Update on the White Dwarf (+ iNS) Working Group

Vadim Burwitz

International Astronomical Consortium
for High Energy Calibration

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WG Members

- **White Dwarfs** (*Chair: Vadim Burwitz*).
  Current members:
  - J.Drake (Chandra),
  - F.Haberl (XMM-Newton/EPIC-pn),
  - J.Kaastra (Chandra/LETG and XMM-Newton/RGS),
  - H.Marshall (Chandra/HETG),
  - N.Schultz (Chandra/HETG).

- **Isolated Neutron Stars** (*Chair: Frank Haberl*).
  Current members:
  - A.Beardmore (Swift/XRT),
  - V.Burwitz (XMM-Newton/EPIC-pn, Chandra/LETGS),
  - J.Cottam (XMM-Newton/RGS),
  - C.de Vries (XMM-Newton/RGS),
  - T.Dotani (Suzaku),
  - E.Miller (Suzaku/XIS),
  - S.Sembay (XMM-Newton/EPIC-MOS).

Overview

- Very briefly: Why use White Dwarfs and iNS

- White Dwarfs
  → analysis of reprocessed and new data HZ 43, Sirius B and GD153

- Isolated Neutron Stars
  → WG activity ramping up: a new LETGS observation of RXJ1856 planned

- Status of home work from IACHEC 2011!

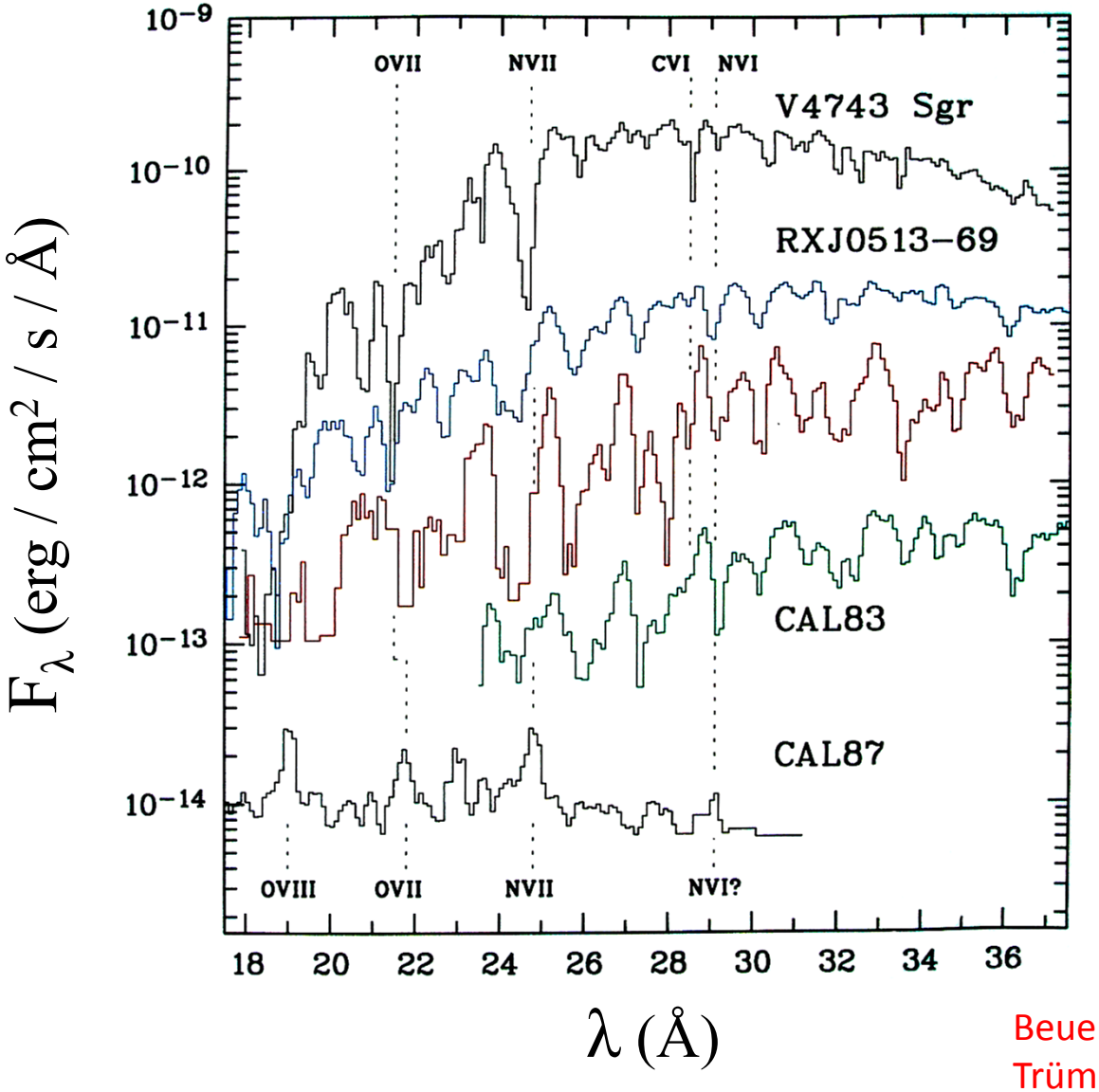
Why calibration at soft X-rays

- Absolute Calibration between

→ Chandra, XMM, ROSAT, EUVE

- Important for better as diverse objects as:
  - White Dwarfs
  - Magnetic CVs
  - Novae
  - Supersoft sources
  - Diffuse emmission
  - Soft end of spectra of of INS and bright powerlaw sources

