RGS fine structure & edges

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20-5-2019

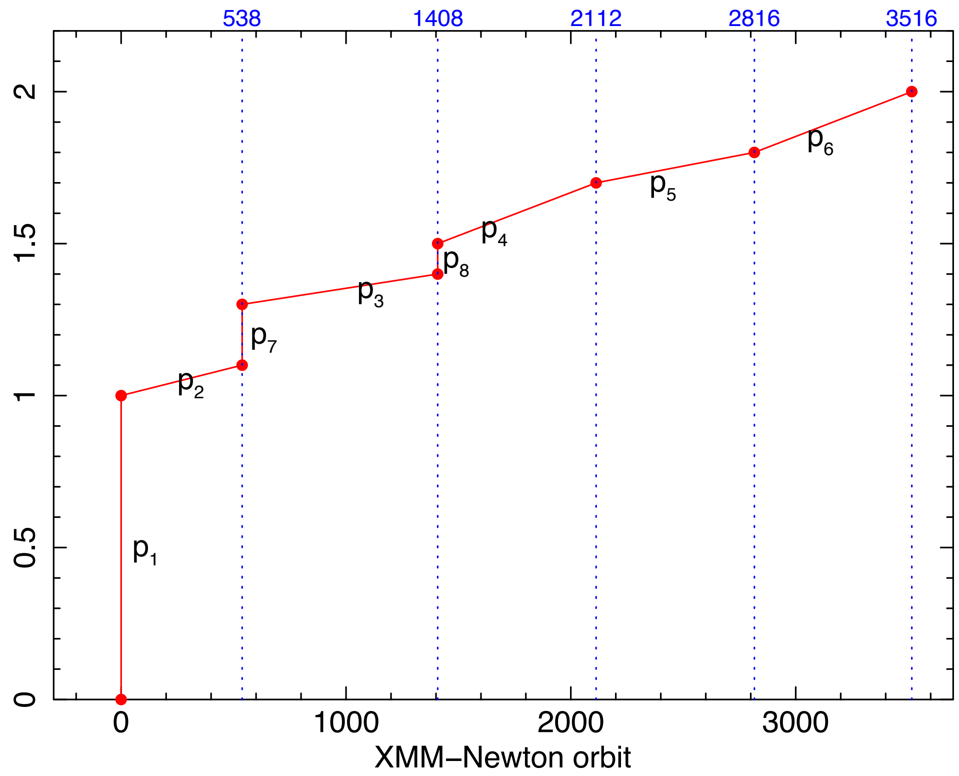
Effective area correction RGS

time- and wavelength dependent

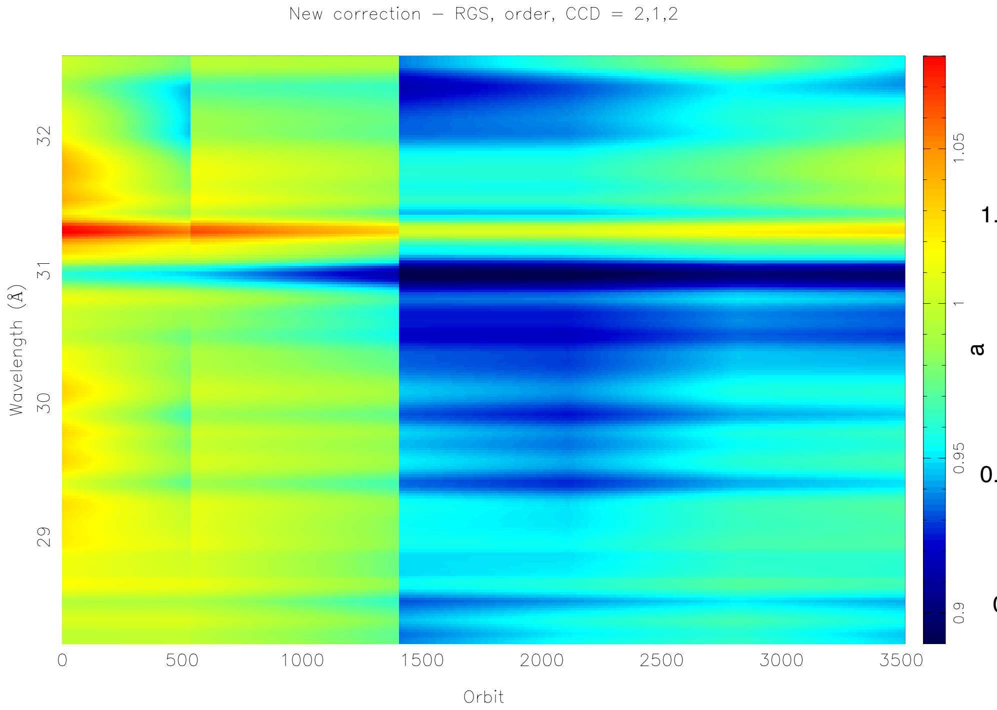
based on ~100 blazar spectra modeled with SPEX

