The quest for Type 2 quasars: What are the X-ray observations of optically selected QSOs2 telling us?

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In collaboration with

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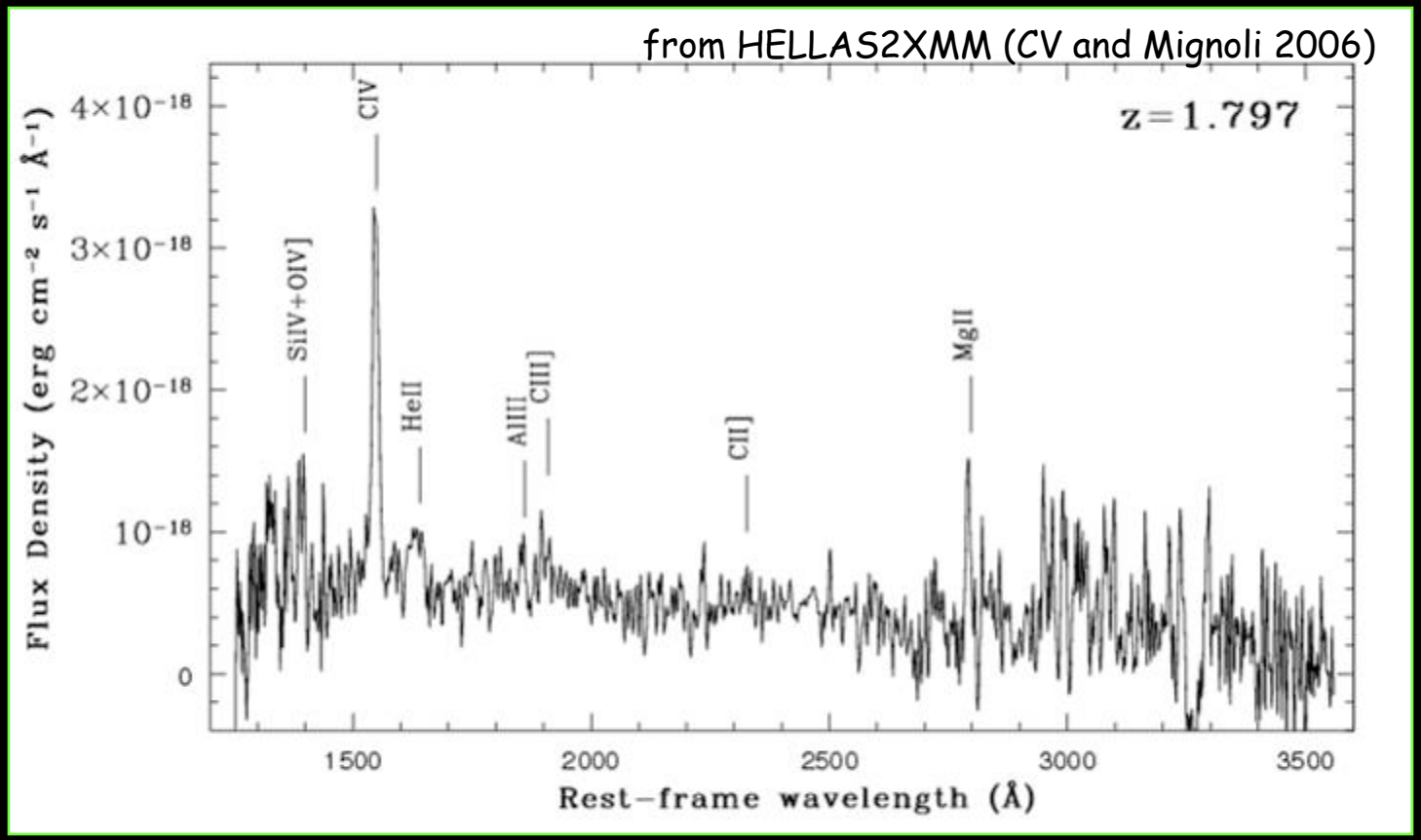

