-70 keV)
- At E > ~ 100 keV (GSO), it is actively collimated to 4.5$^{o}$ x 4.5$^{o}$
- At E < ~100 keV (PIN), it is passively collimated to 0.5$^{o}$ x 0.5$^{o}$



# Science with the HXD

- Results from the HXD cover three areas:
- (1) Sensitive measurements of time-resolved broad band spectroscopy of bright sources (up to ~300 keV)
- (2) Measurements of hard X-ray continuum of faint sources
- (3) WAM results for gamma-ray bursts

- For a ~ 5 mCrab source, in 100 ks, the HXD can measure the continuum up to ~ 200 keV;  for a ~ 1 mCrab source, this will be only through the PIN range, up to ~ 50 keV

# Science with the HXD

- My focus here will be on part (2) - spectra, some admixture of part (1) – variability; examples are active galaxies
- By taxonomy of the different kind of AGN, I'll consider the Seyfert galaxies and jet-dominated ones separately
- Seyferts: the broad-band hard X-ray spectrum consists of primary continuum, with circum-nuclear spectral features, plus the Compton reflection component
- Circum-nuclear emission (mainly atomic spectral features – Fe K line, …) is well studied with the XISs, while the HXD can determine the continuum precisely – especially at the highest energies
- The two new results are:
- (1) the primary continuum is a power law, but the cutoff, previously reported to be "universal" at ~ 200 keV, is *not* "universal" – some Seyferts show cutoffs at ~ 100 keV, others – no sign of cutoffs (MCG-5-23-16; Reeves et al. 2007; others)
- (2) the sensitivity of the HXD allows to study separately the variability of ingredients of the hard X-ray flux: the Compton reflection component does not appear to vary in concert with the continuum (MCG-6-30-15; Miniutti et al. 2007)

# Science with the HXD

Another class of AGN studied with the HXD are jet-dominated objects, aka “blazars”

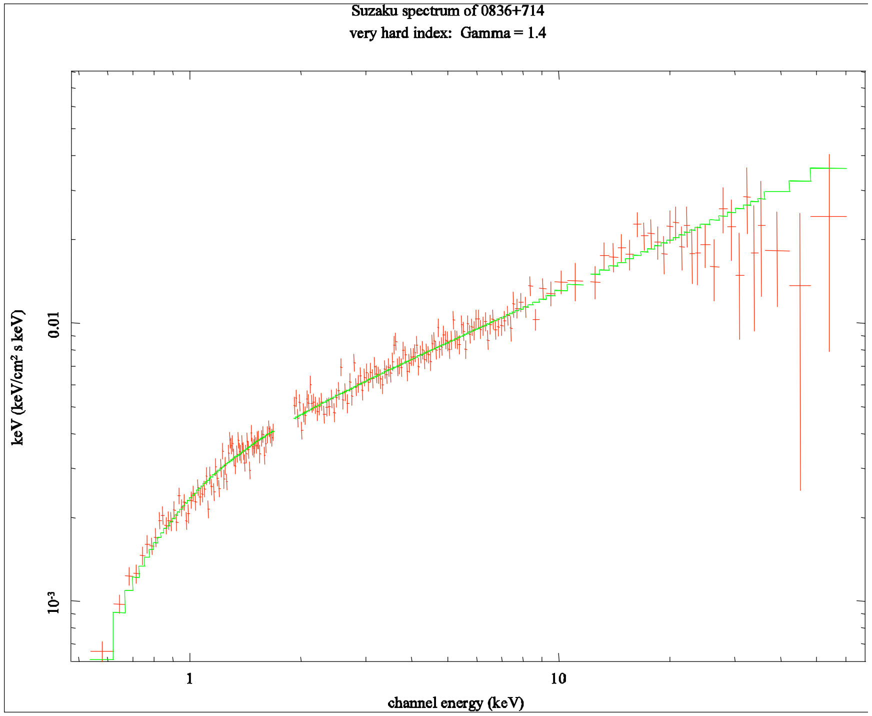
* Example: 0836+714 (=4C71.07), one of most distant EGRET blazars, z = 2.172 shows a power law with $\Gamma$ = 1.4 (SWG data; paper in preparation)

* $\Gamma$ = 1.4 implies power law index of radiating particles p ~ 1.8 – tough to produce in any particle acceleration scenario

* The X-rays are likely produced by Compton upscattering of external, broad emission line photons or IR by highly relativistic electrons in the jet

* Hard X-ray band uniquely probes the „bulk” of the radiating particles (can’t be studied via low $\nu$ radio – contaminated by extended comp.)

