Three-year Swift/BAT survey of AGNs: reconciling theory and observations?

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credits to R. Mushotzky, R. Vasudevan

- Energy range 15-55 keV (Ajello+08)
- quasi-uniform 4.3 Ms
- 0.6 mcrab sensitivity (7.3d-12 cgs)
- |b| > 15°

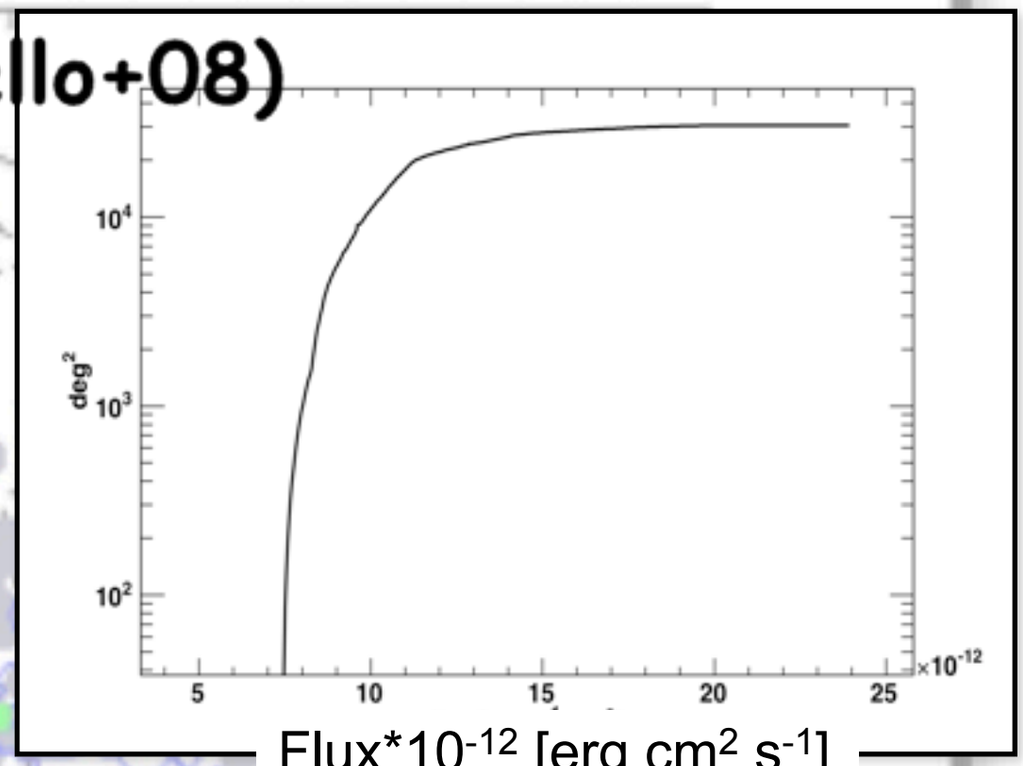
197 sources

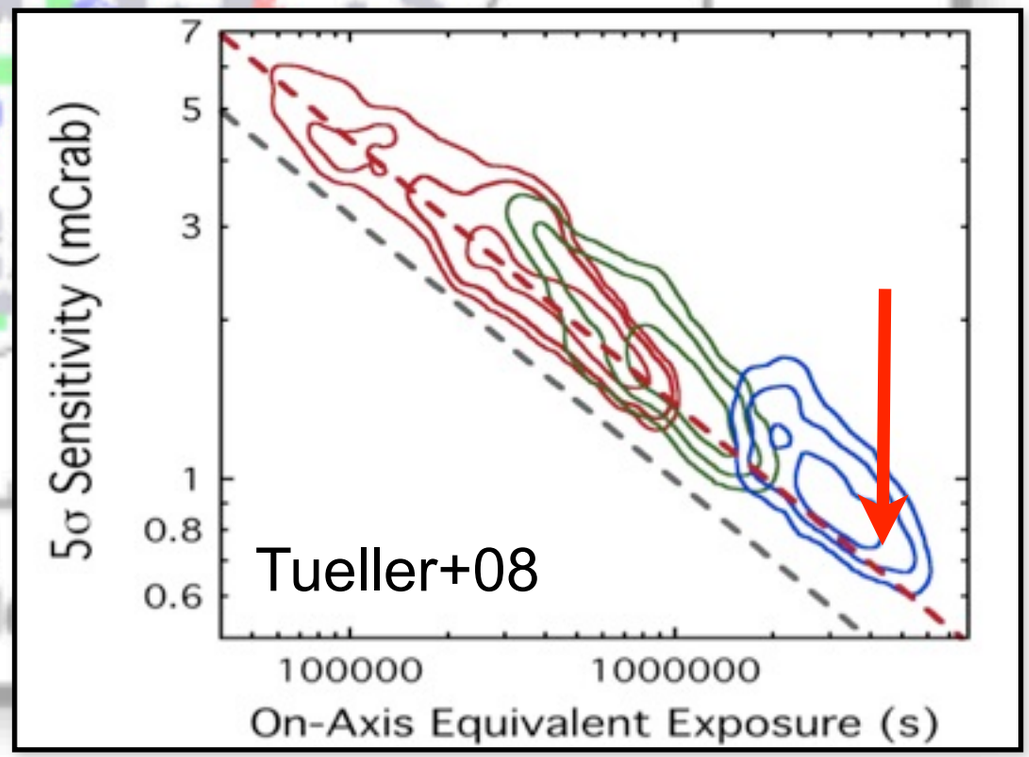
100% completeness

+

XRT and/or XMM

→ Joint fit

