Charting the obscured AGN population in the CDFS with XMM-Newton

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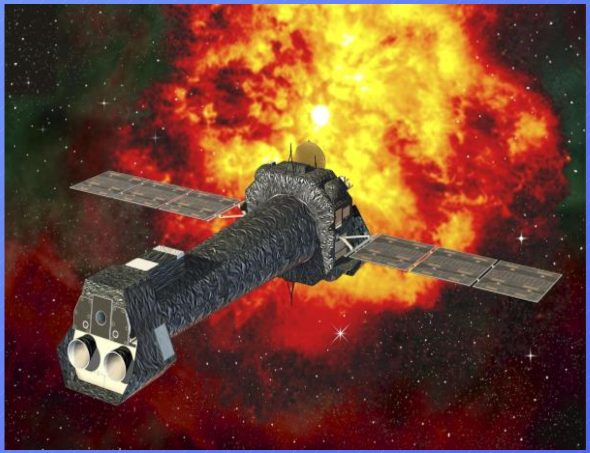
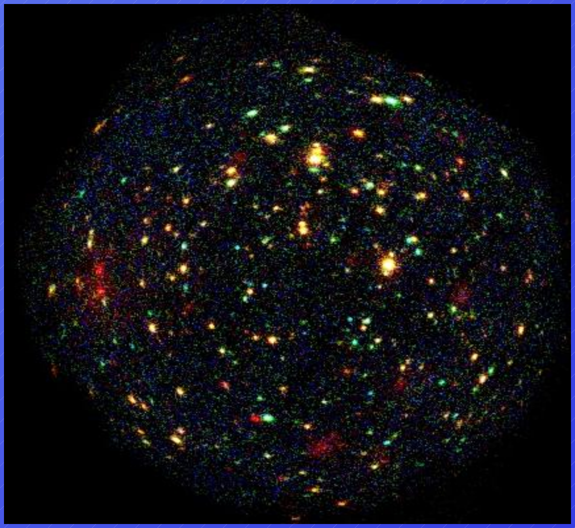
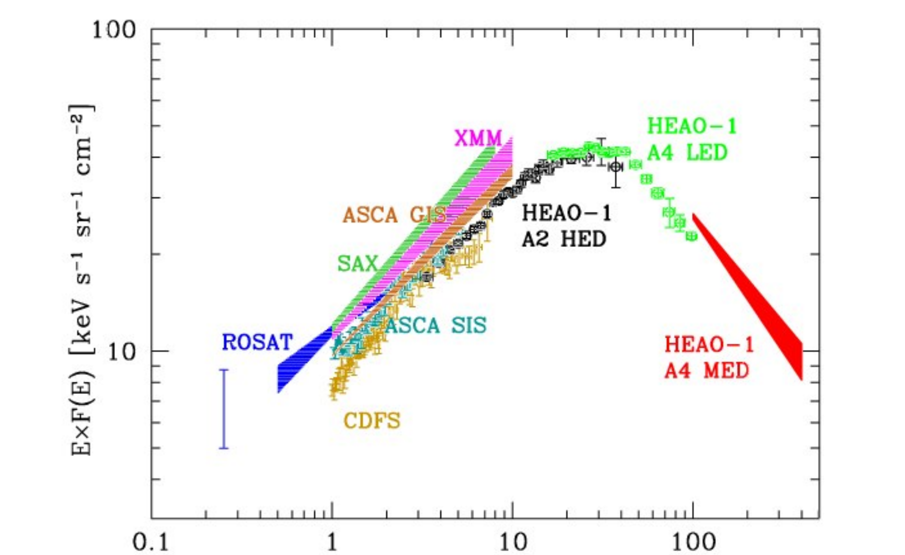


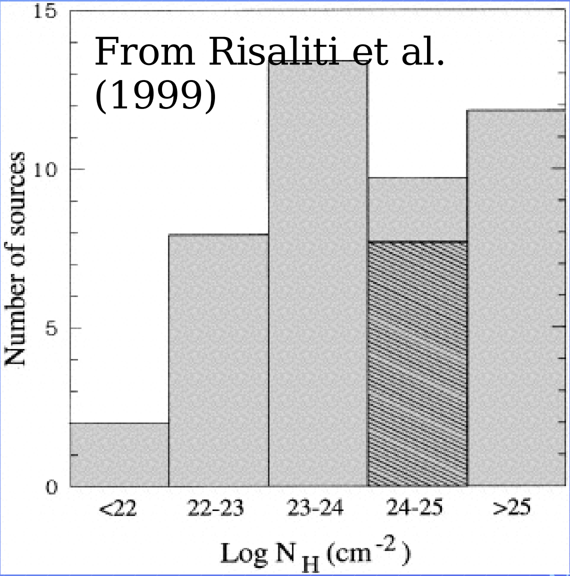


New results in X-ray astronomy, MSSL, 11th July 2006

The origin of the XRB: what mix of AGN?



