New Perspectives on Compton-thick AGN

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Chandra's First Decade of Discovery
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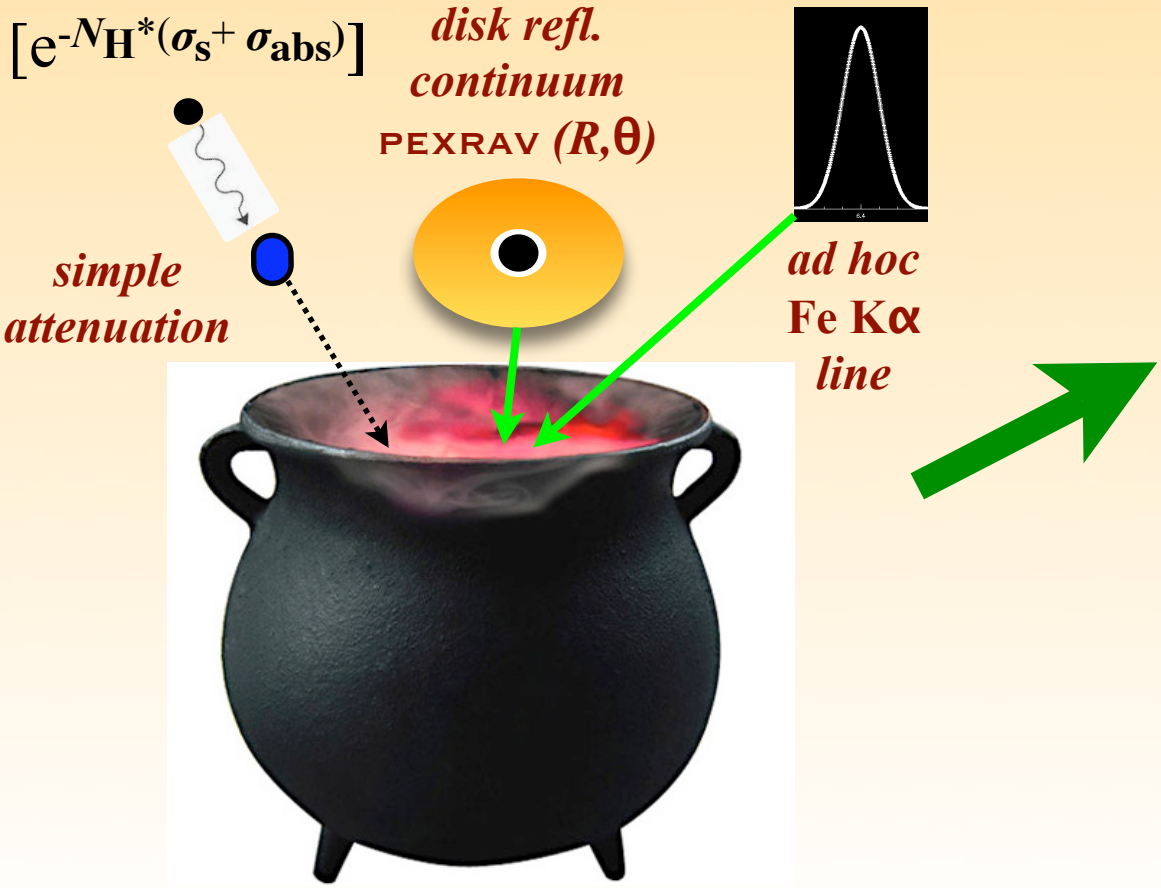
To be or not to be Compton-thick

★ Strictly, $N_H > 1.25 \times 10^{24}$ cm^{-2}. However, column and intrinsic X-ray luminosity highly model-dependent *even with high SNR*.

★ Usual (*ad hoc*) procedure: [high snr & cxrb models] simple l.o.s. attenuation plus disk-reflection (PEXRAV) to mimic Compton scattering:



- *Cannot relate any of the components to each other, in particular R, N_H, and* Fe Kα *line EW.*
- *Amplitude of reflection, R, is arbitrary, θ has no meaning in this context: scattered continuum is highly geometry and angle-dependent.*
- *No physical meaning can be assigned to derived parameters, including element abundances and intrinsic luminosity.*

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Low SNR: Weak Compton-thick AGN

- ★ Large EW (> 1 keV) Fe Kα line considered synonymous with CT AGN.
- ★ Column density estimated from X-ray hardness ratios.
- ★ Intrinsic luminosity indicators (e.g. IR, OIII]) compared to observed X-ray luminosity: High IR/X-ray ratio and/or high OIII]/X-ray ratio used to identify CT AGN.

