The warm absorbers of NLSy1 as seen in the X-rays

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Instruments & techniques

- PN & RGS on board XMM-Newton

\+ Effective area, broad band

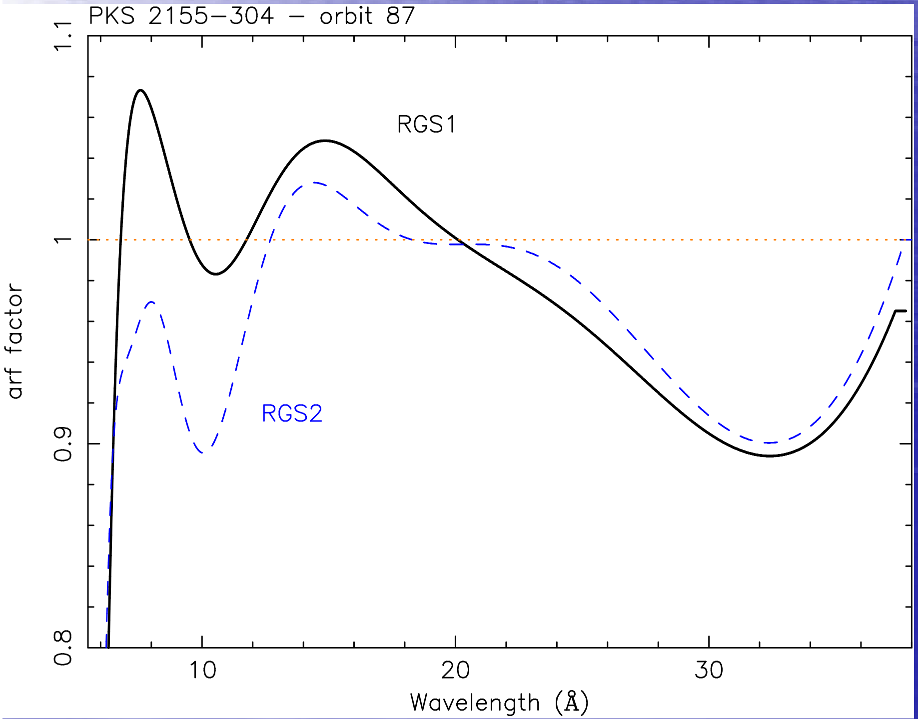
\+ High spectral resolution

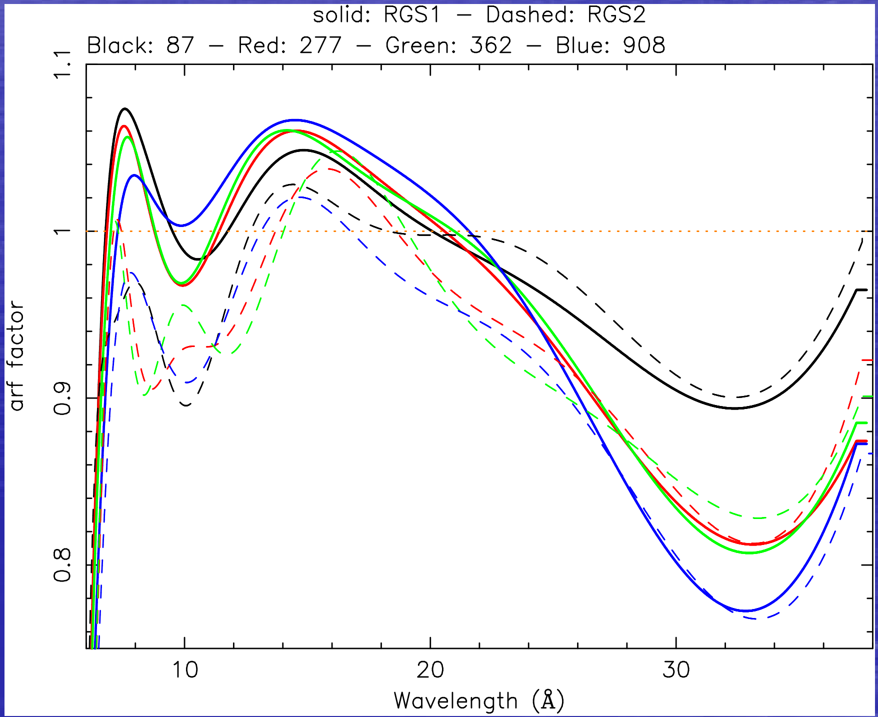
-- Known calibration problems!