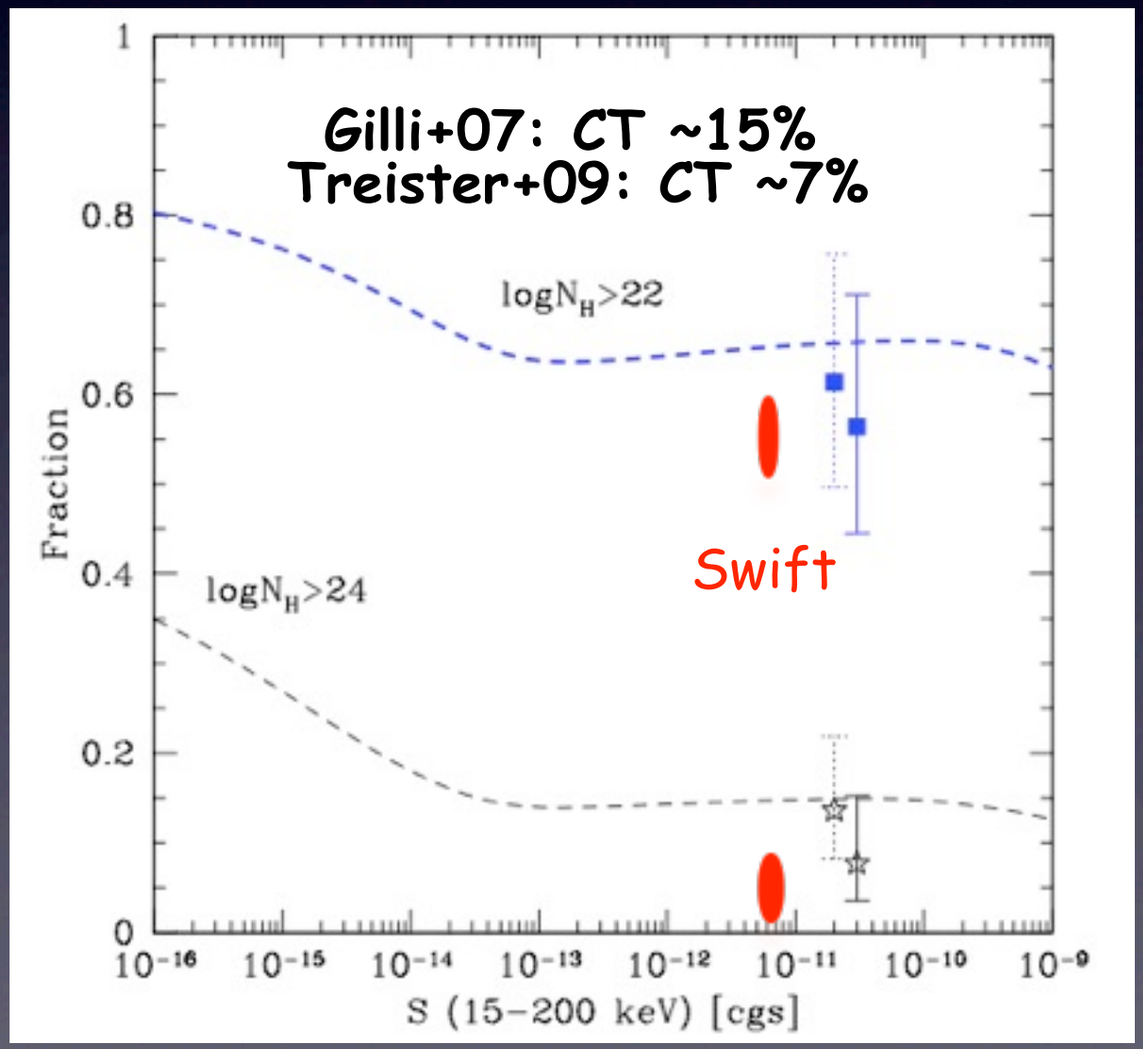


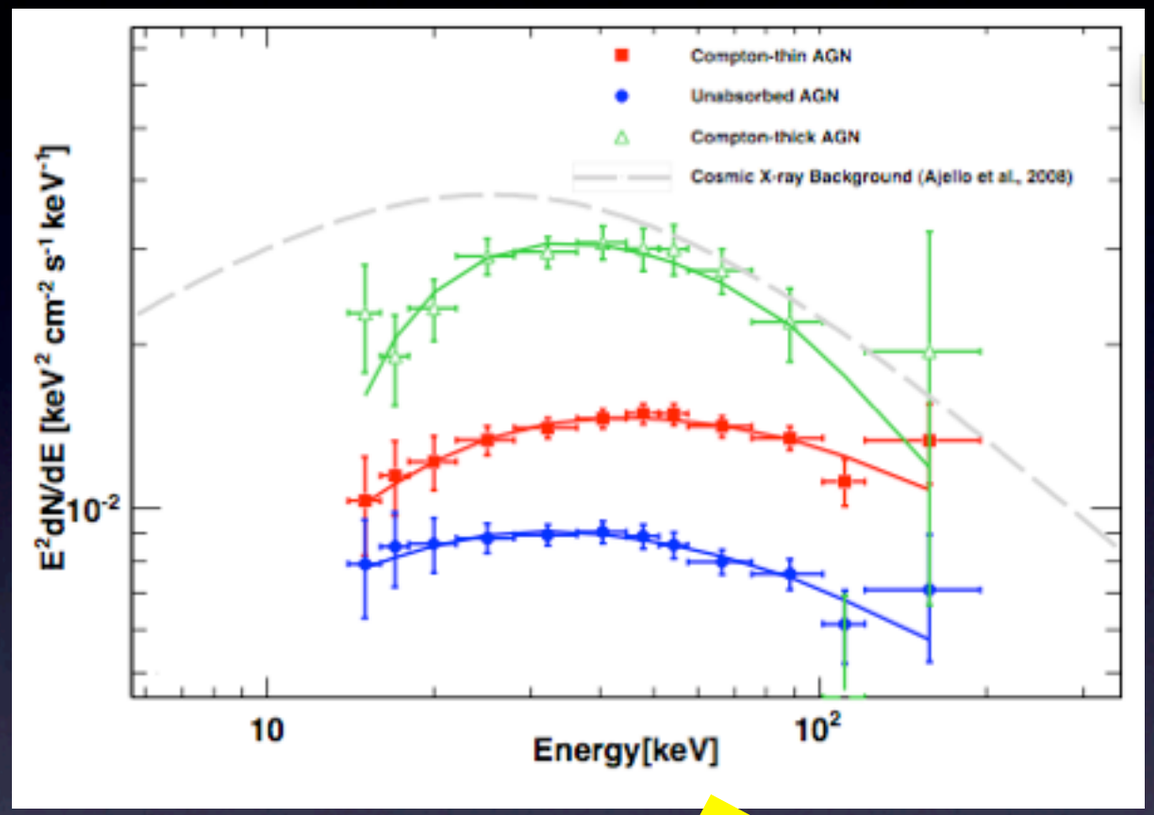


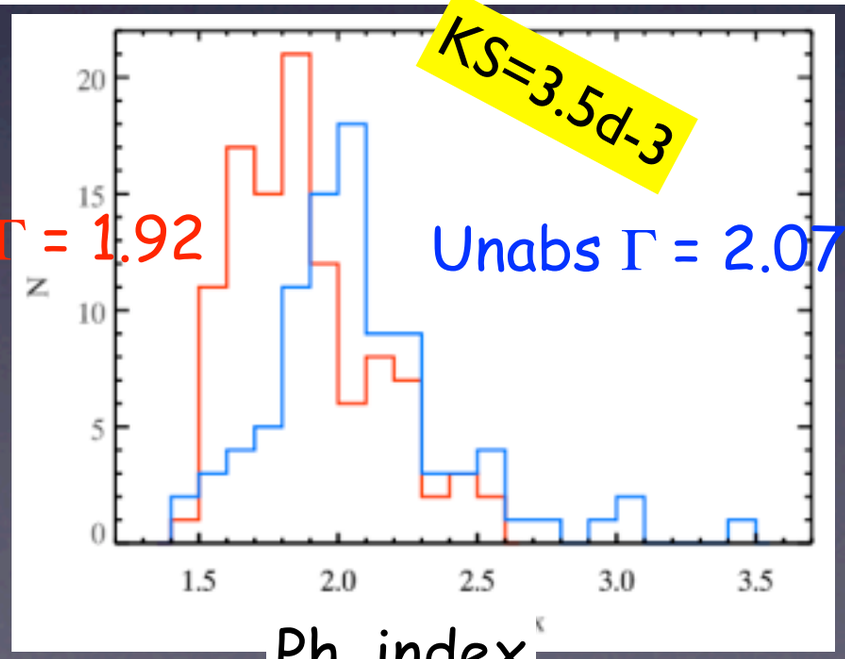
Compton thick sources

$Log(N_H)>22 \rightarrow 53\pm4\%$

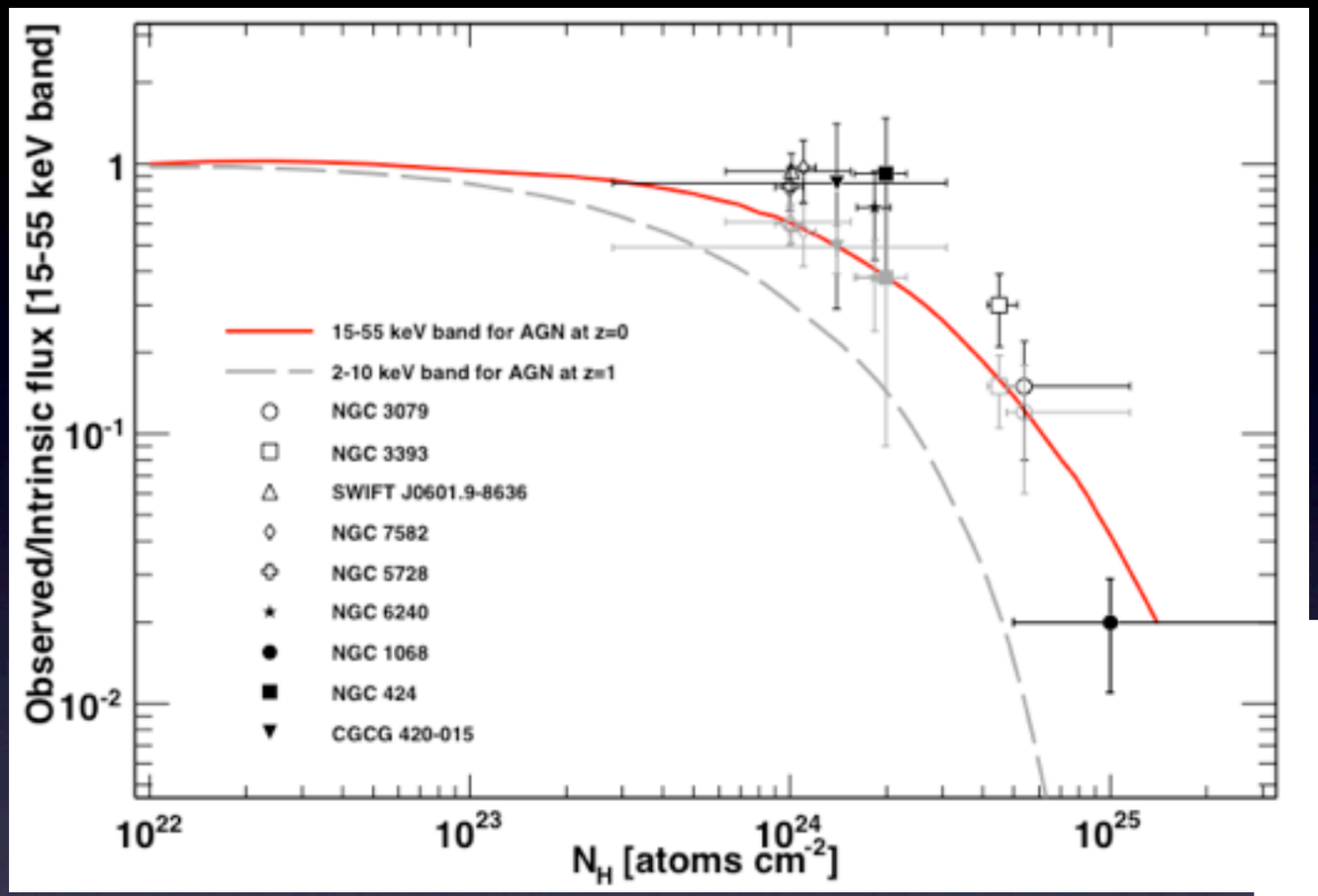
$Log(N_H)>24 \rightarrow 4.6^{+2.0}_{-1.5}\%$





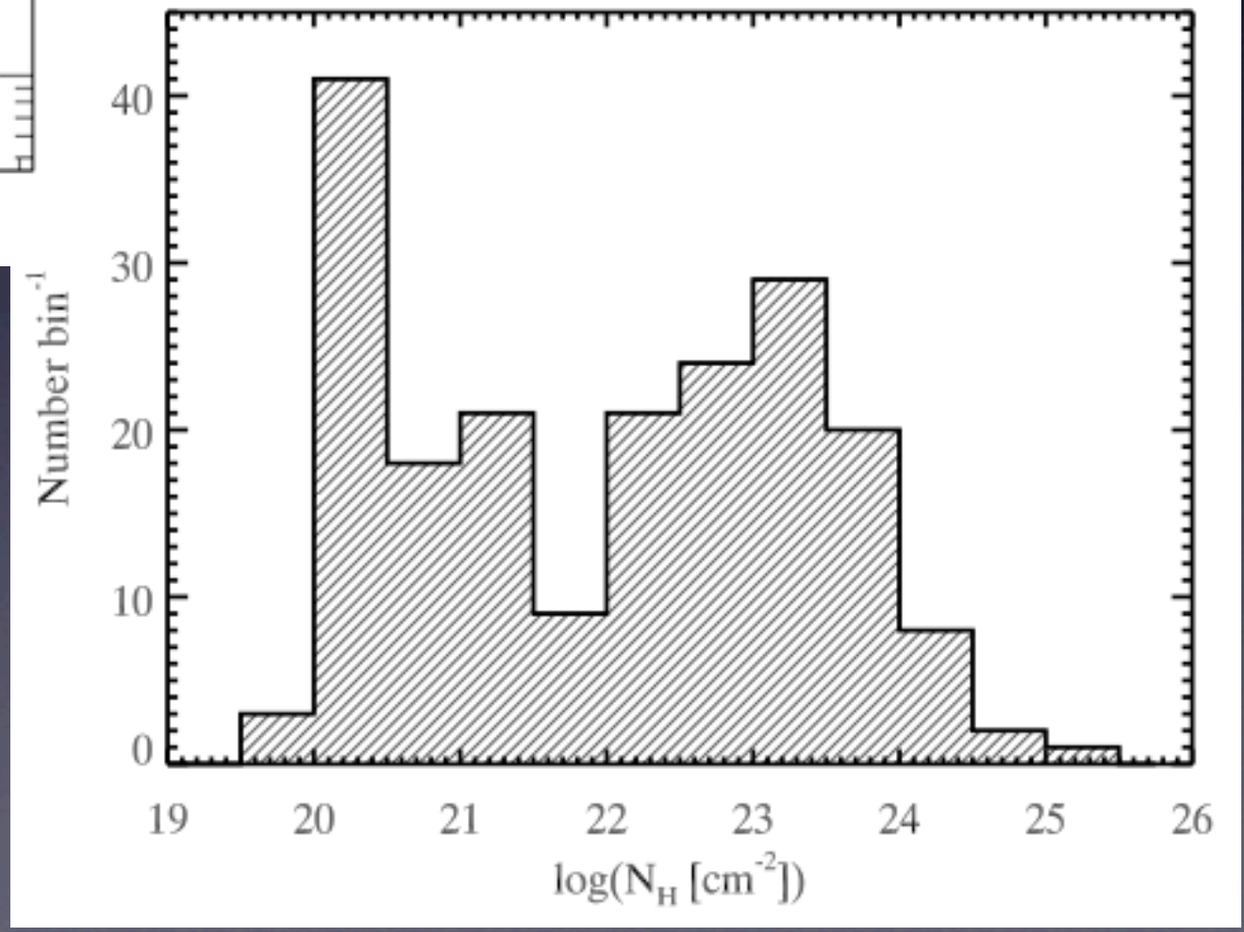


Caveat: BAT is also biased



Courtesy of Yaqoob for fully relativistic Compton scatter treatment (see also Brigthman & Nandra 2011, Ikeda 09)