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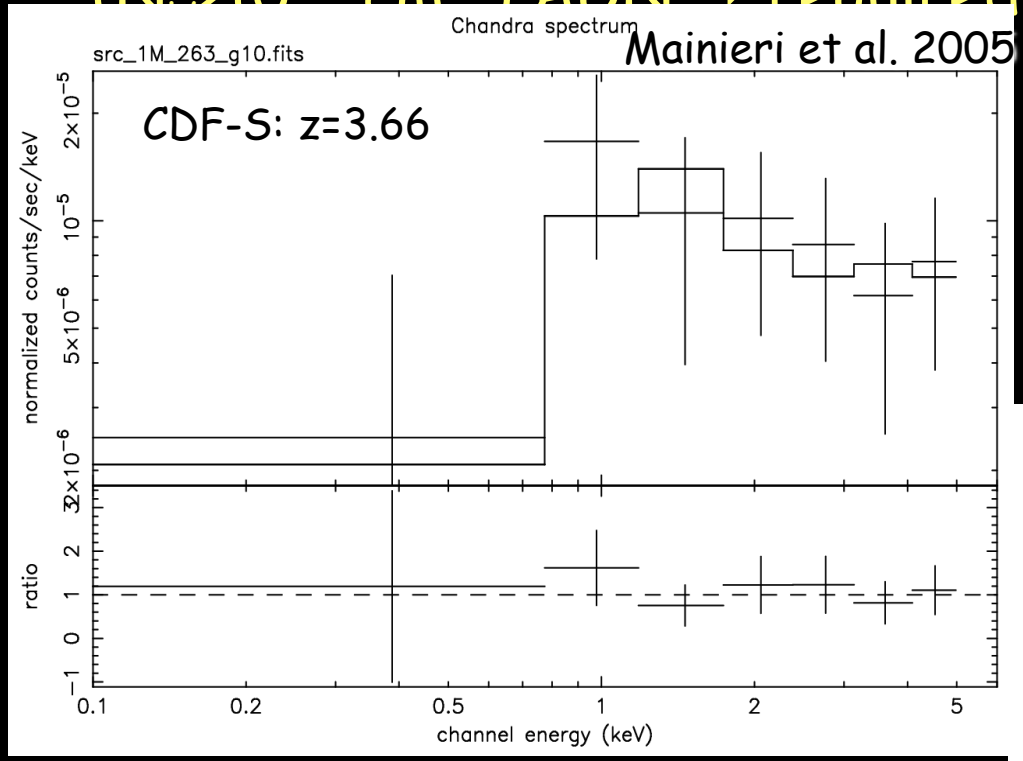

+ many more from *Chandra* and XMM-*Newton* surveys (e.g., Stern+02, Norman+02)

sometimes the two definitions do not match

Selection at other wavelengths (e.g., in the MID-IR?)

Selecting QSOs2 from optical surveys

- A large fraction of the X-ray obscured AGN do not appear as the "big cousins" of the local Seyfert 2 galaxies
- Possibility to pick up a different obscured AGN population through optical selection?

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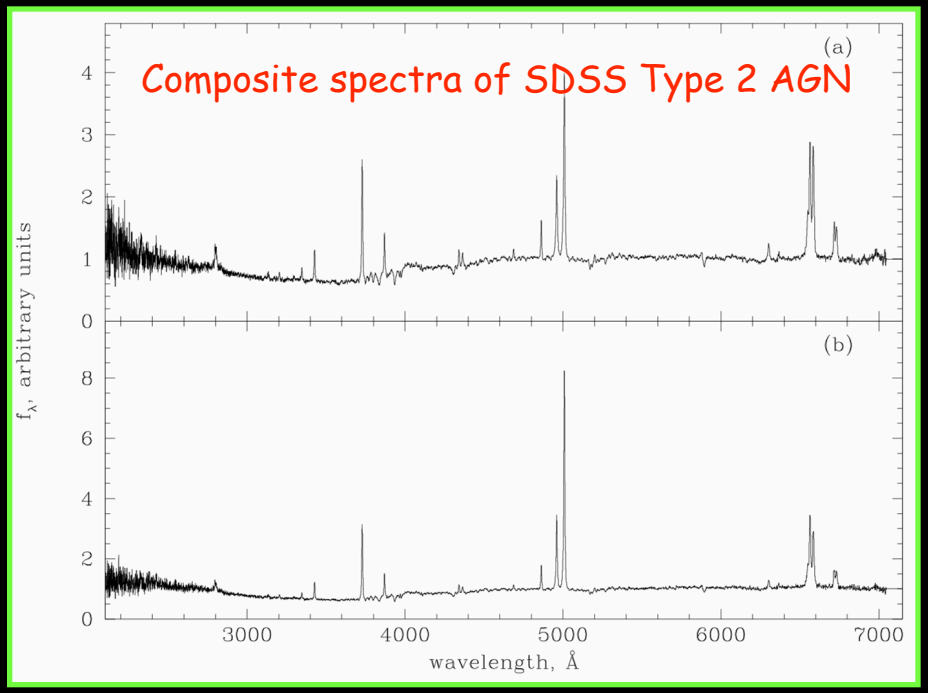
different approach