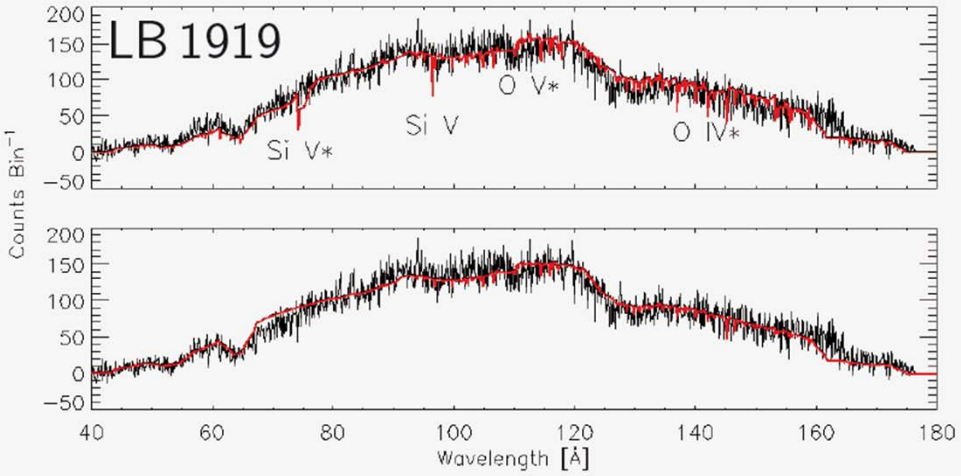
RX J0513-69 vs. other Super-soft sources