From Gilli (2003)



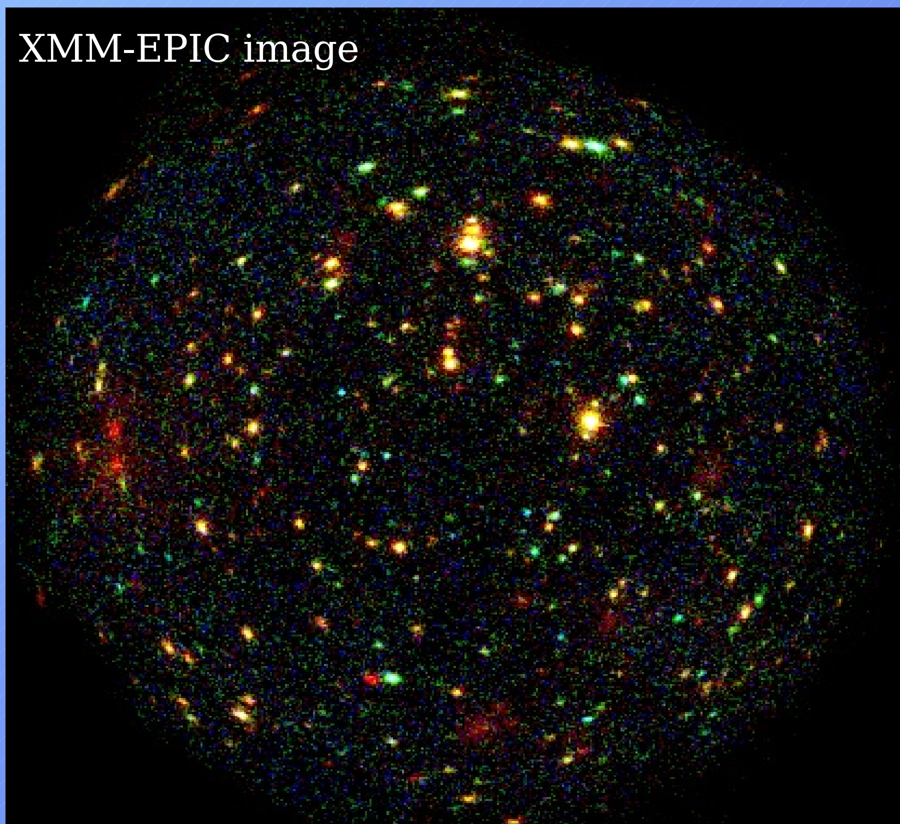
From Risaliti et al. (1999)

- XRB spectrum - slope~1.4
  - but "normal" AGN ~2
  - absorbed AGN needed
- Local Seyferts - 4:1 ratio
  - But at higher z,L_X ?
- "Type-1" AGN peak: z~2
- Do absorbed and unabsorbed AGN evolve similarly?
  - Expect obscured QSOs?
  - Or, less N_H at high-L_X?

Contradictory results to date

- X-ray (mainly Chandra) selected samples
  - Typically narrow area, but deep (e.g. Ueda et al 2003, Steffen et al 2003,Barger et al 2005…)
    - Few luminous absorbed AGN
  - But others
    - no N_H dependence on L_X (e.g. Tozzi et al 2006, Dwelly et al 2005)
- MIR/radio (e.g. Martinez-Sansigre 2005)
  - Wide area but shallow
  - Find large v. luminous obscured QSO pop^n