To look at the X-ray properties of the QSO2 population selected from the **Sloan Digital Sky Survey** (SDSS) at relatively bright magnitude limits

The sample selection

The SDSS Type 2 quasar sample



Zakamska et al. 2003

SELECTION: high-EW, narrow emission-line spectra [3800-9200 Å, 1800<R<2100]

S/N>7.5

EW[OIII] > 4 Å (rest frame)

FWHM(H_β) < 2000 km/s

careful subtraction of the host galaxy contribution

not-homogeneous selection: 28% targets, 42% serend, 19% DSES, 11% special plates

see Zakamska's talk for details

QSO regime (classic): $M_B < -23$

$\langle L_B/L_{[OIII]} \rangle \sim 100$ for BL AGN

$M_B < -23$ → $L_B > 2.9 \times 10^{10}\ L_\odot$

→ **$L_{[OIII]} > 3 \times 10^8\ L_\odot$**

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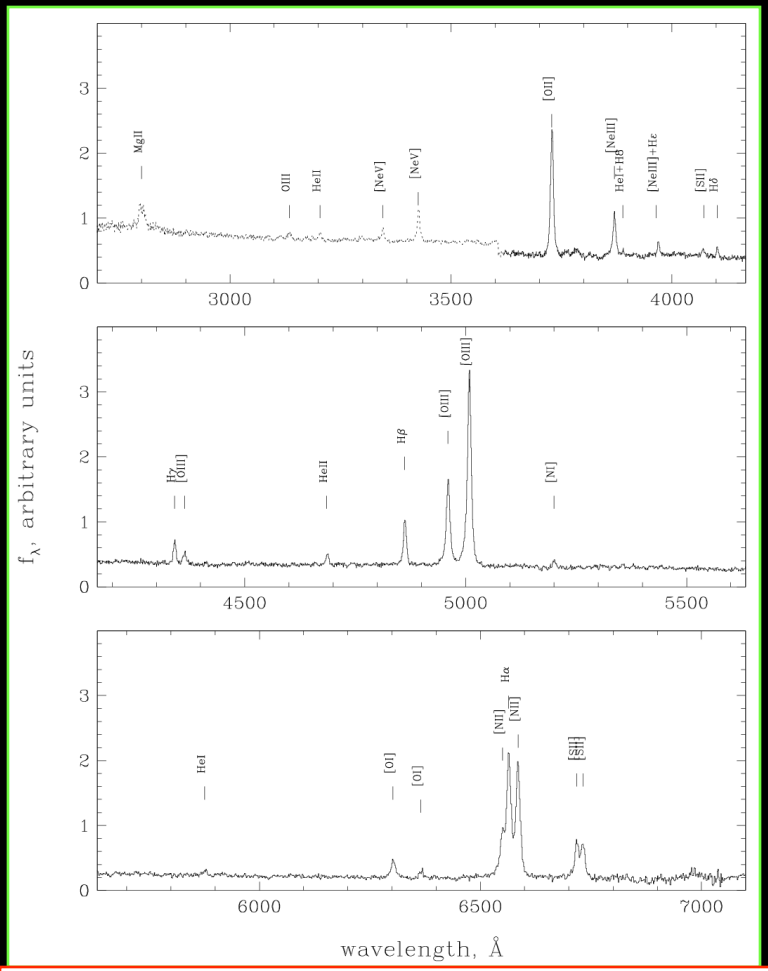