RGS calibration

1) Determine effective area at launch using blazar spectra

2) Determine time variation: Progressive degradation in the carbon region (reason still unknown)





(Den Helder 2006 in prep.)

Characteristics of Narrow Line Sy 1

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UV/optical:

- Narrow permitted lines $FWHM_{H\beta}$ < 2000 km/s
- Weak forbidden lines [OIII]/Hβ < 3
- Strong FeII emission

X-rays:

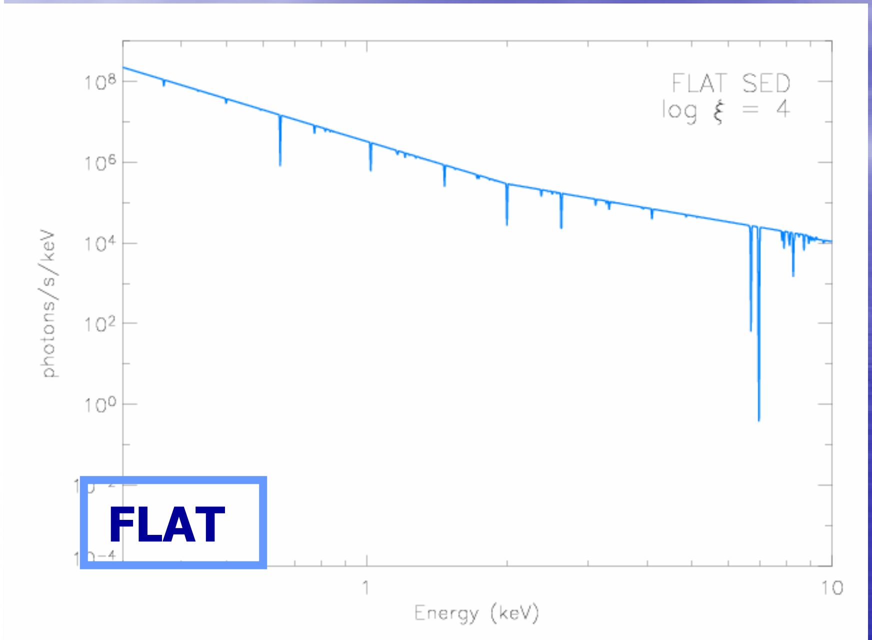
- Steep soft and hard spectrum
- High amplitude variability

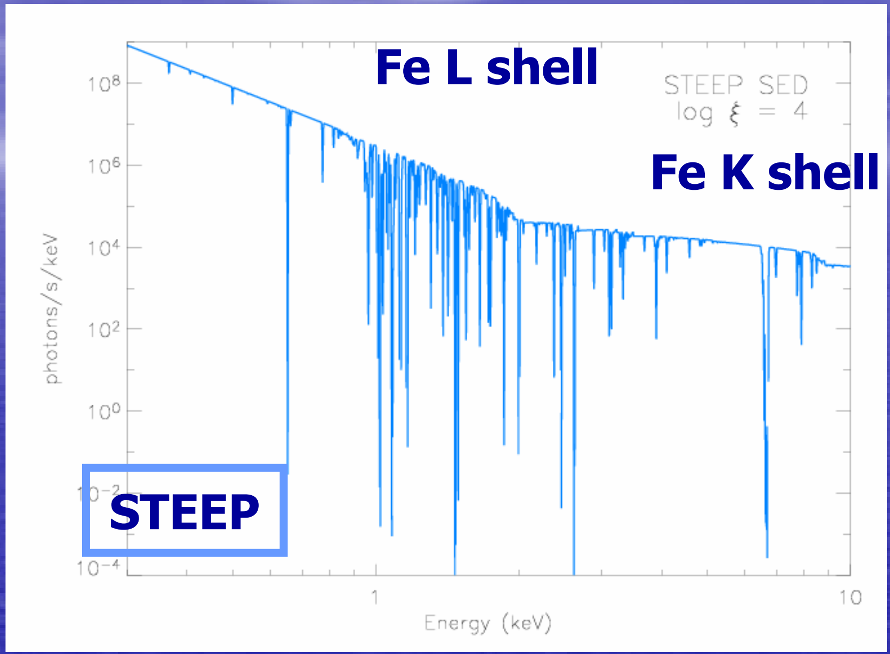
→ Smaller mass and higher accretion rate