Observed N_H distribution



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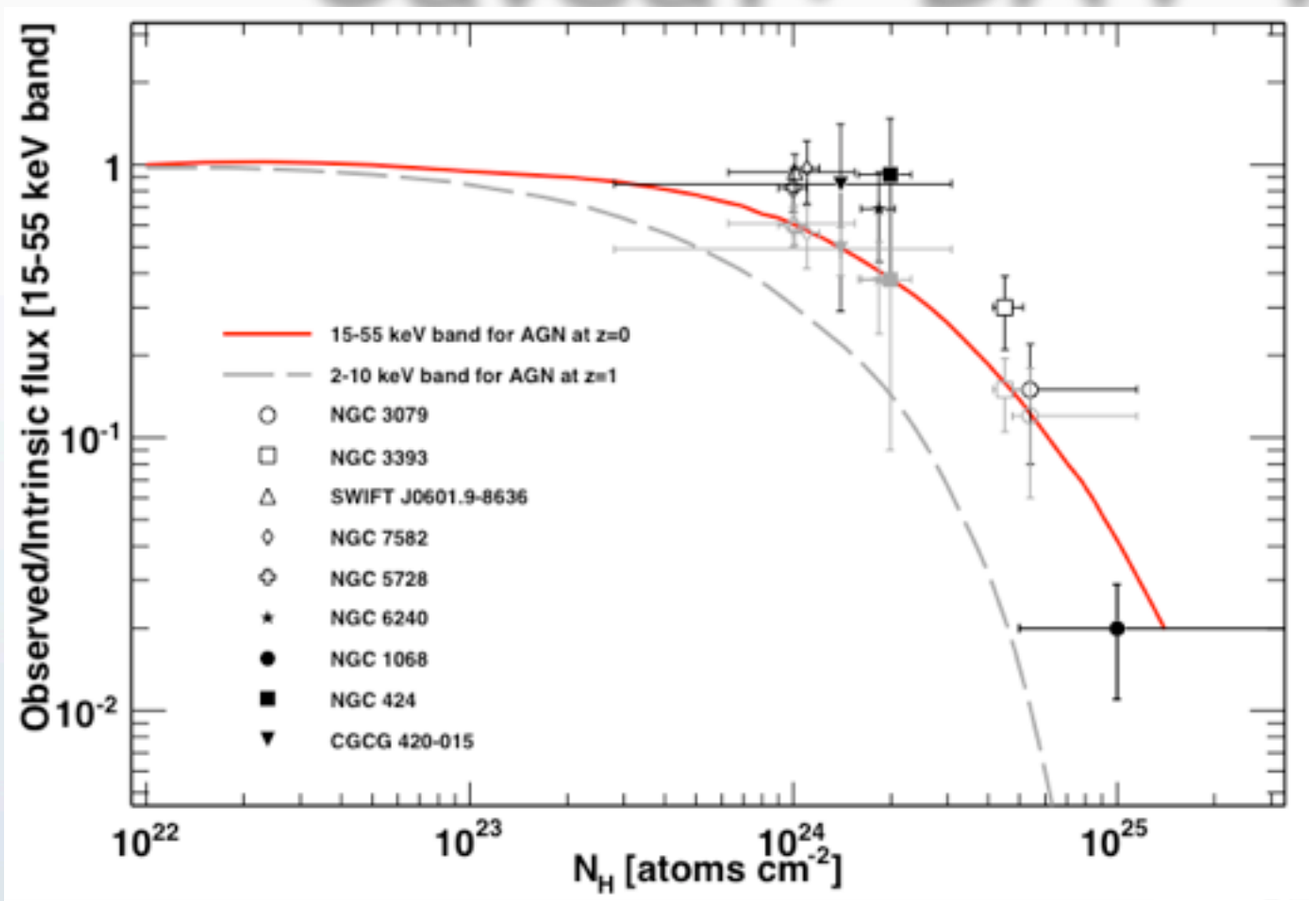
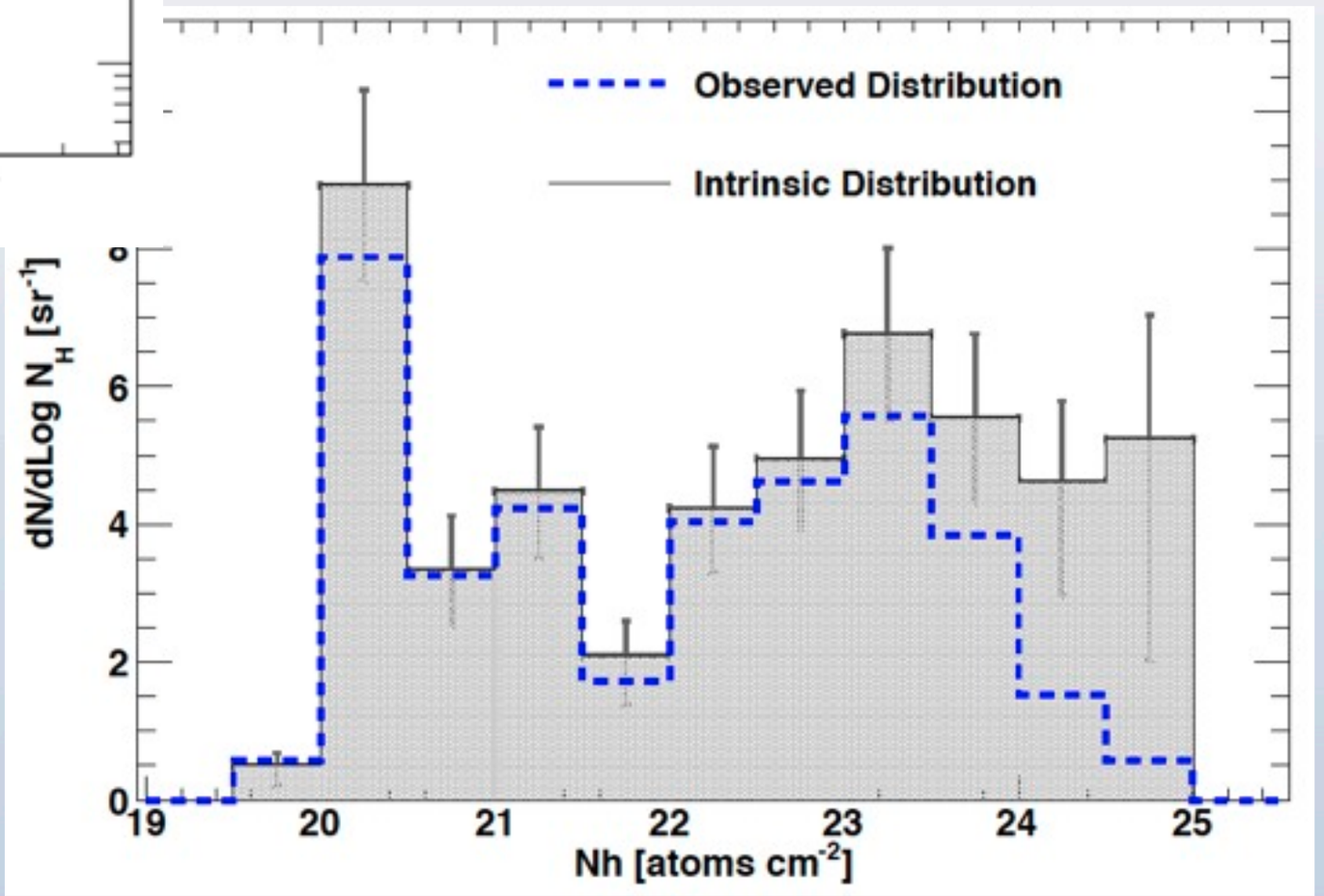


$$\frac{dN}{dLogN_{\rm H}} = \int_{S_{min}}^{S_{max}} \frac{dN}{dS}(N_{\rm H})\ dS$$

$$\frac{dN}{dLogN_{\rm H}} = \frac{A(N_H)}{1-\alpha}\left[S_{max}^{1-\alpha} - (10^{-11}K(N_{\rm H})^{1-\alpha}\right]$$

Intrinsic N_H distribution

Need of CT sources?
Intrinsic CT ratio is ~20% (!!)

