Status of the Isolated Neutron Star and White Dwarf Working Groups

Vadim Burwitz

International Astronomical Consortium
for High Energy Calibration
Apr. 11-15 2010, Woodshole, USA

WG Members

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

- **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).

Overview

- Why White Dwarfs and iNS
- Isolated Neutron Stars
  → WG little activity since last IACHEC
- White Dwarfs
  →low level activity pending new observations
- Status of home work from IACHEC 2009!

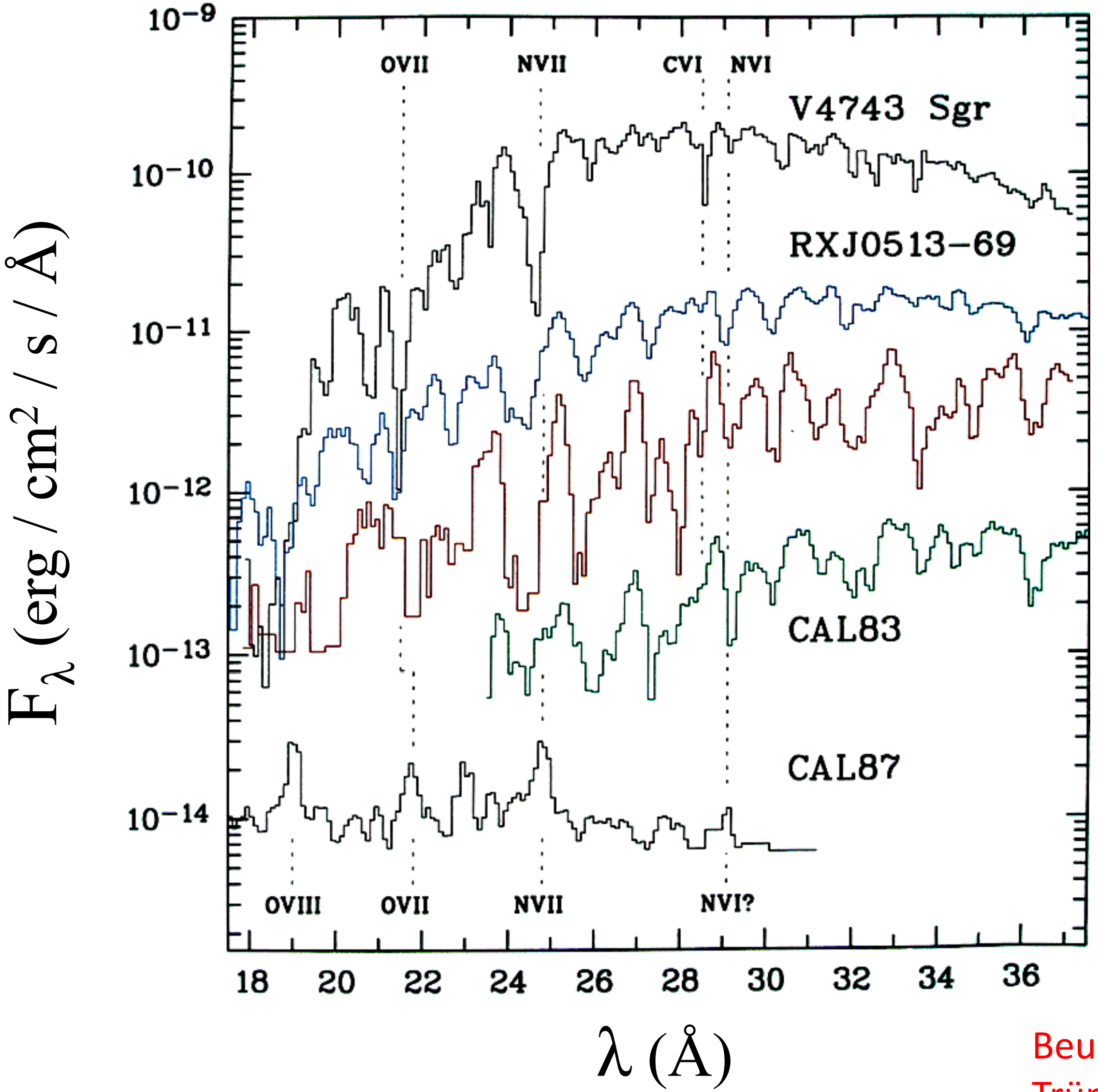
Why calibration at soft X-rays

- Absolute Calibration between

→ Chandra, XMM, ROSAT, EUVE

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

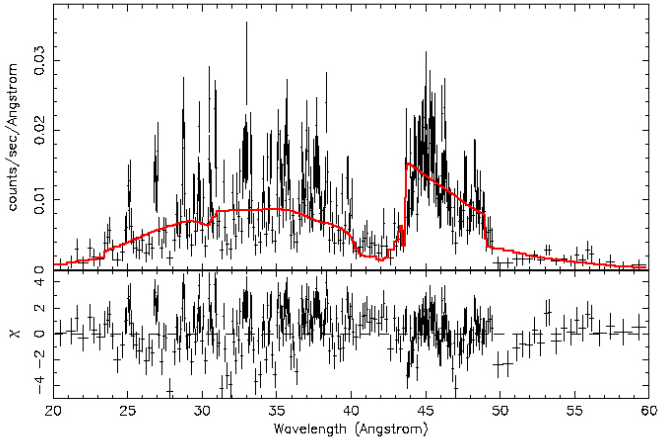
RX J0513-69 vs. other Super-soft sources