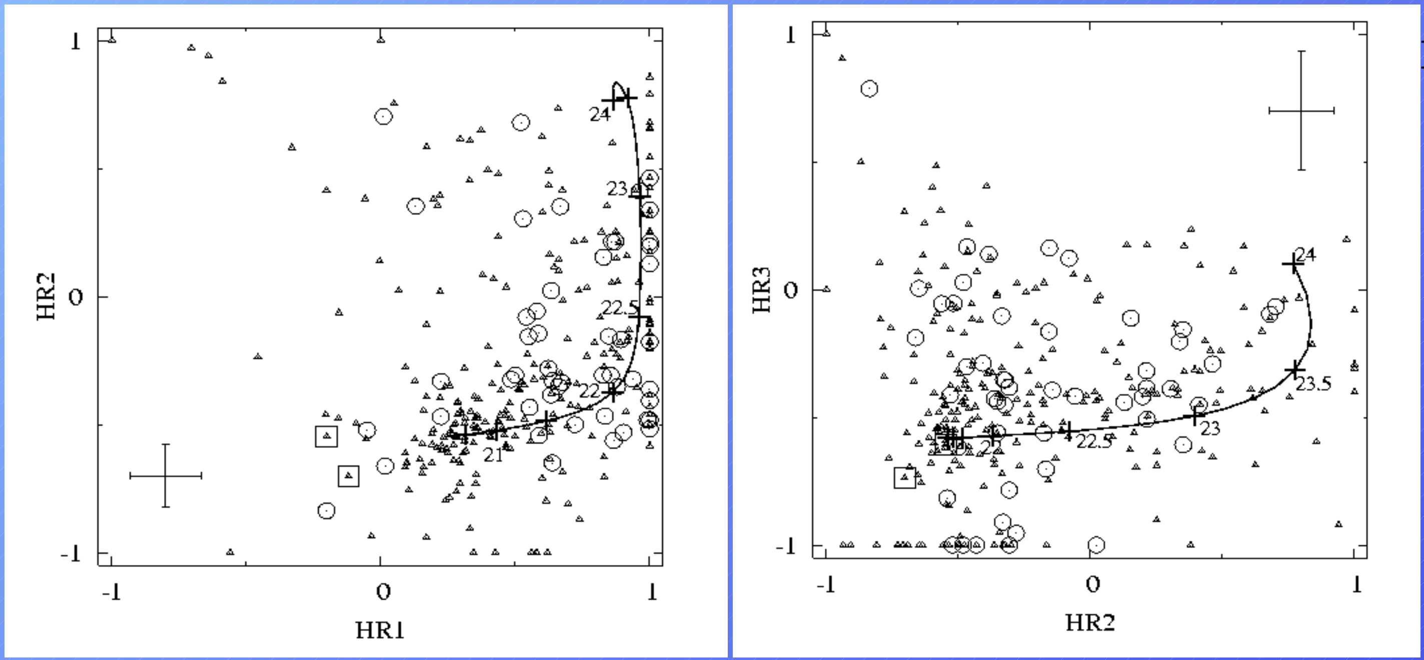
The XMM-CDFS Sample



Red=0.5-2keV, Green=2-5keV, Blue=5-10keV

- 500ks exp. (~340ks good)
  - Use full 0.2-10 keV range
    (four bands: 0.2-0.5, 0.5-2, 2-5, 5-10 keV)
- 309 sources in ~0.2 deg^2
- Chandra counterparts for 95%
  - Sub-arcsec positions
- Deep optical/IR coverage e.g. GOODS, VVDS, EIS, COMBO-17, GEMS, Spitzer
  - Spectra/photo-z for 84%

Deducing AGN properties (N_H/L_X) from X-ray colours



X-ray Hardness ratios

$$HR1=\frac{R_{0.5-2}-R_{0.2-0.5}}{R_{0.5-2}+R_{0.2-0.5}}$$

$$HR2=\frac{R_{2-5}-R_{0.5-2}}{R_{2-5}+R_{0.5-2}}$$

$$HR3=\frac{R_{5-10}-R_{2-5}}{R_{5-10}+R_{2-5}}$$

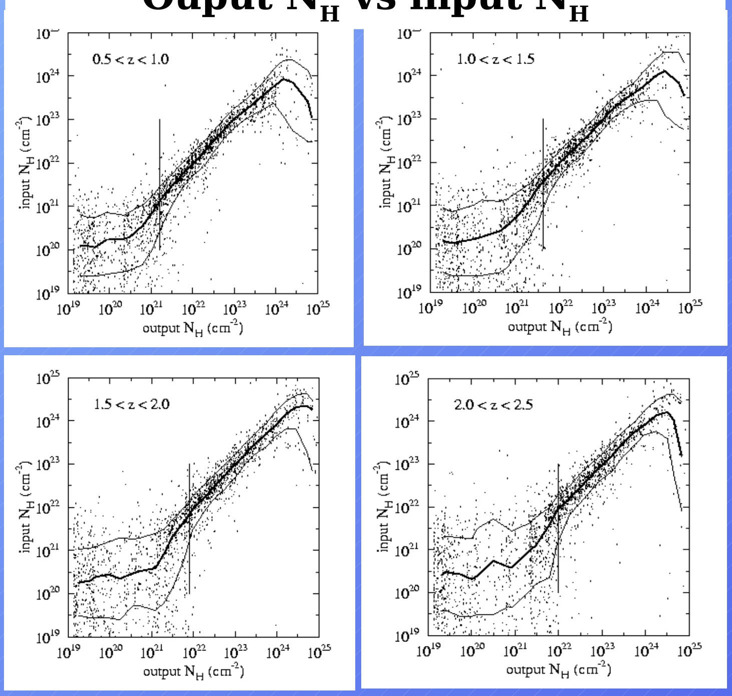
Track: Gamma=1.9 AGN, at z=1, with absorption from $\log N_H=19$ to $\log N_H=24$