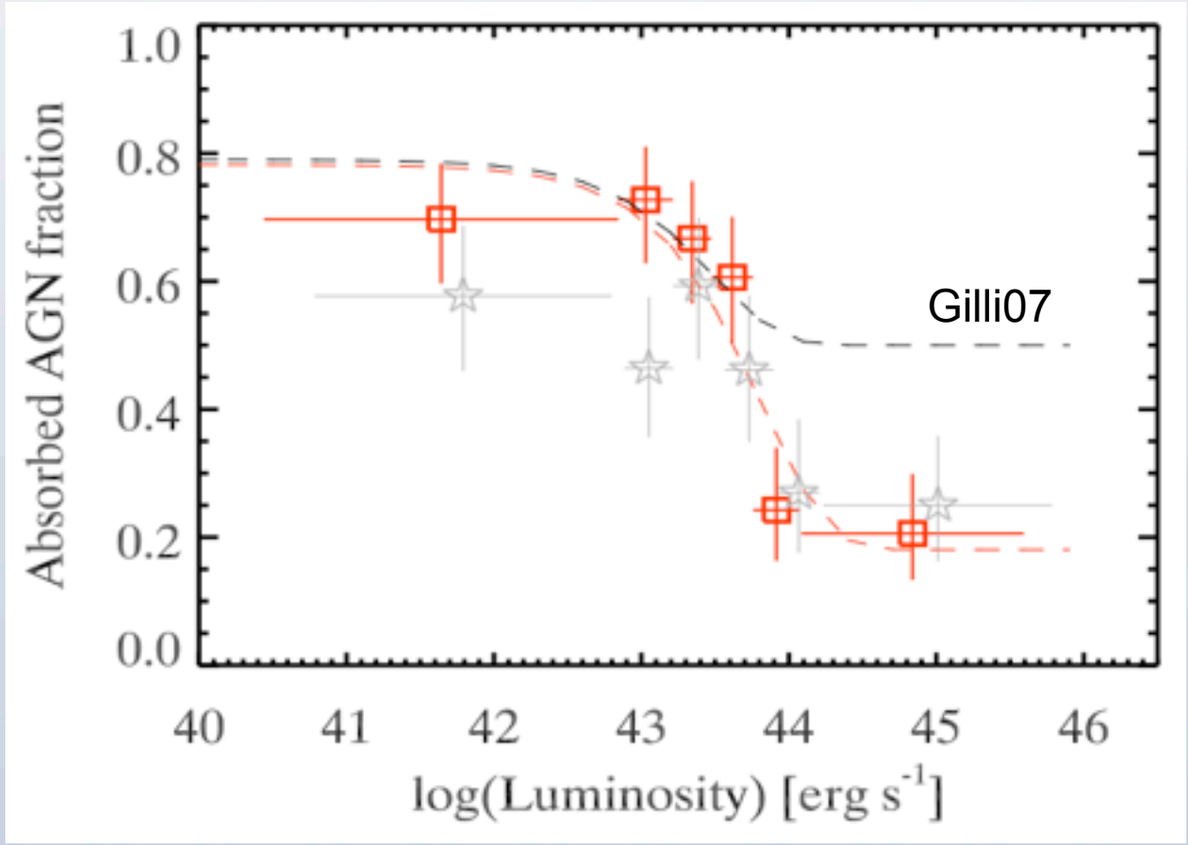


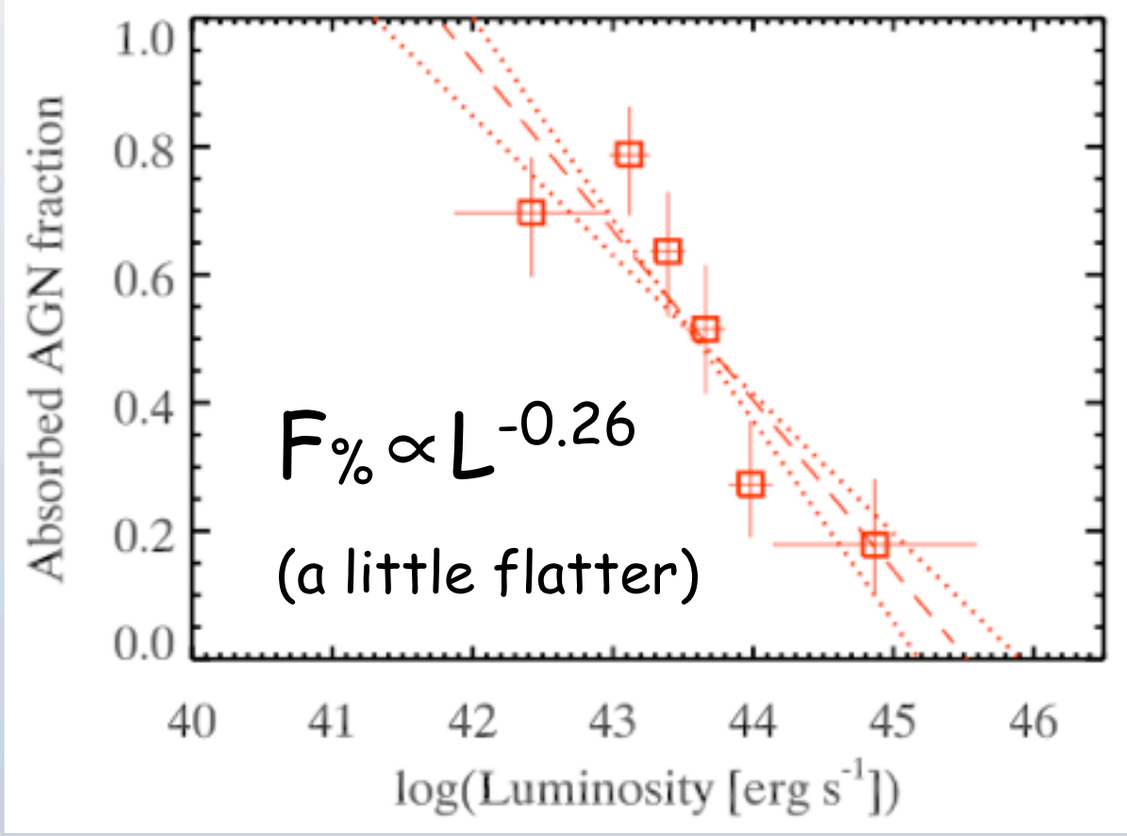
Unified picture?

Breakdown of the unified model (Lawrence&Elvis82, before unification):

- not everything depends (just) on orientation
- receding torus model: the luminous AGN cleans its environment

$$R_d \simeq 0.4 \left(\frac{L}{10^{45} \mathrm{erg}^{-1}} \right)^{0.5} \left(\frac{1500\ \mathrm{K}}{T_{sub}} \right)^{2.6} \mathrm{pc}$$



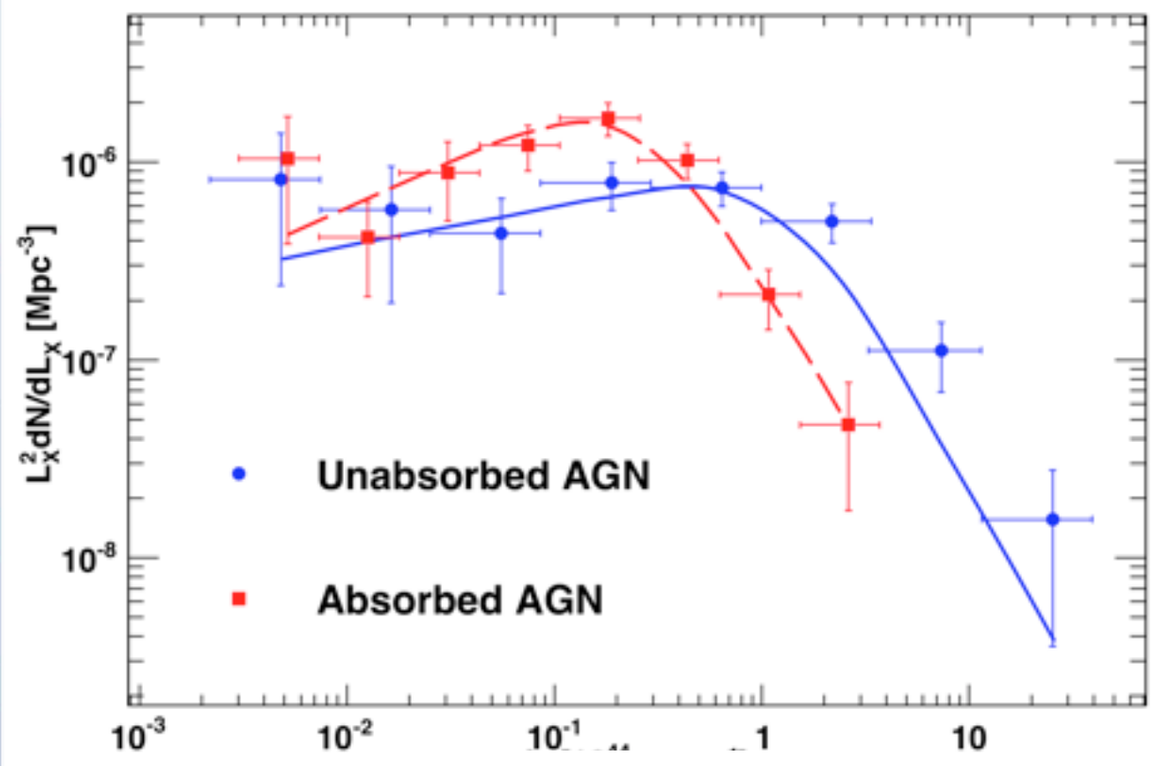


(Ueda03,La Franca05,Treister&Urry06, Lamastra06, Della Ceca08,Hasinger08, Tueller08, Beckmann09, Winter09, Brusa10)

Different XLF?

Absorbed and unabsorbed AGN might be intrinsically different:

- the XLF knee is different at the 2.9σ level (see also Della Ceca08)
- the obscuration-luminosity relation arises from different XLF
- does λ_{Edd} define different subsamples of Seyfert galaxies? (Beckmann09)



$$\Phi(L_X, z=0) = \frac{dN}{dL_X} = \frac{A}{ln(10)L_X}\left[\left(\frac{L_X}{L_*}\right)^{\gamma_1} + \left(\frac{L_X}{L_*}\right)^{\gamma_2}\right]^{-1}$$

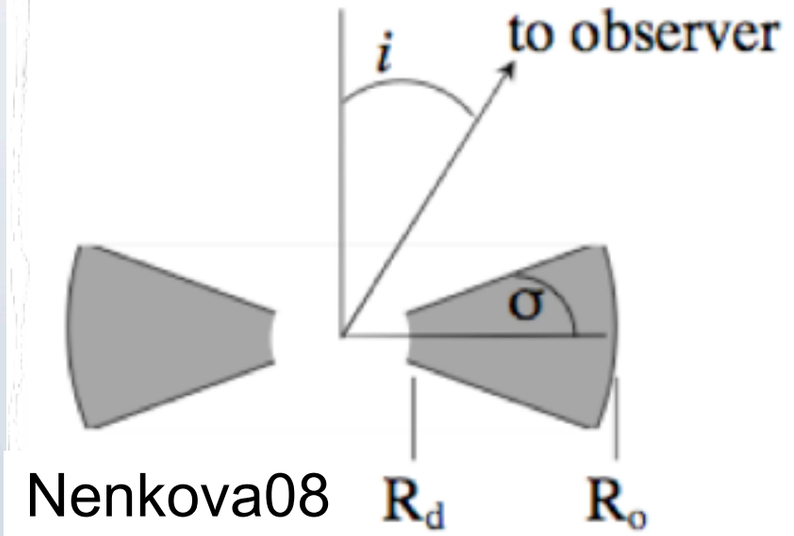
SAMPLE	# Objects	Norm.[1]	L*[2]	γ_1	γ_2
ALL	199	1.53e-5	$0.53^{+0.15}_{-0.15}$	$0.74^{+0.07}_{-0.08}$	$2.60^{+0.19}_{-0.20}$
ABSORBED	104	2.95e-5	$0.25^{+0.08}_{-0.07}$	$0.53^{+0.12}_{-0.13}$	$2.72^{+0.32}_{-0.30}$
UNABSORBED	89	2.13e-6	$1.27^{+0.41}_{-0.36}$	$0.79^{+0.11}_{-0.11}$	$2.87^{+0.36}_{-0.30}$

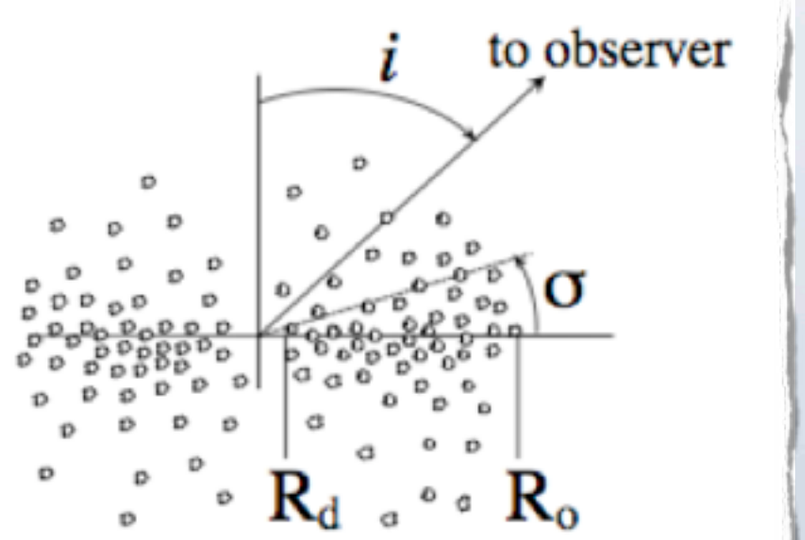
A radiation limited clumpy dust torus in a disk-cloud outflow scenario