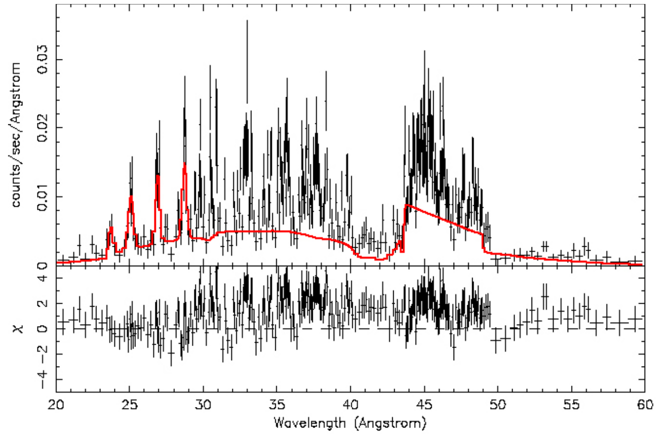
Beuermann in
Trümper & Hasinger 2008

RX J0513-69: fits to LETGS data

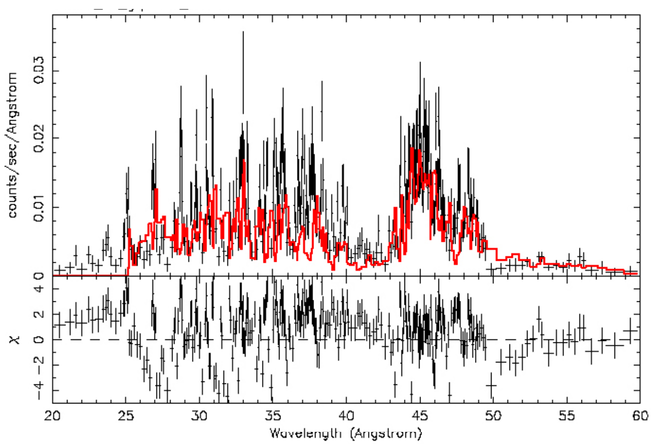
Blackbody model (30-40 eV, L~10^{38} erg/s)



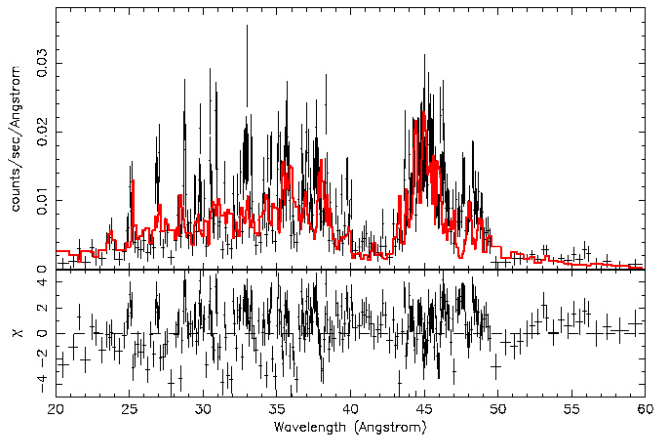
Planckian model + 4 and more Gaussians ...