- N_H/L_X Computation Method:
  - build “library” of simulated sources
    - z, L_X, N_H --> X-ray colour, count rate
  - compare real sources to simulated objects with similar redshift+HR1+HR2+HR3+0.2-10keV count rate
  - Calculate absorption and intrinsic 2-10 keV luminosities

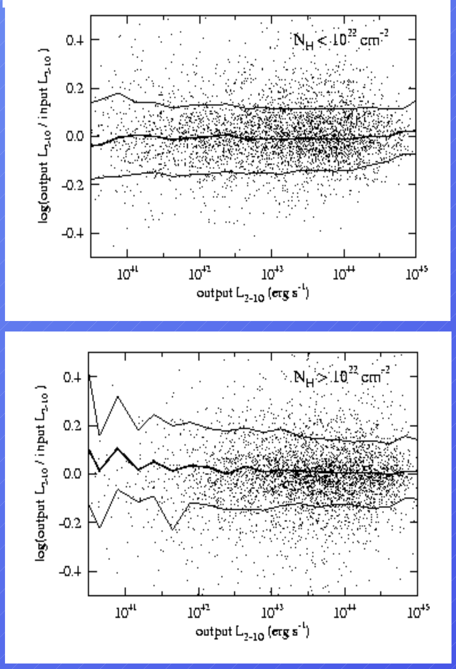
Fidelity of N_H/L_X calculation process

- Check process on test sources
- Sensitive to low column densities

Ouput N_H vs input N_H



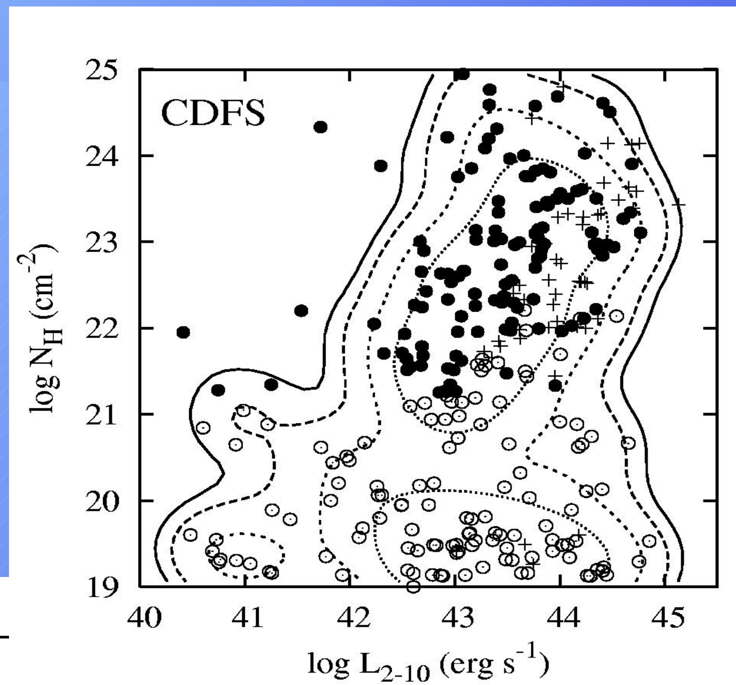
Ouput L_X vs input L_X

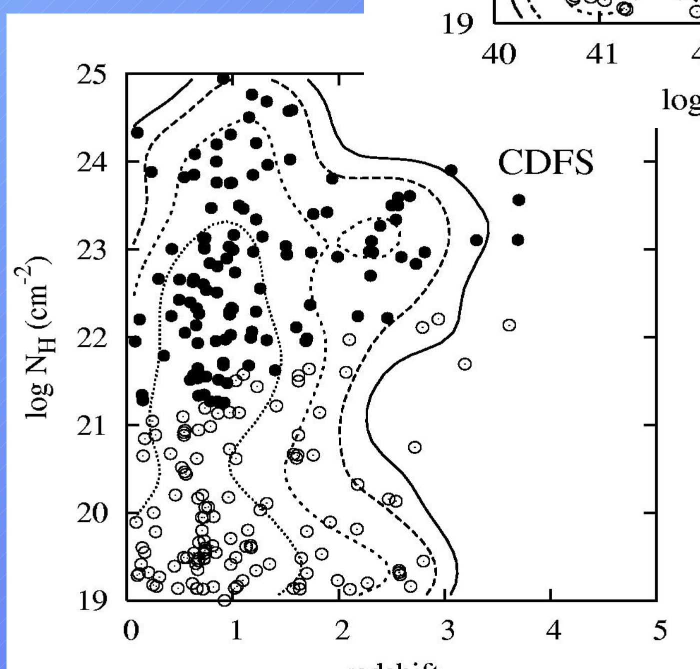


Points: test sources, thick line median, thin lines contain 68% of test sources

- Absorption: 68% sources within 0.5dex for:
  - $>10^{21.1}$ cm^{-2} @ z=0.5
  - $>10^{21.6}$ cm^{-2} @ z=1.5
  - $>10^{22.6}$ cm^{-2} @ z=3
- Luminosity
  - Scatter ~0.2dex for all luminosities
  - **Recovers intrinsic L_X of heavily absorbed sources**

