ACIS-S Contamination and modeling of X-ray absorption in High Redshift Quasars

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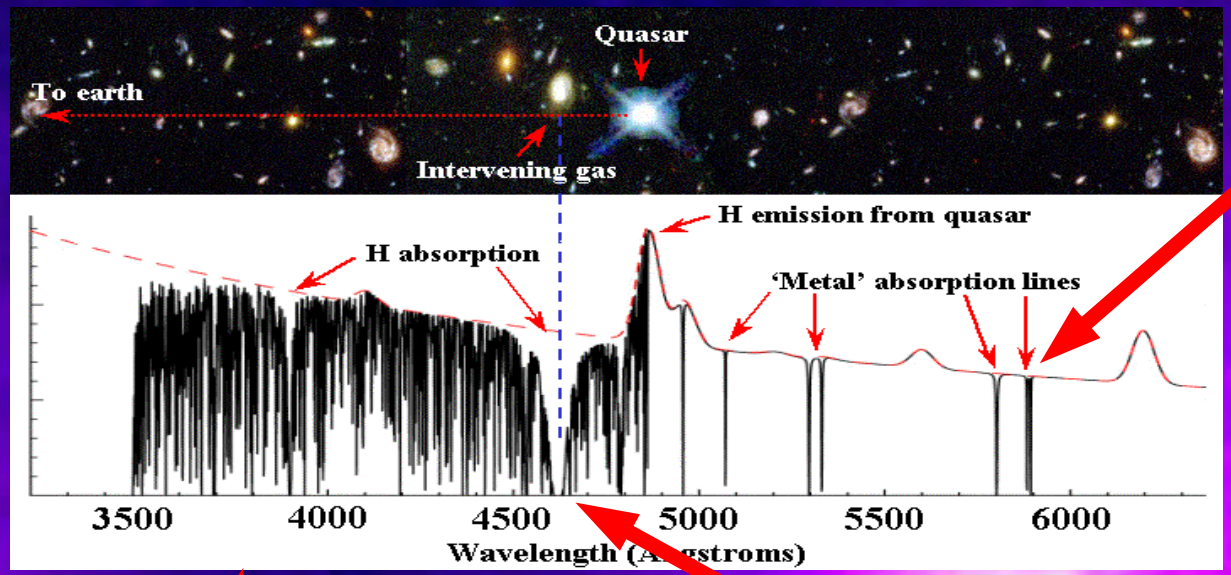
Outline

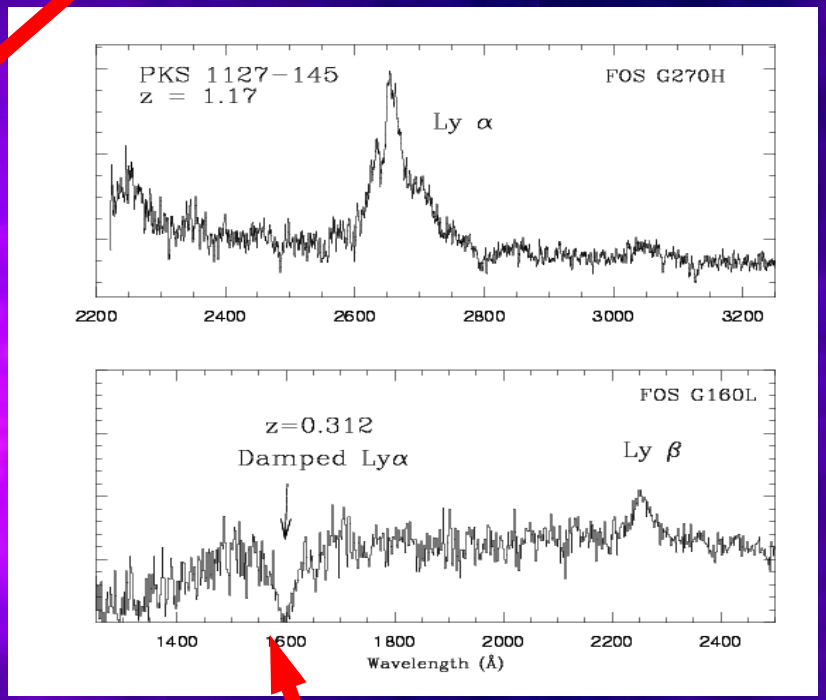
- X-ray absorption in high redshift quasars
- Chandra ACIS-S data and contamination.
- Model tests on a sample of quasars observed with Chandra.
- Chandra and XMM-Newton observations