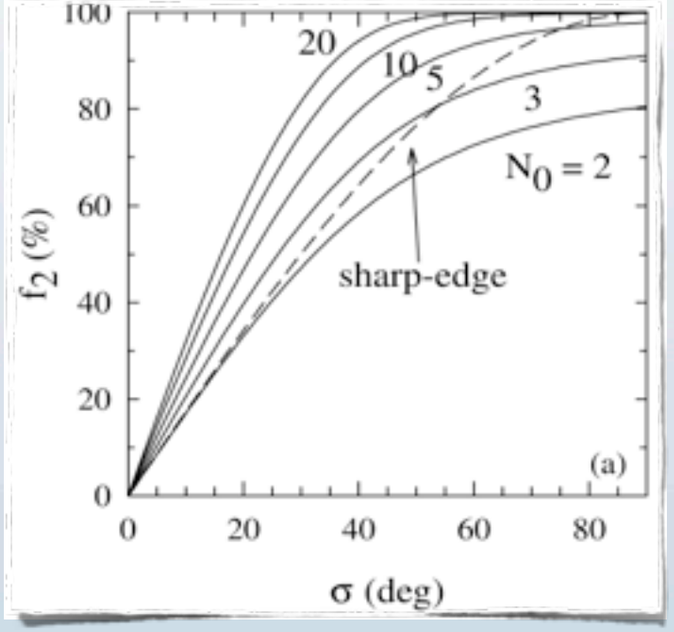
The torus and BLR are a continuous distribution of clouds
(e.g. Elitzur06, Gaskell+08 and talks by Marinucci, Bianchi)

- e.g. Risaliti+02,07: some clouds lie @ 0.1 pc (within R_d)
- predicted slope of $F_{\%}$-L relation: -0.25 (Hönig&Beckert08, Nenkova+08, but see Liu+11)

Outflows develop in the central region -> clouds become unbound





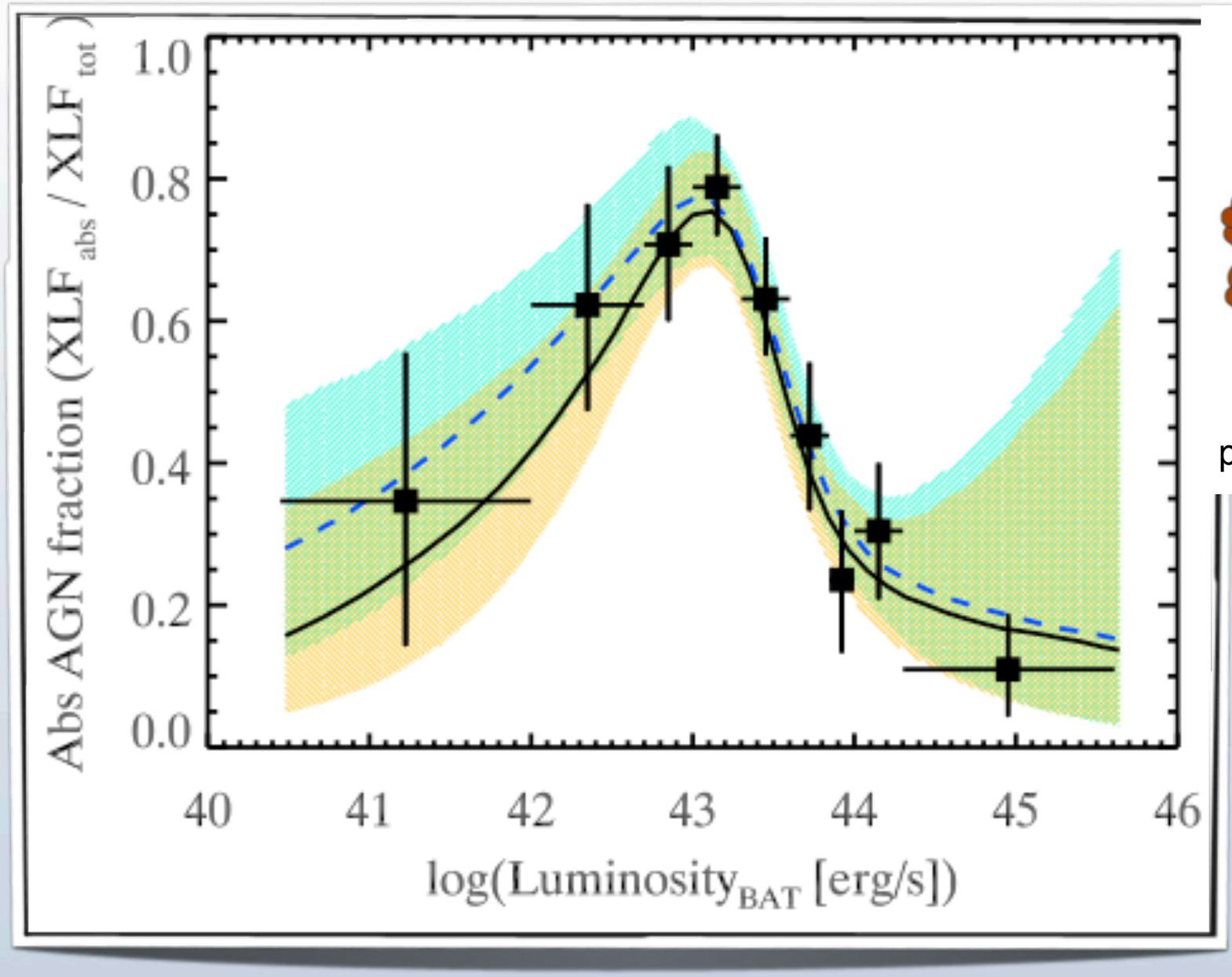


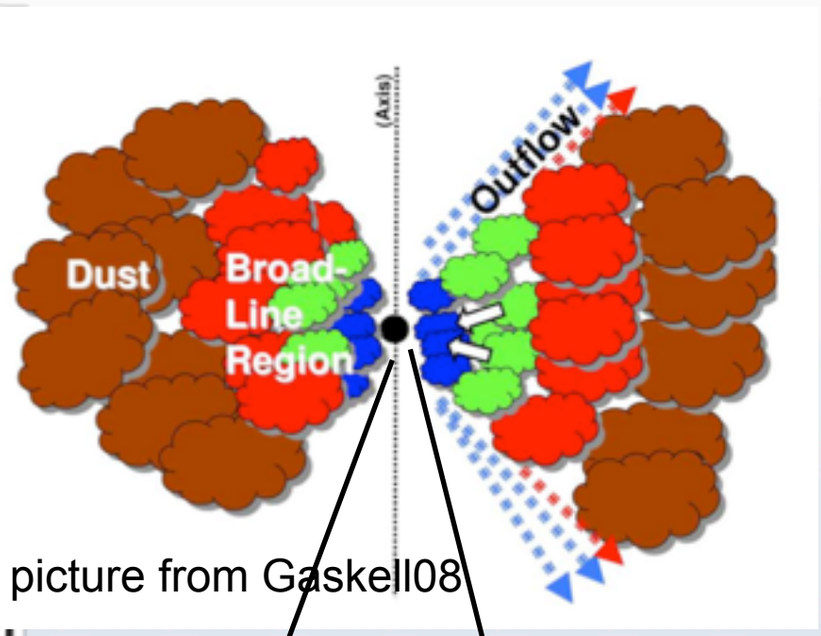
Prediction: @L_{bol}<~10^{42} erg/s unsustainable outflow

- **Torus & BLR disappear** (Elitzur&Shlosman09, Ho08, …)
- How does this limit depend on λ_{Edd} (see e.g. Nicastro00,03)?