Column density distribution from AGN in deep X-ray surveys is another critical ingredient for making the CXRB.

High z further complicates measurement of column density since the low-energy part of the spectrum is shifted out of the observed X-ray band compared to z=0.

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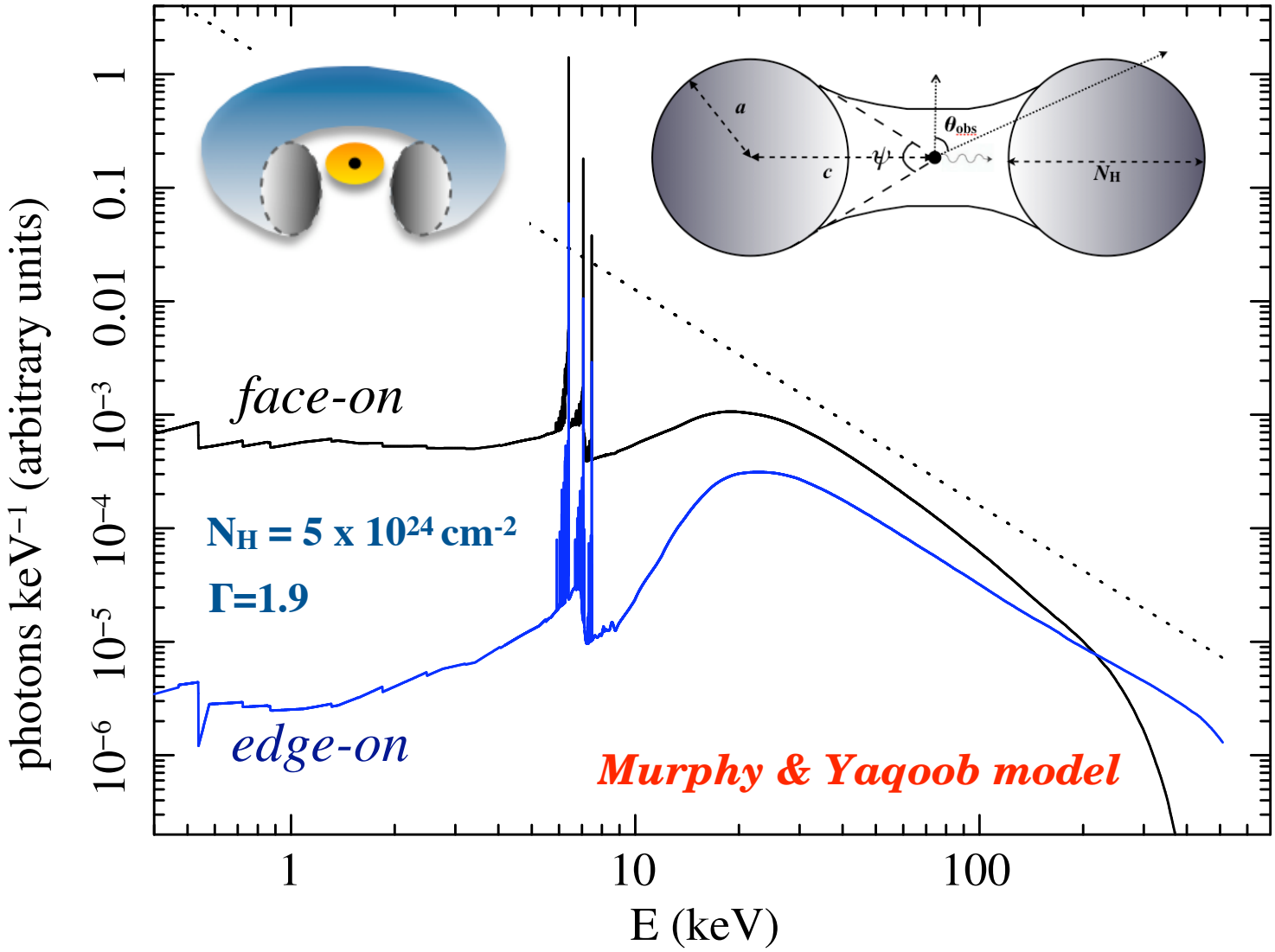
A new, self-consistent model for Compton-thick *and* Compton-thin AGN

Severe geometry dependence: reflection spectrum SIX times weaker than disk, & different in spectral shape.