Quasar Absorption

Webb, www page
also Pettini 2003

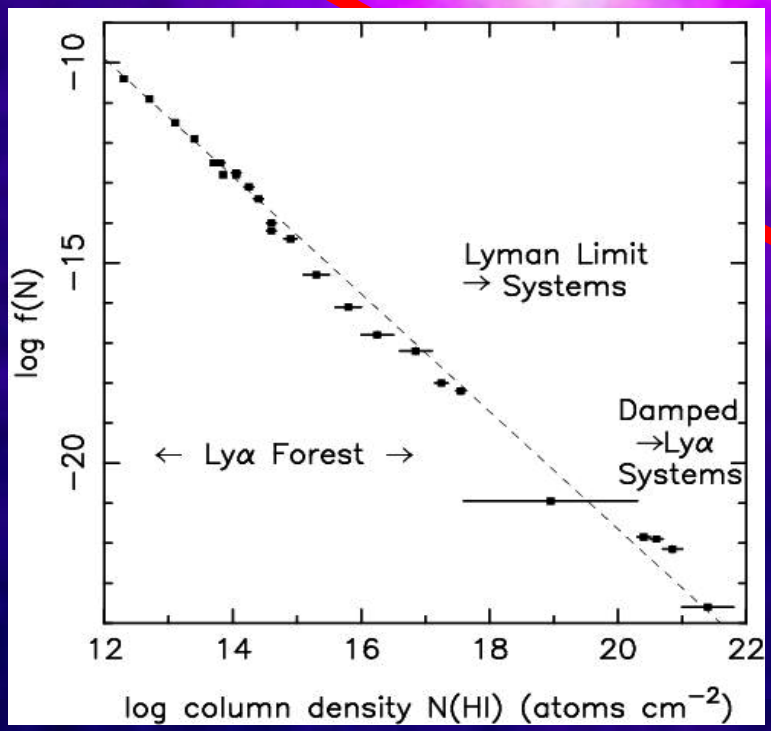


Metal lines: N(HI) >10^{18}cm^{-2}



HST/FOS, *Bechtold et al (2001*

Ly Forest
N(HI) < 10^{17}cm^{-2}

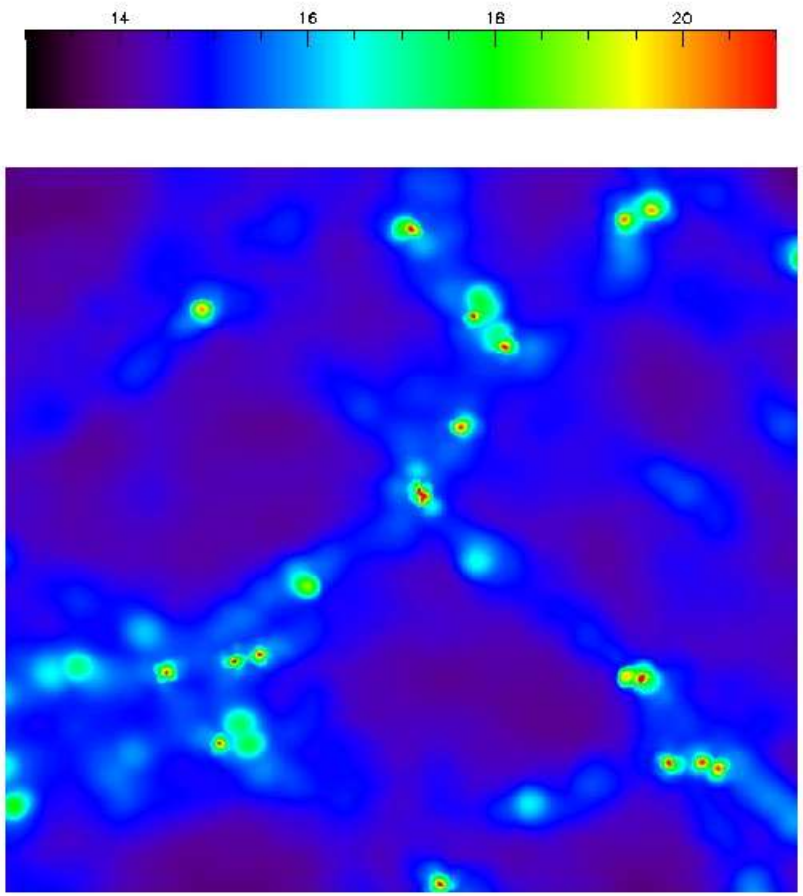


Pettini 2003

Damped Lyα
N(HI) > 2x10^{20} cm^{-2}

Damped Ly-alpha Absorption