The importance of the Spectral Energy Distribution in NLSy1s

- Strength of the soft excess ∝ fractional amplitude variability *(Leighly 1999)*
- Spectral complexity & steepness of α_{ox} ∝ historical low flux state *(Gallo 2005)*
- Steep X-ray spectrum → different ionization balance *(Nicastro et al. 1999)*

Importance of the SED





$$\xi = L / nr^2$$

Steep spectrum (NLSy1):

- Low values of ξ (-0.5- 0.5) → not a noticeable difference
- High values (ξ>3) → C, N, O completely ionized while iron L, K shell relevant

NLSy1 and warm absorbers

- High variability → response of the warm absorber → gas density (and distance)!
- Different ionization balance → Iron features are privileged
- Complex and highly ionized components → mass budget of the outflow

Method

- → Spectral Energy Distribution (XMM-OM+Epic)
- → Ionization balance (Cloudy)
- → SPEX warm absorber modeling (ξ, N_H)

  www.sron.nl/divisions/hea/spex/index.html

Method

Continuum:
'classical' power-law + black body or broken power-law.

Alternative modeling:

1) Reflection dominated spectrum
   (e.g. Ross & Fabian 05)
2) power-law absorbed by a relativistically blurred absorber possibly in the disk
   (Gierliński & Done 04)

Not critical for the SED shape

The sample:

- PHL 1092
- NGC 7314
- I Zw1
- 1H 0707- 495
- IRAS 13224-3809
- NAB 0502+024
- Mrk 110
- Ark 564

(Costantini et al. 2006 in prep.)

The sample:

	α_{ox}
PHL 1092	1.6
NGC 7314	1.2
I Zw1	1.2
1H 0707- 495	1.5
IRAS 13224-3809	1.5
NAB 0502+024	1.5
Mrk 110	1.3
Ark 564	1.2
	1.2

(Costantini et al. 2006 in prep.)

The sample:

	α_{ox}	Γ_{soft}
PHL 1092	1.6	3.5
NGC 7314	1.2	2.5
I Zw1	1.2	2.2
1H 0707- 495	1.5	2.8
IRAS 13224-3809	1.5	3.1
NAB 0502+024	1.5	2.8
Mrk 110	1.3	2.3
Ark 564	1.2	2.4
	1.2	2.5