Single LTE WD model

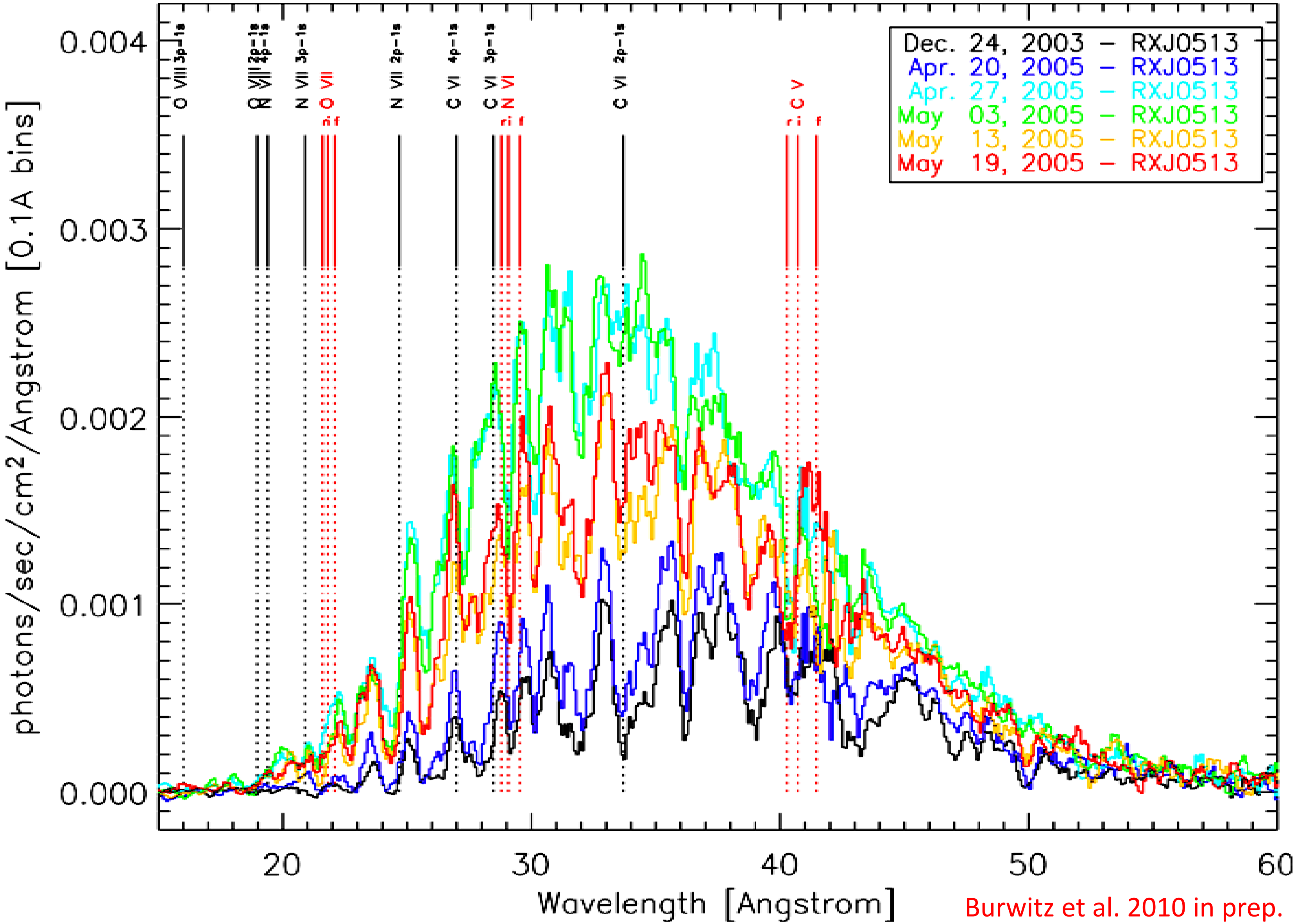


Two LTE WD models



Burwitz et al. 2007

RX J0513-69 LETGS spectra



Burwitz et al. 2010 in prep.

Absolute Calibration at Soft X-rays

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

Talk tomorrow by Valery Suleimanov

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

→ discrepancies between different Model spectra found and understood

Rauch et al. 2008

* TMAP (Tübingen Group)
* TLUSTY (Hubeny & Lanz)'

Parameters obtained from fit

Beuermann et al. 2006, 2008

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

[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.

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.