Method:

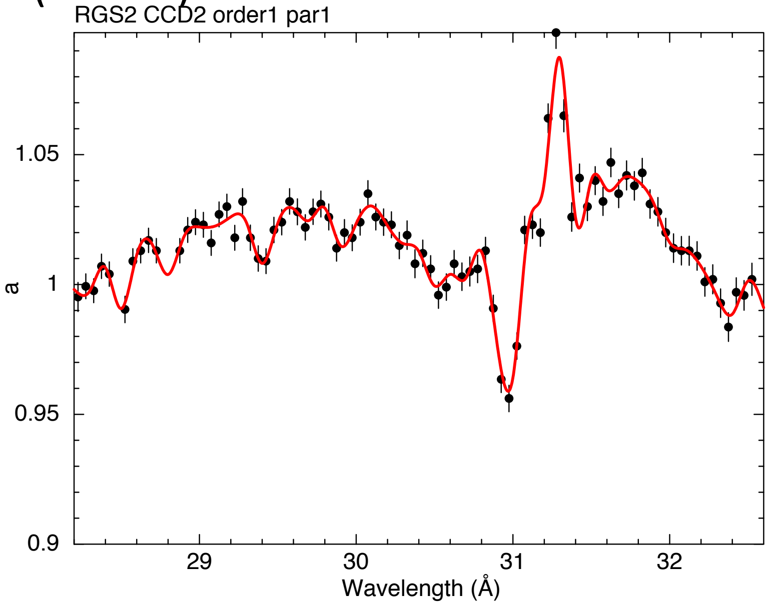
- Use ~100 spectra of Mrk 421 & PKS 2155 with RGS1&2
- For each spectrum: Fit broken power law with fixed Galactic absorption to joint RGS1 & RGS2 data
- Determine relative fit residuals for RGS1 and RGS2 separately
- Stack the residuals in 0.05 Å wide bins
- Fit the ~100 residuals R(λ,t) for each λ to a stepwise function in t with 8 parameters p_i (λ)
- Store $p_i(\lambda)$ to file, use these to correct each RGS to common scale
- Now both RGS agree; only need to find absolute calibration