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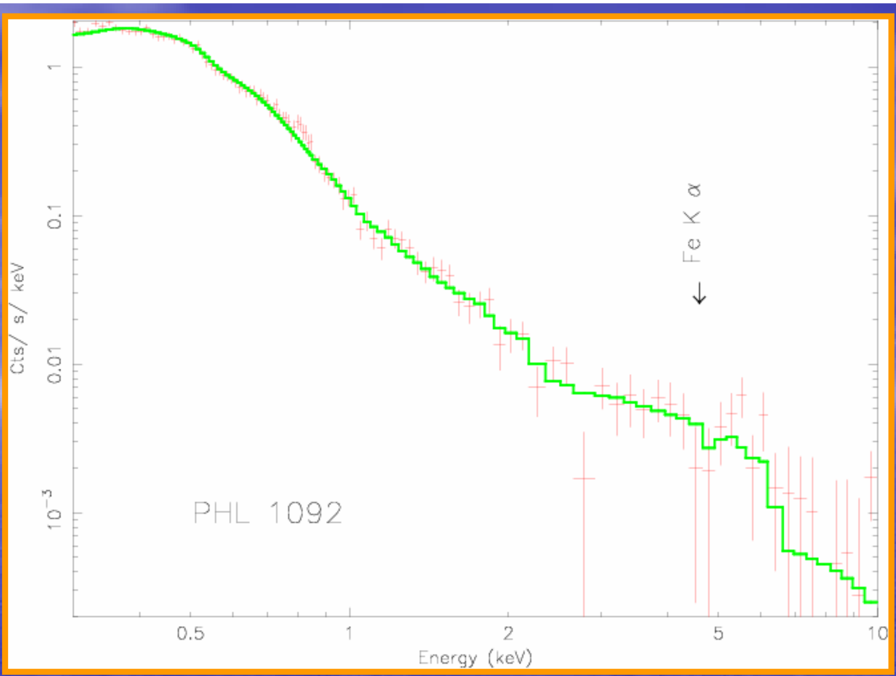
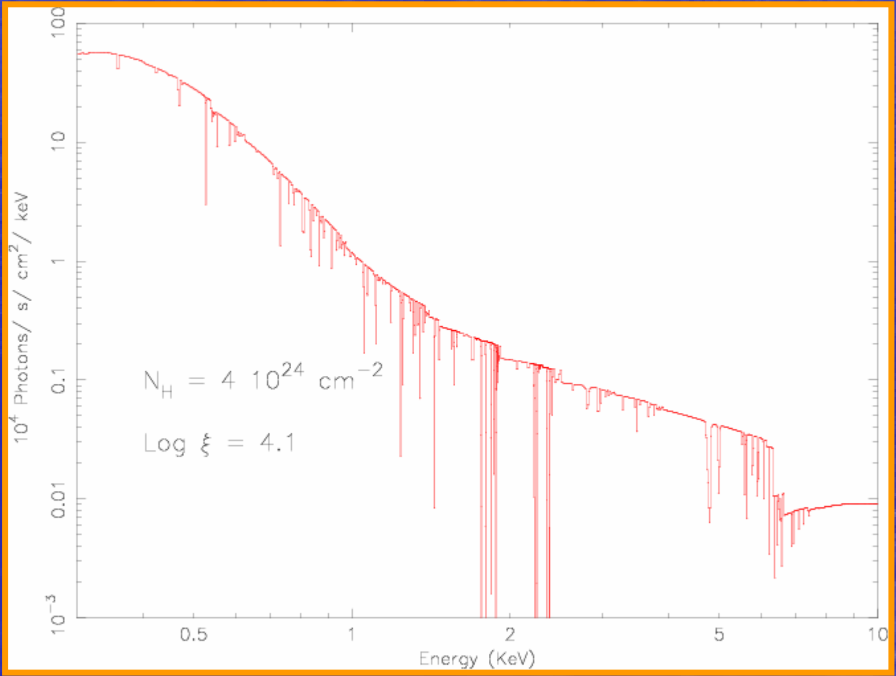
PHL 1092

- z=0.39
- very steep SED
- RGS N/A

- Warm absorber:
  $N_H \sim 4 \times 10^{24}$ cm^{-2}
  Log $\xi \sim 4$
- No evidence of Fe emission lines