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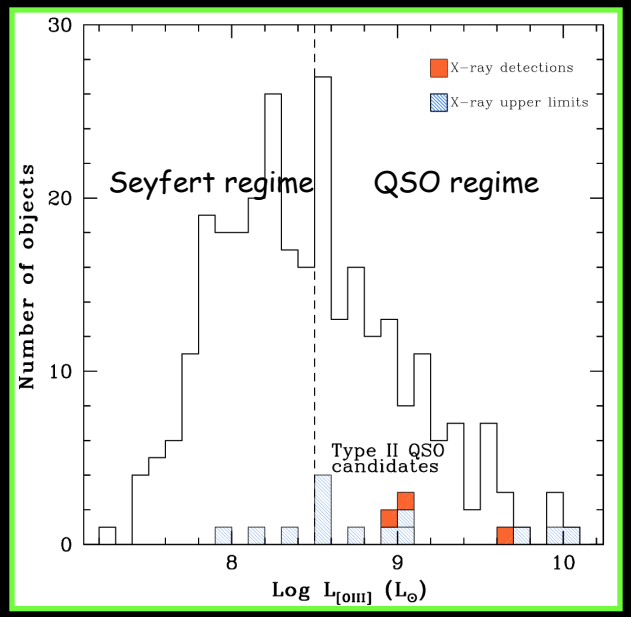
The X-ray view of SDSS

A preliminary study with ROSAT

Using mostly *ROSAT* data (CV, Alexander & Comastri 2004a,b)

