Does the obscured AGN fraction really depend on luminosity?

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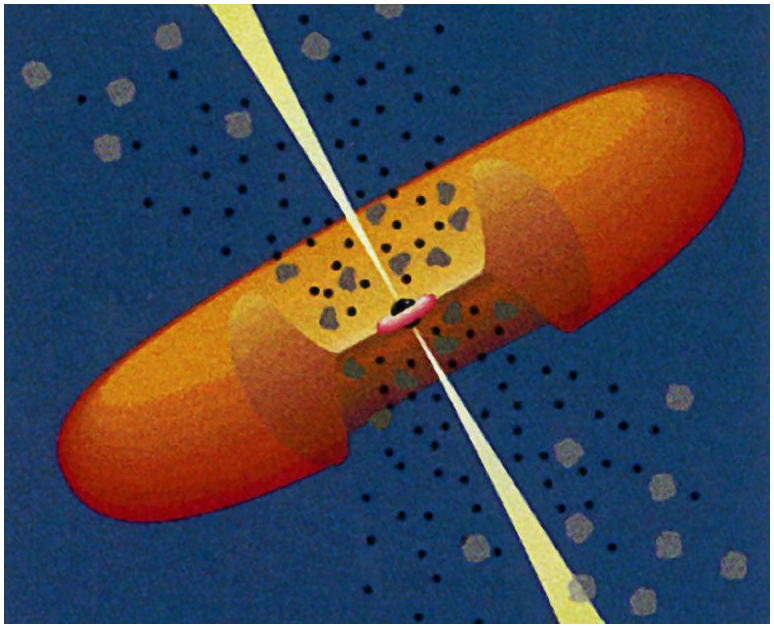
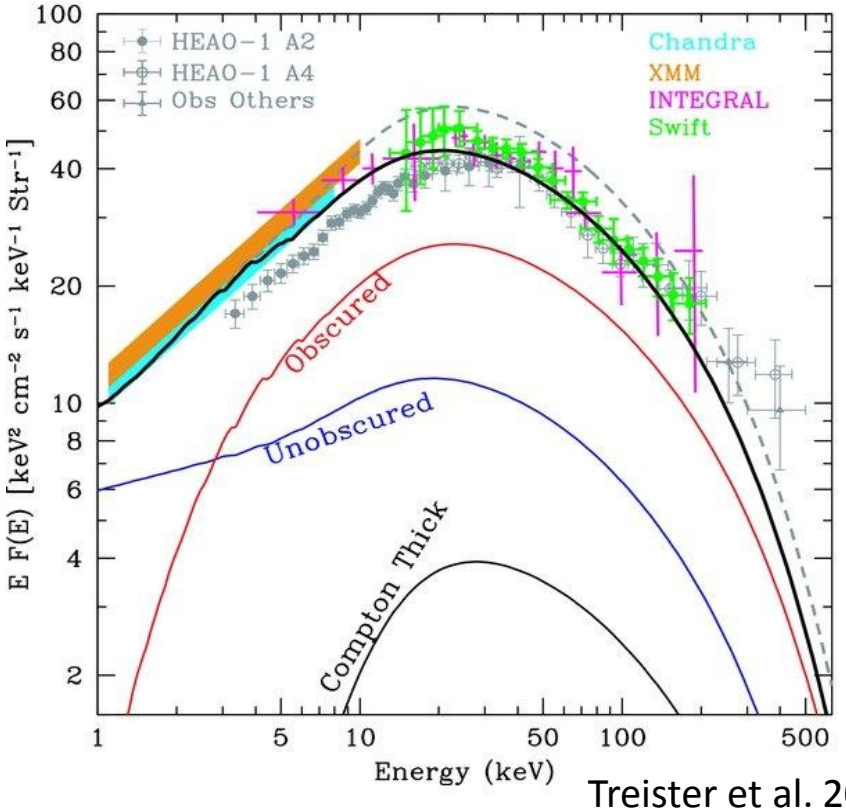
SS, Churazov, Krivonos, MNRAS 454, 1202 (2015)

Motivation



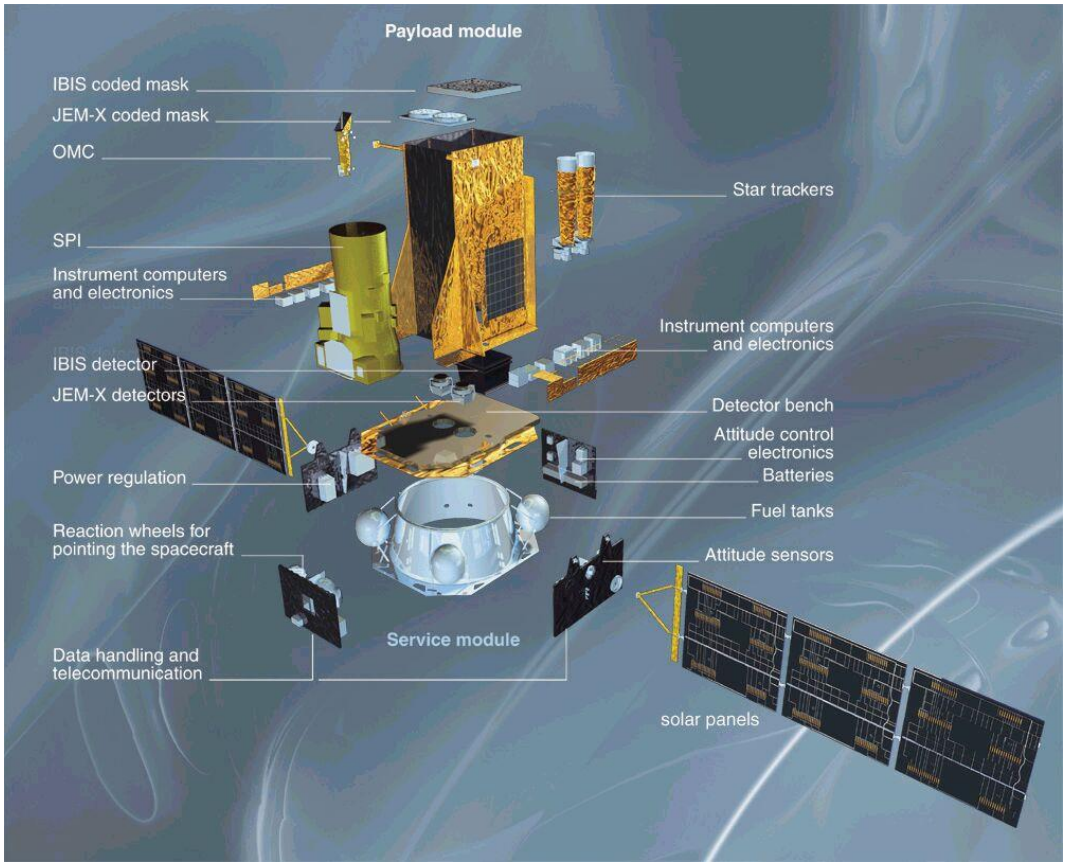


Treister et al. 2009

- What is the TORUS?
- How is it affected by the central source?
- Are there many obscured AGN?
- History of SMBH growth

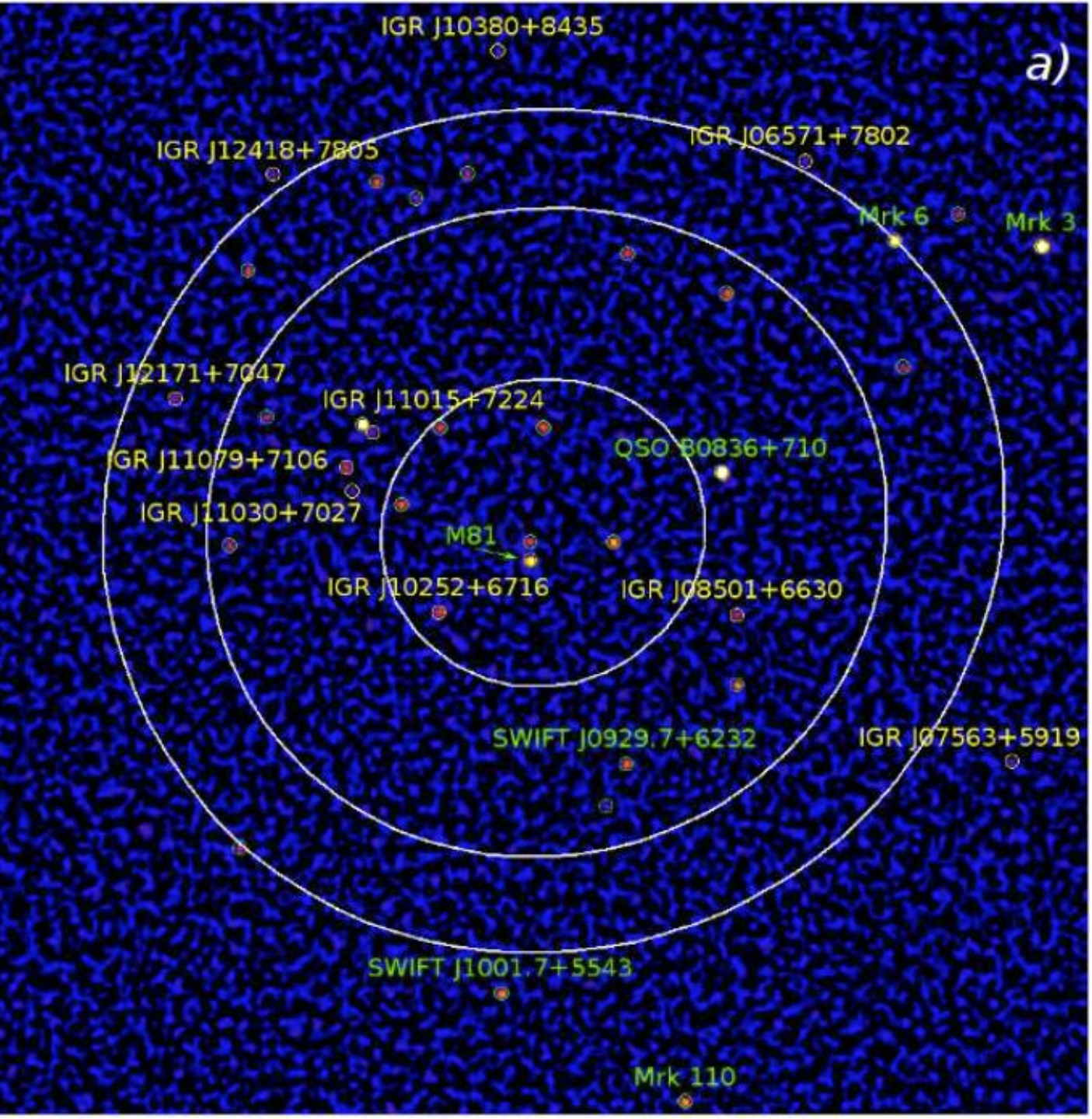
INTErnational Gamma-Ray Laboratory

- Launched October 17, 2002 by a Russian Proton
- In a high 3-day orbit
- ESA payload
- Continues to operate flawlessly