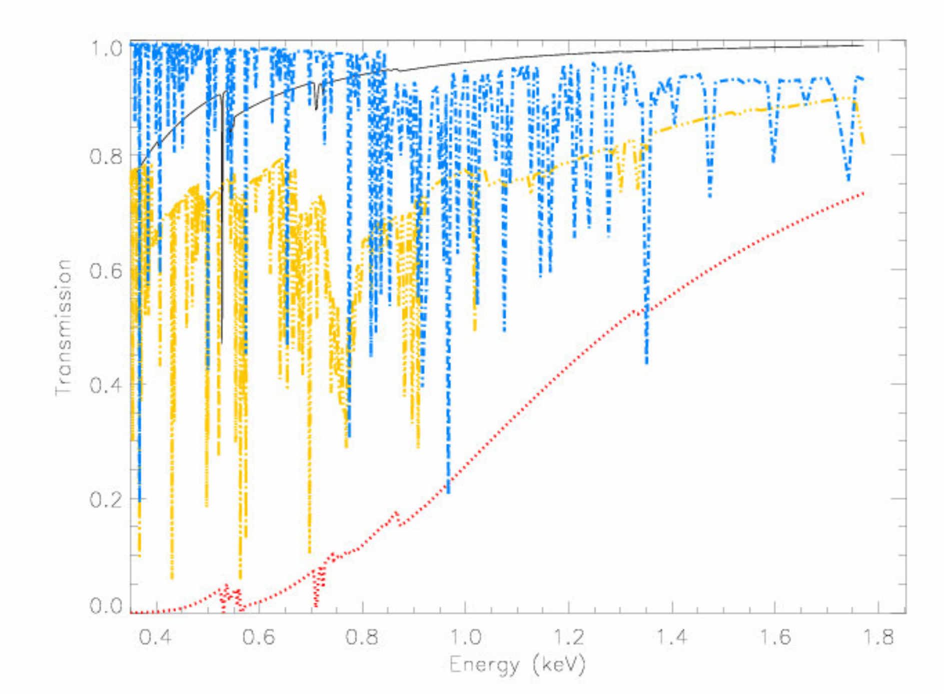


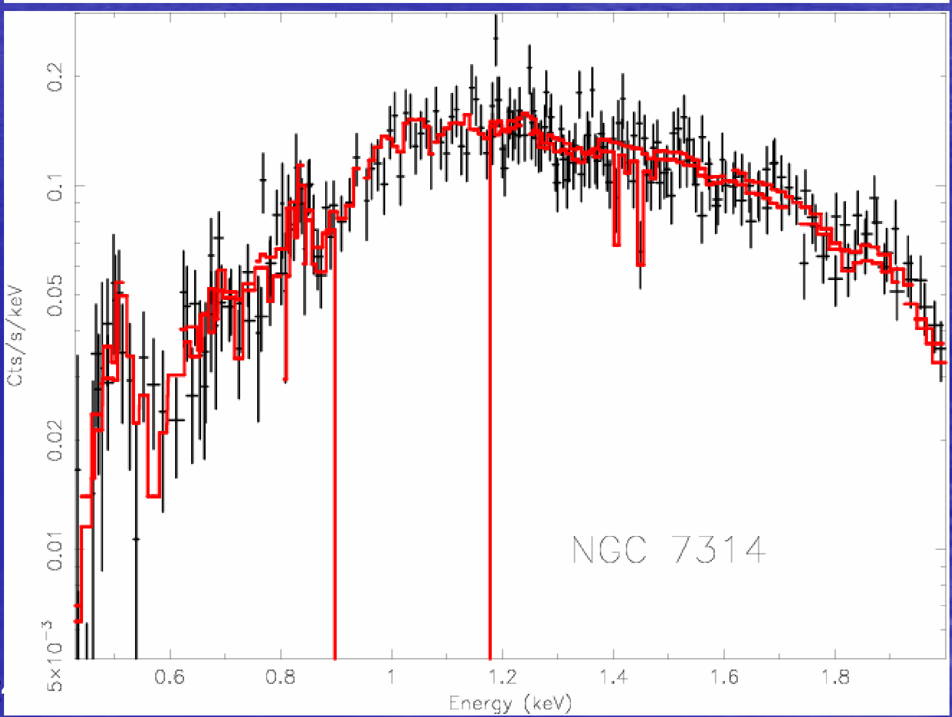
NGC 7314

- Sy1-like SED (flat)