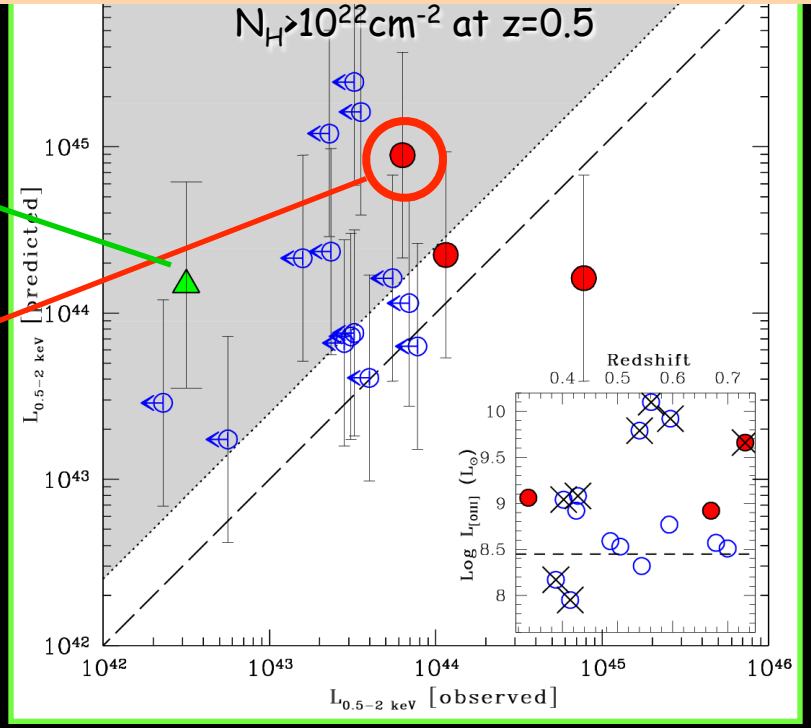


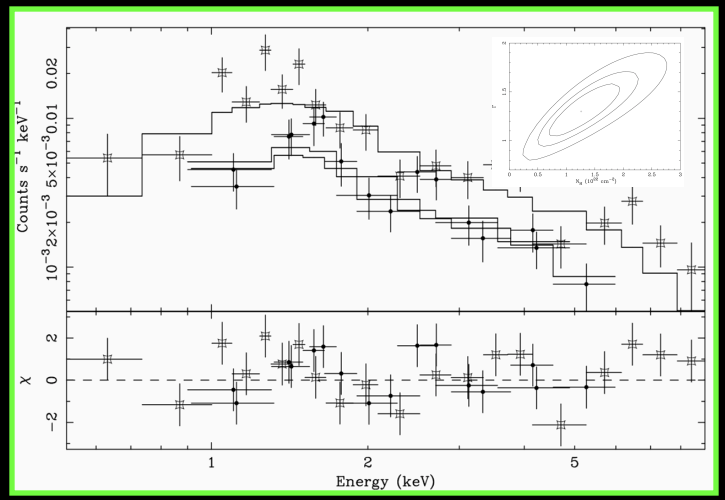
3/17 SDSS Type 2 quasar candidates detected

"Toy model": $L_{[OIII]}$ ➔ $L_{[2\text{-}10\ keV]}$ using Mulchaey et al. '94

➔ extrapolated $L_{[0.5\text{-}2\ keV]}$ to be compared with that observed

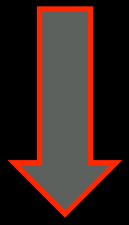
Stacked
$N_H=(1\text{-}3)10^{23}cm^{-2}$





XMM-Newton ➔ "genuine" Type 2 quasar
($L_X=4.5x10^{44}$ erg/s, $N_H=1\text{-}3x10^{22}$ cm^{-2})

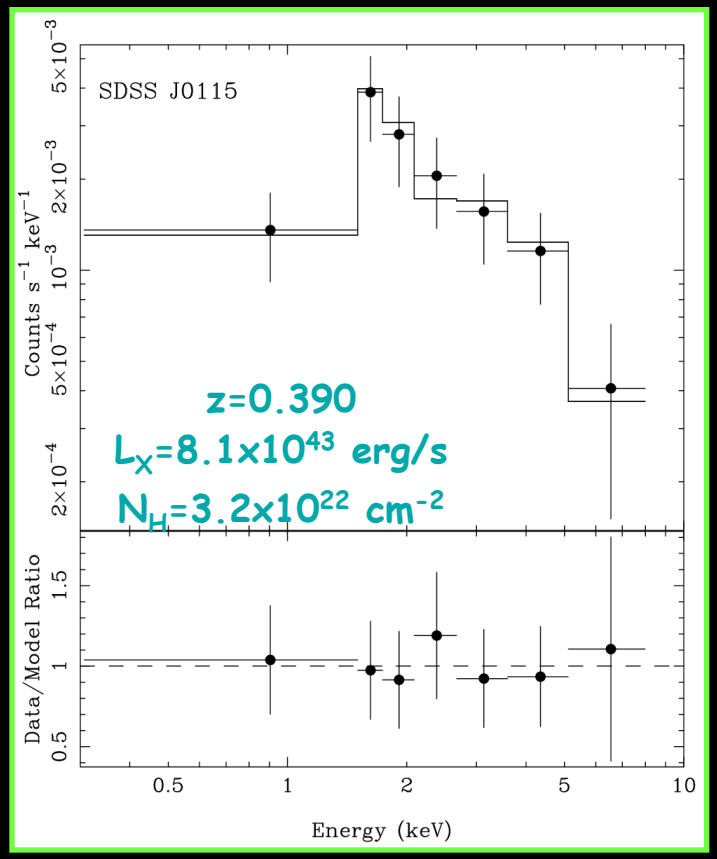
[OIII] luminosity is a proxy of the nuclear activity
(see also Panessa et al. 2006)