* Very important towards the determination of the jet content, and – because of the radiation environment of the host galaxy – the distance from the black hole where the jet forms



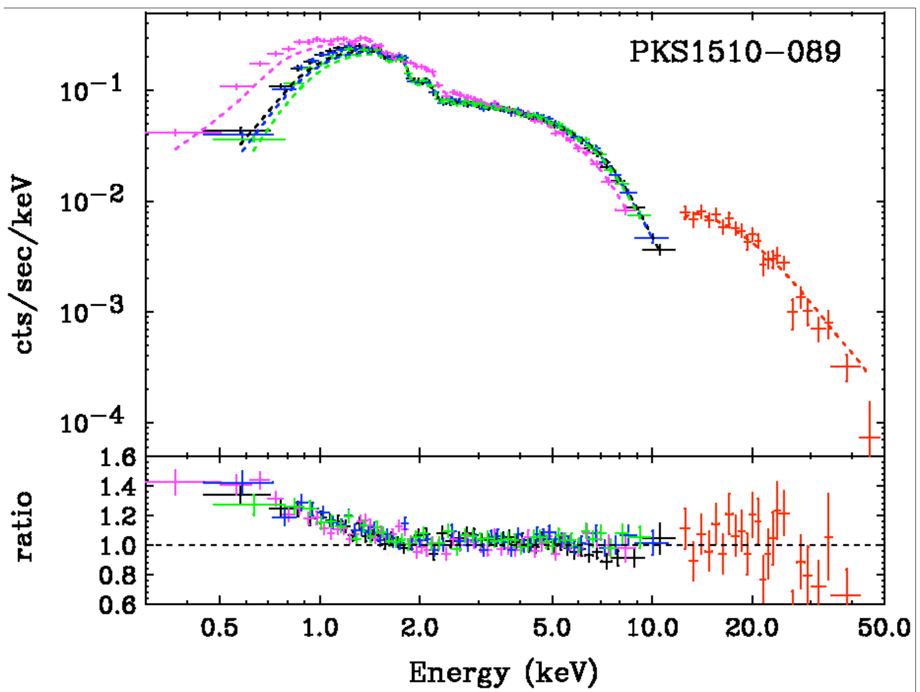
# Science with the HXD

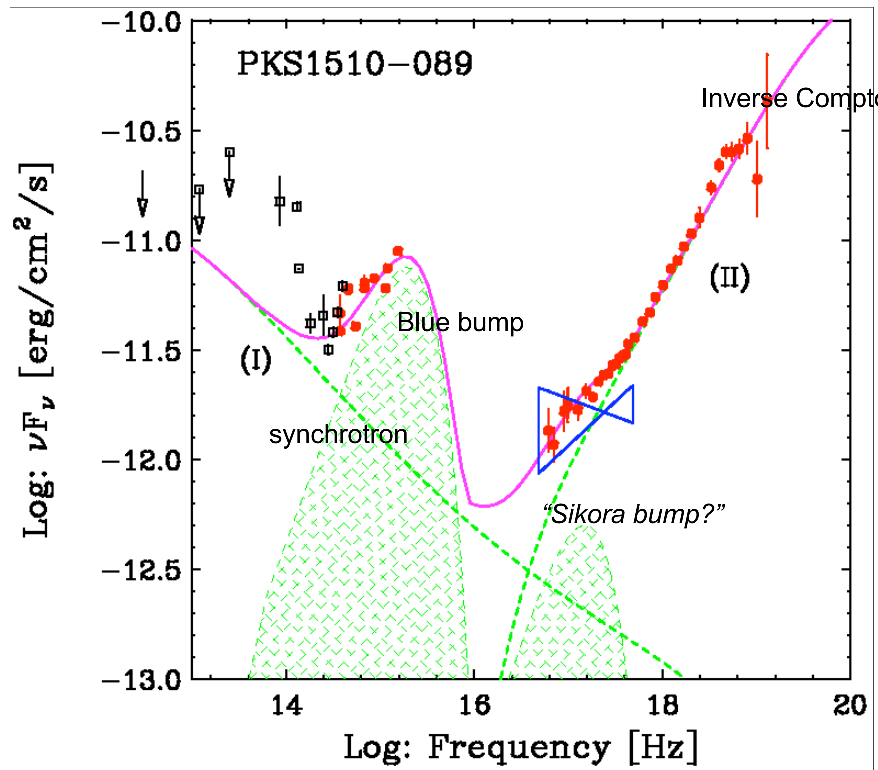
- More blazar science: possible detection of the “cold” particle component in the jet

* PKS 1510-089 is another luminous blazar (z ~ 0.3), observed via the GO program by Suzaku, but also simultaneously by SWIFT (Kataoka, Madejski, Takahashi, et al. 2007)

•The broad-band spectrum shows a “soft excess” – signature of “cold” (non- or mildly-relativistic) electrons in the jet (aka “Sikora bump”)?

•Best results will be obtained by future observations joint with GLAST



# Science with the HXD

- Prospects for the GSO data for active galaxies

* Good example: SWG GTO observation of Cen A (Markowitz et al. 2007)

•The soft X-ray part is very rich in lines (Fe overabundance, …) but above 10 keV, continuum dominates

•Even a ~100 ks observation provides GSO good detection to over 200 keV – here, power law with no break, no Compton reflection

•Is this due to the jet pointing somewhat away from the line of sight?