- 2 warm absorbers:
Log ξ ~ 0.6, 2.5
- 1 neutral absorber
→ host galaxy

- No high energy absorber





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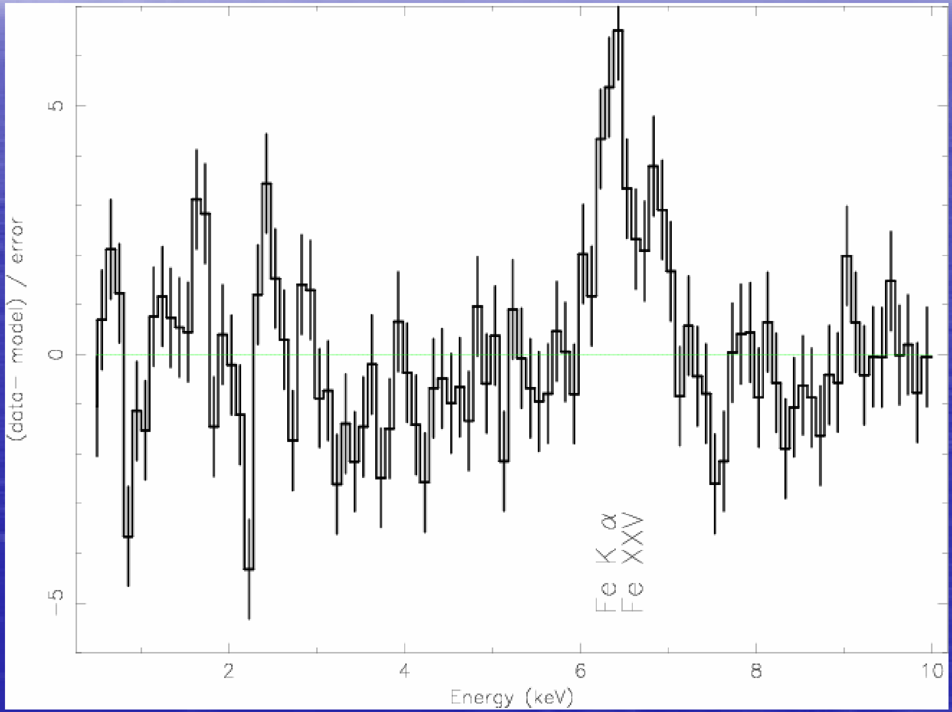
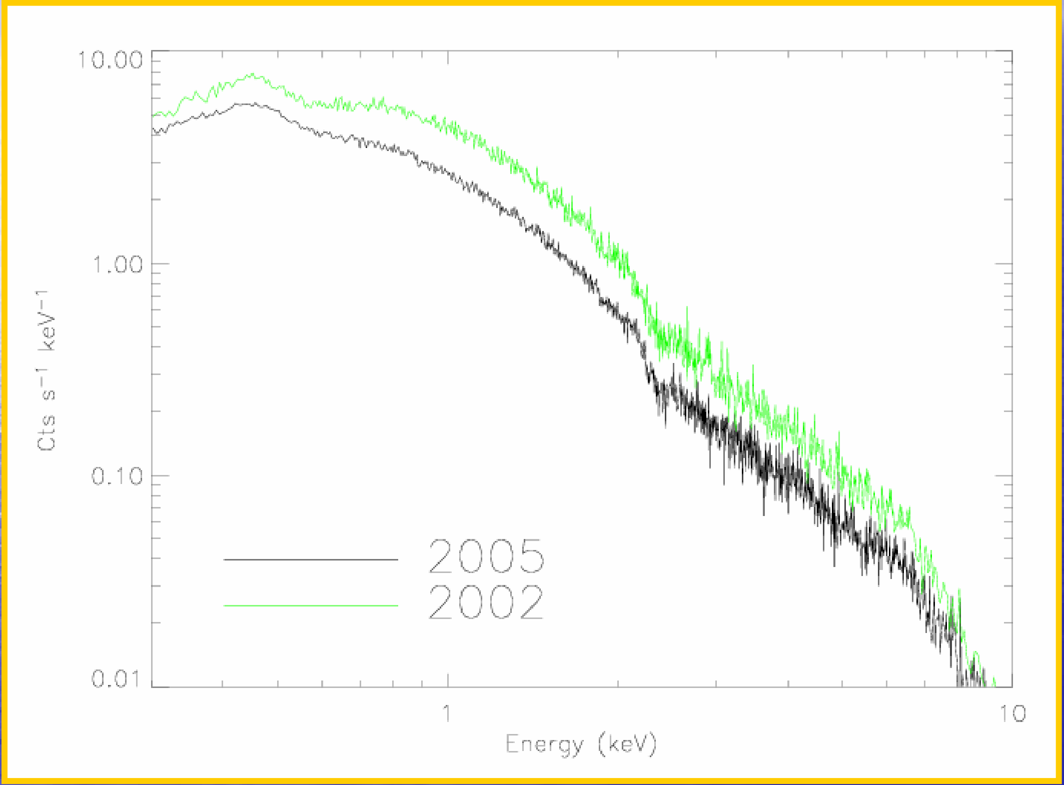
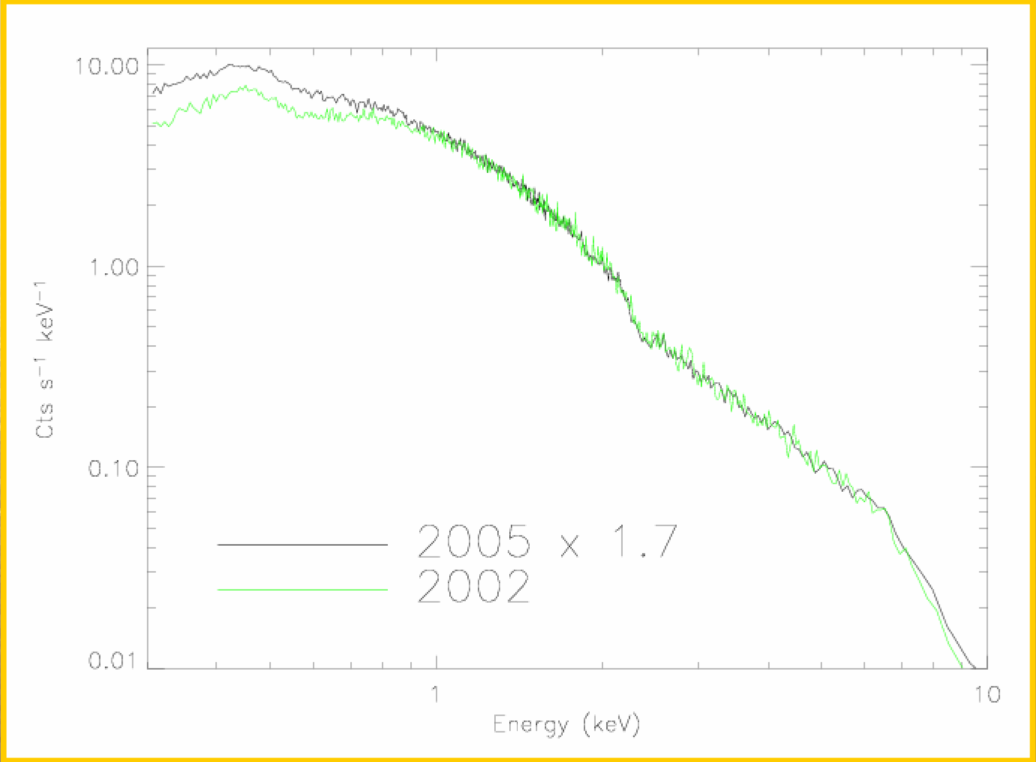