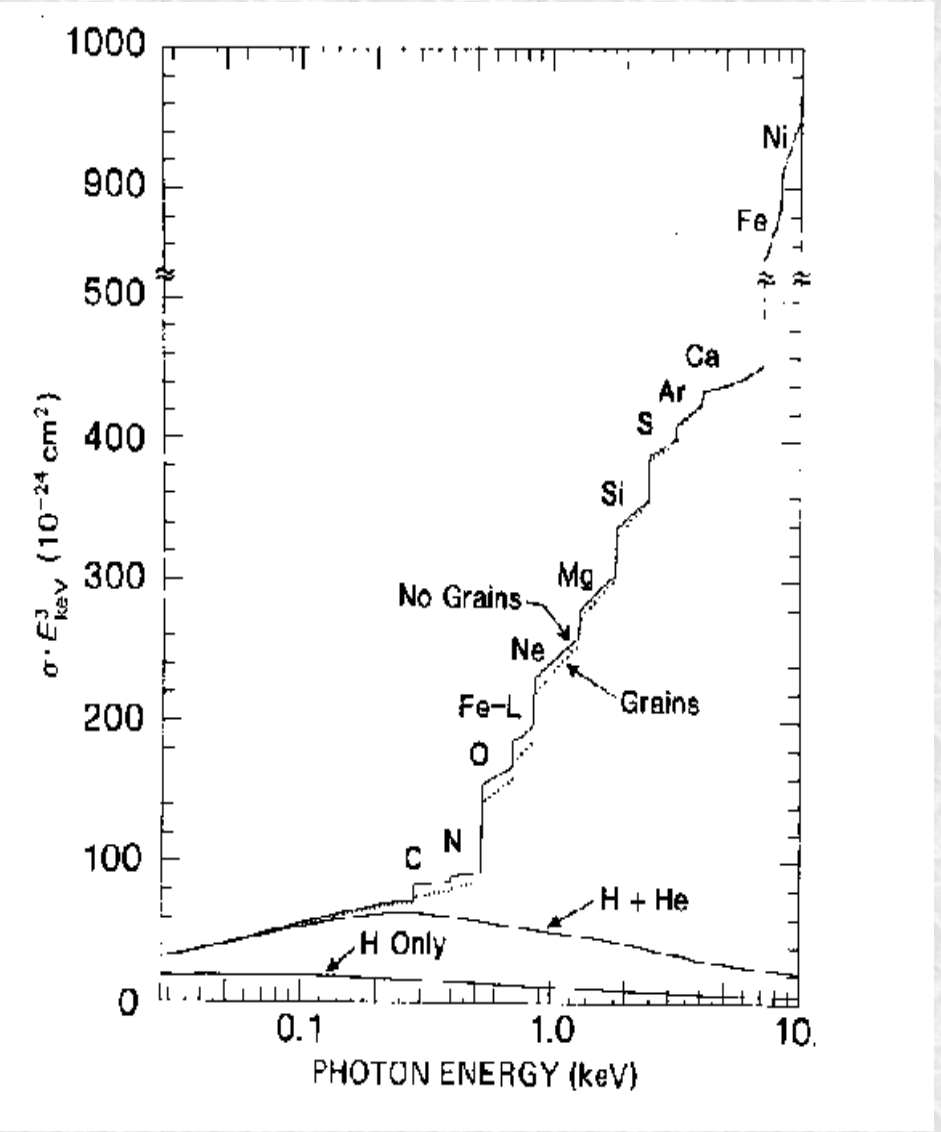
- Absorption systems on the line of sight towards quasars with **$N(HI) > 2 \times 10^{20}$ cm^{-2}**
- The **highest N(HI)** among QSO absorption systems.
- Some systems can be identified with galaxies.
- Metallicity at different redshift => structure formation.
- Why X-rays?