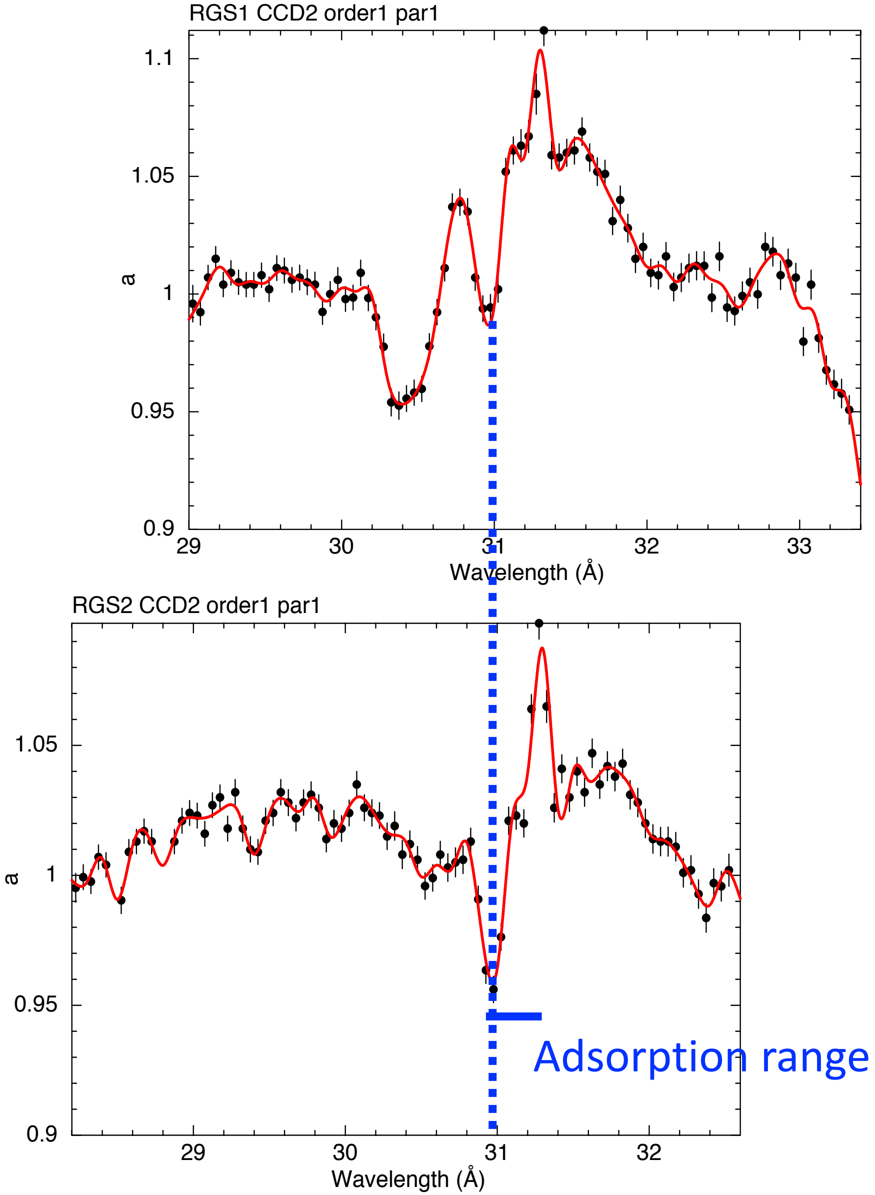
Example for RGS2



Effective area correction at orbit 0 (launch) for RGS2 CCD2



Nitrogen features



Note 31.000 Å = 400.0 eV

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ADSORPTION OF HYDRAZINE AND AMMONIA ON ALUMINIUM

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Hydrazine = N2H4
Coldest part XMM-Newton is RGS surface (Al-oxide)