Beuermann in
Trümper & Hasinger 2008

LB1919 and GD146

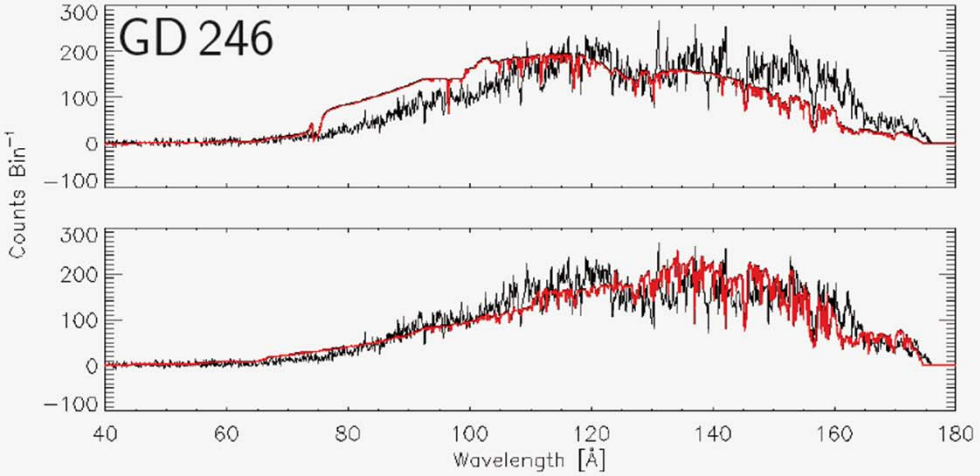
Adamczak et al. 2010



$T_{\rm eff} = 56\,000$ K, $\log g = 8.5$
homogeneous

metal poor DA white dwarf

$T_{\rm eff} = 52\,000$ K, $\log g = 8.5$
diffusion



$T_{\rm eff} = 55\,000$ K, $\log g = 7.3$
homogeneous

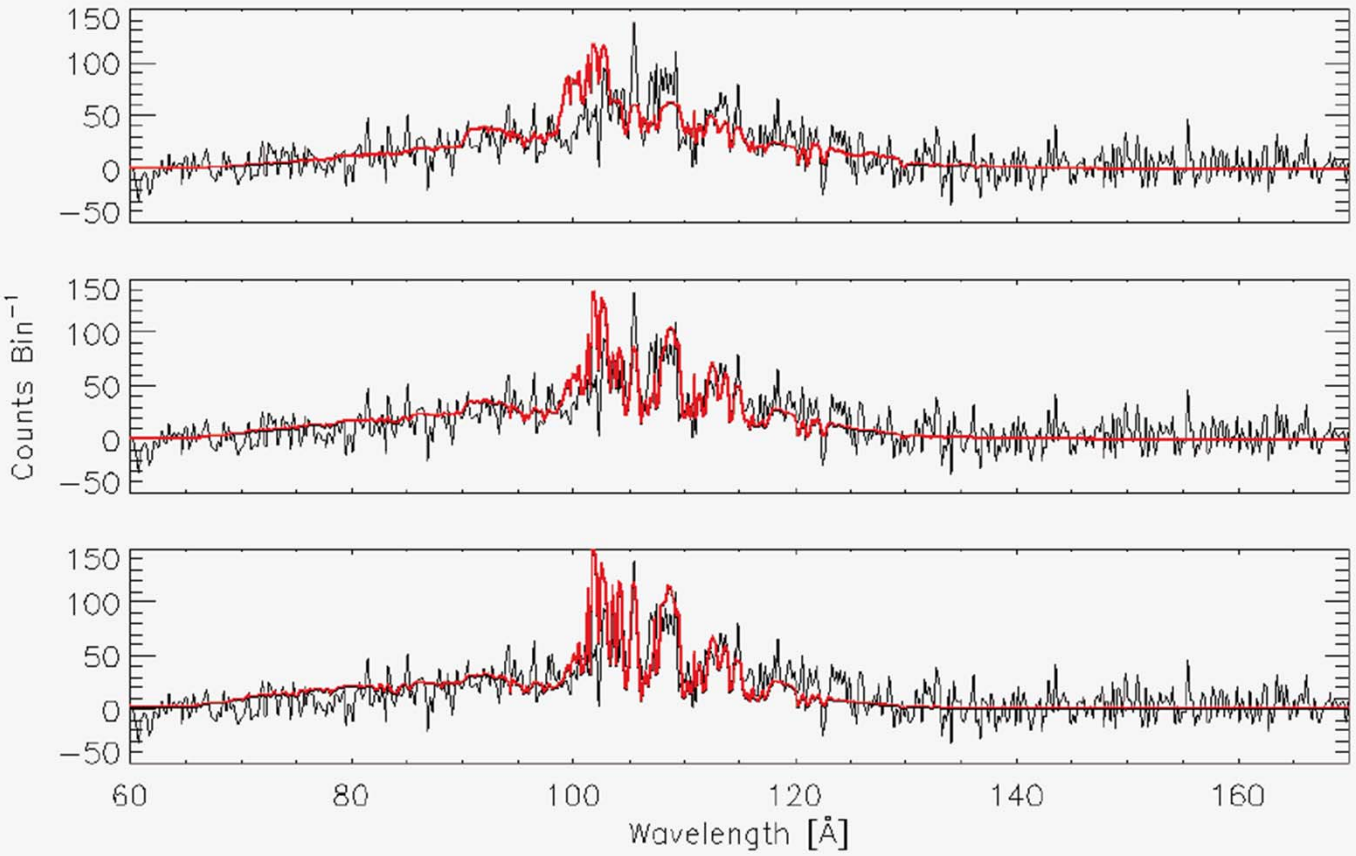
DA white dwarf

$T_{\rm eff} = 55\,000$ K, $\log g = 7.9$
diffusion

PG 1520+525

Adamczak et al. 2010

PG 1520+525: He, C, O, Ne, Mg, $\log g = 7.5$ a non-pulsating PG 1159 star



$T_{\rm eff} = 140\,000$ K

$T_{\rm eff} = 150\,000$ K

$T_{\rm eff} = 160\,000$ K

Absolute Calibration at Soft X-rays

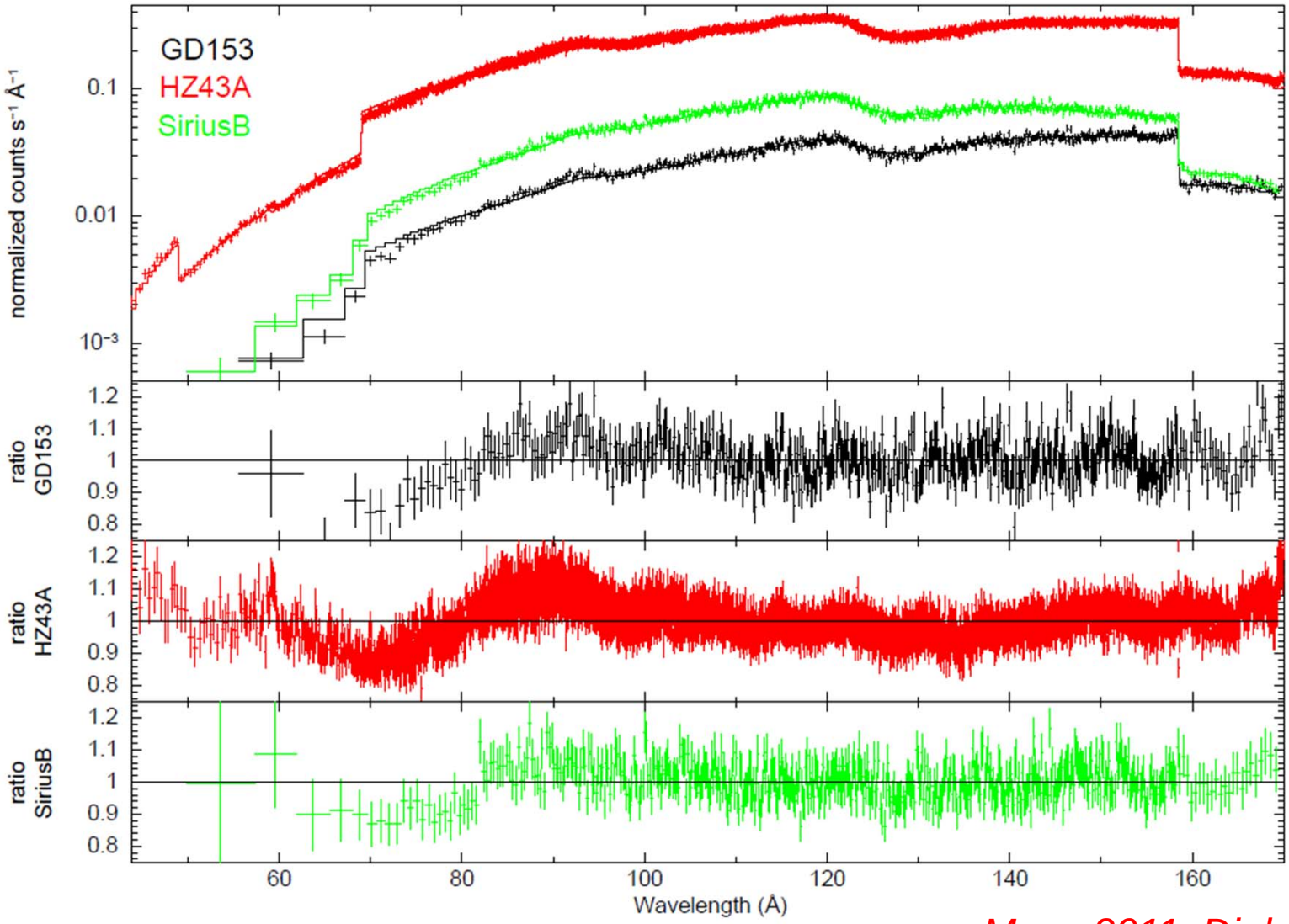
- is dependant on model spectra of WDs and iNS
- what models to use? → physical vs. descriptive
- uncertainties?