Simultaneous fit to RXJ1856 and the WDs

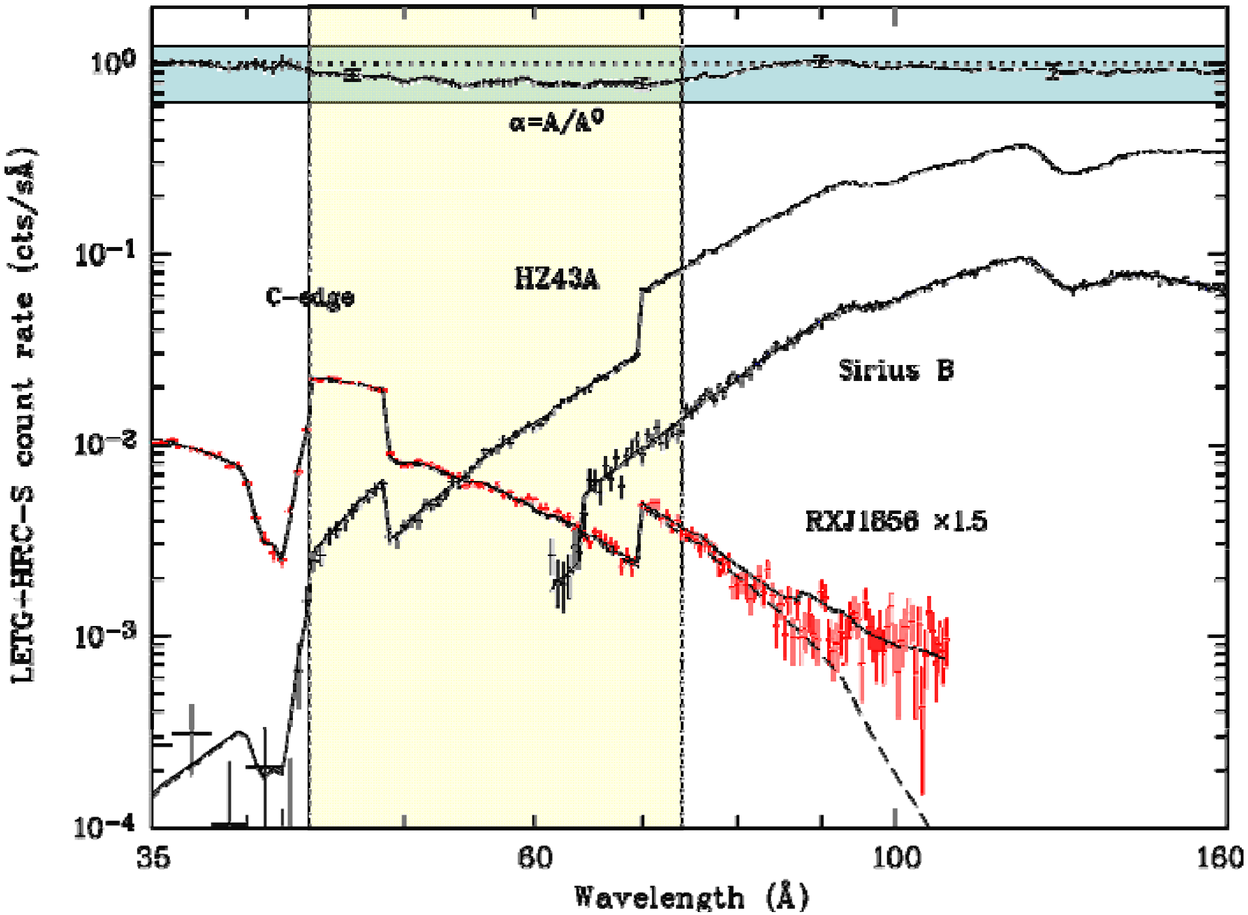
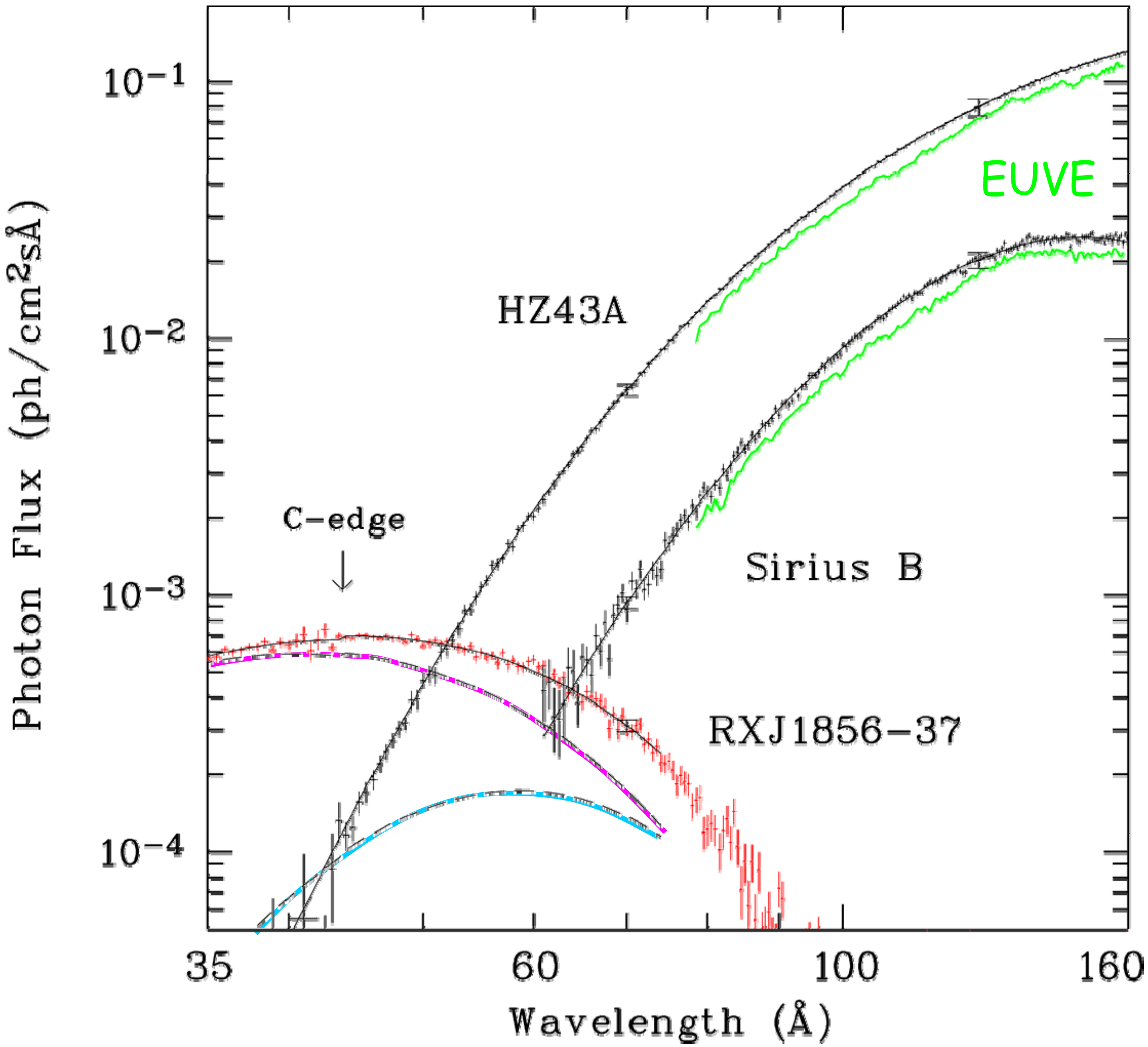


Fig. 5. Simultaneous fit of RX J1856, HZ43 A, and Sirius B in the wavelength ranges marked by vertical dotted lines (see Sect. 4.4.2). The LETG spectra binned to 0.5Å are shown as data points, the corresponding best-fit models as solid curves, and the first-order contributions as dashed curves. The area 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).