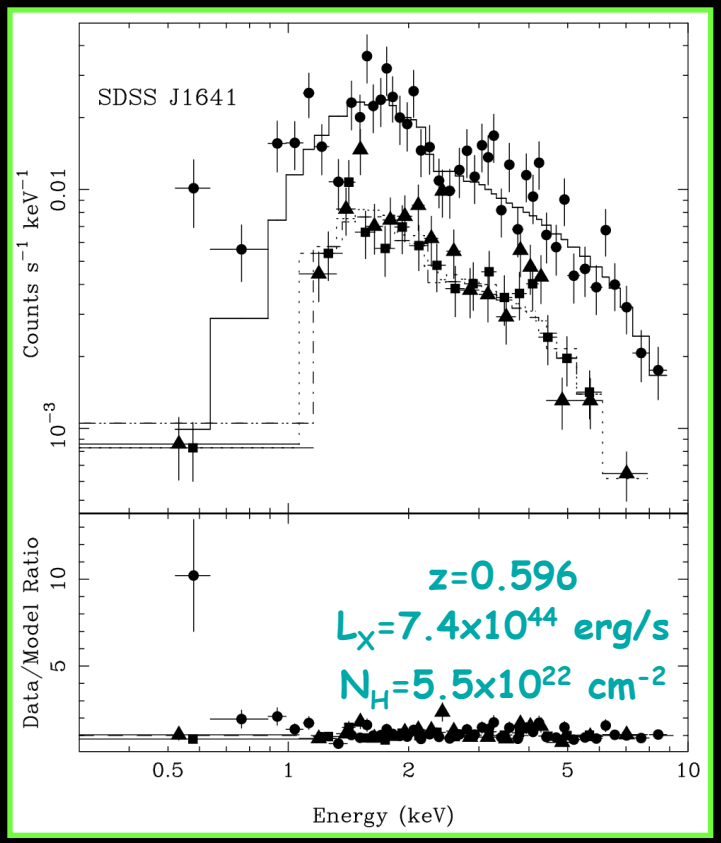


≈50% of the SDSS QSO2 candidates with *ROSAT* observations are consistent with being obscured
(see also Zakamska et al. 2004)

since 2004 ...

Chandra and XMM-*Newton* follow-up observations of the optically brightest

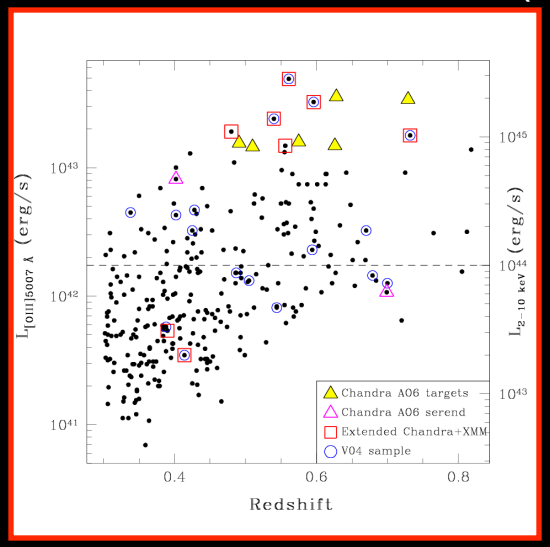




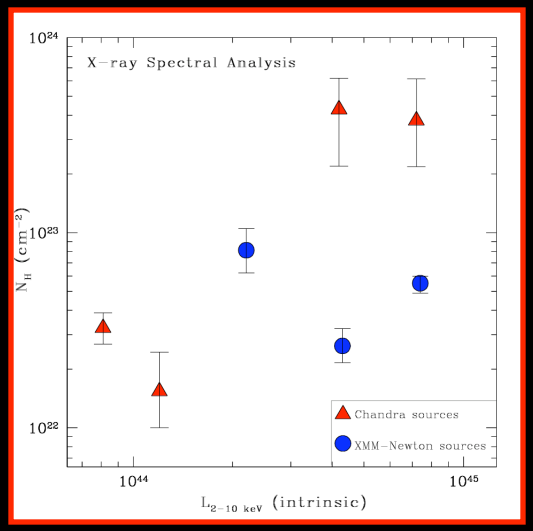
Ptak et al. 2006

up to the most recent results...