I Zw 1



- NLSy1 prototype (strong FeII)
- UV and X-ray warm absorber *(Laor et al. 97, Leighly 99)*
- 2 XMM-observations:
  2002 *(Gallo et al. 04)*
  2005 *(pi: Gallo)*

I Zw 1



2002:

$N_H \sim 1.5\ 10^{21}\ cm^{-2}$

Log $\xi \sim$ --0.6

2005:

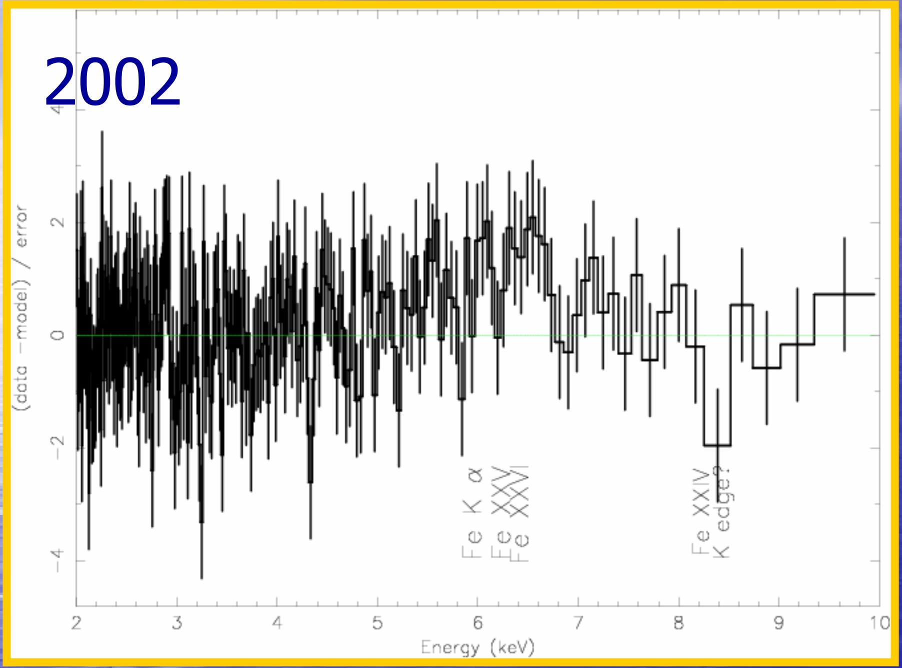
$N_H \sim 1.7\ 10^{21}\ cm^{-2}$

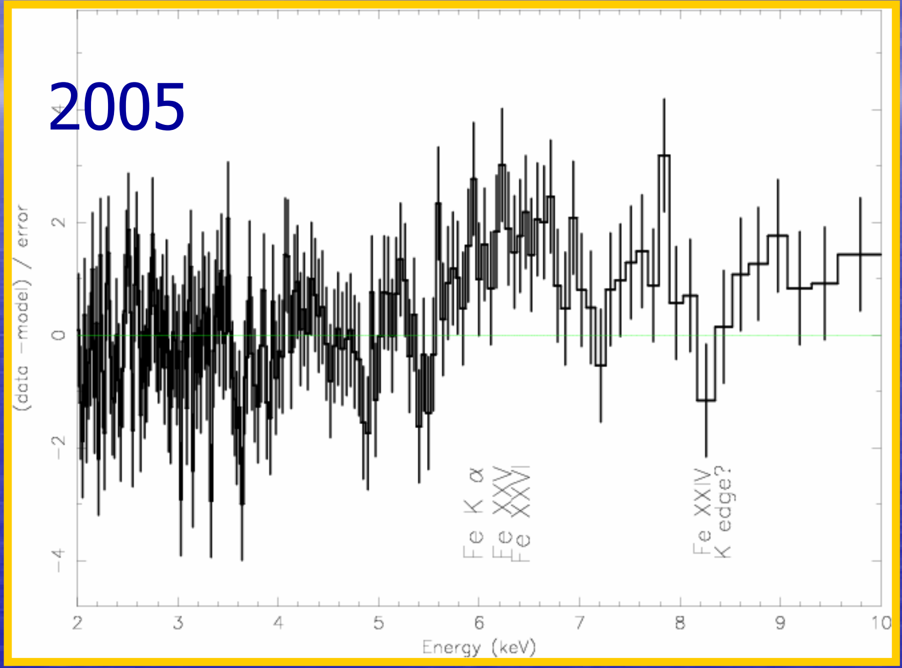
Log $\xi \sim$ 0.8

→ Absorber at smaller distance?

→ Transient ionized cloud?

The iron K-alpha line region





1. Same iron line complexity

→ multiple narrow lines or broad Iron XXV line

2. Hints of iron XXIV edge?

→ allowed but implies strong resonant lines at 6.7 keV

→ Much stronger emission line required

Outlook

- NLSy1 warm absorbers not (observationally) homogenous
- Hints of high ionization outflows (but higher statistics is needed)→ importance for chemical enrichment
- complex RGS spectra →
  1) multi-component warm absorbers,
  2) possibly transient features,
  3) contribution of the host galaxy

The End