IBIS/ISGRI detector

Effective energy band: 15-300 keV
Geometrical area: 2600 cm^2
Field of view: 28°x28°, 9°x9° fully coded
Angular resolution: 12 arcmin



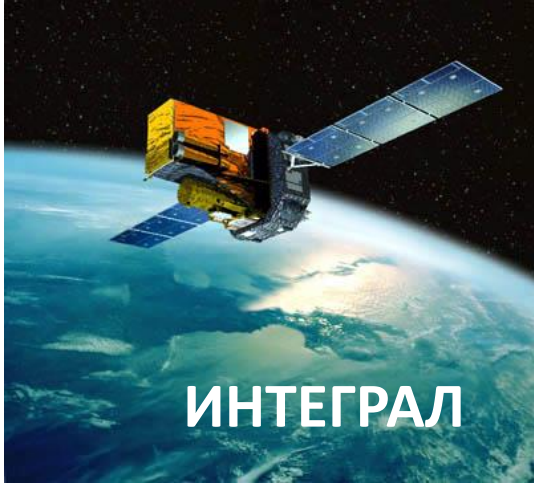
35 deg x 35 deg field around M81

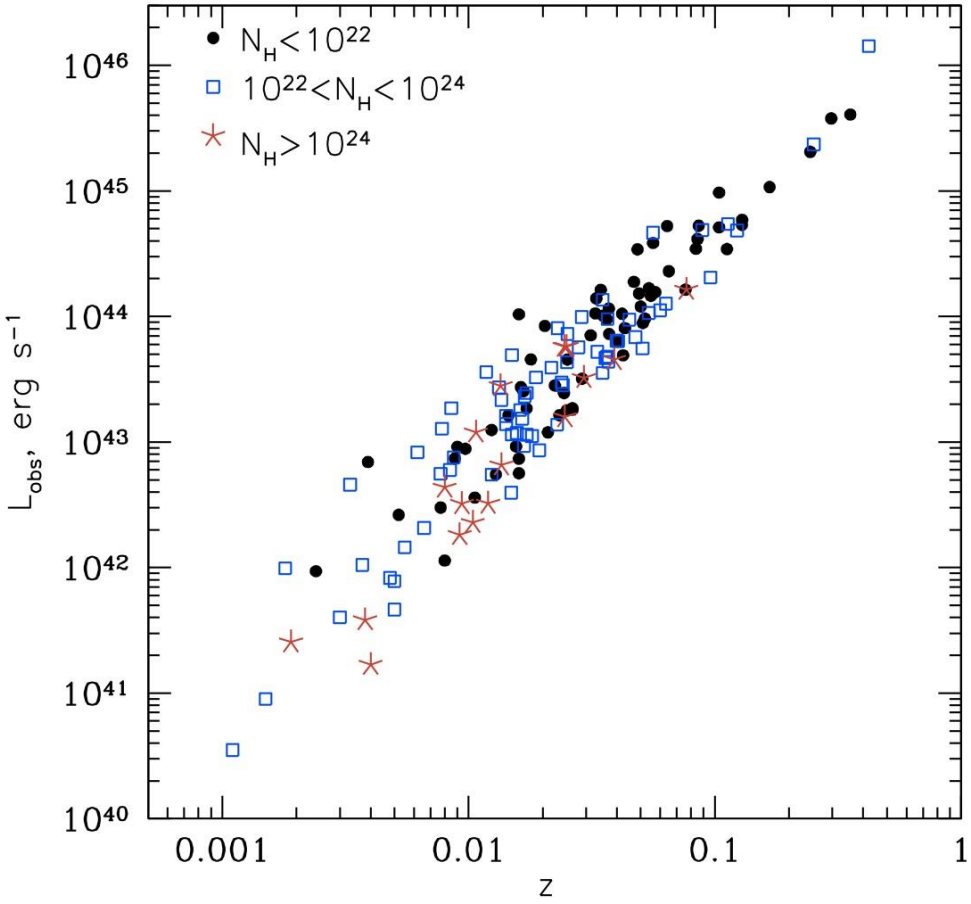
Peak exposure ~10 Msec

Mereminsky et al., in prep.

AGN in the local Universe:

INTEGRAL all-sky hard X-ray survey



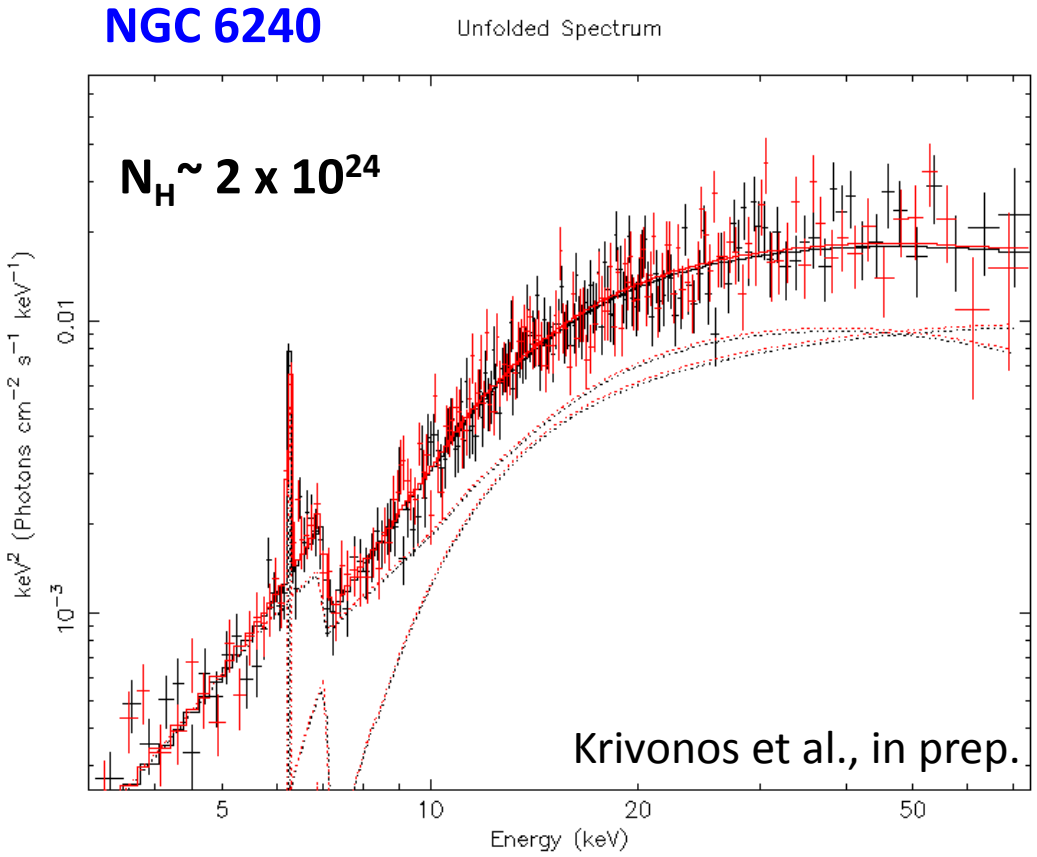


7-yr (2002-2009) catalog:

151 non-blazar AGN at |b|>5°

Krivonos 2010

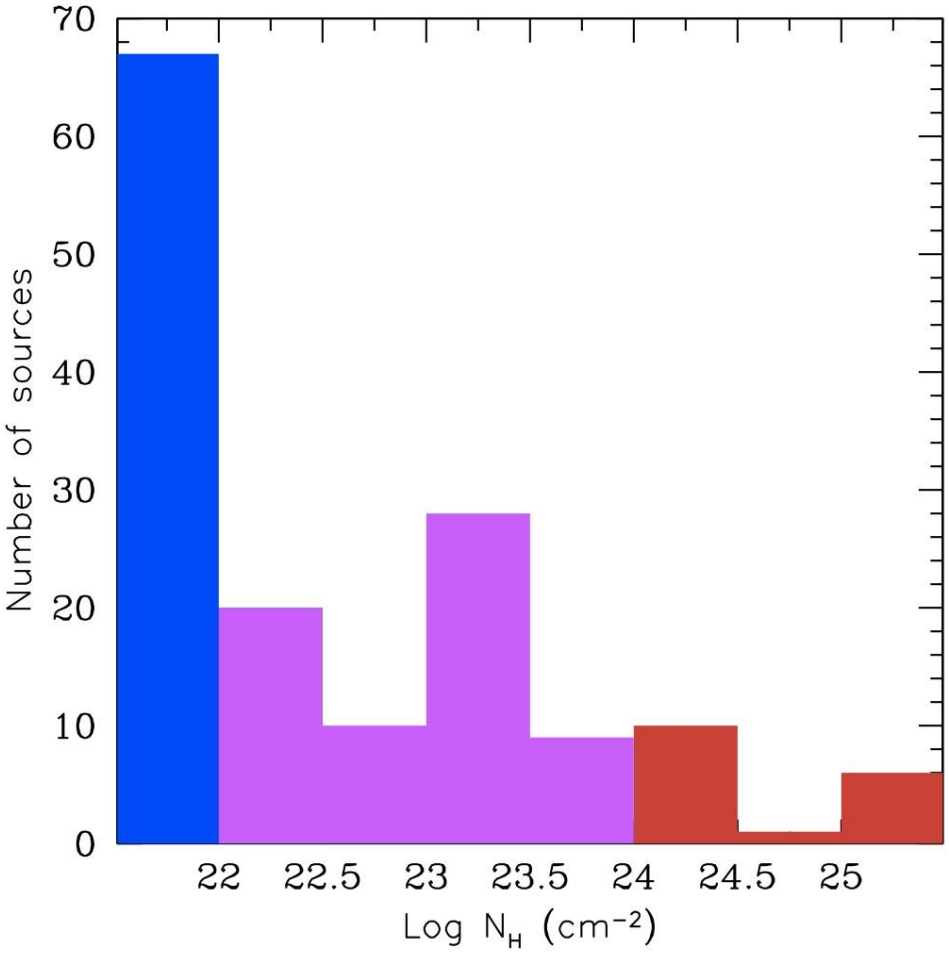
Compton thick AGN



Using high-quality X-ray data, one can estimate N_H or show that $N_H > 10^{25}$ (reflection-dominated)

Our INTEGRAL sample contains 17 such objects (out of 151), most of them now with good spectral data (*NuSTAR*)

Distribution of X-ray absorption columns

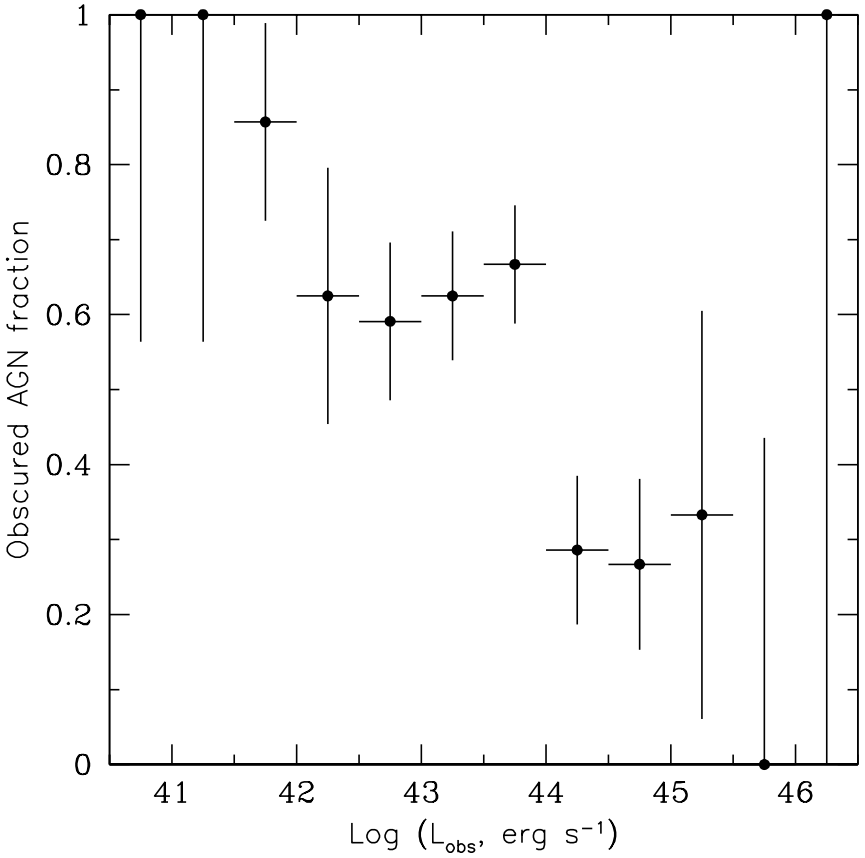


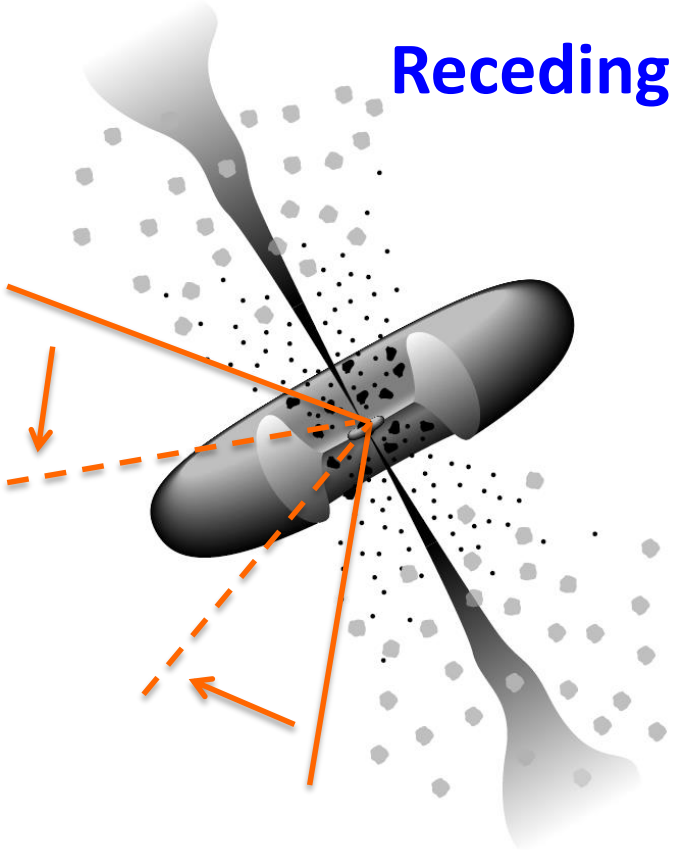
44%
unabsorbed ($N_H<10^{22}$)

44%
weakly absorbed ($10^{22} < N_H < 10^{24}$)

12%
strongly absorbed ($N_H>10^{24}$)

Fraction of obscured (N_H>10^{22}) AGN as a function of luminosity

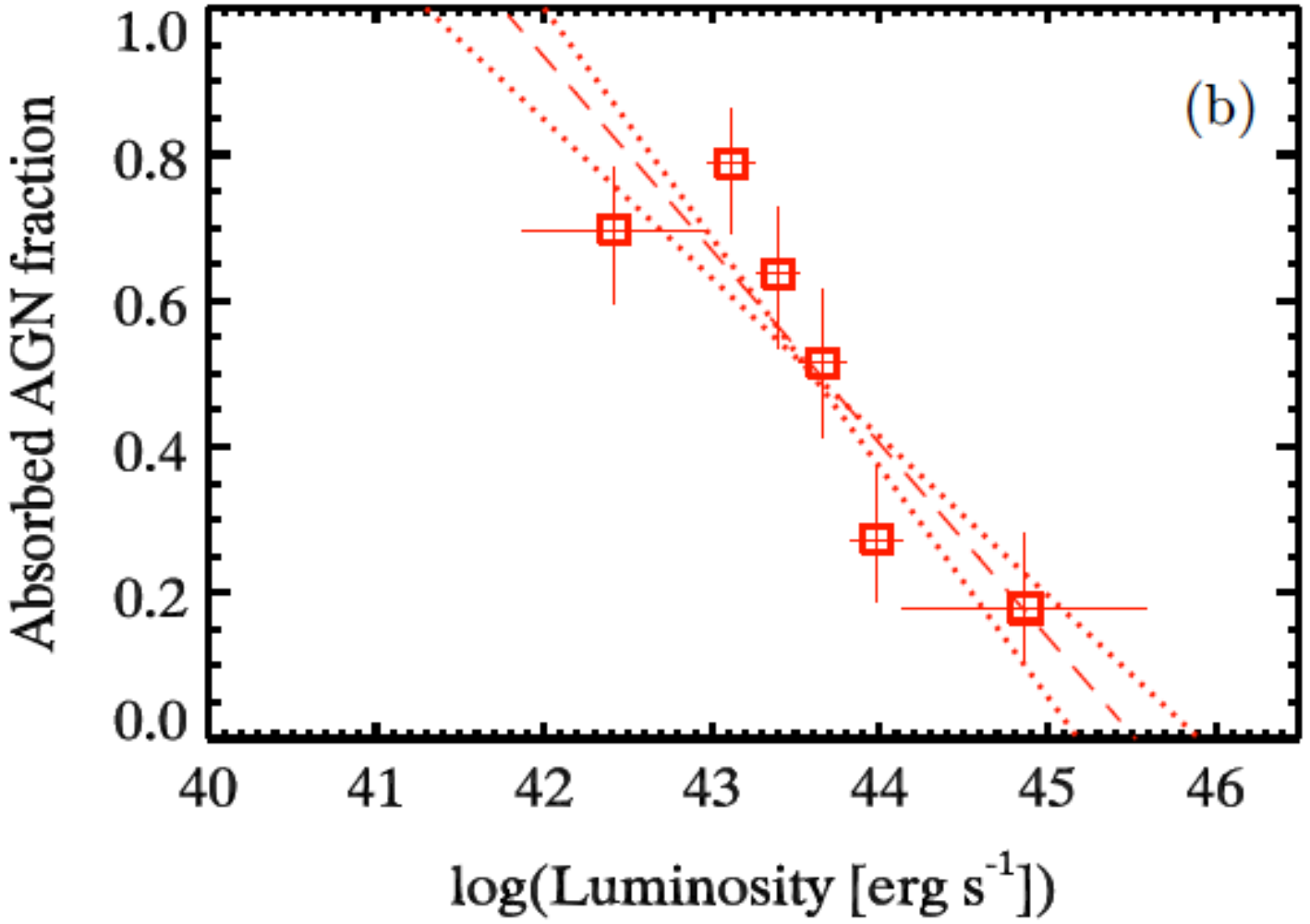




Receding torus?