TOR/BLR disappearance

Burlon+11

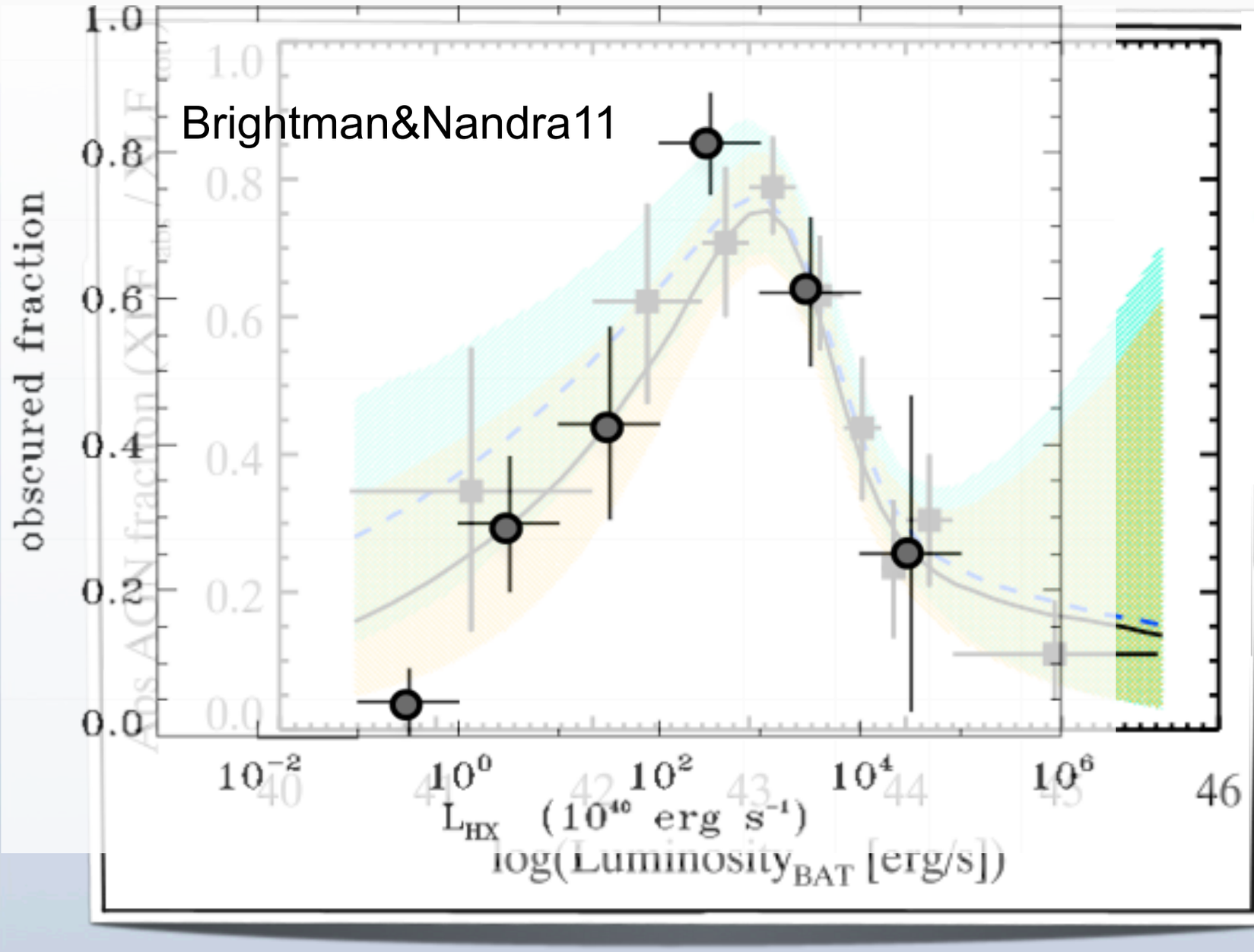




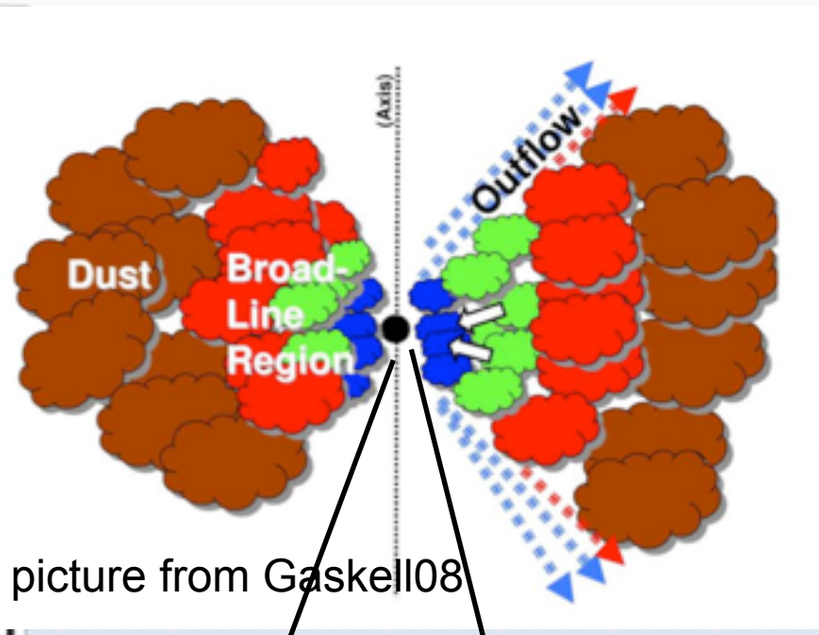
picture from Gaskell08

TOR/BLR disappearance

Brightman&Nandra11



Burlon+11



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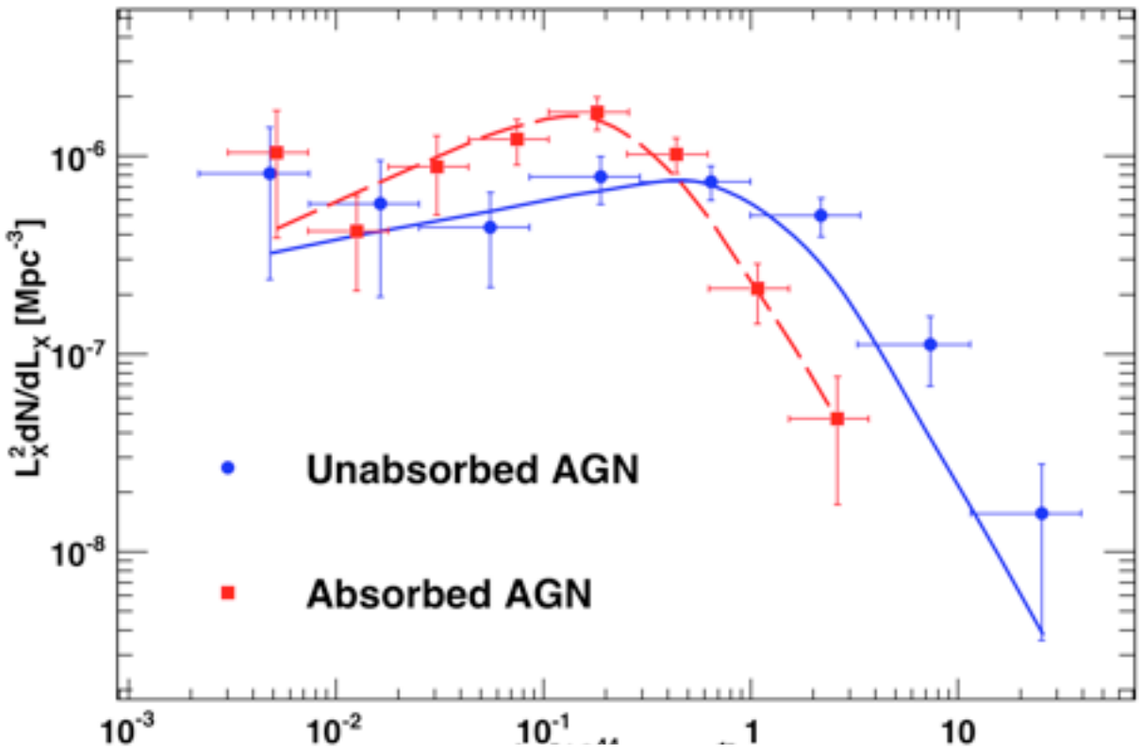