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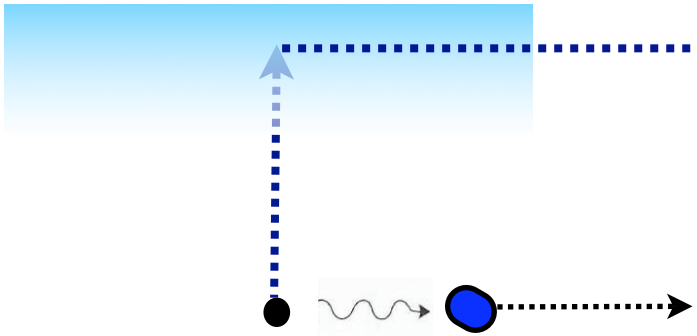
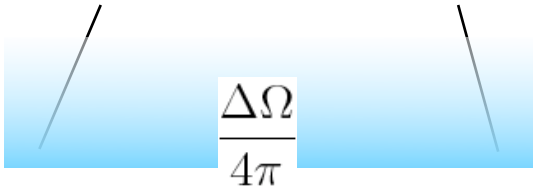
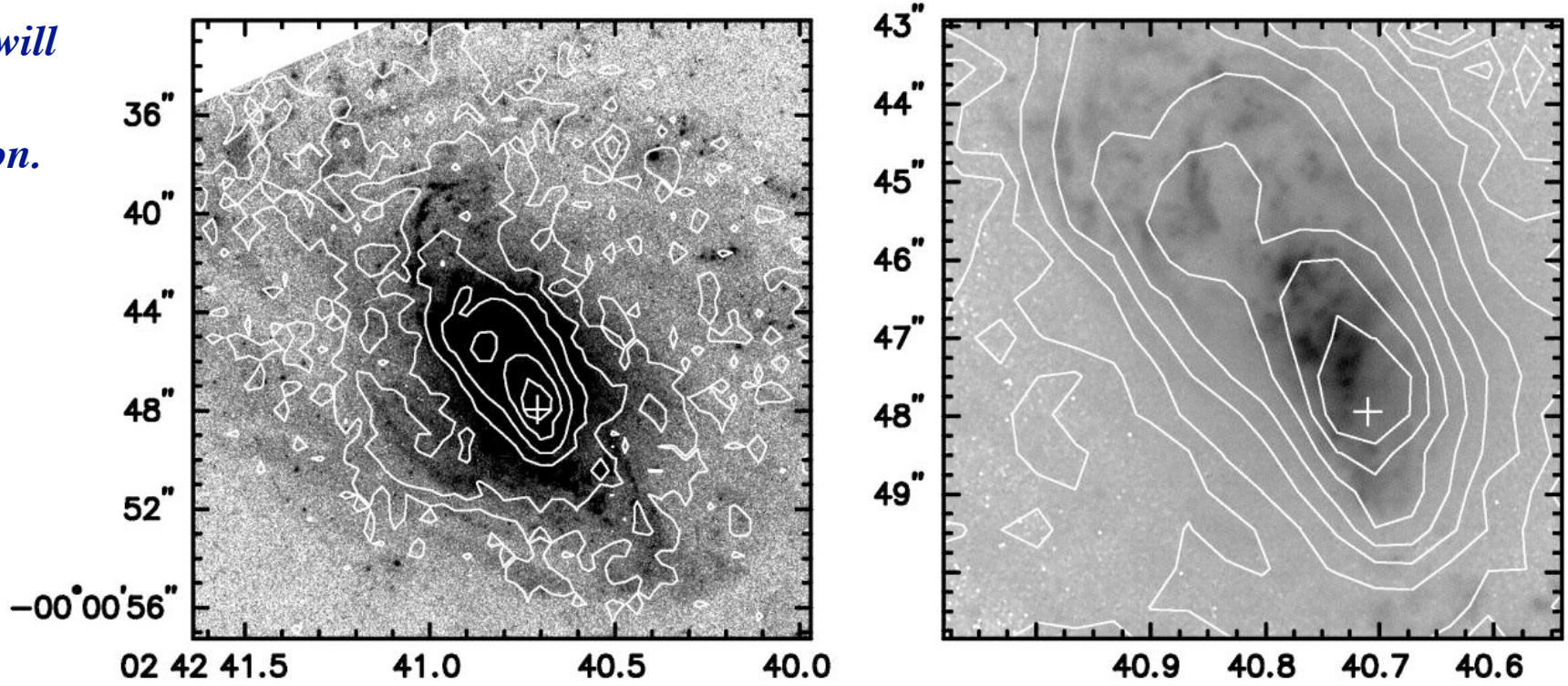


$$f \equiv \tau_{\rm es}\left(\frac{\Delta\Omega}{4\pi}\right)$$



Patchy/clumpy absorber has the same effect: f will correspond to leakage fraction.