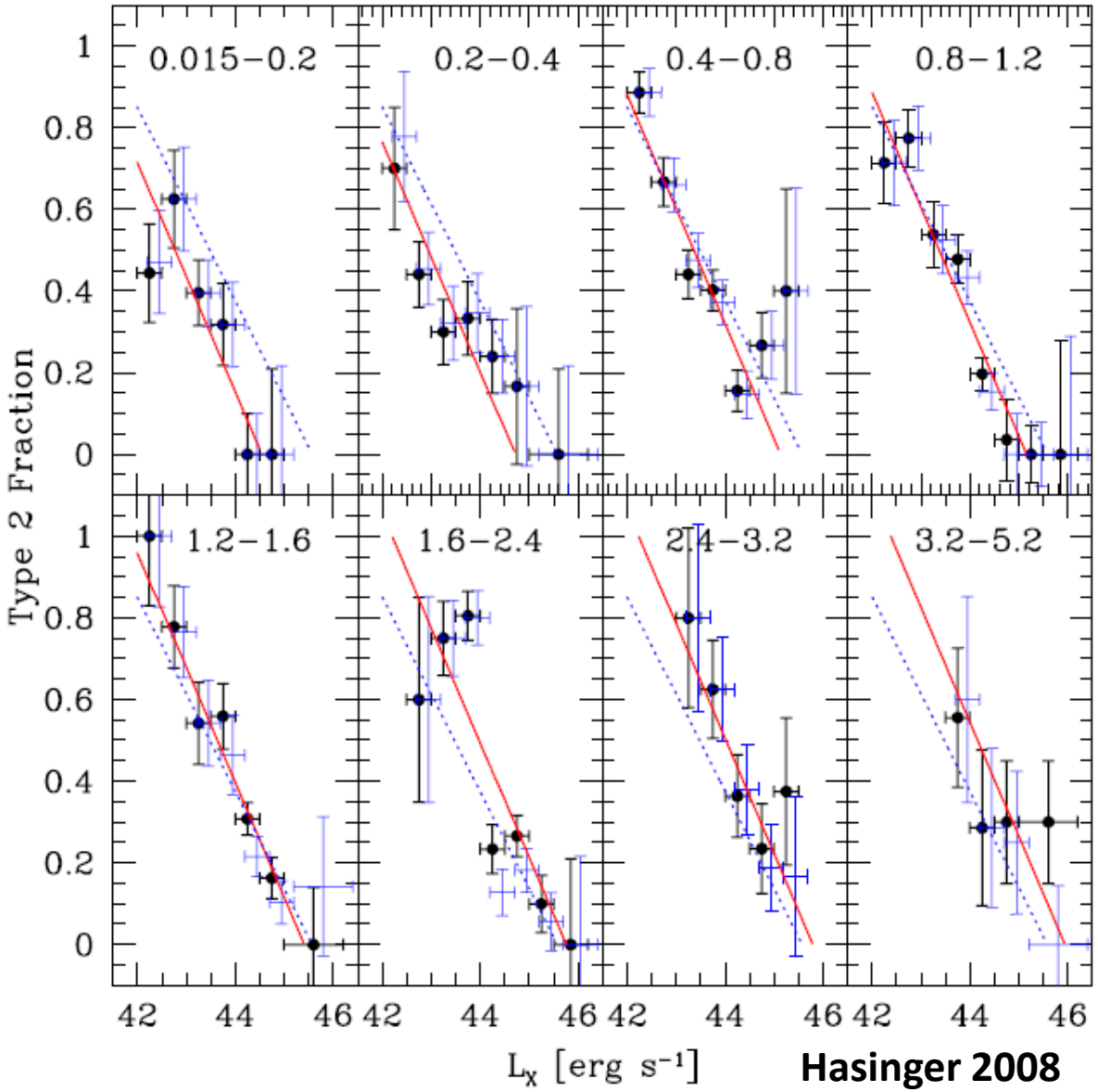
$\Omega_{Torus}/4\pi \approx 1-0.25(\log L_{17-60\ keV} - 41.5)$

The same is seen in the Swift/BAT hard X-ray survey

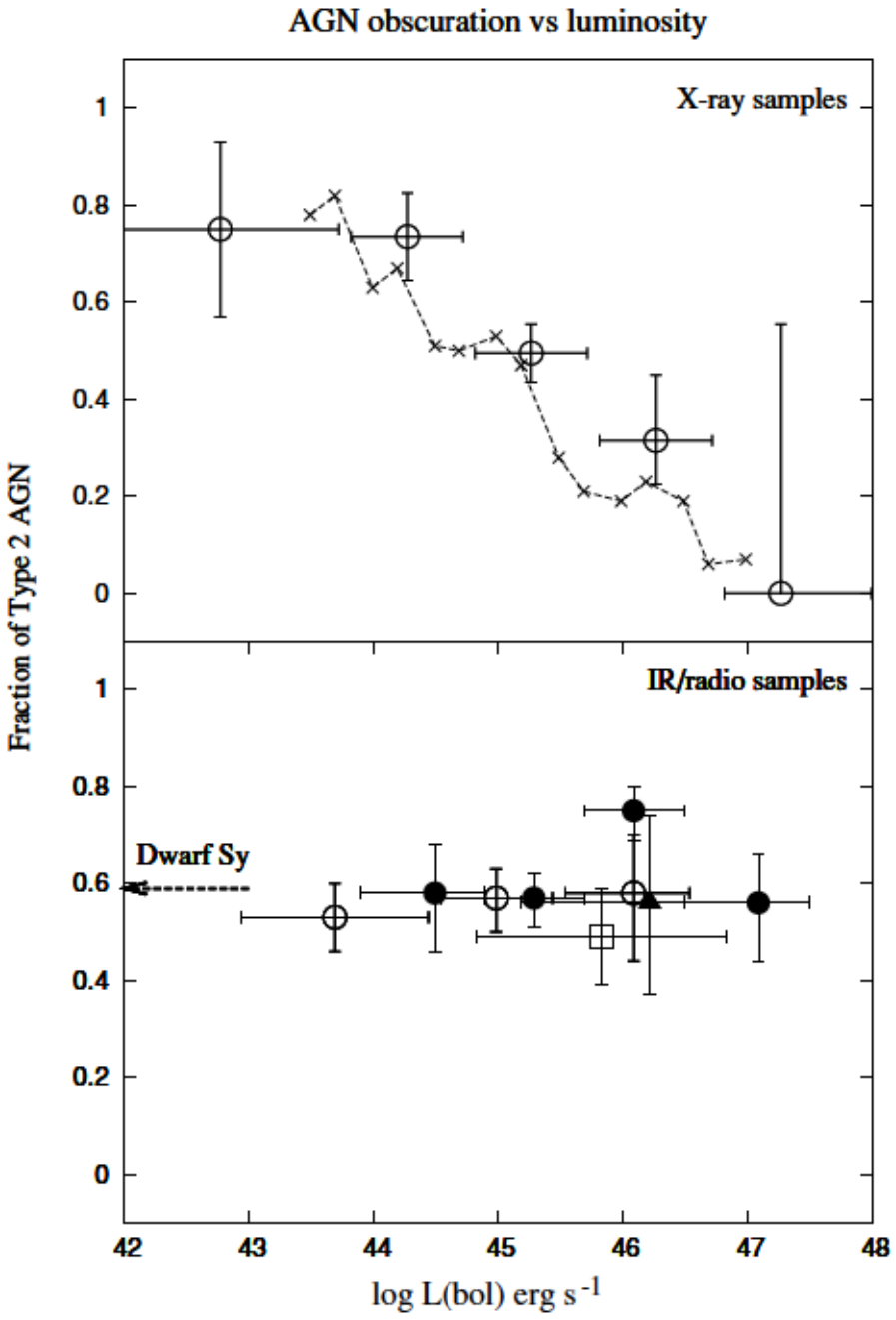


Burlon et al. 2011

… and in X-ray (below 10 keV) surveys



Hasinger 2008
(Chandra, XMM, ASCA, HEAO-1)