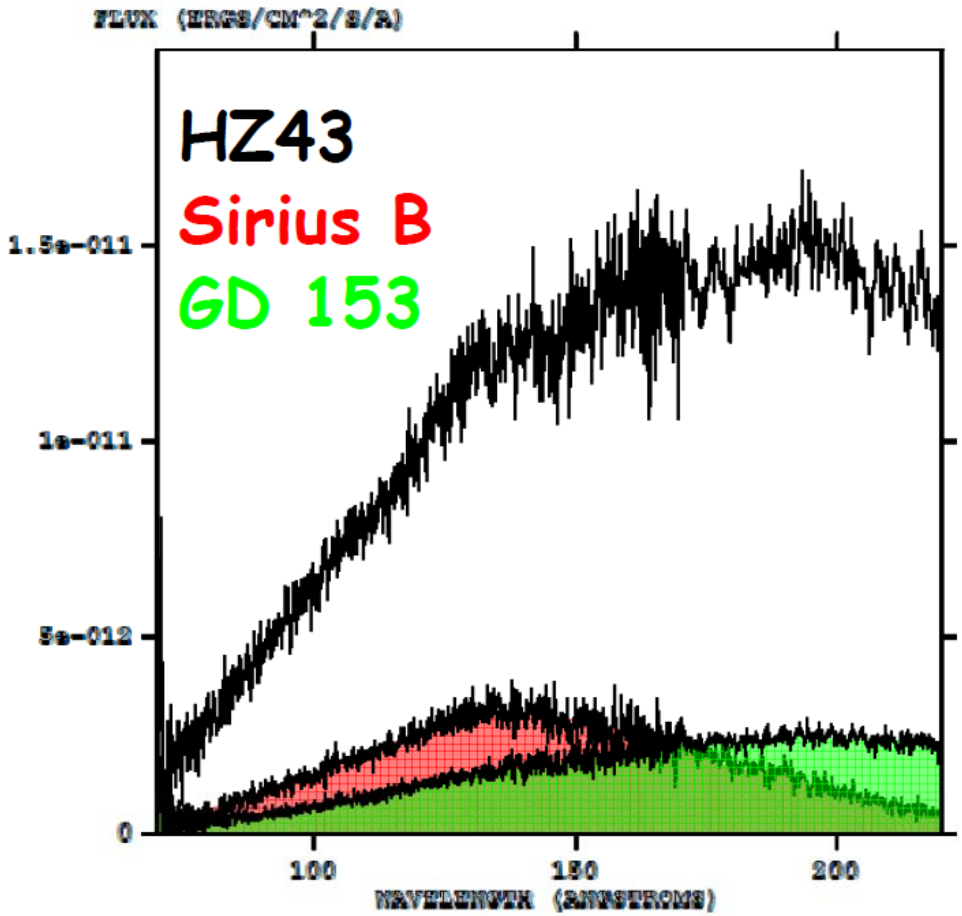
Beuermann et al. 2006, 2008

Comparison of photon spectra



Beuermann et al. 2006, 2008

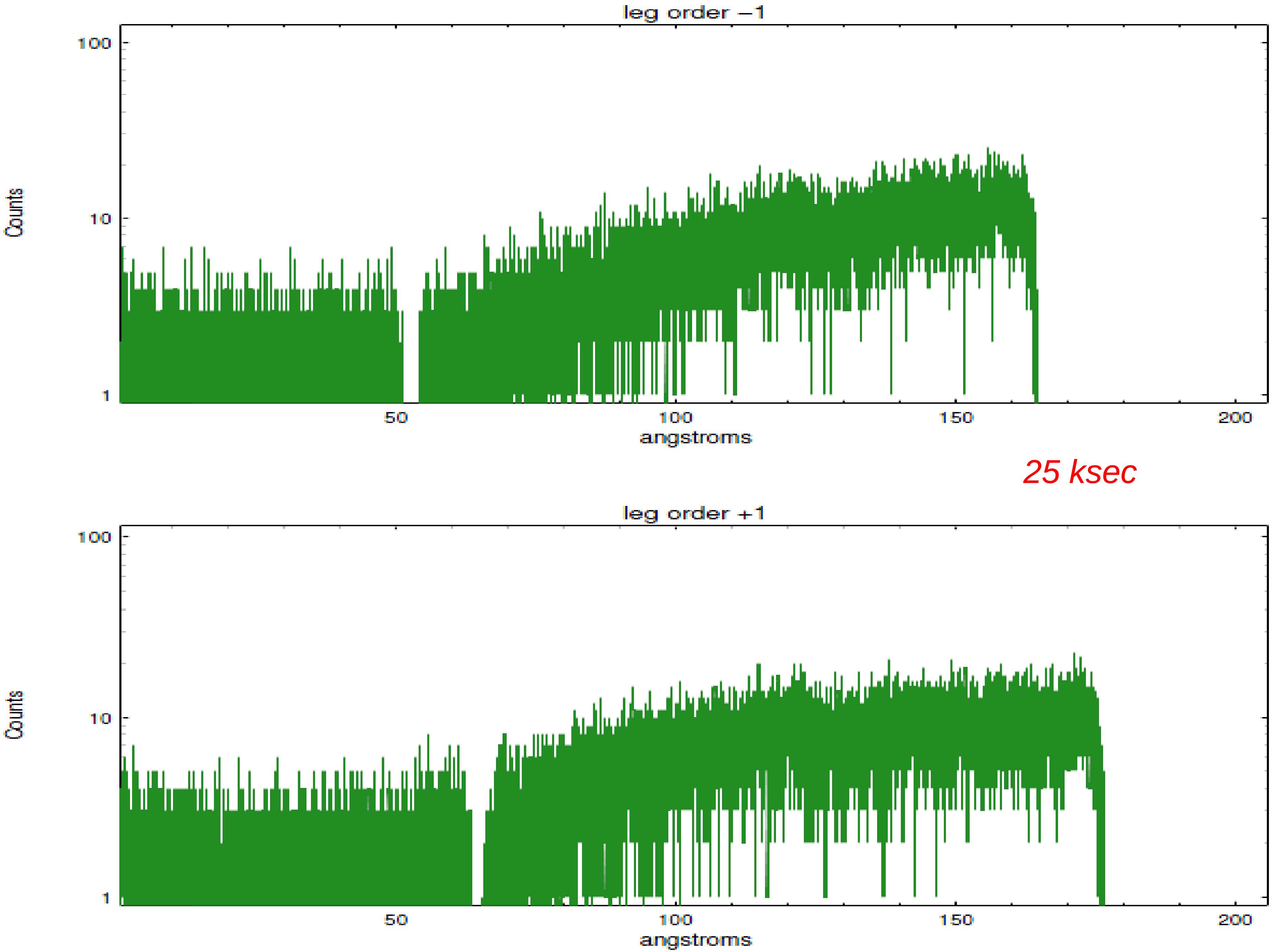
Comparison of EUVE data of WDs



Teff ~ 51100 K
Log g ~ 7.95
D ~ 63 pc
15.3 mas

Teff ~ 24900 K
Log g ~ 8.6
D ~ 3 pc
379 mas

Teff ~ 38000 K
Log g ~ 7.87
D ~ 69 pc


leg order −1
100
10
1
Counts
50
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angstroms
25 ksec
leg order +1
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10
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Counts
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100