Wolfe and collaborators
Storrie-Lombardi & Wolfe 2000
ApJ 543, 552
Rao & Turnshek 2000 ApJS 130, 1
Pettini 2003, astro-ph/0303272

X-ray Absorption

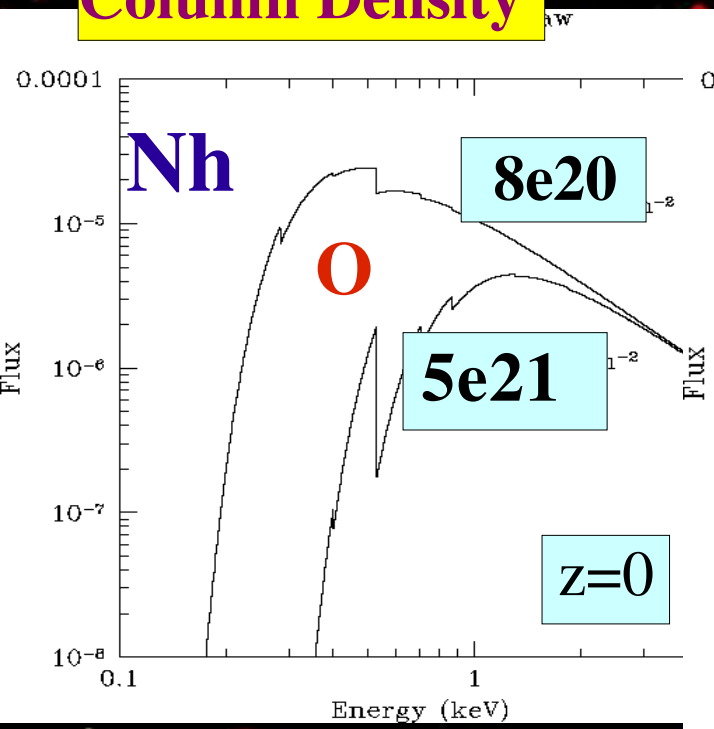
- Soft X-ray absorption primarily due to
  => Helium, Carbon and Oxygen
- Dust independent .
- UV lines are often saturated.
- H Lyα measurements give N(HI) column.
- Compare X-ray absorption to Zinc (undepleted) => relative abundance of Fe group to alpha group
- Pop II has enhanced O/Fe