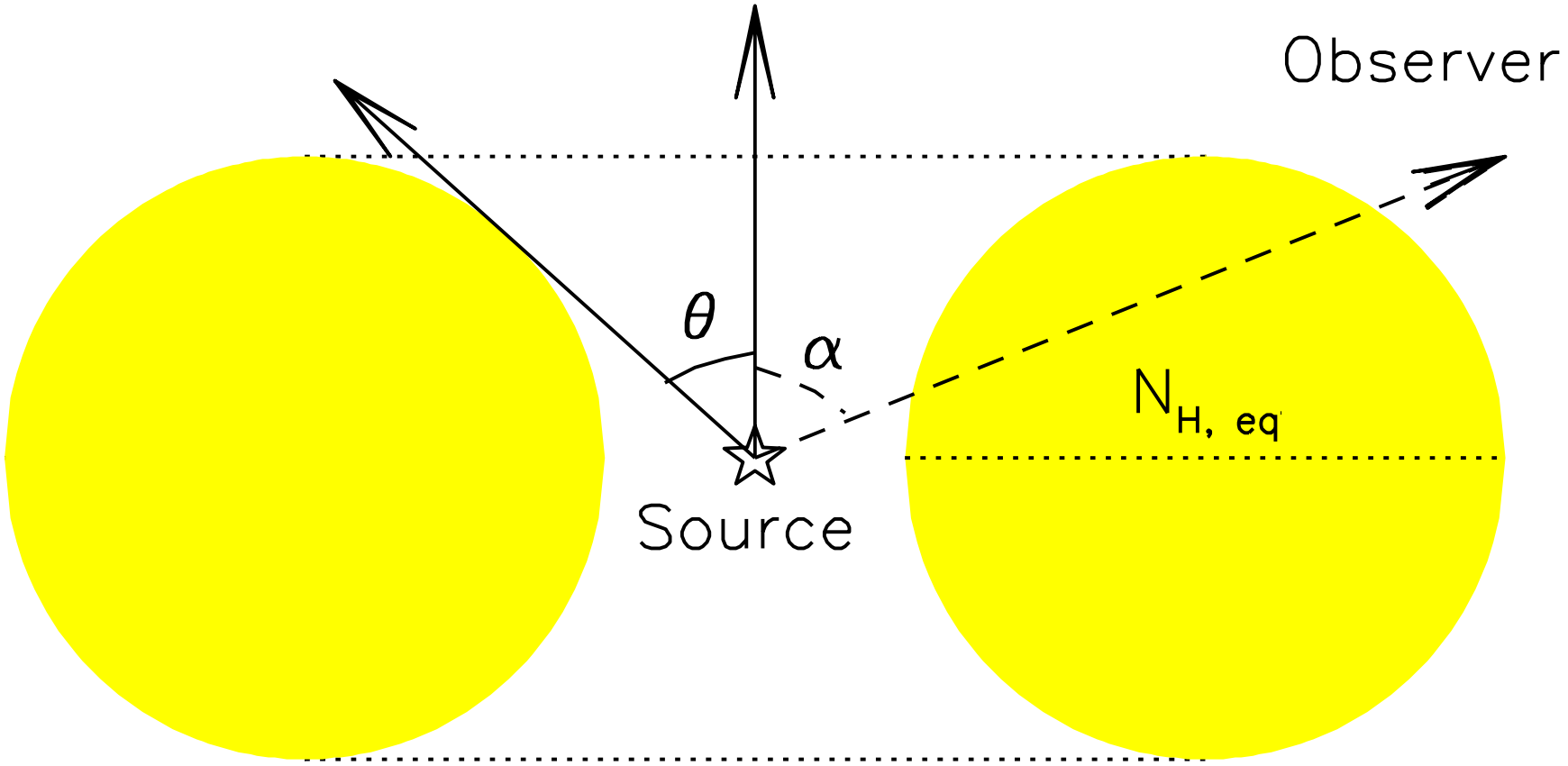


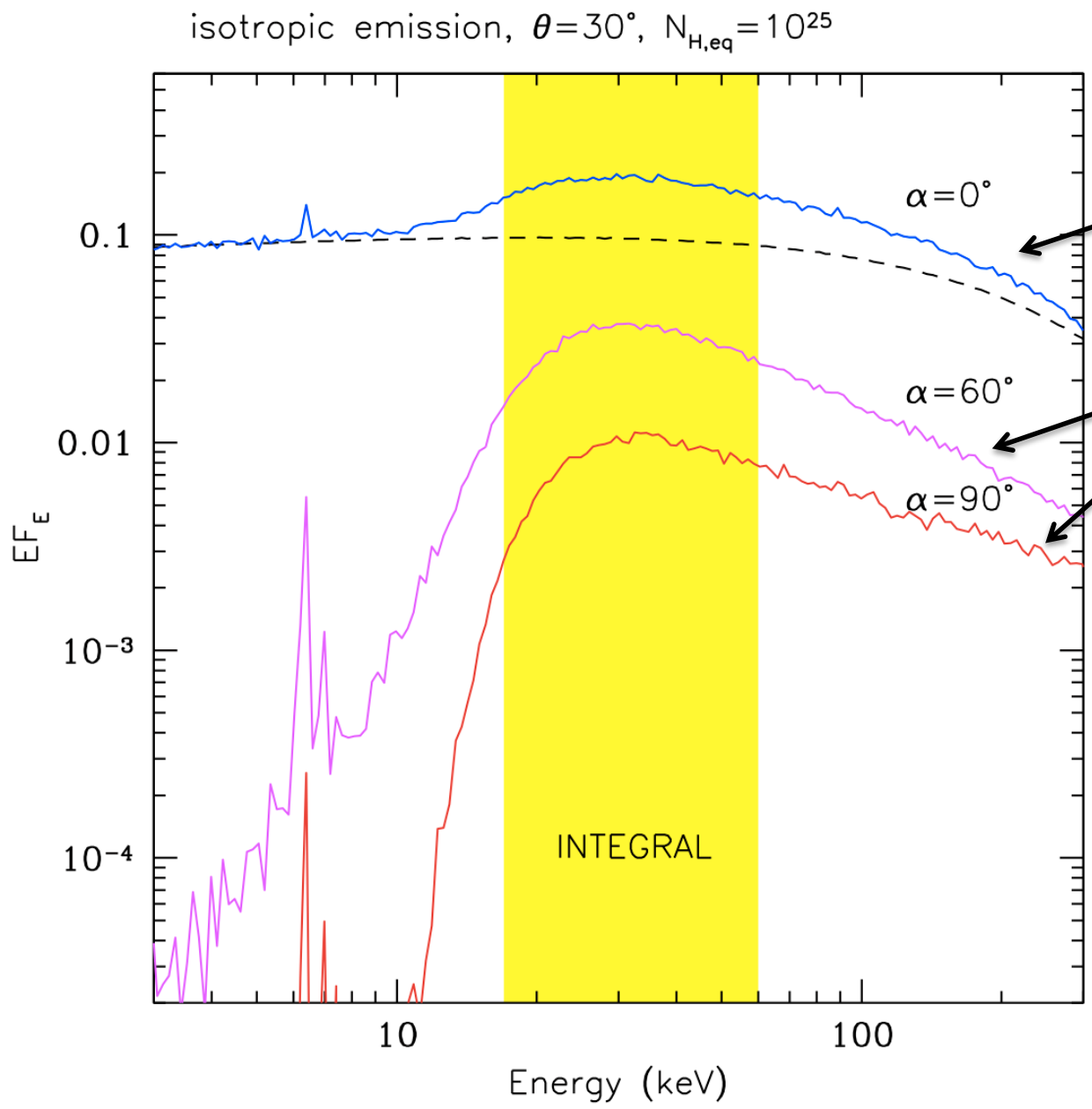
Discrepancy with IR/radio selected samples?

Lawrence & Elvis 2010

A selection effect?