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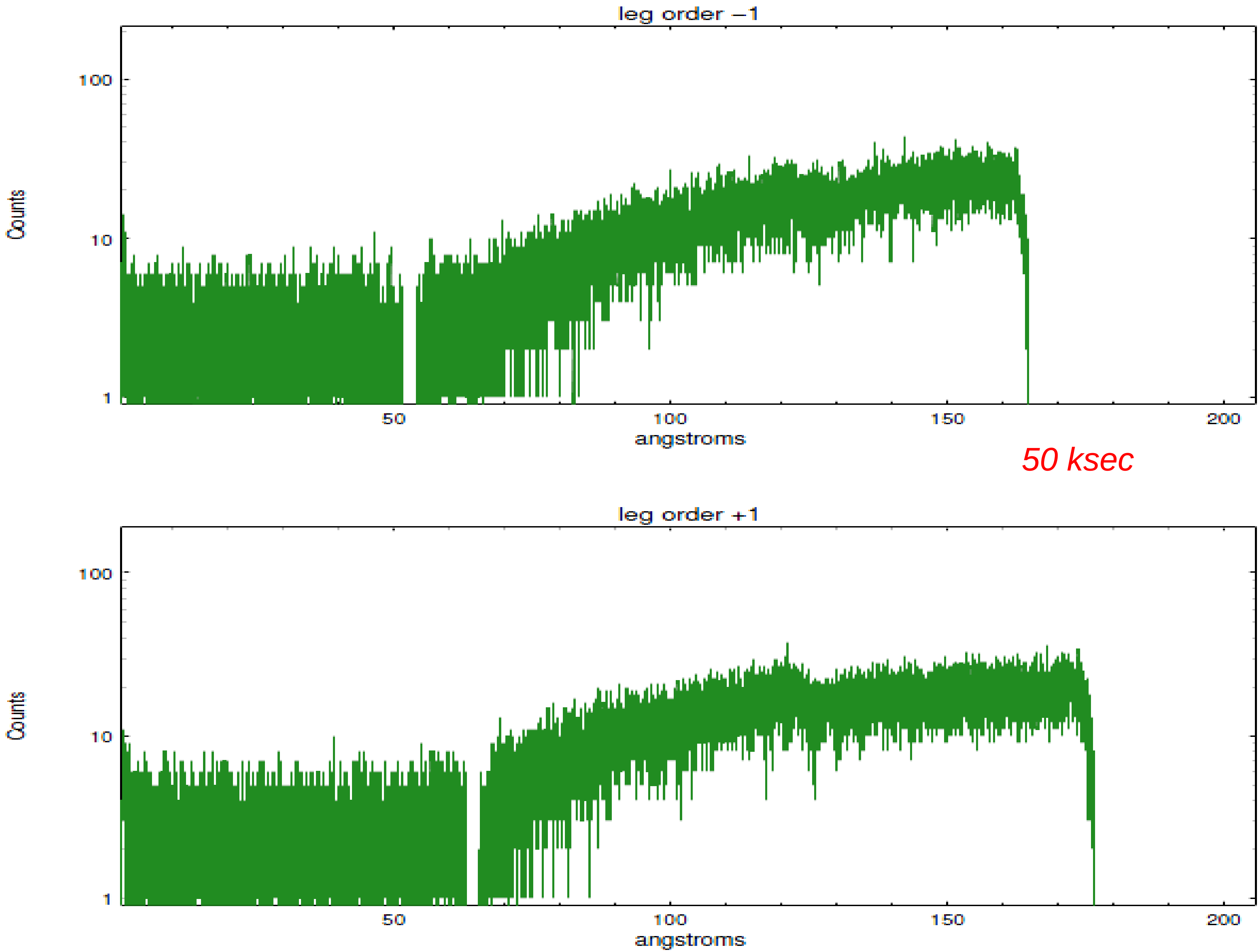
angstroms


leg order −1
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200
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Uncertainties in (E)UV model atmosphere fluxes (Research Note)

Thomas Rauch, Tübingen 2008, A&A 481, 807

Context. During the comparison of synthetic spectra calculated with two NLTE model atmosphere codes, namely *TMAP* and *TLUSTY*, we encounter systematic differences in the EUV fluxes due to the treatment of level dissolution by pressure ionization.