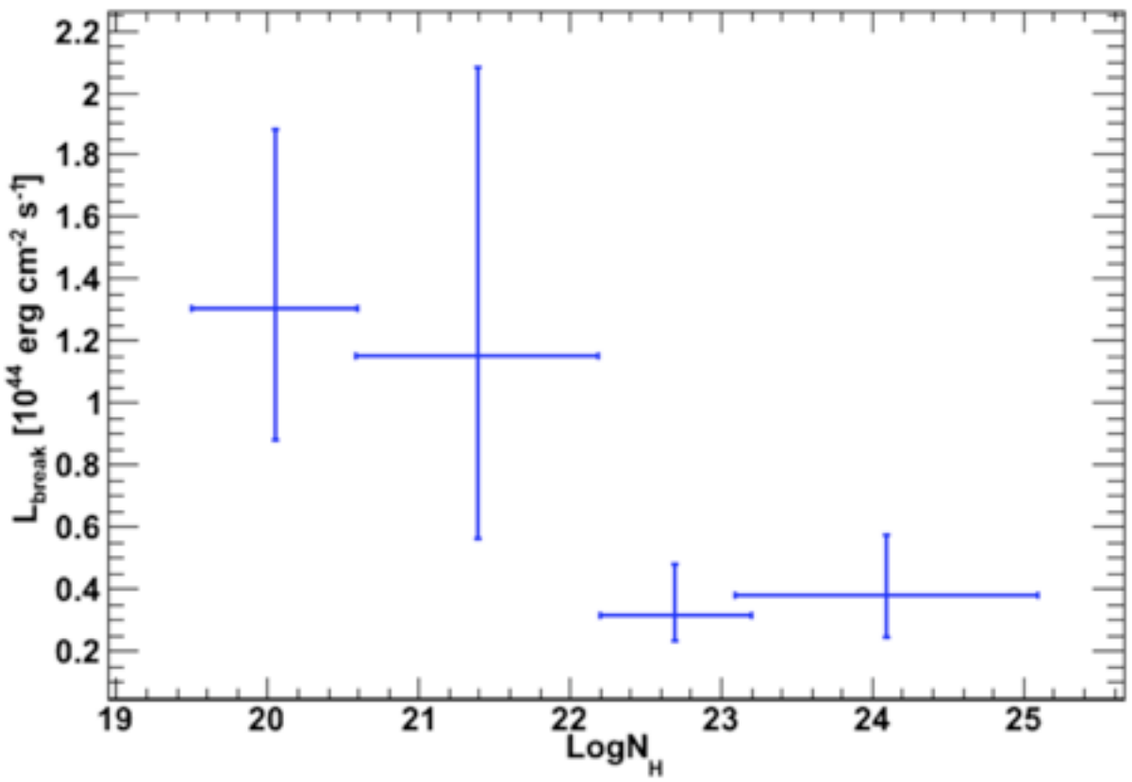

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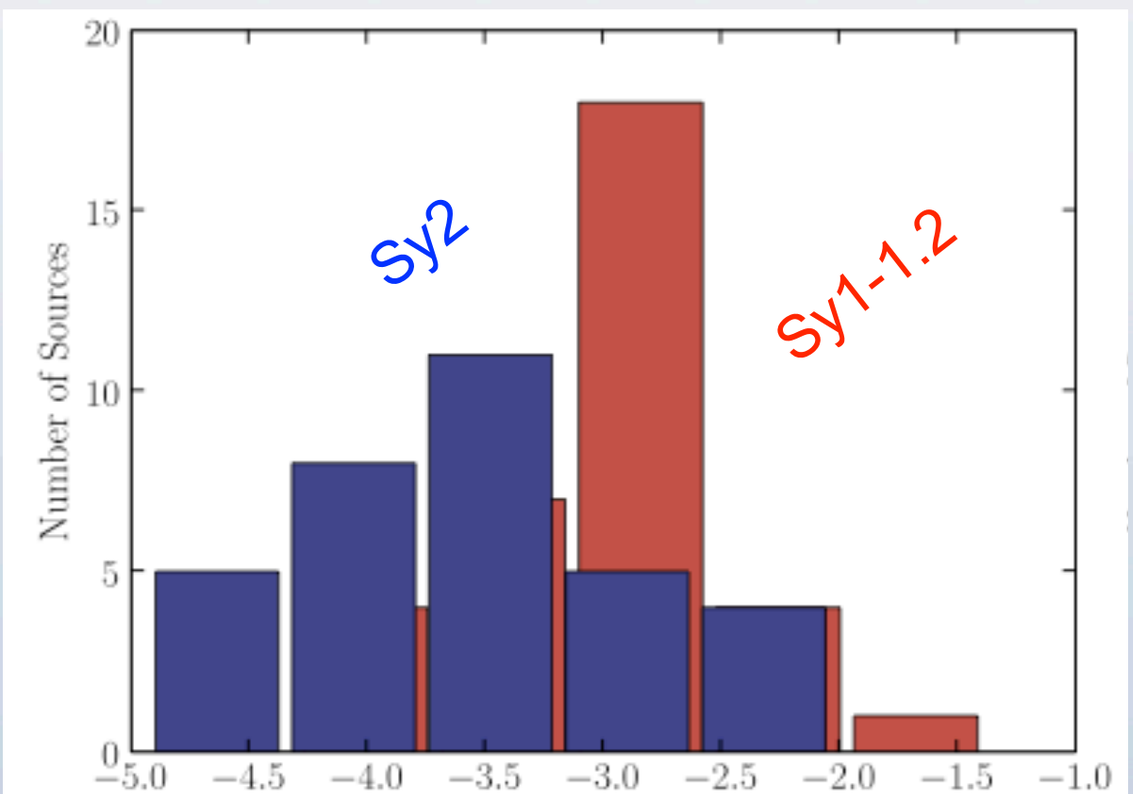
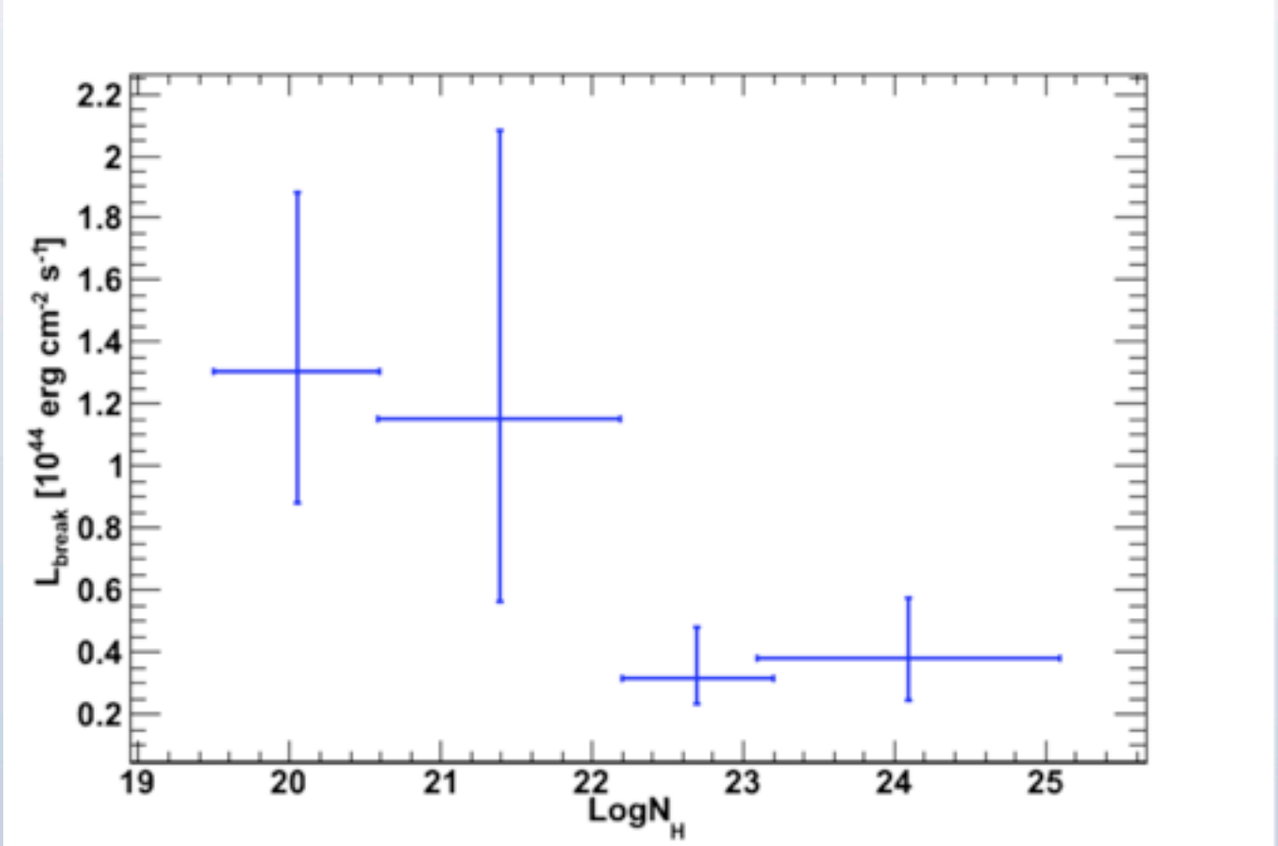
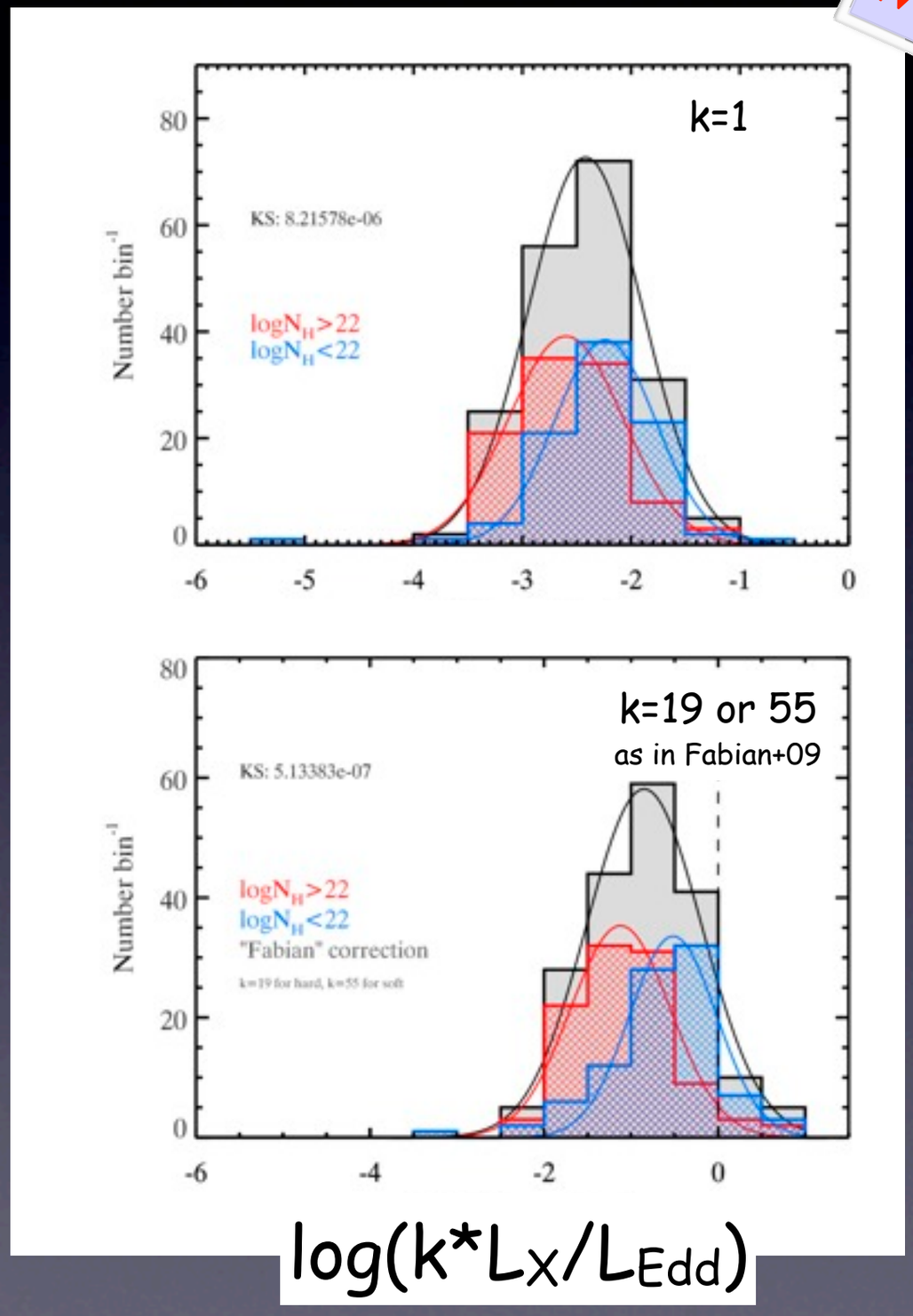




A difference in efficiency

work in progress



(see also Beckmann+09, Middleton+08,
for the BH mass estimate see Vasudevan+09)

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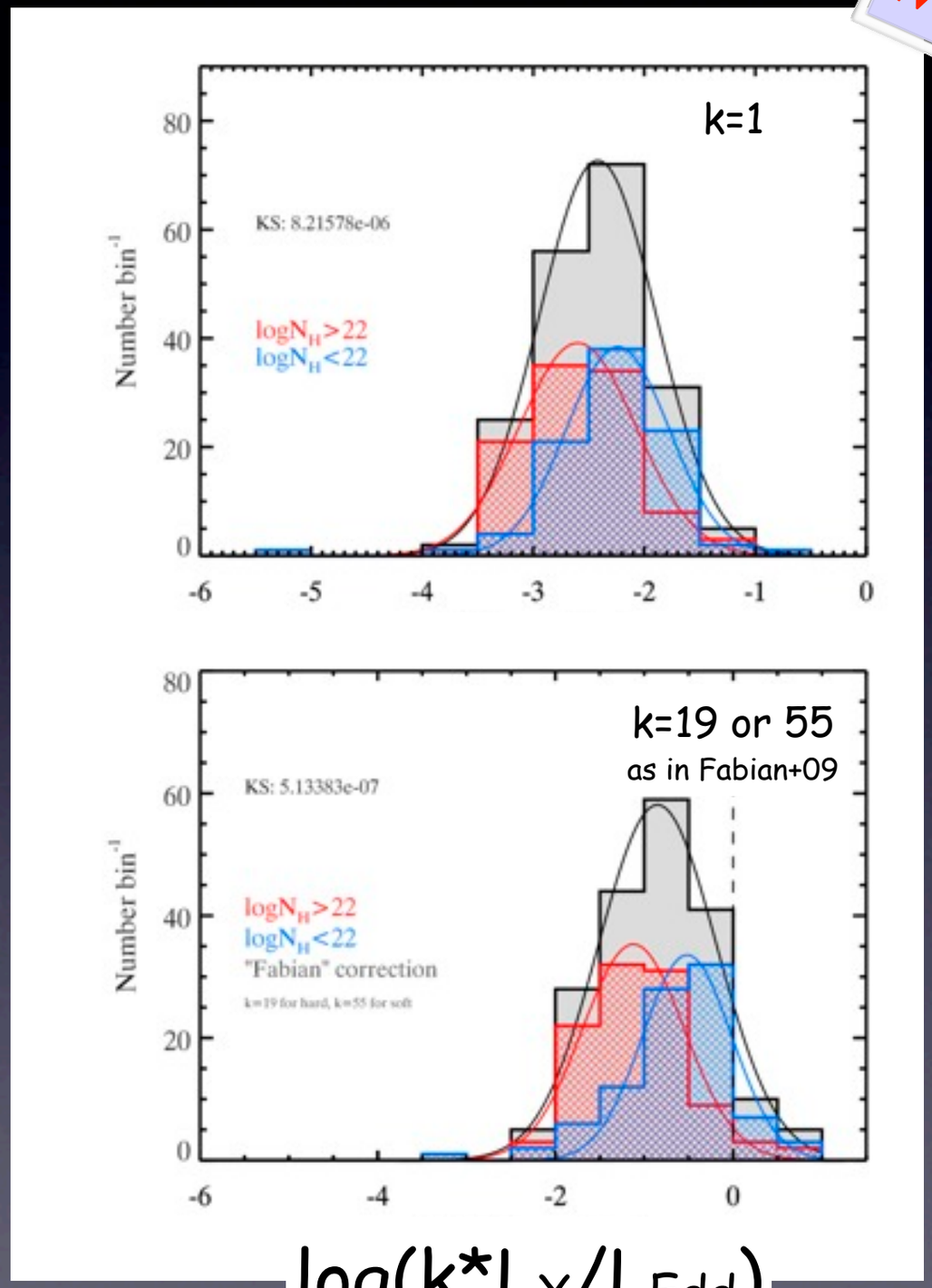