Propagation of hard X-rays through TORUS

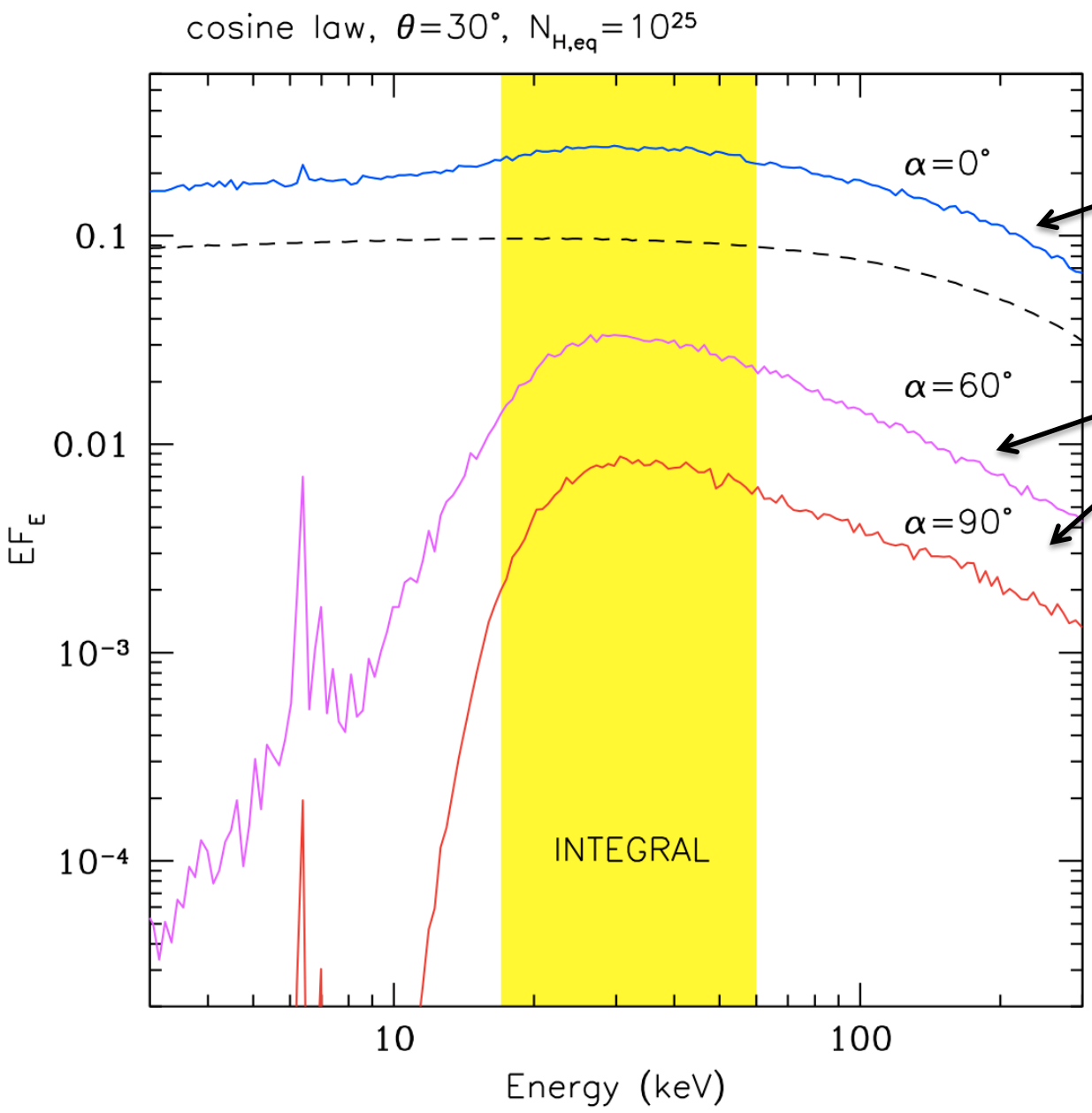




AGN-1

AGN-2

$$\frac{dL}{dW} = const$$

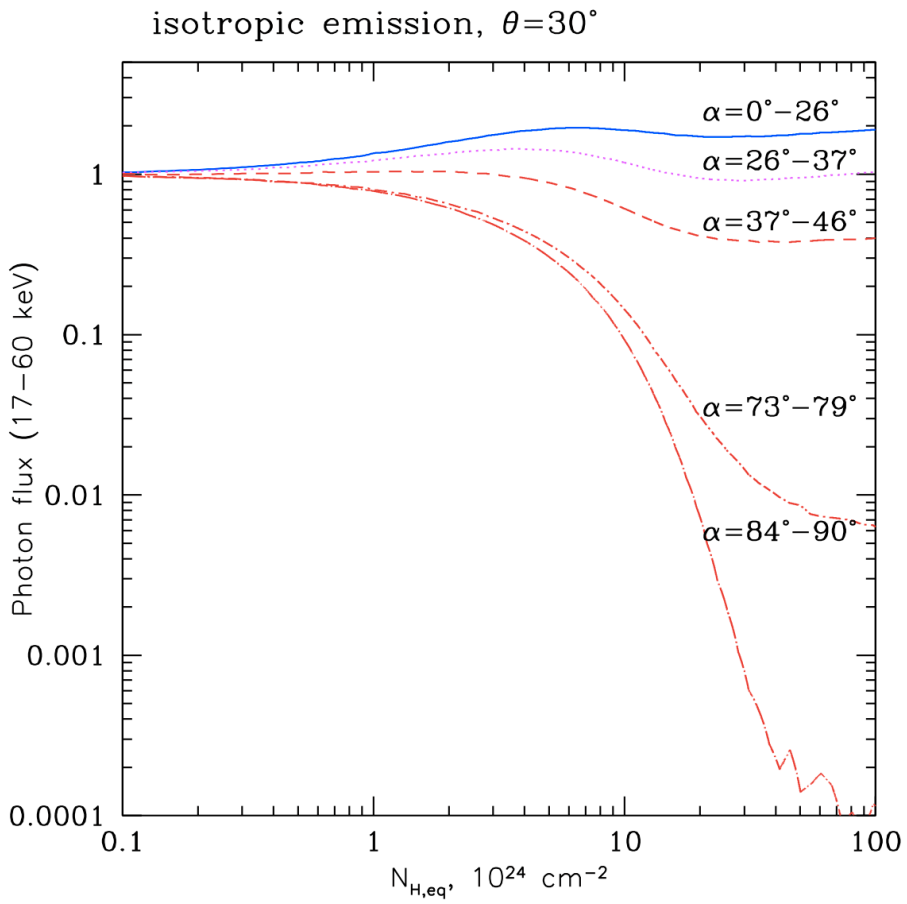


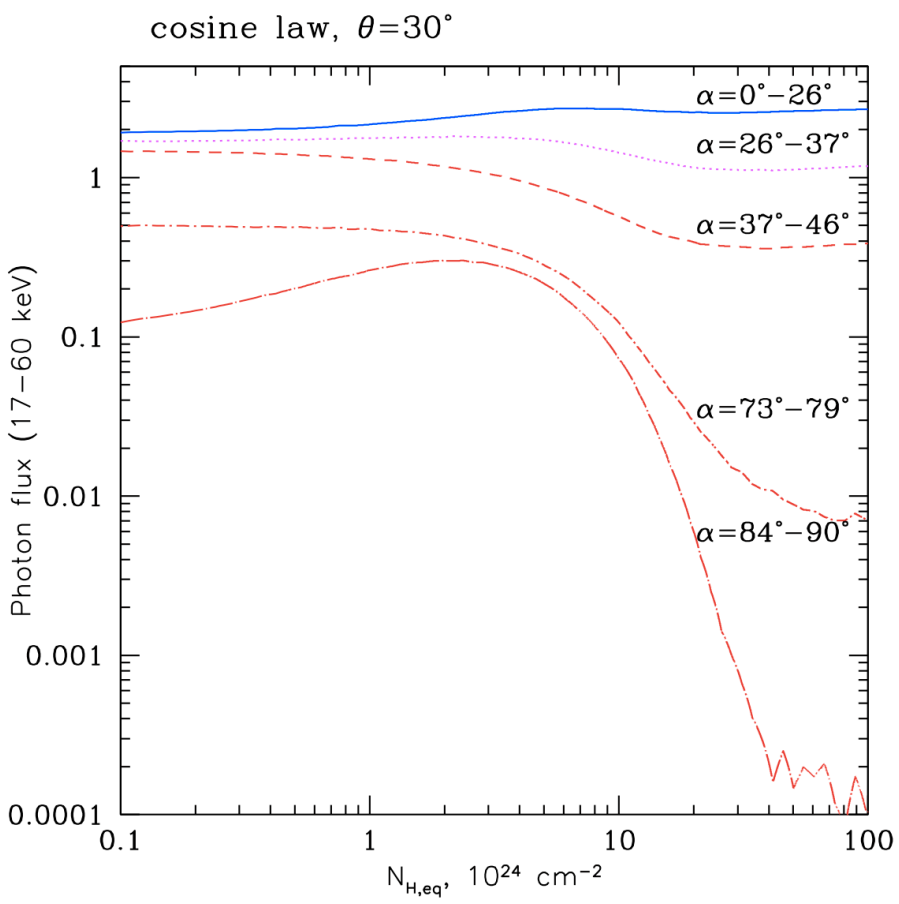
AGN-1

AGN-2

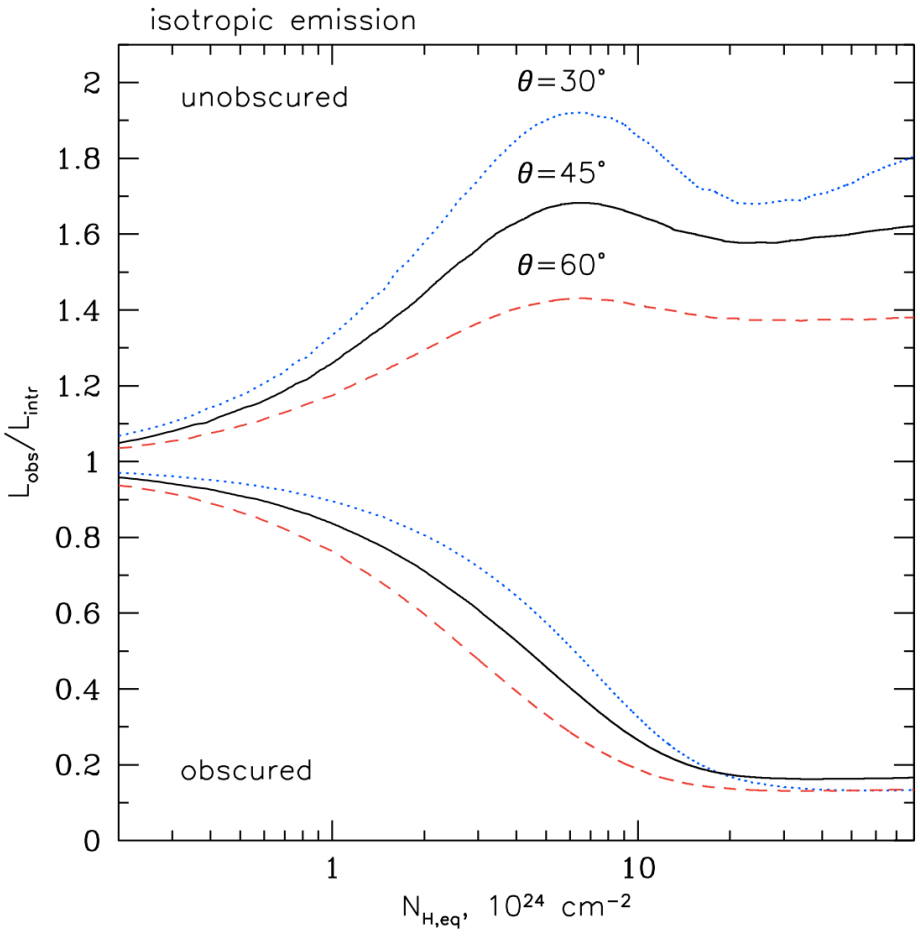