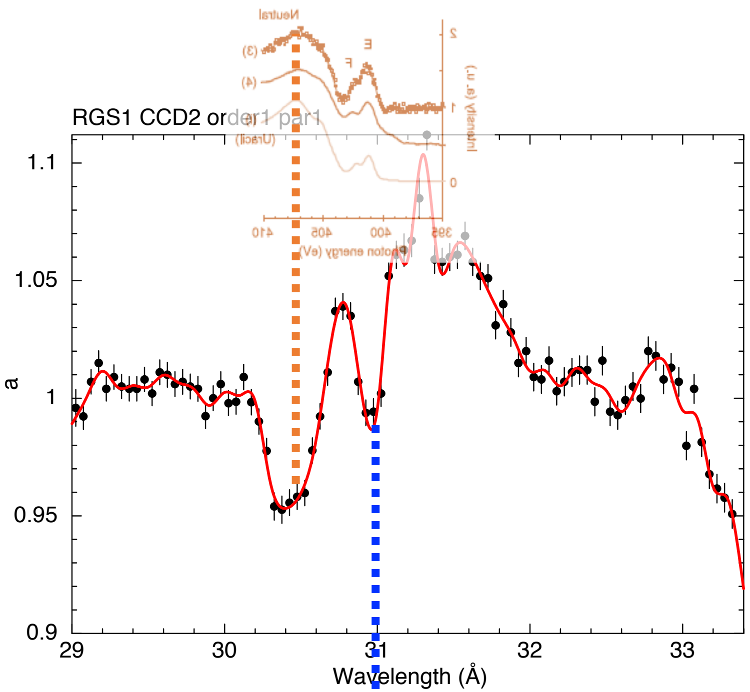
$$N_2H_4 \rightarrow N_2 + 2H_2$$

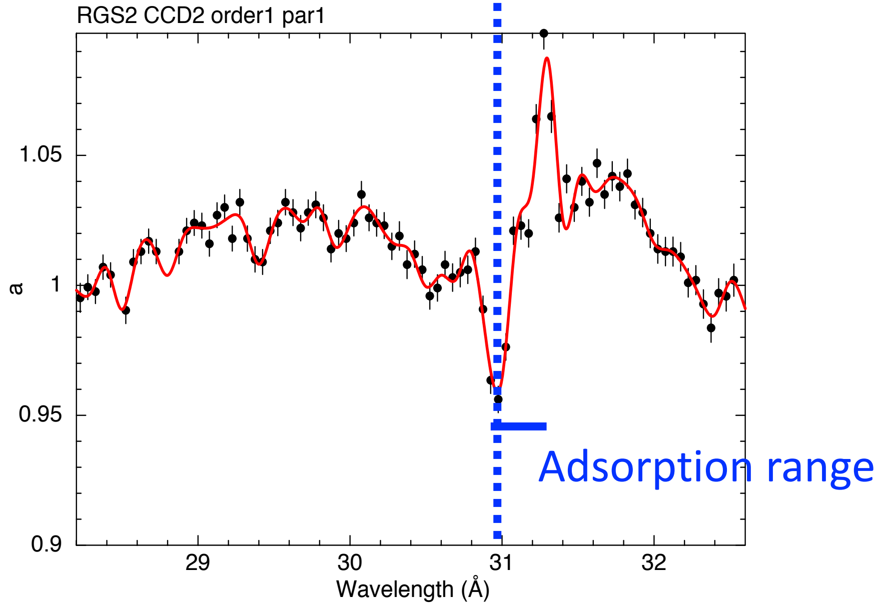
$$3N_2H_4 \rightarrow 4NH_3 + N_2$$

Ammonia on Al gives line: depending on deposition temperature & thermal history between 399.6 and 400.5 eV, FWHM between 2.6 and 3.6 eV
= (30.96-31.03 Å, FWHM 0.020-0.028 Å)

In excellent agreement with data!

In general N ad-atoms line between 397.0 -400.5 eV (30.96-31.23 Å)



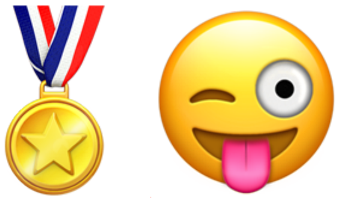


Nitrogen features

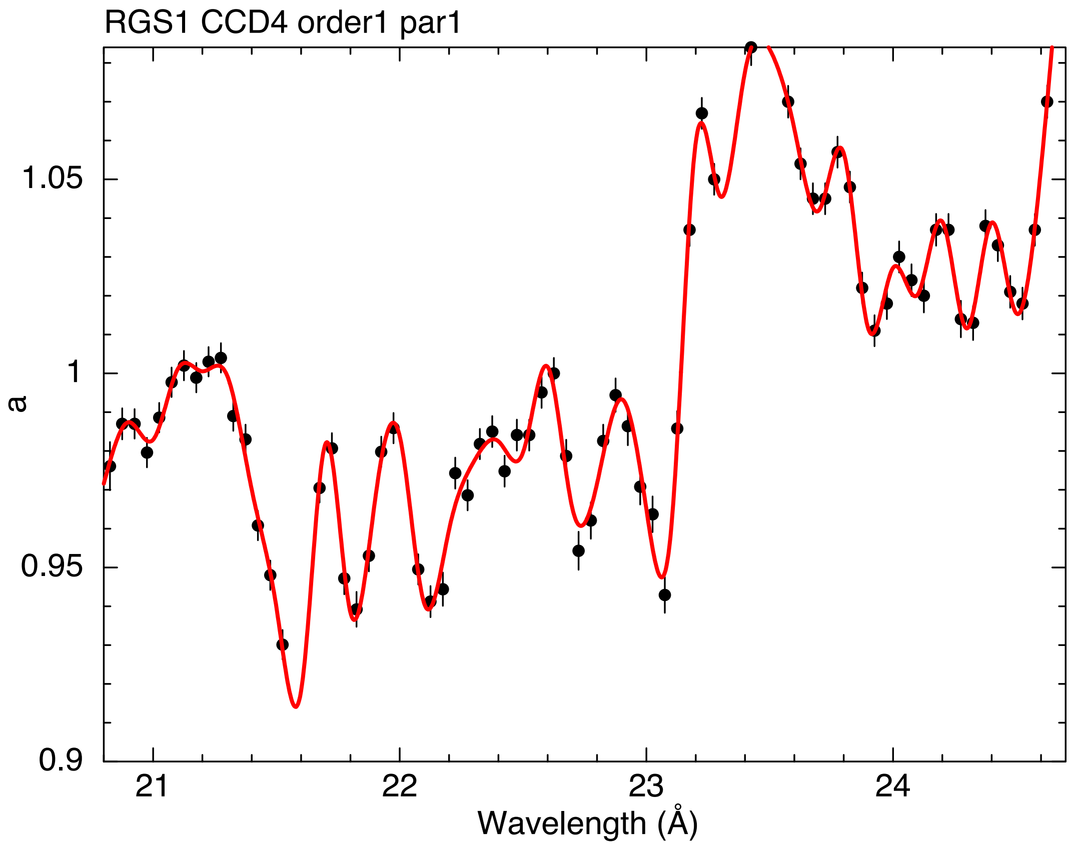
Title	Nitrogen K-edge X-ray absorption near edge structure of pyrimidine-containing nucleotides in aqueous solution
Author(s)	Hiroyuki Shimada, Hirotake Minami, Naoto Okuizumi, Ichiro Sakuma, Masatoshi Ukai, Kentaro Fujii, Akinari Yokoya, Yoshihiro Fukuda, and Yuji Saitoh
Citation	Journal of Chemical Physics, 142(17), 175102 (2015)