Beuermann et al. *2006, A&A 458, 541*
Beuermann et al. *2008, A&A 481,769*
Rauch et al. *2008, A&A 481,807*
Kaastra et al. *2009, A&A 497,311*

Detailed talk on iNSs was given at the last IACHEC #5 by
→ Valery Suleimanov

Detailed talk on WDs was given at the last IACHEC #6 by
→ Thomas Rauch

HZ43, Sirius B and GD153



Menz 2011, Diploma Thesis

Figure 5.1.: Model fits to the calibration sources with the *Chandra* effective area. In the upper panel the folded models and data are plotted. The ratios from data to model are plottet for each calibration source in the lower panels.

HZ43, Sirius B and GD153

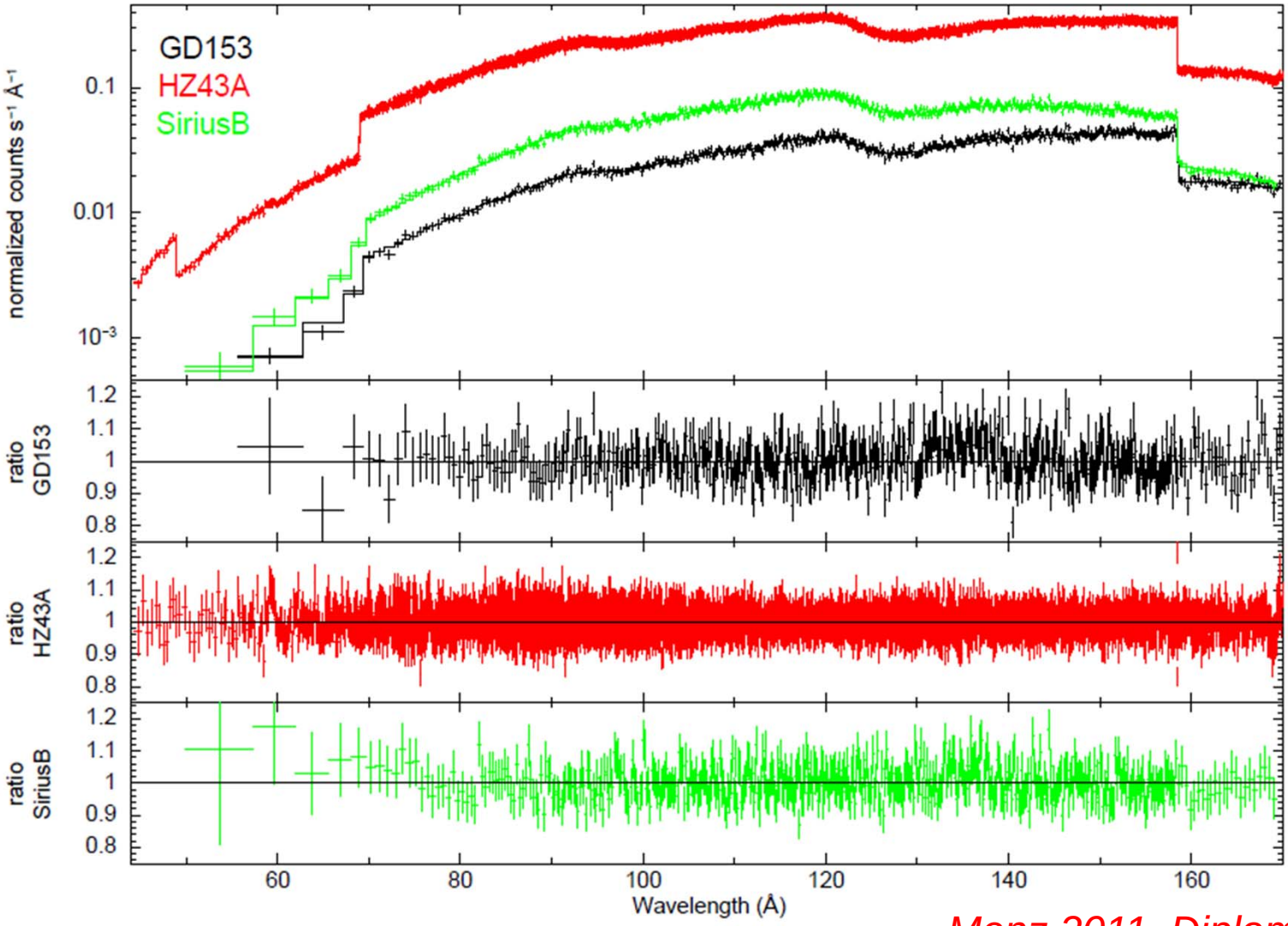


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Figure 5.2.: Fits to the calibration sources with the corrected effective area. Fits and ratios are plotted in the same way as in Fig. 5.1