$$\frac{dL}{d\Omega} \propto \cos a$$

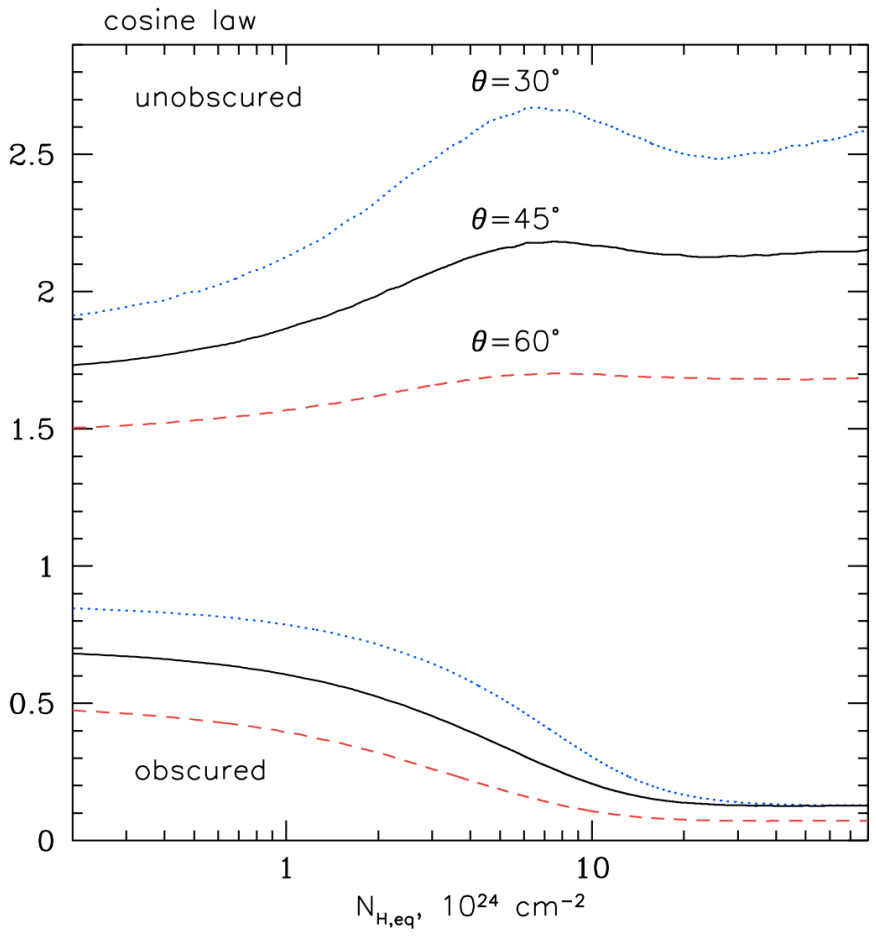
Measured hard X-ray flux as a function of viewing angle and N_H





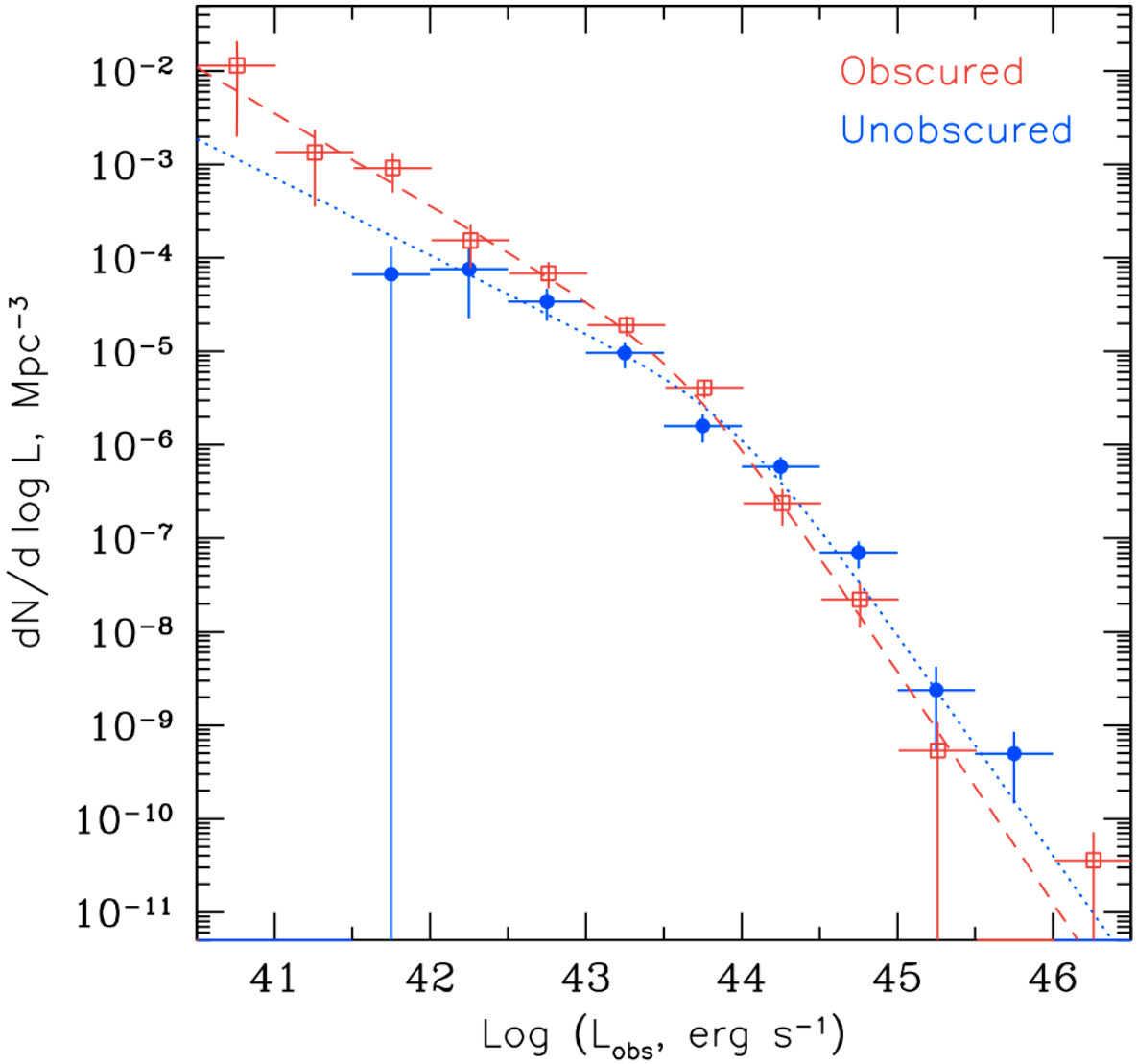
Average impact on AGN-1 and AGN-2 luminosities