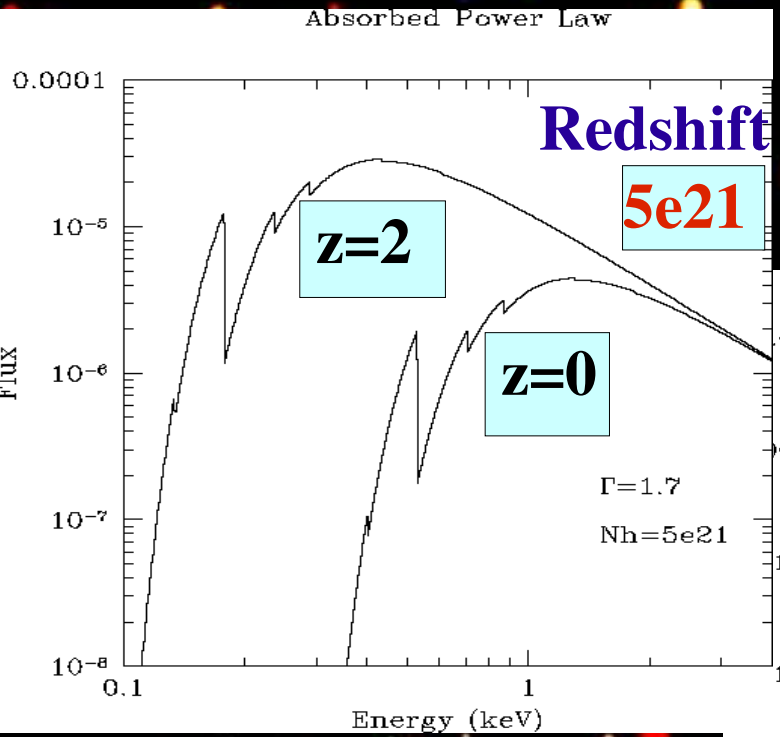
M&MC 1983

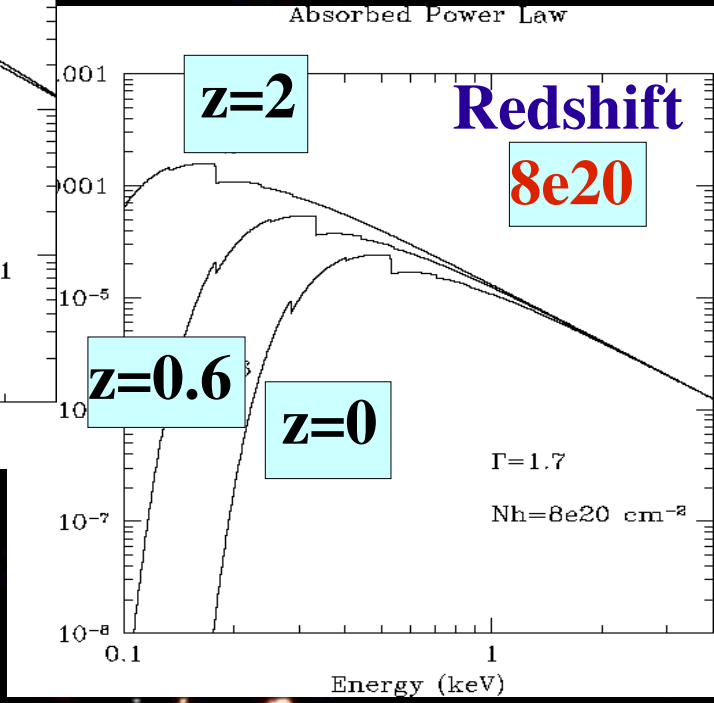
Photoelectric Absorption in X-rays

Column Density



Redshift





Chandra Energy: 0.3-7keV
Absorption Effects : E < 1keV

ACIS-S Contamination Strongest E < 1!

ACIS-S Quasars Observations

- Long exposures to detect absorption
- Point sources on axis
- Strong Contamination effects at E < 1keV
- Two contamination models:
  - acisabs
  - contamarf

ACIS-S Quasars Sample

Quasar	N_H(gal)	ObsID	Obs. Date	Exposure	Mode	Frame time	Total counts
PG 1634+706	4.54	62	2000-03-23	4854	F	0.441	1773
GB 1508+5714	1.4	2241	2001-06-10	88970	F	3.241	5242
1328+254	1.08	3103	2002-01-06	36213	VF	0.441	4198
1458+718	2.33	3105	2002-01-28	16946	VF	0.441	6035
0134+329	4.54	3097	2002-03-06	9224	VF	0.441	7160
PKS 2201+044	5.15	2960	2002-04-27	36641	F	0.441	10511
PKS 0458-020	7.49	2985	2002-10-10	70522	VF	0.441	7253
1250+568	1.22	3102	2002-10-27	14006	VF	0.441	2916

N_H in 10^{20} cm^{-2}

Exposure in sec

All sources on ACIS-S3 at ~35 arcsec off axis

S3: (chipx,chipy) (264,515) - (297,590)