Correction function for the LETGS

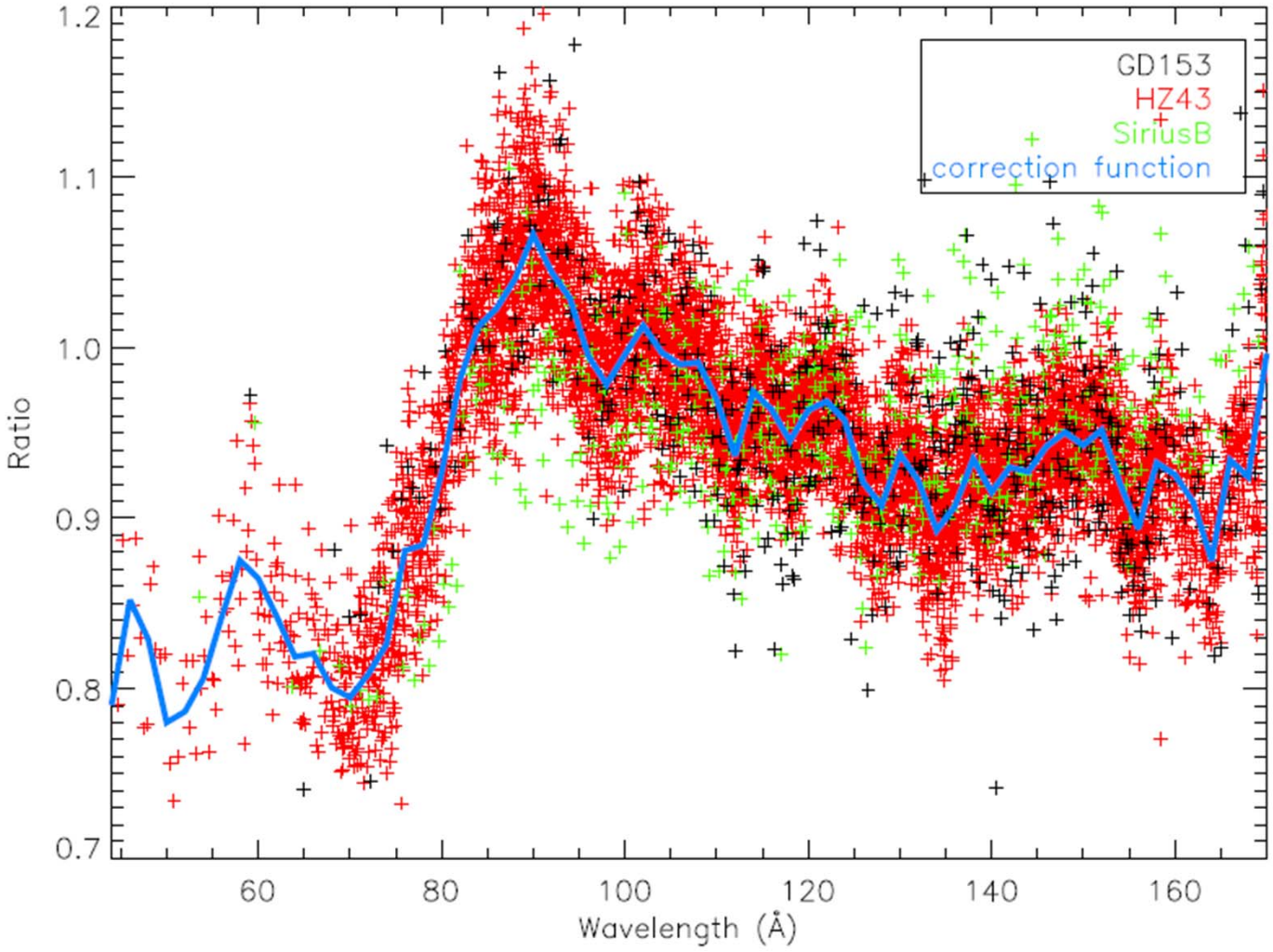

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Figure 5.3.: The calculated correction function. Overplotted are the ratios from data to the uncorrected models with the same parameters as used for the correction function.