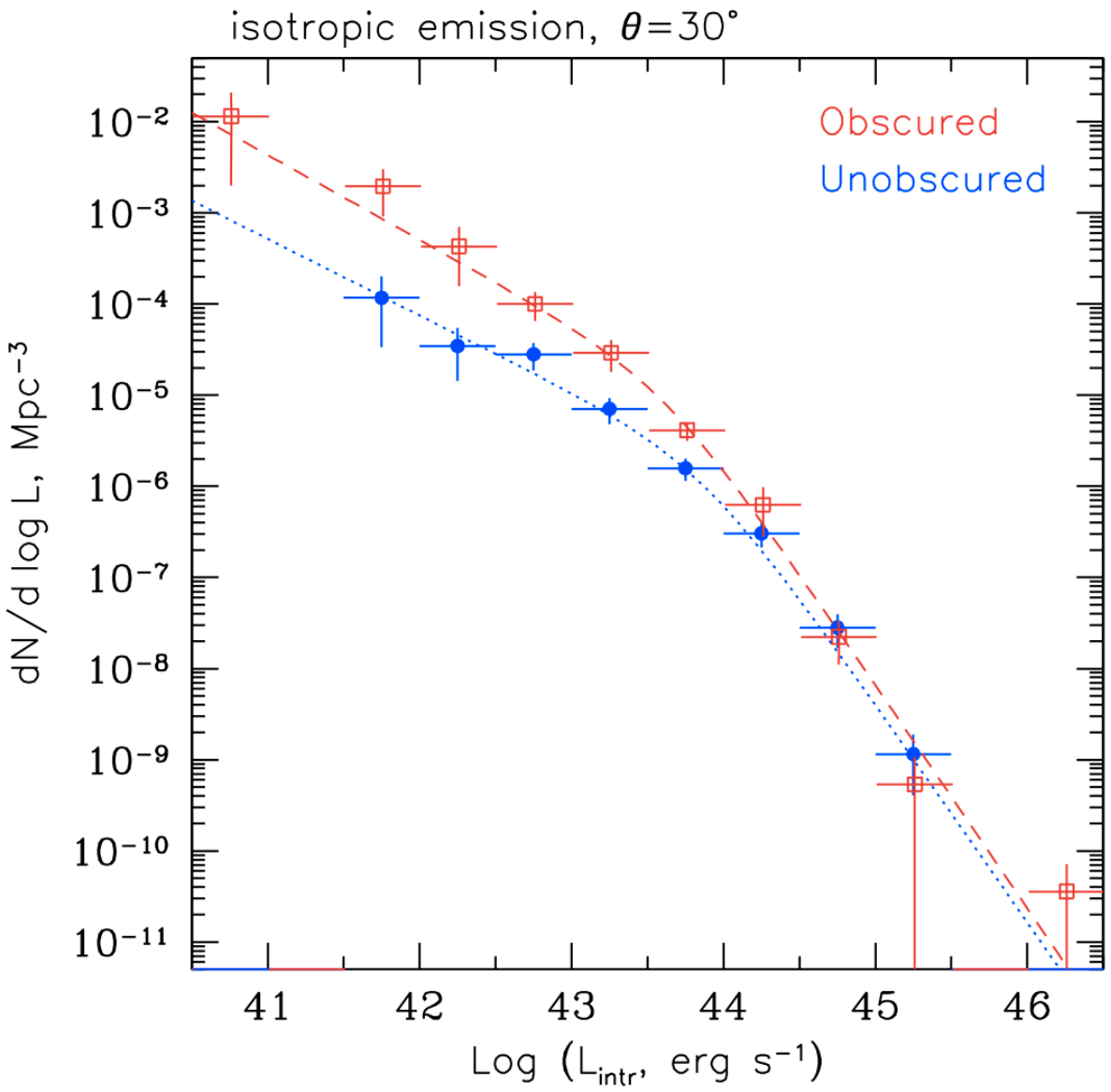


Number of detected sources is proportional to $V_{max} \sim L_{obs}^{3/2}$

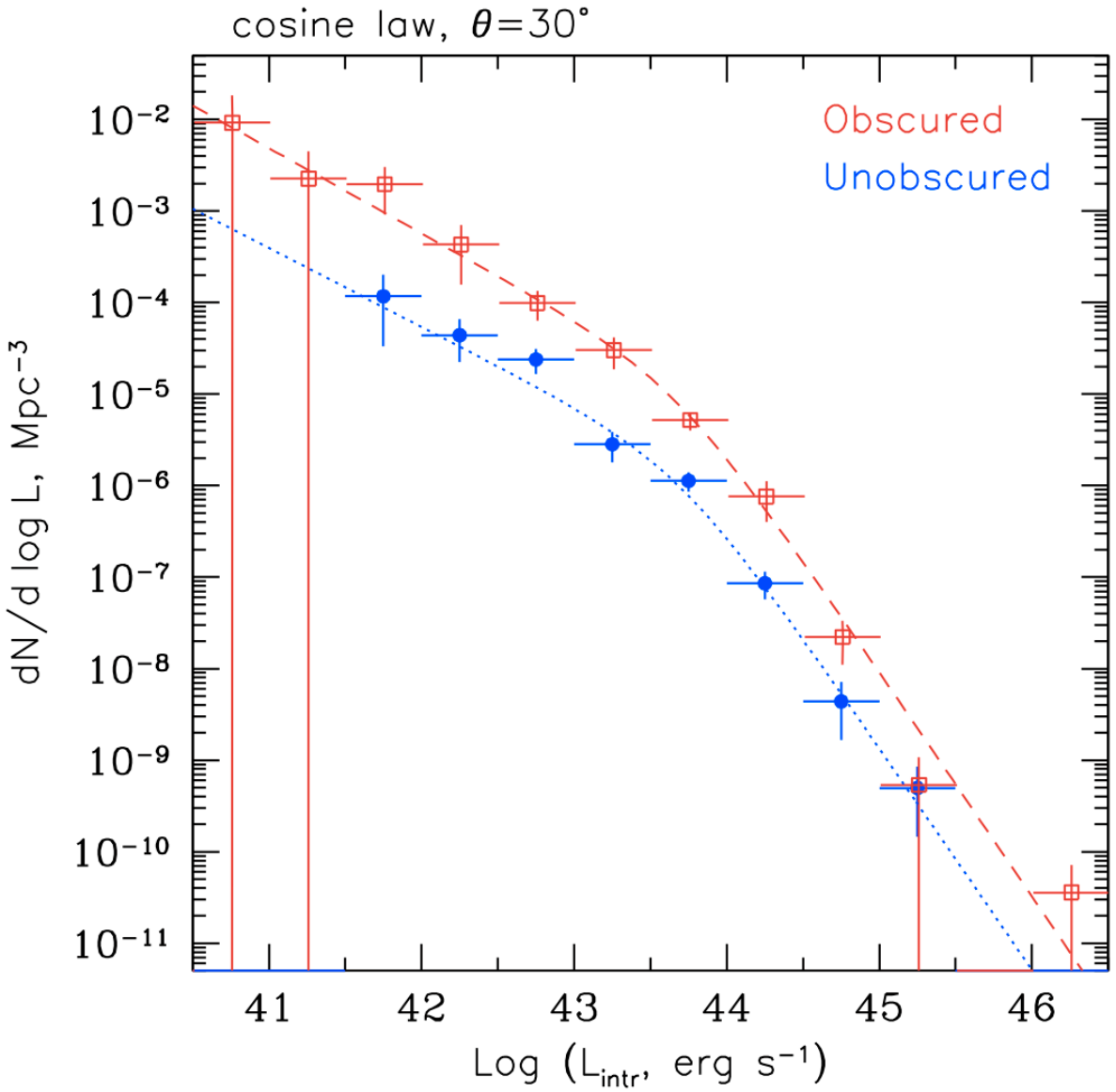
Observed AGN luminosity function



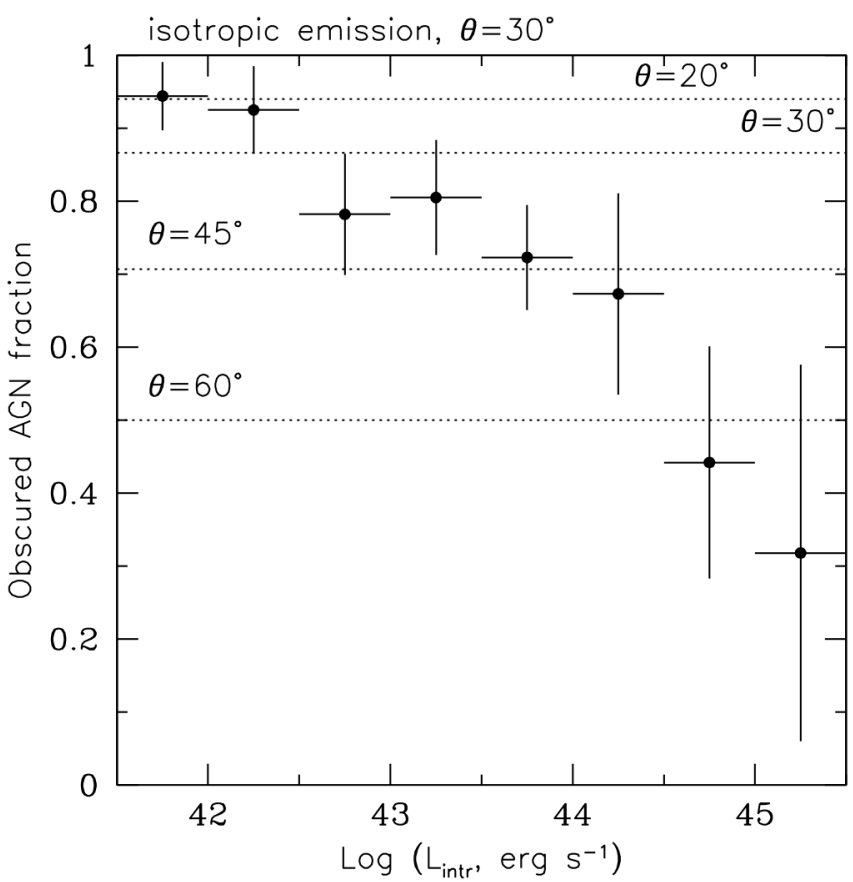
Intrinsic AGN luminosity function

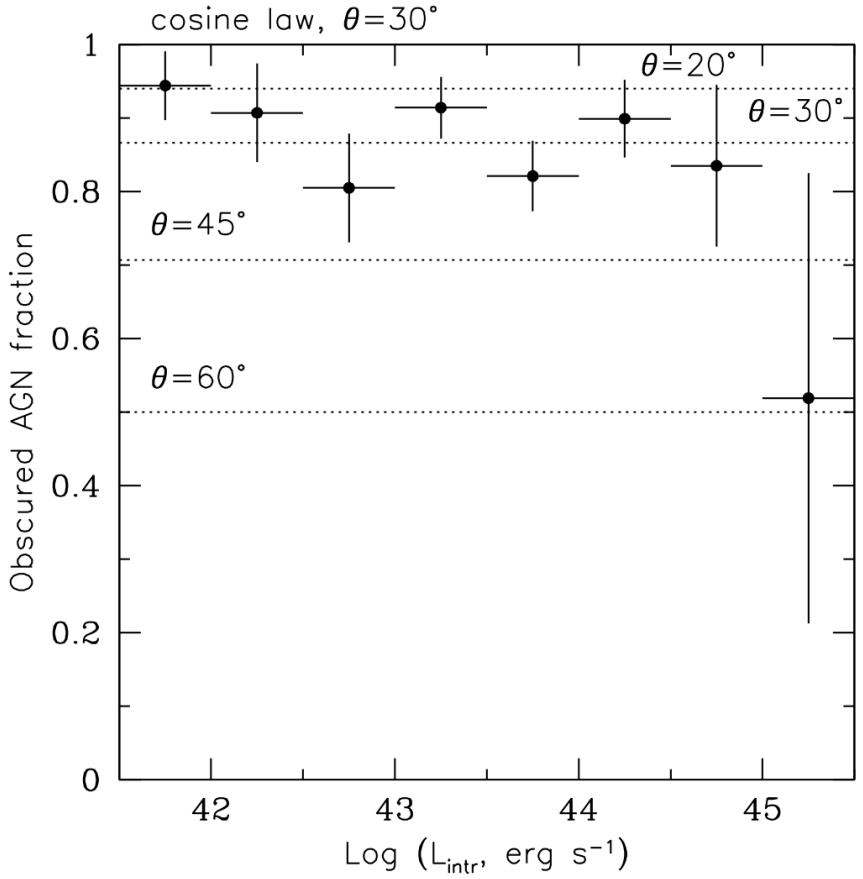


Intrinsic AGN luminosity function



Intrinsic fraction of obscured AGN as a function of luminosity





Conclusions

- **Observed fraction of obscured AGN decreases with luminosity.**
- **This trend retains when AGN counts are corrected for selection bias and assuming isotropic central source. However, the intrinsic fraction of obscured AGN is higher than observed.**
- **If AGN emission is moderately collimated, there is no intrinsic declining trend of obscured AGN fraction with luminosity. Constant opening angle of the Torus?**

Future work:

- ***Use larger local AGN samples***
- ***Uniform spectral analysis for N_H estimation***
- ***Comparison with clumpy torus models***
- ***Extension to higher z and standard X-ray band***