Aims. In the case of Sirius B, we demonstrate an uncertainty in modeling the EUV flux reliably in order to challenge theoreticians to improve the theory of level dissolution.

Methods. We calculated synthetic spectra for hot, compact stars using state-of-the-art NLTE model-atmosphere techniques.

Results. Systematic differences may occur due to a code-specific cutoff frequency of the HI Lyman bound-free opacity. This is the case for *TMAP* and *TLUSTY*. Both codes predict the same flux level at wavelengths lower than about 1500 Å for stars with effective temperatures (*Teff*) below about 30 000 K only, if the same cutoff frequency is chosen.

Conclusions. The theory of level dissolution in high-density plasmas, which is available for hydrogen only should be generalized to all species. Especially, the cutoff frequencies for the bound-free opacities should be defined in order to make predictions of UV fluxes more reliable.

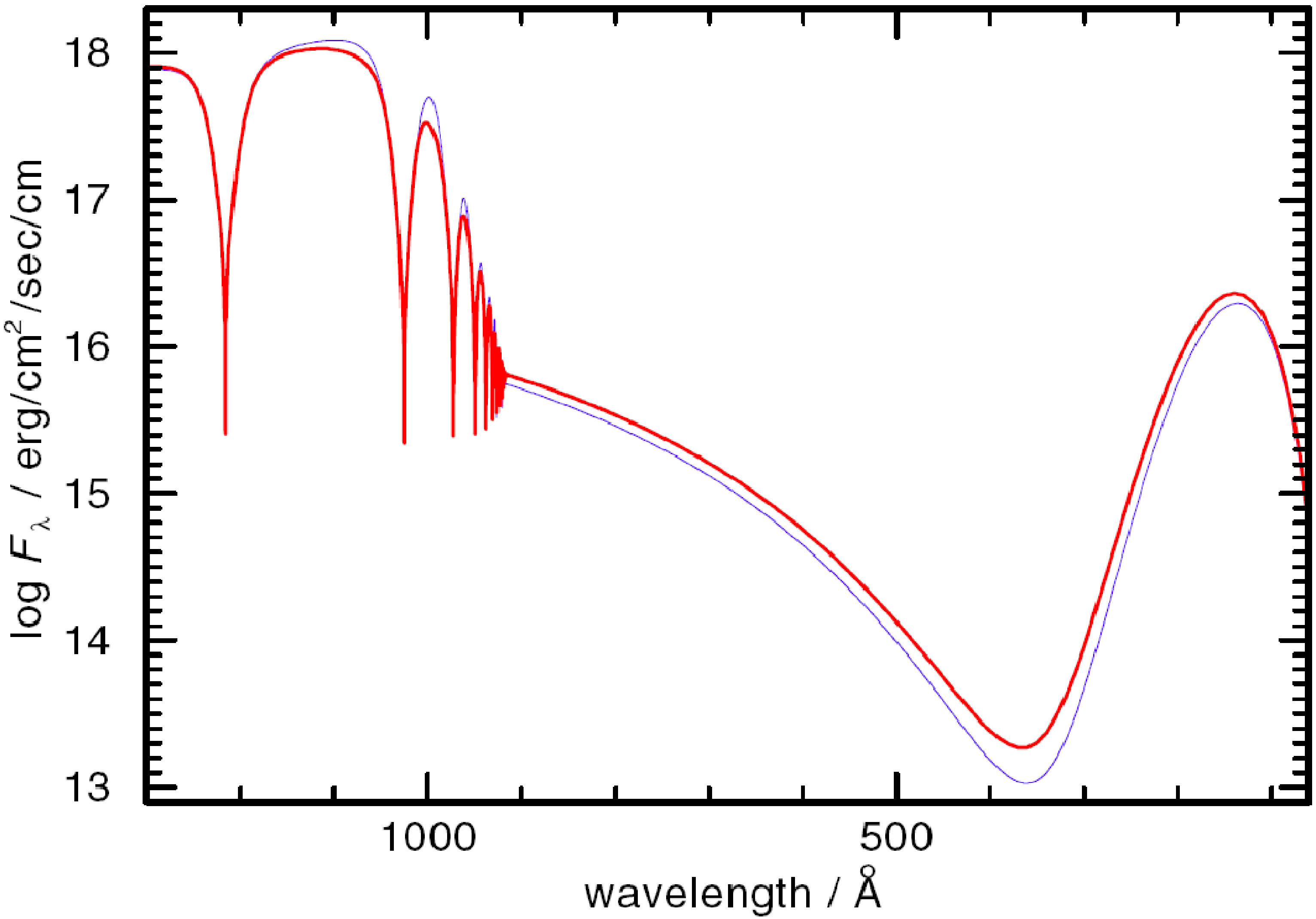

Fig. 2. Discrepancy between synthetic spectra for SiriusB calculated by *TMAP* (thick, long cutoff, see text) and *TLUSTY* (thin, short cutoff, Lanz priv. comm.) with the same parameters.