N_H,L_X,z distributions of AGN in the CDFS

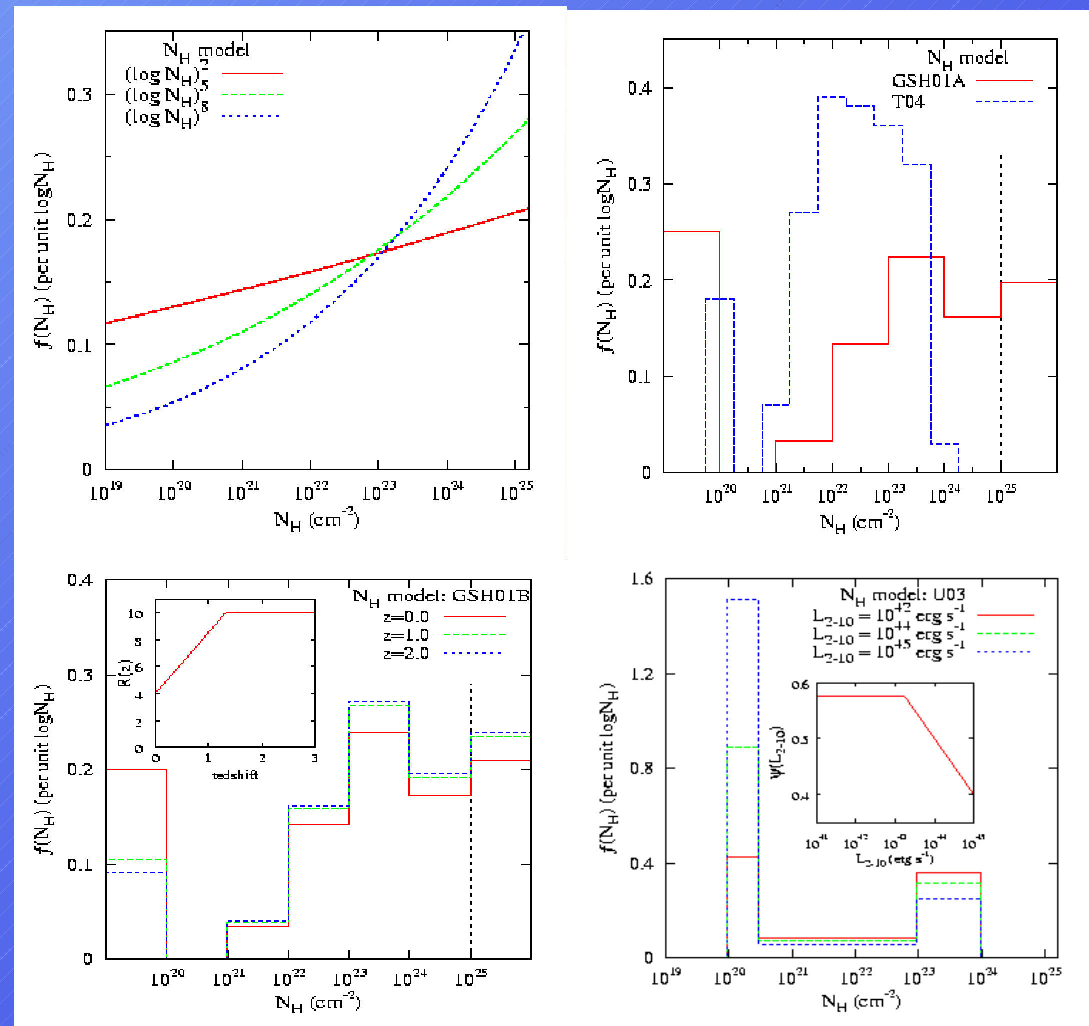




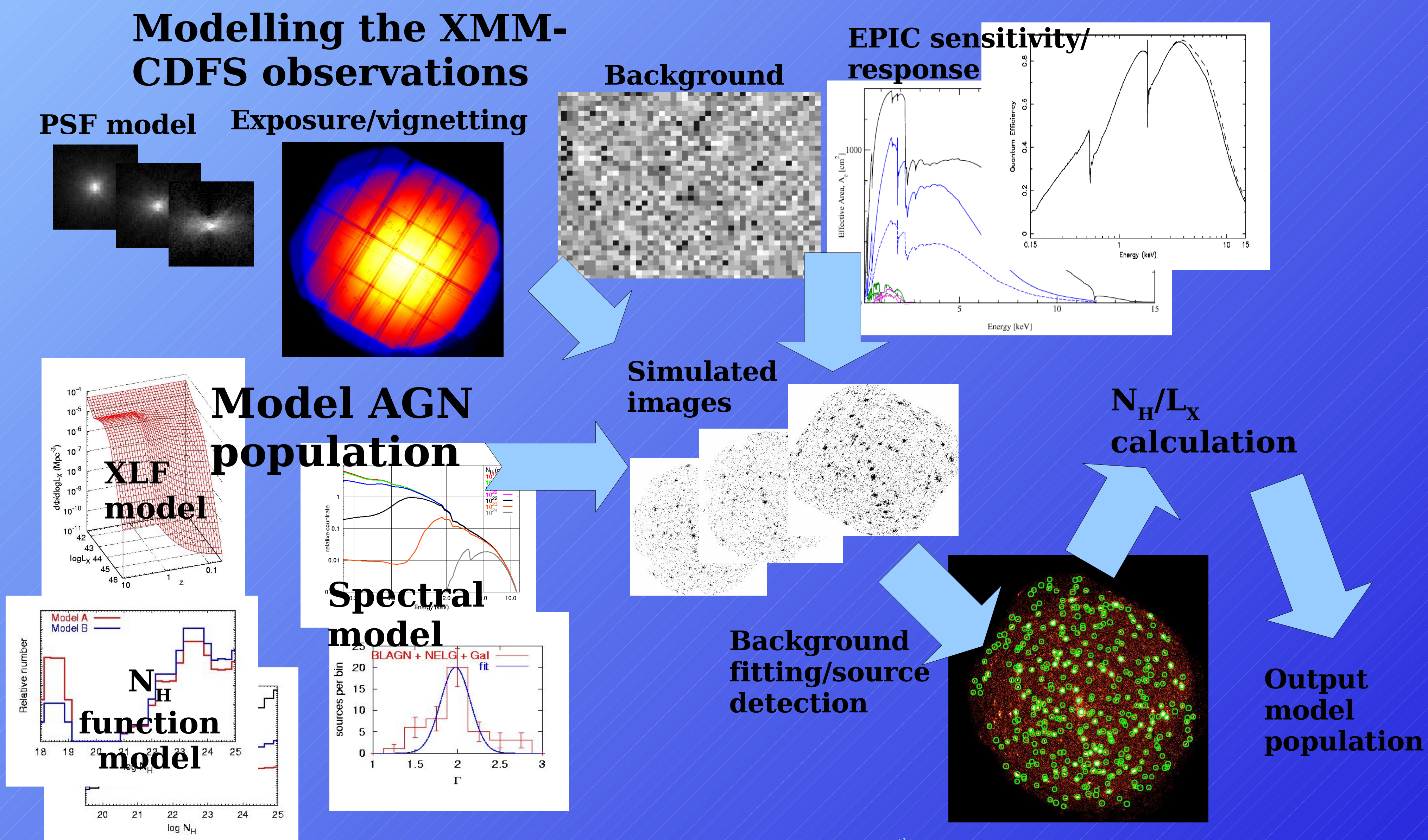
- Wide range of N_H in the AGN population
- Some abs AGN with high-L_X
- No clear z dependence
- But…
  - Selection effects!
  - How many AGN of each type should we expect?