Data Analysis

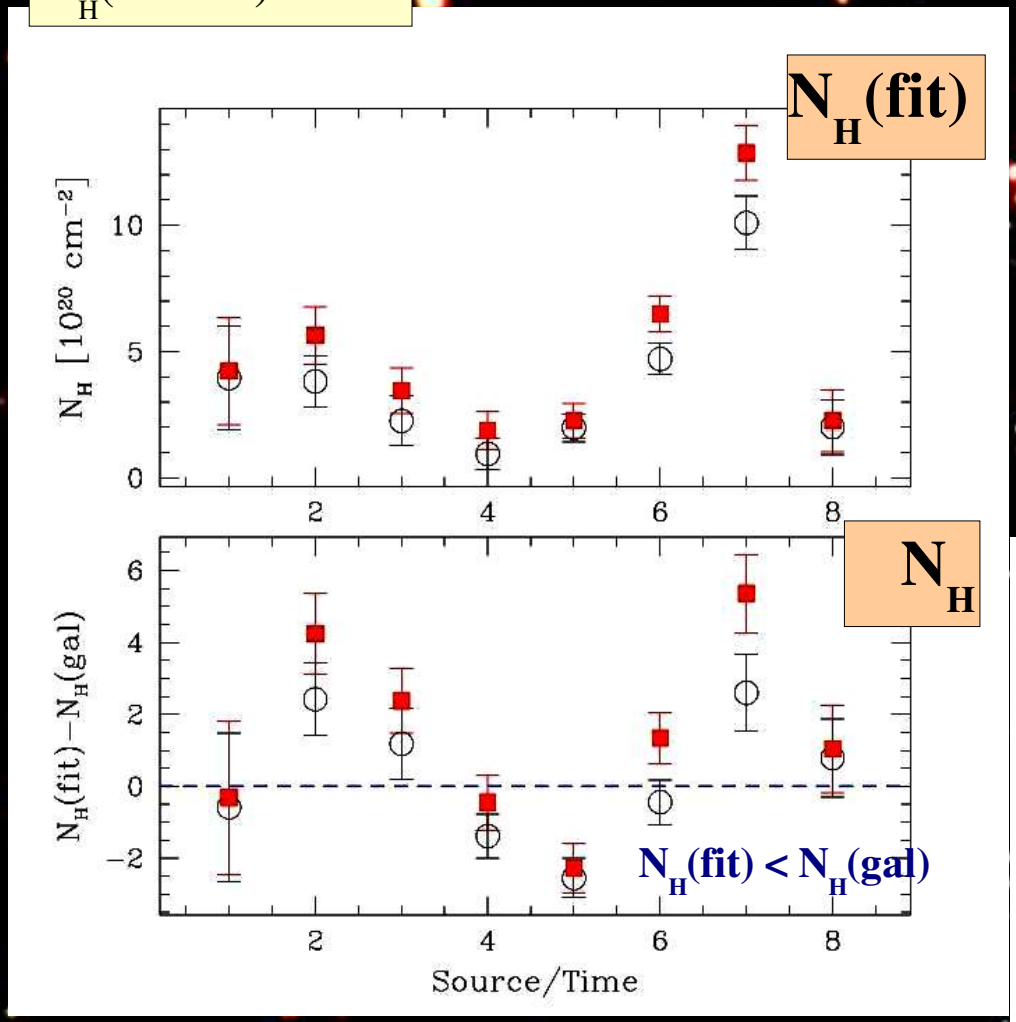
- Analysis in CIAO 3.0 and CALDB 2.23
- Two contamination methods:
  - **apply_acisabs**
  - Run **mkarf** with CONTAM set to the contamination file **acisD1999-08-13contamN0001.fits** to create an ARF which includes correction for the contaminant.
- Modeling in Sherpa with absorbed power law model :

$$N(E)=\text{Norm} \cdot E^{-} \exp(-N_H (E)) \text{ photons cm}^{-2}\text{sec}^{-1}\text{keV}^{-1}$$