Chandra exploratory observations + archival fields
(CV, Alexander & Comastri 2006)



4/6 targets detected
(3-80 counts, 7-11 ks,
$F_X \approx 10^{-15}$-10^{-13} erg/cm^2 s)
+
6/10 archival/serend detected



direct X-ray spectral information for 7 sources
$N_H \approx 10^{22}$ - 5×10^{23} cm^{-2}

Number density of Type 2 QSOs?
$\rho_{sdss} \approx 0.05$ deg^{-2} vs. ≈ 0.15 deg^{-2} from LDDE models (Gilli et al. 2007) at $0.3<z<0.8$ and $F_{2\text{-}10\ keV} \approx 2 \times 10^{-13}$ cgs
➔more complete census of obscured QSO activity in the X-rays?

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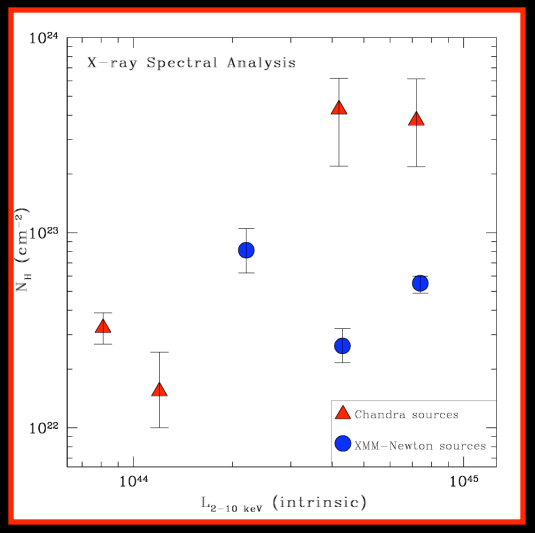

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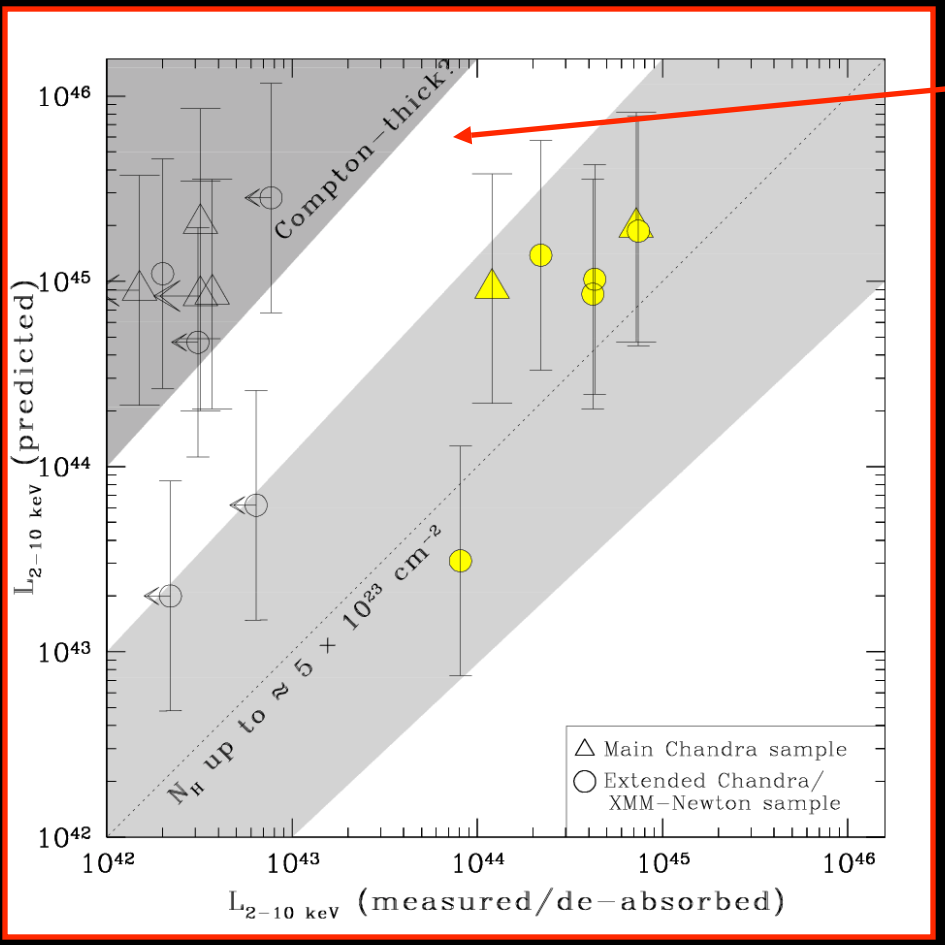
Compton-thick quasars?