LETGS QE updates

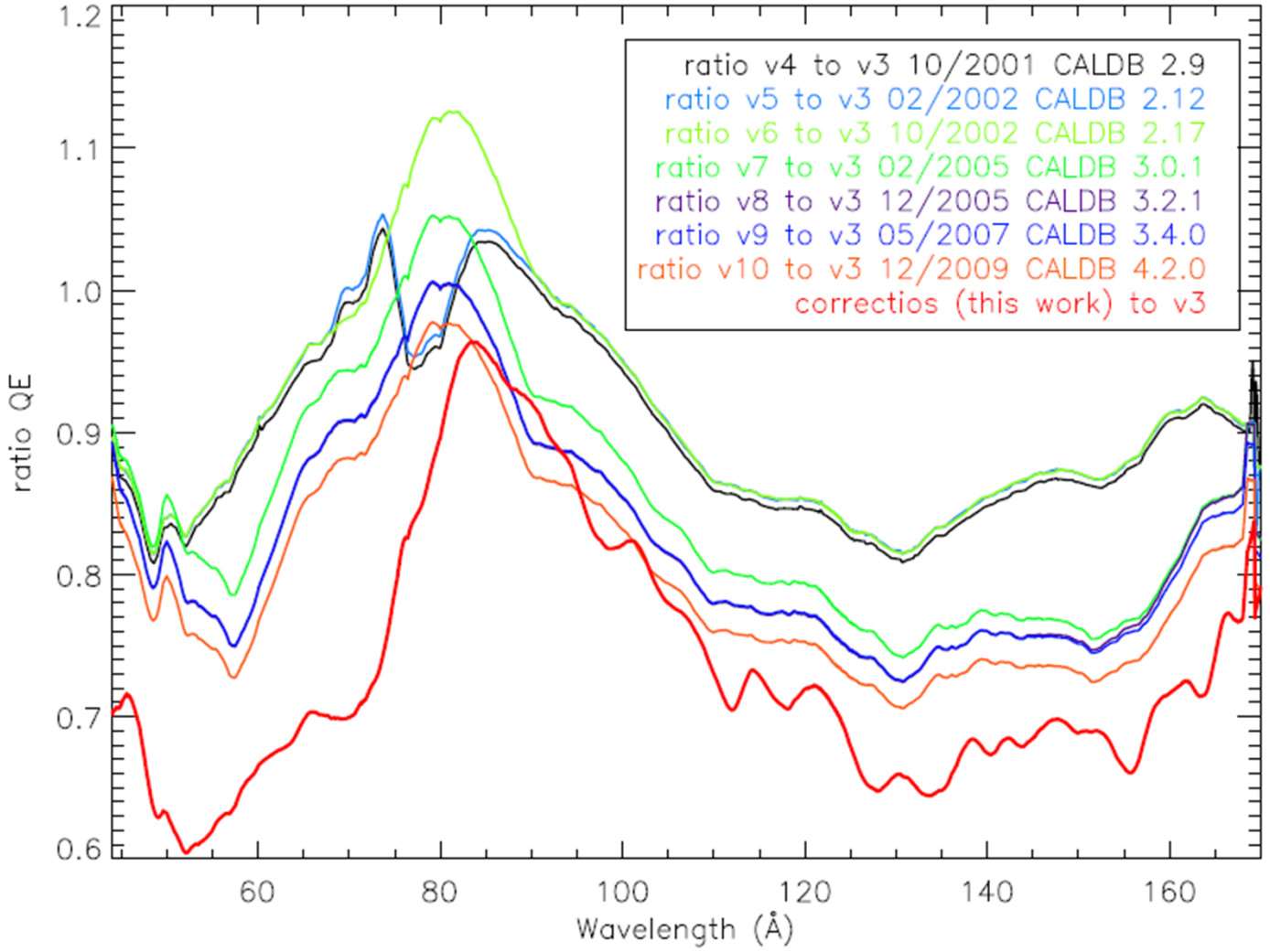

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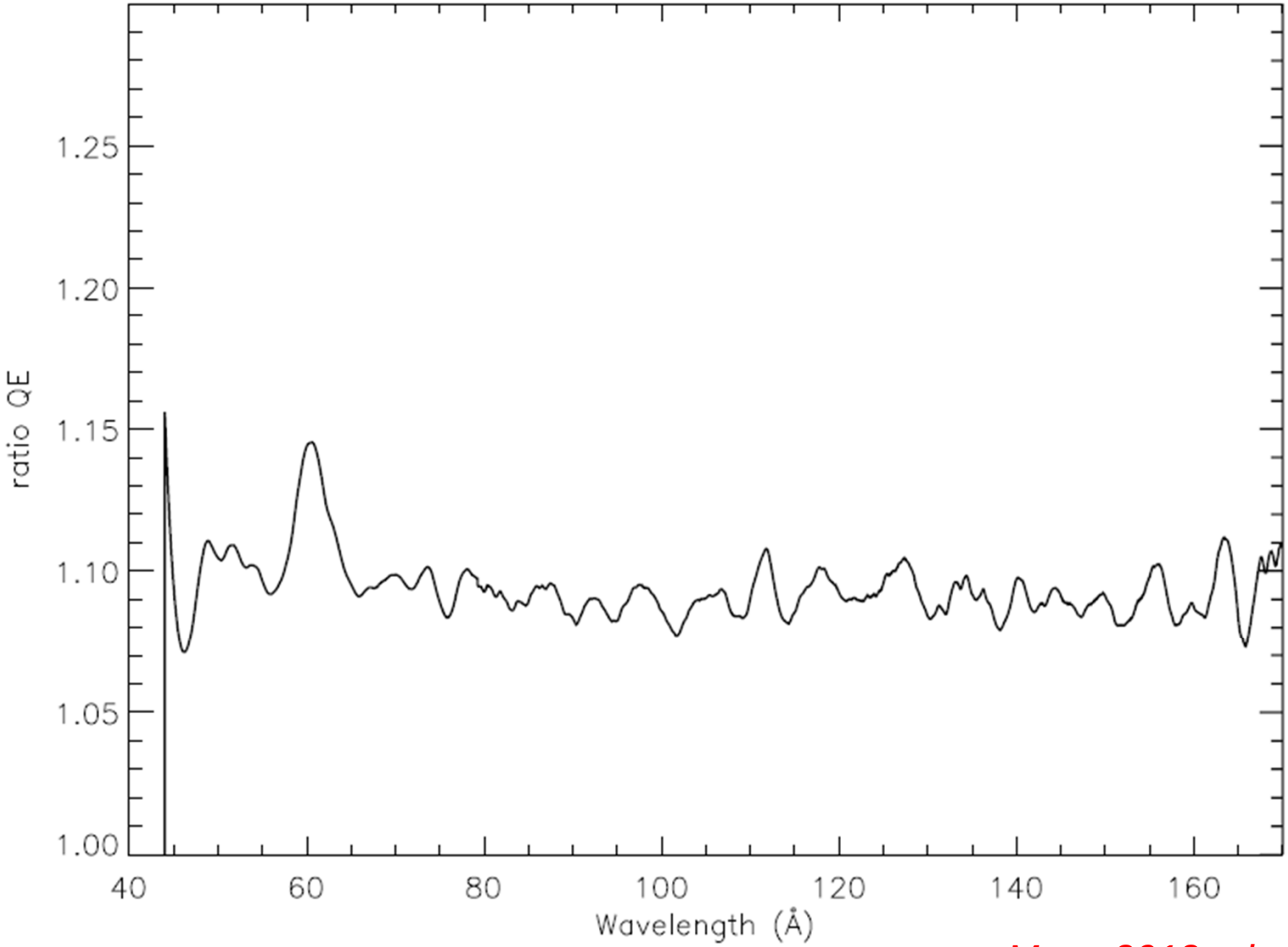
Figure 5.8.: The ratios between different QE calibration updates and the propsed change, which results from the best fit to the WD data.