16 Markowitz et al.

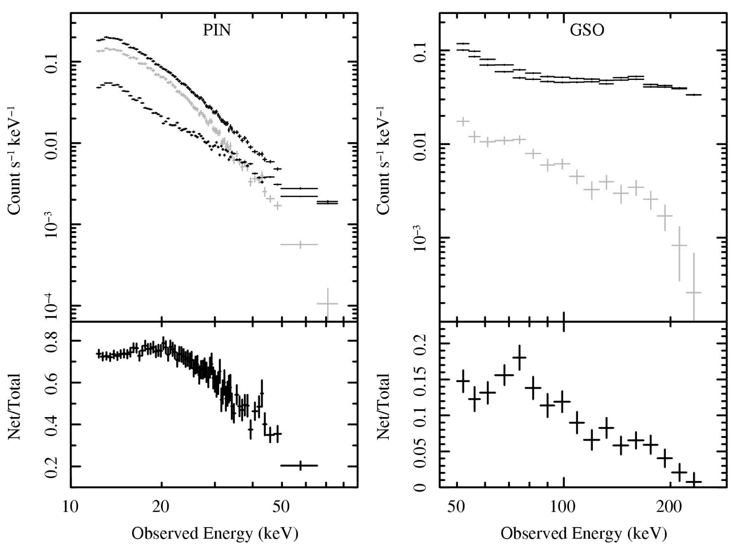



Fig. 2.— HXD-PIN (*left*) and GSO (*right*) spectra. The upper panels show the net source spectrum (*gray points*), the background (*lower black points*), and the total (source + background) spectrum (*upper black points*). The PIN spectra have been binned such that the net spectrum has a minimum signal-to-noise ratio of $10\sigma$ per bin. The GSO spectra have been binned as described in §2. The lower panels shows the ratio of the net source spectrum to the total spectrum.

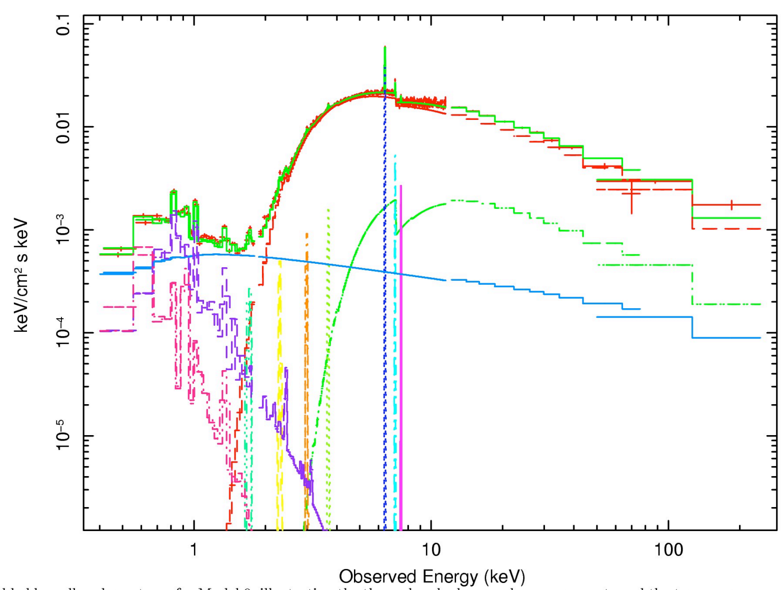
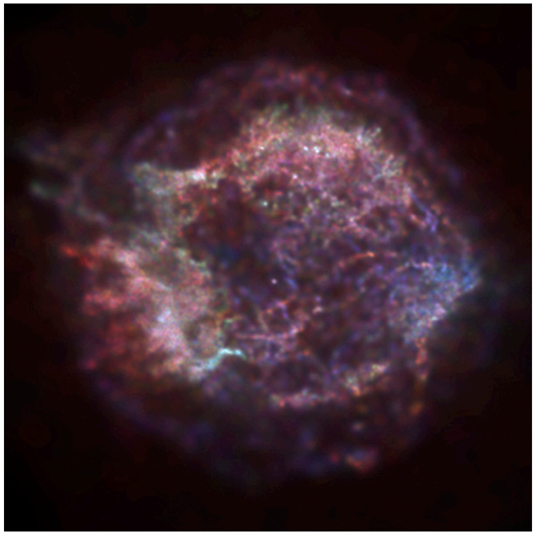



Fig. 11.— Unfolded broadband spectrum for Model 8, illustrating the three absorbed power-law components and the two vapec components. All data have been plotted with a binning factor of 10.

# Science with the HXD: future – SNRs and Clusters

- Diffuse sources are also great targets:
- In supernova remnants, hard X-rays might point to the origin of cosmic rays
- Example: Cas-A (on the right), many others



- Hard X-ray emission from galaxy clusters is also expected – via energetic electrons (inferred from radio data) by Compton-scattering the CMB (see Abell 2029 on the right)

- Need careful understanding of PIN and GSO background, collecting dark Earth data, …