Rauch, 2008 A&A 481, 807

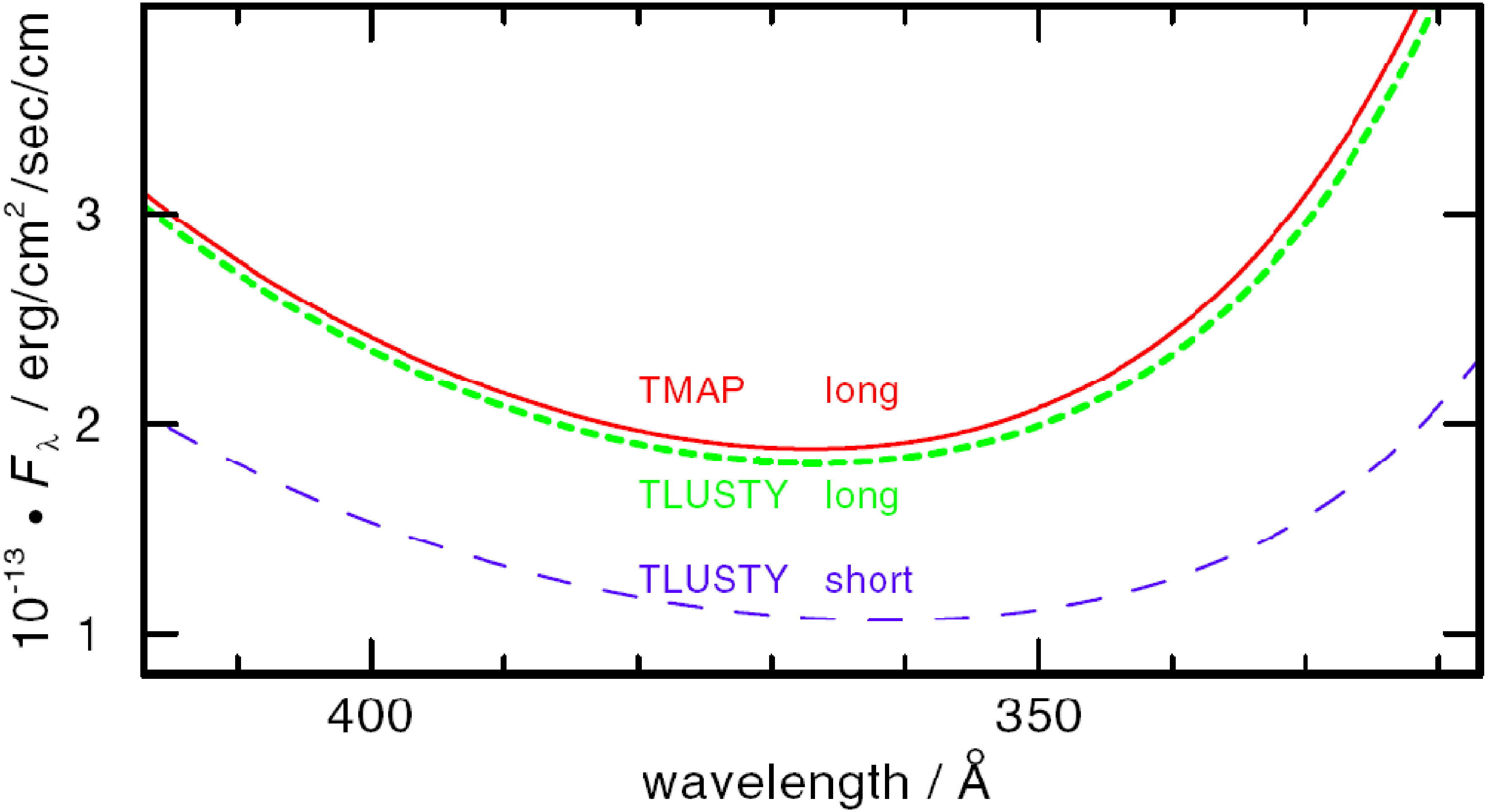

Fig. 4. Comparison of *TMAP* and *TLUSTY* (dotted: long cutoff, dashed: short cutoff) fluxes in the vicinity of the largest deviation (Fig. 2).

Rauch, 2008 A&A 481, 807

Home work from IACHEC 2009

- Discuss possible Chandra LETGS improvements
  with Chandra calibration Group
  - influence of new HRMA effective areas …
- Analyse LETGS data on
  - Sirius B (50ks on-axis and 50ks off-axis observations)
- GD153 110ks observation in the queue
  - Prepare grid of models (Lanz, Rauch)
  - analyse data as soon as available.
- Provide WD spectra in xspec format on web
- Improve link to iNS RXJ1856

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GD153 110ks LETGS Observation just performed

Summary

→ Other Calibration Observations

- Chandra Calibration data

  → Sirius B in 2008 (off axis, on axis).
  2 x 50 ks Chandra LETGS observation of

  → HZ 43 regular observations

  → INS RXJ1856 observation have been done since the 500 ks observation , XMM observes it regularly.

  → INS RXJ0720 original observed regularly calibration target, is observed regulary as a science target since ist spectrum varies precesses over timescale of 7-10 years

→ Recent observations

- Joint SRON/MPE/CXC

  → 110 ks Chandra LETGS observation of
  the white dwarf GD153 performed last week,
  will be analysed a.s.a.p.

- WG Meeting

  → informal sometime between the other splinter meetings