Comparison with AGN population models

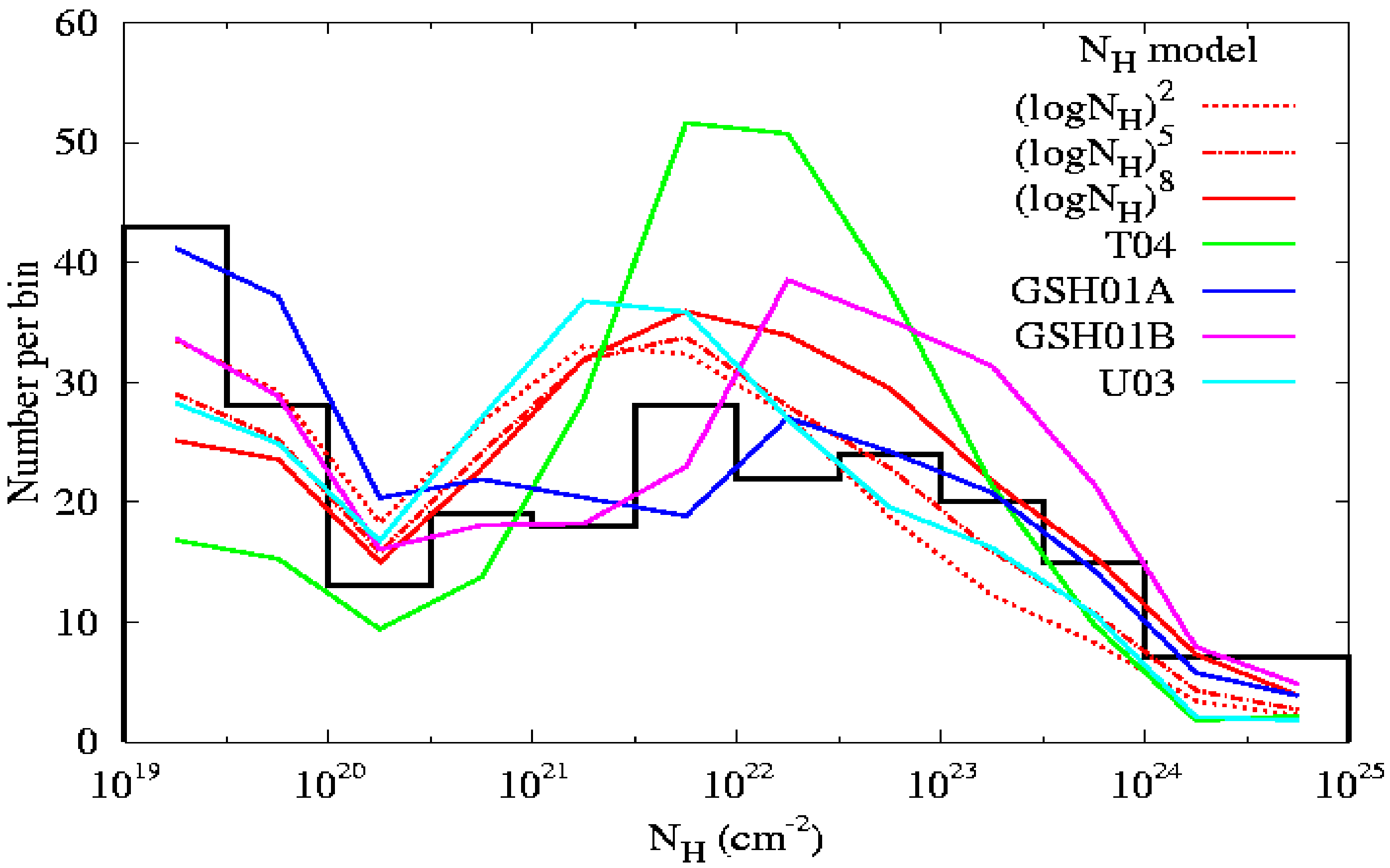
- Several model N_H distributions
  - "Unified" - Gilli et al 2001 "A", $(\log N_H)^B$, Treister et al. 2004
  - z dependent - Gilli et al 2001 "B"
  - LX dependent - Ueda et al. 2003
- XLF model
  - Ueda et al 2003 – 2-10keV
- simulations to "image" model AGN pop^n
  - Selection function