Comparison with latest LETGS QE



Menz 2012 priv. comm.

Results from fit to 3 WDs

Parameter	literature values	*Chandra* effective area	combined fit	new effective area
GD153				
$\log g$(cgs)	7.870 ± 0.010	$7.66^{+0.05}_{-0.05}$	7.87	$7.92^{+0.1}_{-0.1}$
$T_{\rm eff}$(kK)	38.487 ± 0.247	$42.15^{+2.1}_{-2.1}$	38.487	$38.15^{+3.9}_{-3.9}$
$R^2/d^2(10^{-22})$	0.25[1]	$0.48^{+0.16}_{-0.02}$	$0.95^{+0.69}_{-0.69}$	$1.0^{+0.1}_{-0.1}$
nH (10^{19} cm^{-2})		$0.14^{+0.04}_{-0.03}$	< 0.01	< 0.2
reduced χ^2		1.22		0.96
HZ43 A				
$\log g$(cgs)	7.970 ± 0.030	$7.7^{+0.2}_{-0.2}$	7.97	$7.92^{+0.2}_{-0.2}$
$T_{\rm eff}$(kK)	50.377 ± 324	$50.98^{+2.7}_{-2.7}$	50.377	$51.25^{+3.5}_{-3.5}$
$R^2/d^2(10^{-22})$	0.3037 ± 0.013	$1.2^{+0.5}_{-0.5}$	$1.10^{+0.9}_{-0.9}$	$1.0^{+0.1}_{-0.1}$
nH (10^{19} cm^{-2})	0.085 ± 0.004	$0.27^{+0.07}_{-0.07}$	0.085	$0.082^{+0.03}_{-0.03}$
reduced χ^2		2.36		1.04
Sirius B				
$\log g$(cgs)	8.57 ± 0.06	$8.40^{+0.05}_{-0.05}$	8.57	$8.49^{+0.2}_{-0.2}$
$T_{\rm eff}$(kK)	24.790 ± 0.100	$24.83^{+0.4}_{-0.2}$	24.79	$25.01^{+0.4}_{-0.4}$
$R^2/d^2(10^{-22})$	48.77 ± 0.36	170^{+10}_{-24}	179^{+129}_{-129}	152^{+5}_{-11}
nH (10^{19} cm^{-2})	0.065 ± 0.02	$0.02^{+0.1}_{-0.02}$	0.065	< 0.09
reduced χ^2	0.96		0.76	
reduced χ^2 combined fit			1.05	

[1] R^2/d^2 value calculated with $M = 0.60 M_\odot$, $d = 67.9pc$, and $\log g = 7.86$ and $g = GM/R^2$. Values are taken from Lajoie & Bergeron (2007). An error cannot be calculated since all values are tabulated without errors.

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Simultaneous fit to RXJ1856 and the WDs