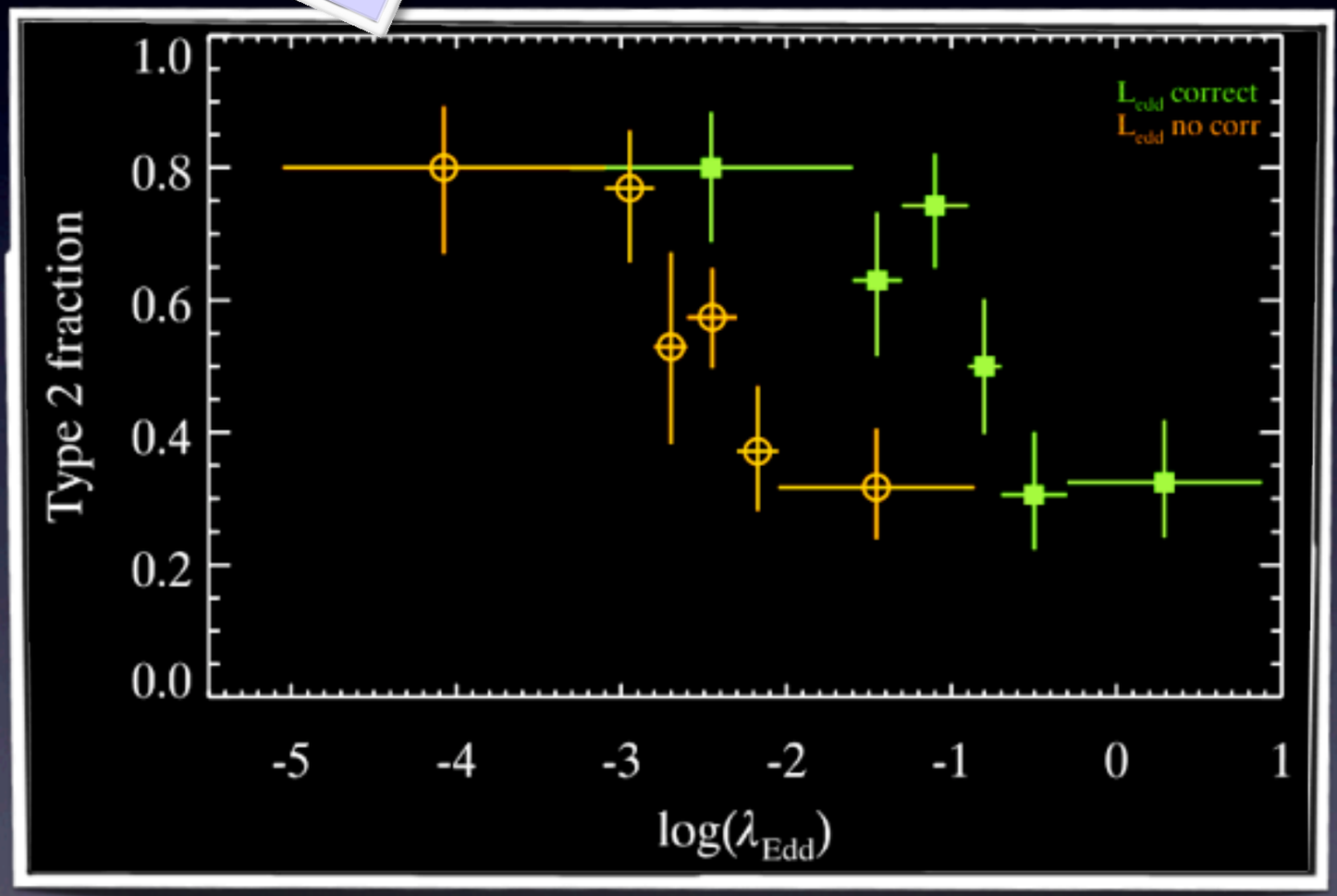

(see also Beckmann+09, Middleton+08,
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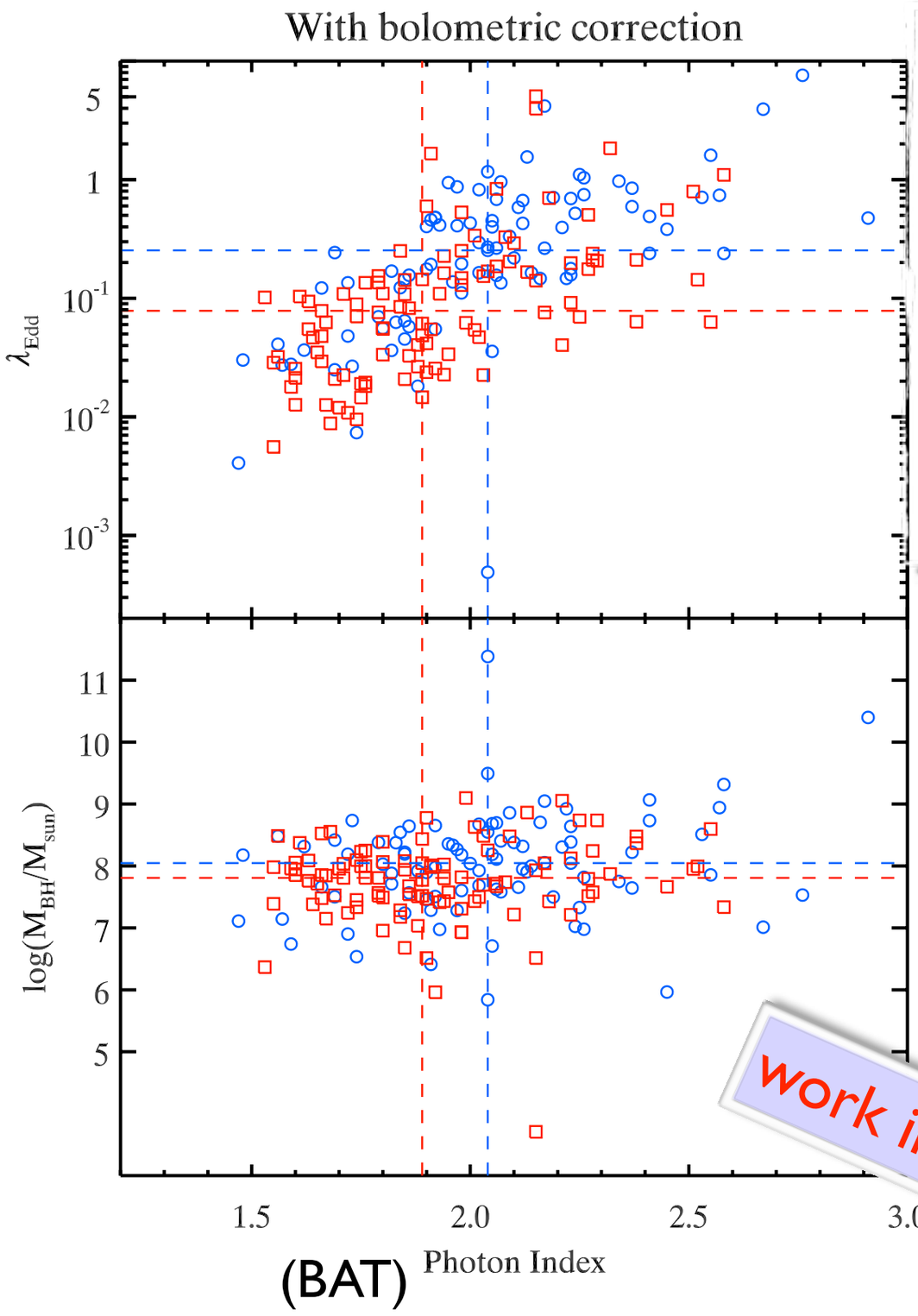
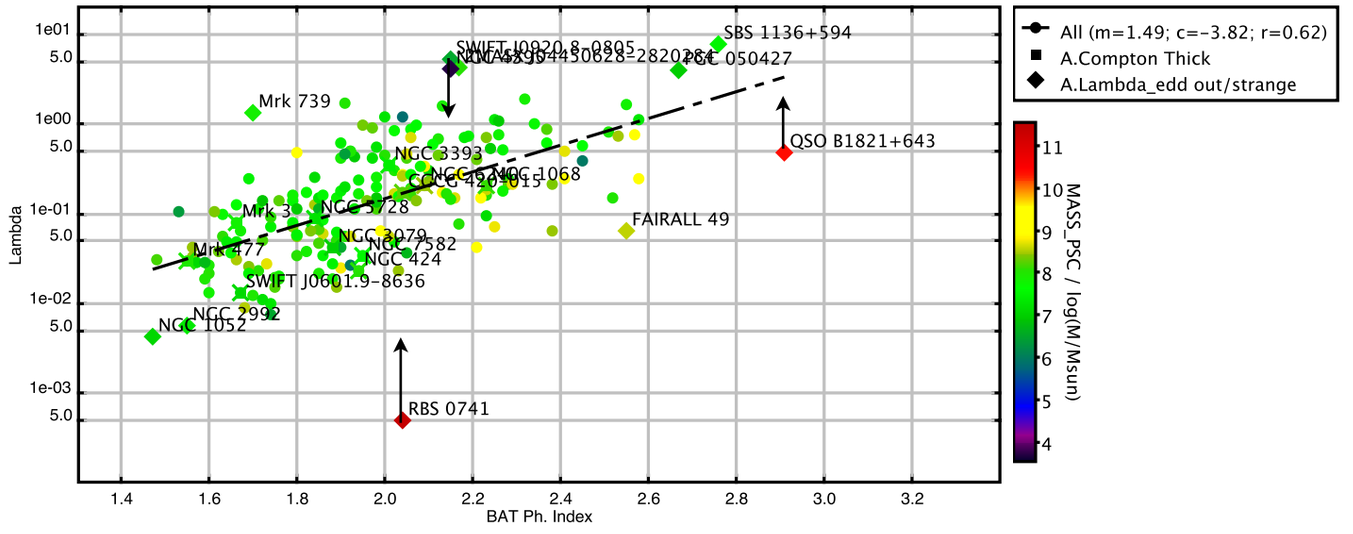
Higher efficiency = higher cooling?

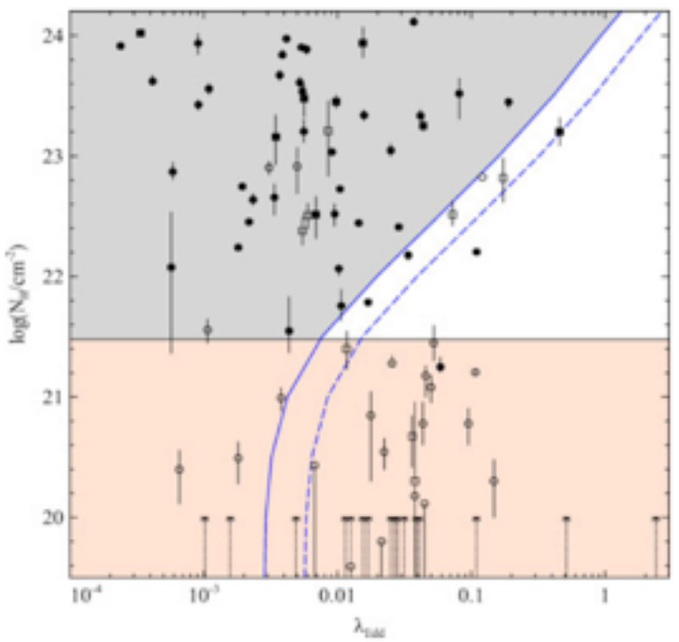




Corona acts as a "thermostat" (Shemmer+06,08) or is there an "aborted jet" (Ghisellini+04)?

Are there forbidden areas in the N_H-Lambda plane? (Fabian08,09, Raimundo10)

work in progress



Conclusions

- The Compton-thick sources show <on average> an extremely curved spectrum and as numerous as ~20%
- The anti-correlation between the Ty2 fraction vs. luminosity is a difference in the intrinsic XLF
- At low luminosity there is a tentative evidence of the disappearance of the absorbing region (which is likely clumpy)
- The anti-correlation of the Ty2 fraction translates into a "physical" relation vs. λ_{Edd}
- Ty1 AGN are not just intrinsically brighter (and powered by more efficient BH), but have also a more efficient cooling?