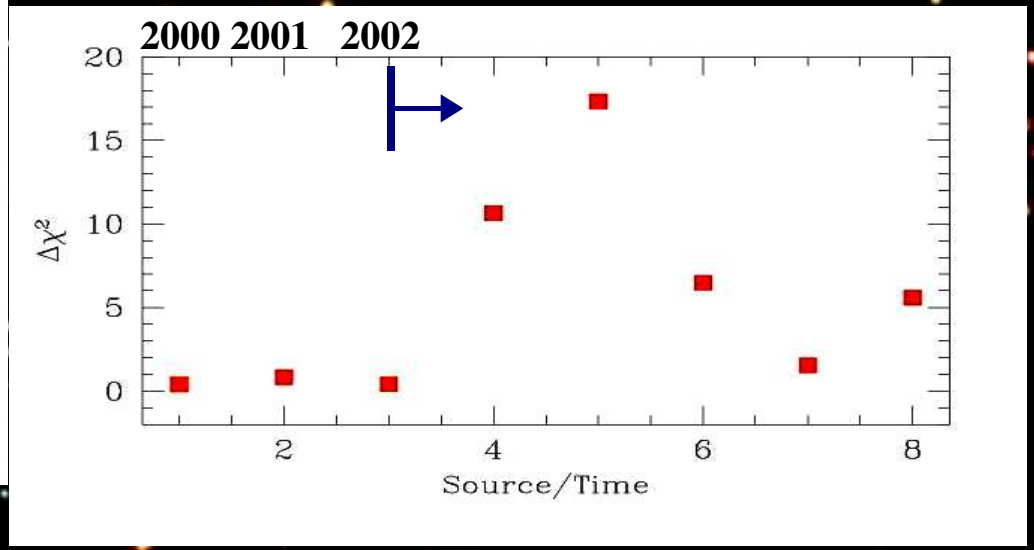
  - assume **phabs** absorption model

N_H(data) vs. N_H(gal)

N_H(contam) - red
N_H(acisabs) -black



^{2} => ^{2}(N_H(acisabs))- ^{2}(N_H(contam))



Chandra/XMM B2 0738+393

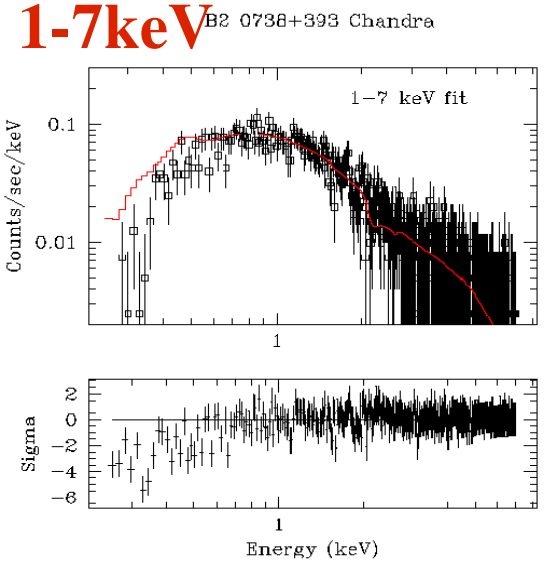
- Low redshift radio-loud Quasar at z=0.63
- L_{bol} ~10^{46} ergs~sec^{-1}
- **Two DLA** systems at: z=0.0912 and z=0.2212;
- Chandra ACIS-S => 27 ksec exposure.
- XMM-Newton => 20 ksec exposure