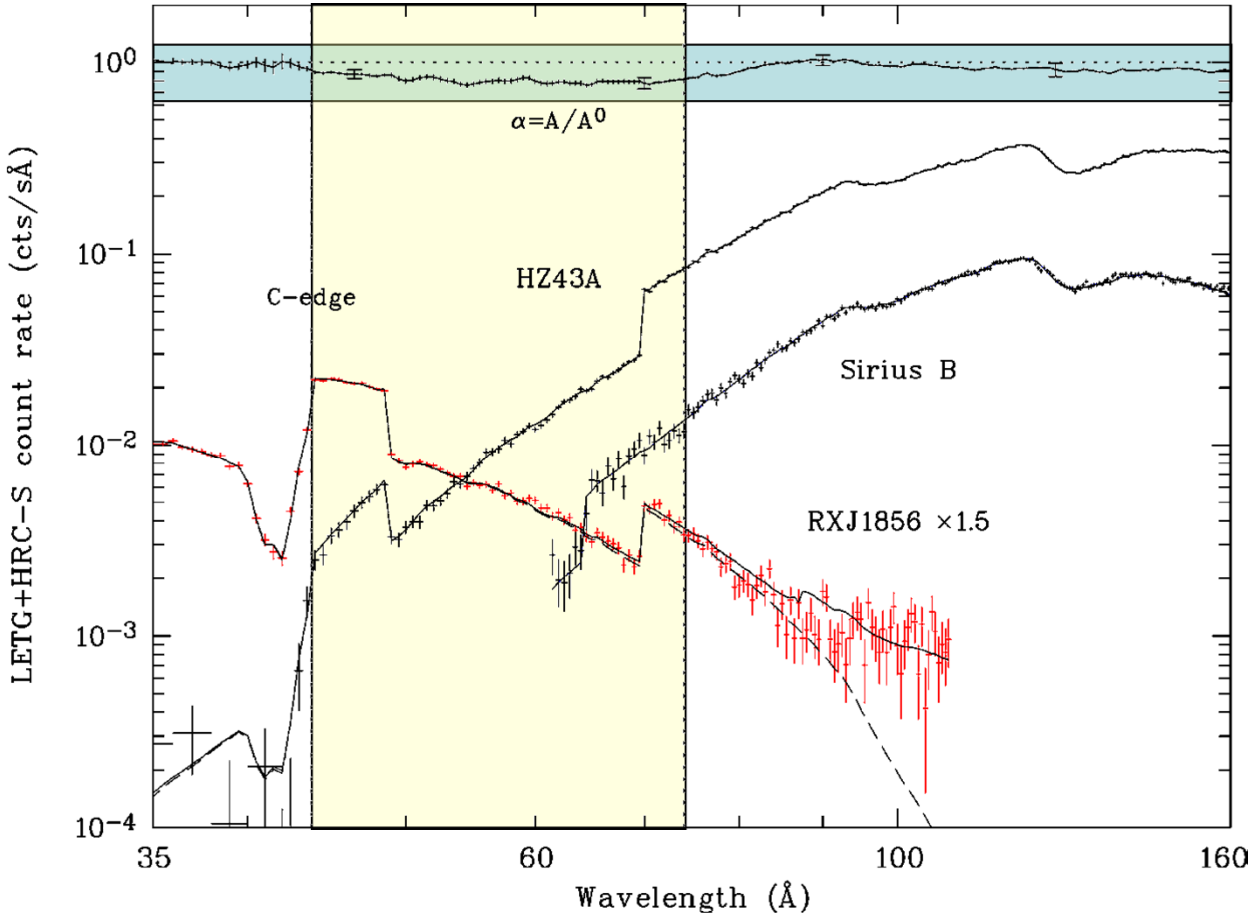

Fig. 5. Simultaneous fit of RX J1856, HZ43 A, and Sirius B in the wavelength ranges marked by vertical dotted lines (see Sect. 4.4.2). The LETG spectra binned to 0.5Å are shown as data points, the corresponding best-fit models as solid curves, and the first-order contributions as dashed curves. The area correction function α is shown at the top. It converts the nominal LETG+HRC-S first-order effective area A^0 of the November 2004 release into the adjusted area A used in this paper. Systematic uncertainties in α are indicated by error bars at 46, 70, 90, and 125Å. The steps in the count rate spectra of HZ43 A and RX J1856 at 49 and 69Å result from the dectector gaps. Sirius Bwas observed off axis and its gaps are located differently (see text).

Beuermann et al. 2006, 2008

Parameters obtained from fit

Beuermann et al. 2006, 2008

Parameter	Value±Error
(a) HZ43 A ($\lambda = 45 - 160\,\AA$)	
$T_{\rm eff}$ (K)	51126 ± 660
$\log g$	7.90 ± 0.08
R^2/d^2 (10^{-23})	3.011 ± 0.010
$N_{\rm HI}$ $(10^{17}\ {\rm cm}^{-2})$	8.91 ± 0.37
(b) Sirius B ($\lambda = 74 - 160\,\AA$)	
$T_{\rm eff}$ (K)	24923 ± 115
$\log g$	8.6 f [1]
R^2/d^2 (10^{-21})	4.877 ± 0.010
$N_{\rm HI}$ $(10^{17}\ {\rm cm}^{-2})$	6.5 ± 2.0 [2]
(c) RX J1856 ($\lambda = 15 - 74\,\AA$)	
$kT_{\rm spot}$ (eV)	62.83 ± 0.41
$kT_{\rm star}$ (eV)	32.26 ± 0.72
R_1/d (km/pc)	0.0378 ± 0.0003
R_2/d (km/pc)	0.1371 ± 0.0010
$N_{\rm HI}$ $(10^{20}\ {\rm cm}^{-2})$	1.10 ± 0.03

Table 2. Parameters of HZ43 A, Sirius B, and RX J1856 based on the simultaneous fit of our model spectra to the LETG+HRC count rate spectra in the wavelength intervals given. The quoted 1-σ ($\Delta\chi^2 = +1$) errors are correlated and derived from fits with the other parameters for each object kept free. The letter f indicates: fixed.

[1] Based on Barstow et al. (2005); Holberg et al. (1998)

[2] Hébrard et al. (1999). Our fit is required to stay within the 1-σ error.

Home work from last IACHEC 2011

II. WDs + iNS

- RXJ1856 is a bridge spectrum between
  - the blazar (high energy) WDs (low energy) calibration
- New physical model
  - based on classical NS model atmospheres will be attempted
- Also proposal for new RXJ1856 discussed
  - **Cross Mission Calibration observation.**
  - With (200ks) LETGS observation
  - Check stability of Object Spectrum

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RXJ1856 110ks LETGS has been accepted as GTO/DDT Observation

Summary

→ Other Calibration Observations

- Chandra Calibration data
  - → HZ 43 regular observations
  - → no Chandra LETGS INS RXJ1856 observation has been done since the 500 ks observation
    XMM and SWIFT and SUZAKU observe it regularly.

→ Proposed observations

- Joint SRON (Kaastra) /MPE (Predehl) /CXC (Murray) /CXC (Drake)
  - →110 ks Chandra LETGS observation of the of the iNS RXJ1856
- WG Meeting
  - →Meet to discuss about the iNS proposed observations