XANES structures near Nitrogen edge measured in Japan match well RGS1 (and less deep in RGS2)

Lower curve is Uracil (DNA constituent)
We found first evidence for life in space!



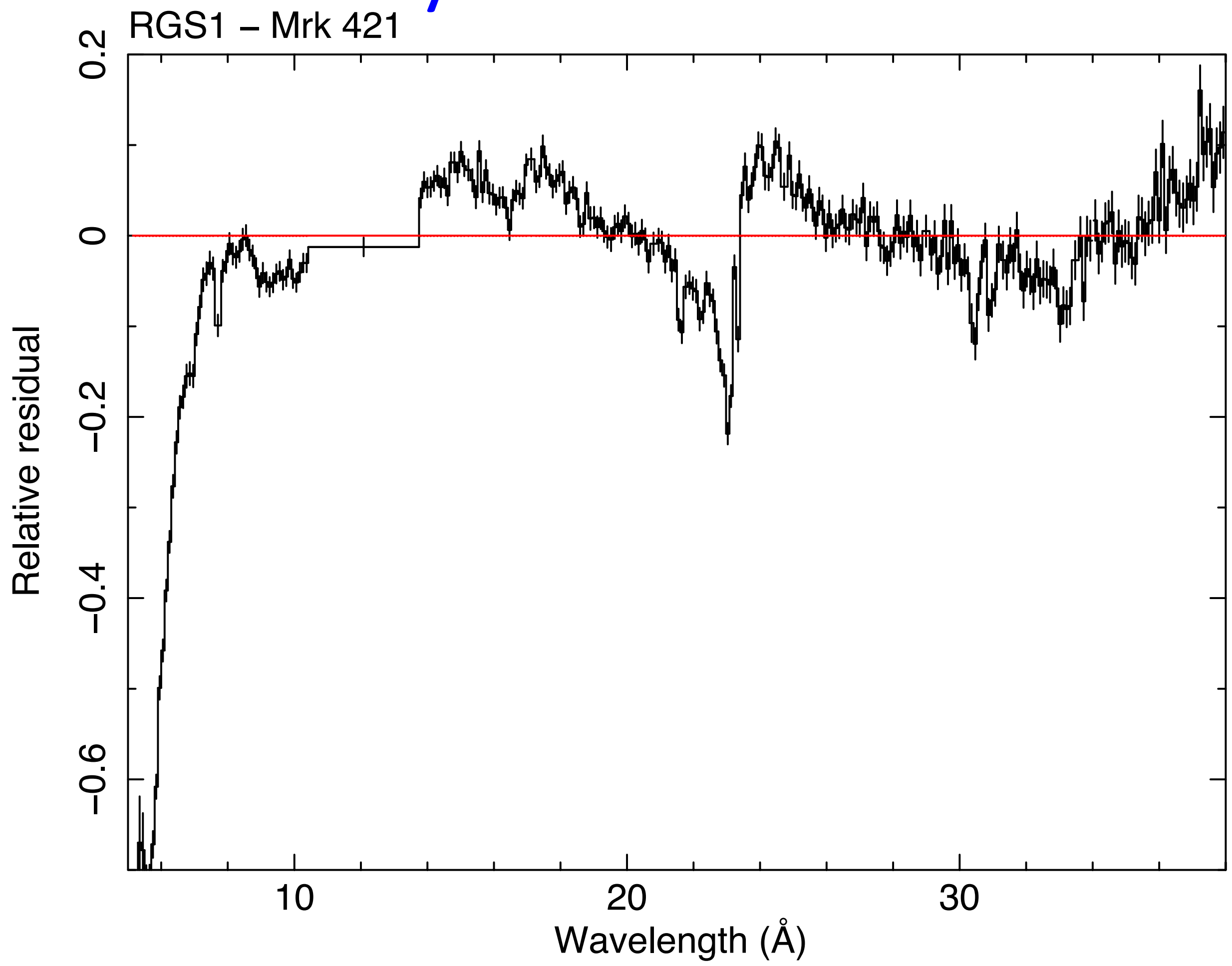
Near the oxygen edge



Motivation

- As noted during last years meeting by Charo:
- Current area correction is stack of several factors:
  - Vignetting
  - Oxygen edge structure
  - Jacco correction (Chebychev)
  - Time-dependent contamination
  - Last year’s empirical t,lambda dependent corrections
- Time to create one correction factor!

Surprise: relatively smooth area

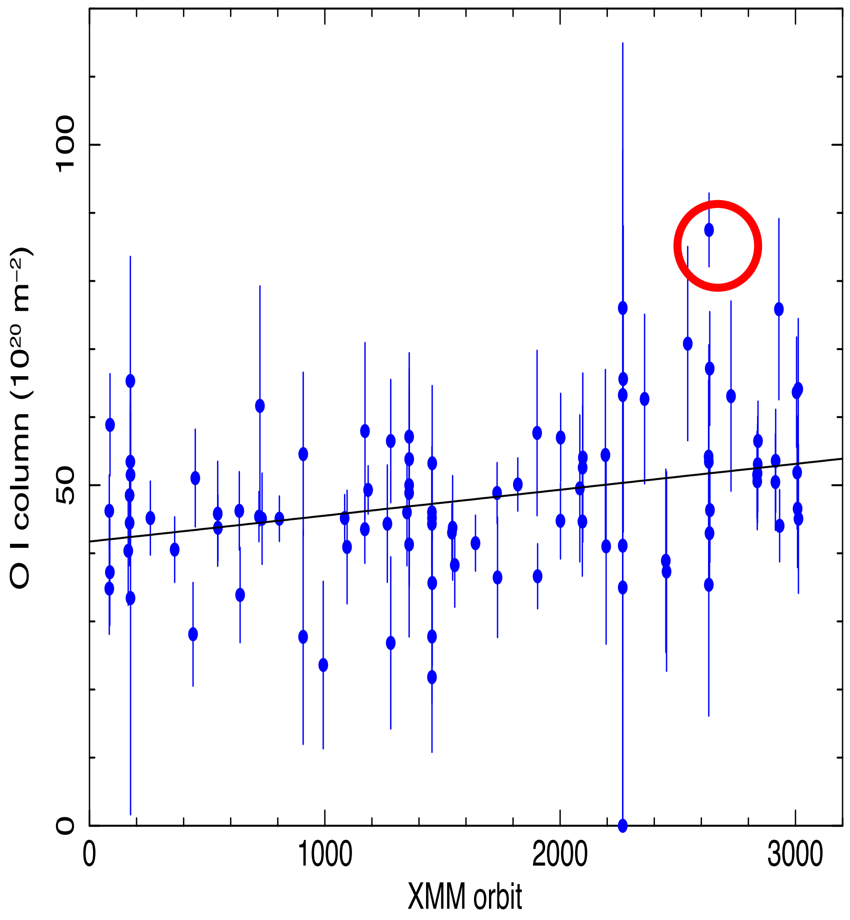


Analysis of O-edge

- fit RGS1 between 20.8-24.8 Ang (same CCD)
- Exclude fine structure 22.5 – 23.7 Ang.
- Fit locally a power law with Galactic absorption (*hot+amol*),
- Add *slab* component. Use σ_v=50 km/s and O VII log column 20.24.
- Leave O I as free parameter that is fitted.

Results

- Linear function (without 1 outlier):
- N=a+bt
- *t in XMM orbits*
- *N in 10^{20} m^{-2}*
- χ^2=88.4 for 93 dof
- b = 0.0028±0.0008
- a = 42.5±1.4
- N(3200)=51.3
- ➔ increase in total neutral oxygen column by about 20% at 3.5σ significance since launch
- No difference between Mrk 421 & PKS 2155-304 (mean N is 46.3±0.8 & is 46.9±1.8, respectively)



Fitting the O I 23.5 Å line

- Fit the O I line
- columns
- Mrk 421: 9.72±0.64 (Expected from 21cm: 9.75)
- PKS 2155-304: 6.35±0.75 (Expected from 21 cm: 5.75
- ➔ no dust depletion? (TBC)

Stacked residuals after removing atomic O I at t=0