possibility that the X-ray faintest Type 2 QSOs and those undetected hide Compton-thick quasars (see also Ptak et al. 2006)

➜ needs further checks and larger samples with sensitive X-ray observations to probe the X-ray weak Type 2 quasar population (e.g., through stacking analysis)

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average properties from stacking analysis for the X-ray weak sources *(limited at present by the paucity of counts)*

stacked X-ray spectra in different N_H bins to search for faint spectral features *(e.g., Alexander et al. 2005)*

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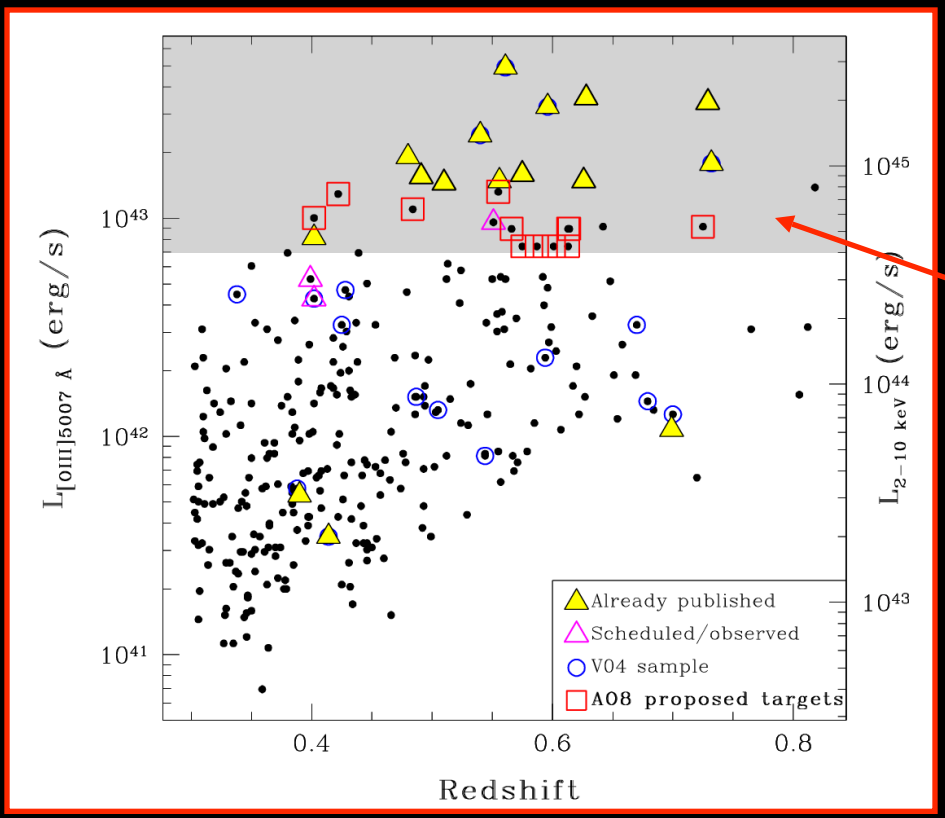

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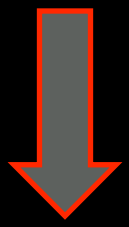
Chandra and XMM-*Newton* confirm the presence of a population of SDSS obscured quasars
(following the selection by Zakamska et al. 2003)



X-ray brightest Type2 QSOs: peak of the iceberg of the SDSS Type 2 QSO population, where many are either Compton-thick or intrinsically X-ray faint

or

highly variable population: weak in the X-rays (X-ray "quiet" state) but still luminous in [OIII]?