B2 0738+393

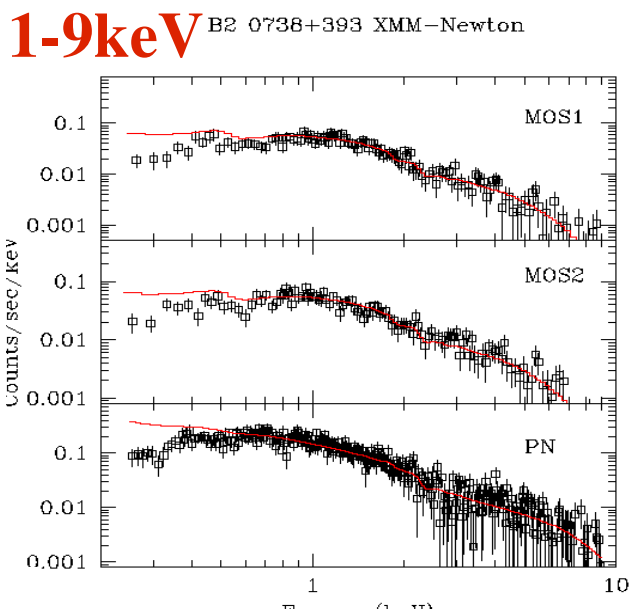
Chandra

XMM

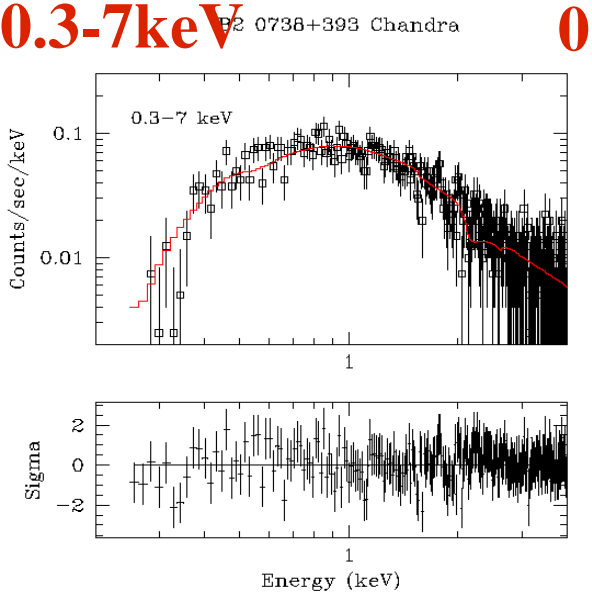
1-7keV



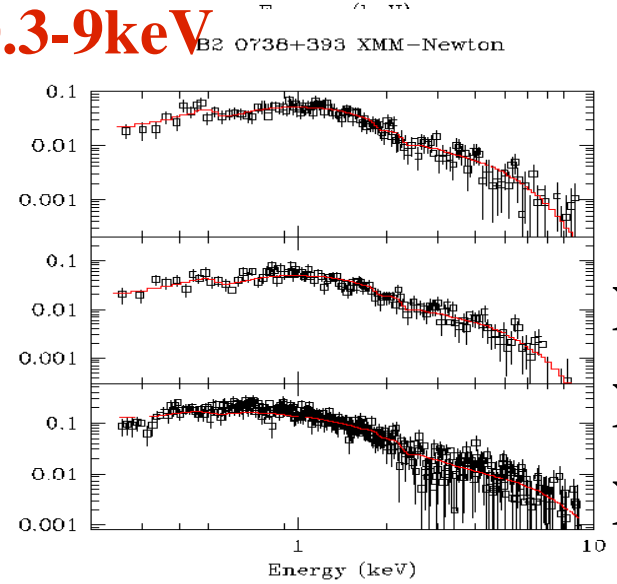
1-9keV

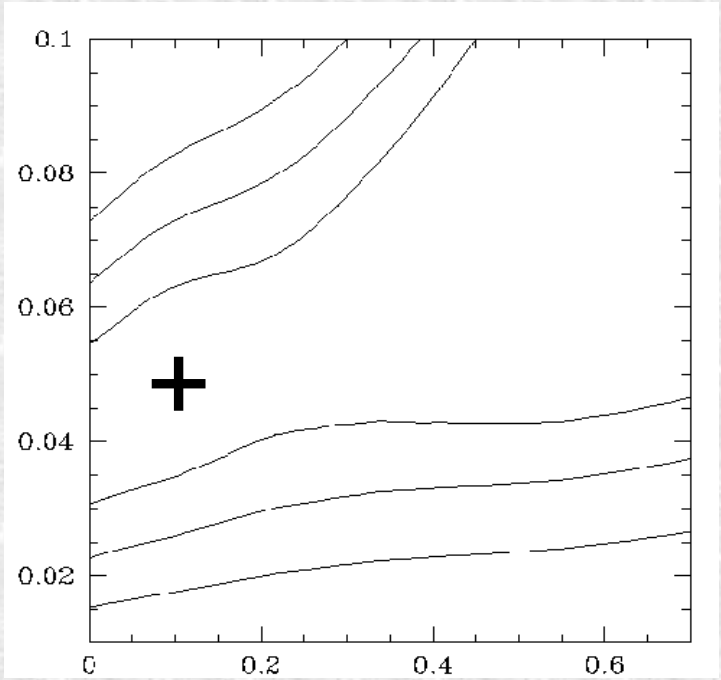


0.3-7keV



0.3-9keV





$N(z_{abs}=0.09) = 5.1^{+/-0.7}$e20 cm^{-2}

$N(z_{abs}=0.22) = 6.3^{+/-0.7}$e20 cm^{-2}

$N(z_{qso}=0.63) = 1.1^{+/-0.1}$e21 cm^{-2}

Summary

- Understanding contamination properties at the default CCD location for on-axis observations is critical to studies of X-ray absorption in quasars.
- Fitting the quasars data with two contamination models => acisabs gives always lower column densities. In some cases the values are lower than the Galactic columns.
- It seems that acisabs model underpredicts column densities for quasars observed on-axis.
- Chandra and XMM measurements of N(H) agree for B2 0738+393.
- Good calibration of the contaminant for on-axis source is still needed.