Monte Carlo simulations of the AGN population imaged with XMM-Newton

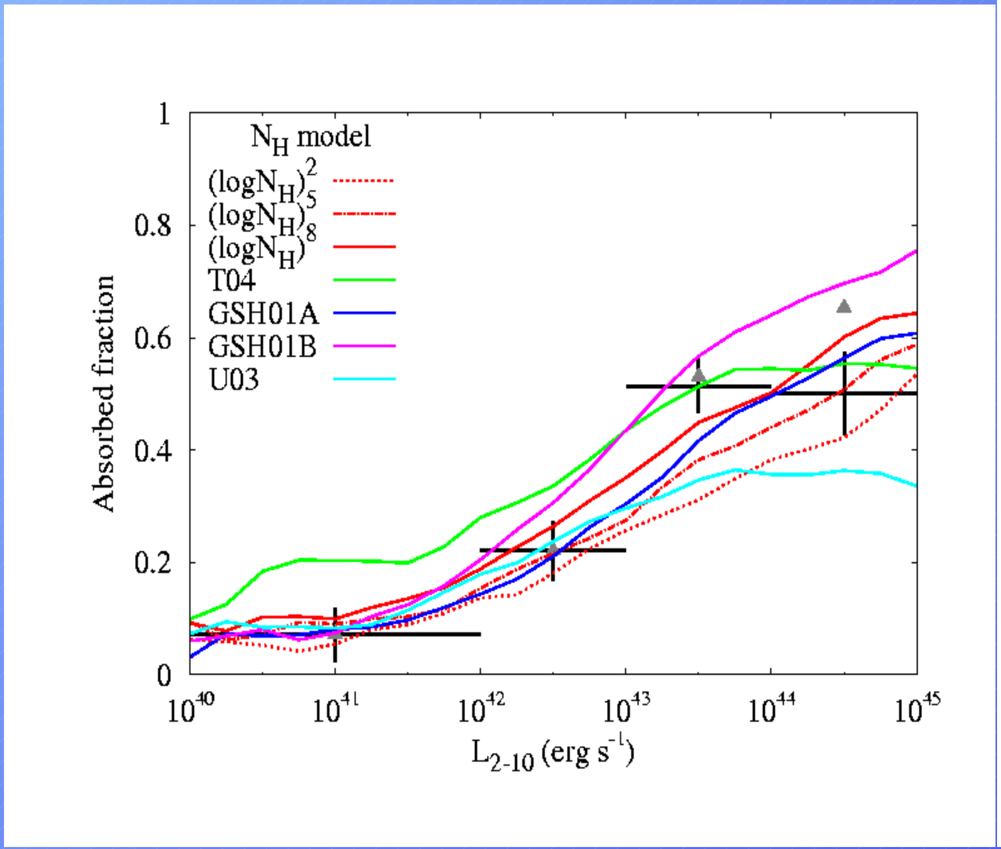


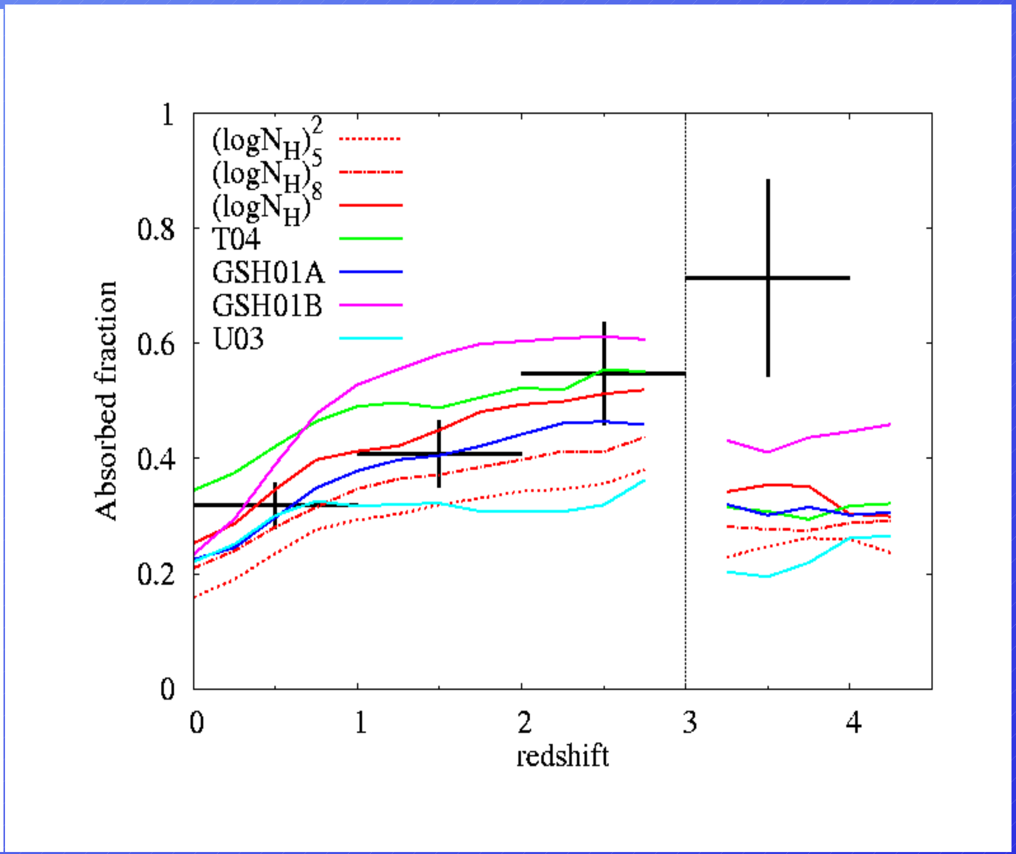
N_H distribution vs model predictions



Absorbed AGN fraction in z,L_X bins

- Trace luminosity/redshift dependence





For AGN to be "absorbed": $\log N_H > 22$ if $z < 3$, $\log N_H > 22.6$ if $z > 3$

Summary and Conclusions

- z, L_X dist^n of absorbed AGN similar to unabsorbed
  - Consistent with old XRB synthesis models
- Best models have 3:1 absorbed to unabsorbed AGN
- Lots of absorbed luminous AGN
  - most at faint fluxes ($S_{2\text{-}5keV} < 3.10^{-15}$ erg cm^{-2} s^{-1})
  - At least 23 in sample (~125deg^{-2})
  - no-ID sources -->23 more absorbed QSO candidates
- Next: Wider sample – field to field variations?