Now add the effect of electron scattering in a warm/hot, Thomson-thin, extended region surrounding the absorbed X-ray source. ***This is directly imaged in nearby Sy 2***; e.g. NGC 1068, Young et al. 2001.



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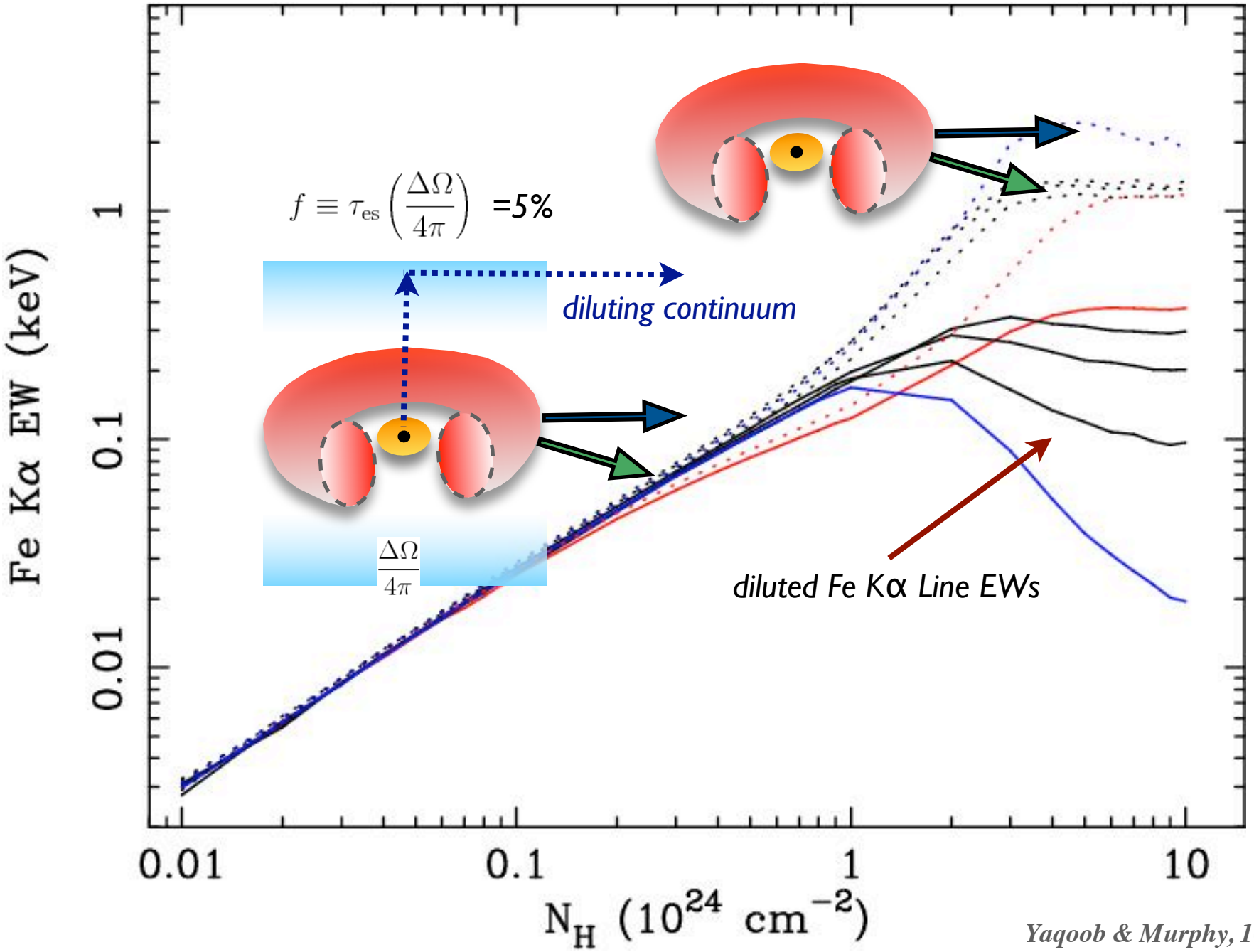
Now including the effect of dilution by continuum scattering in the Thomson-thin zone



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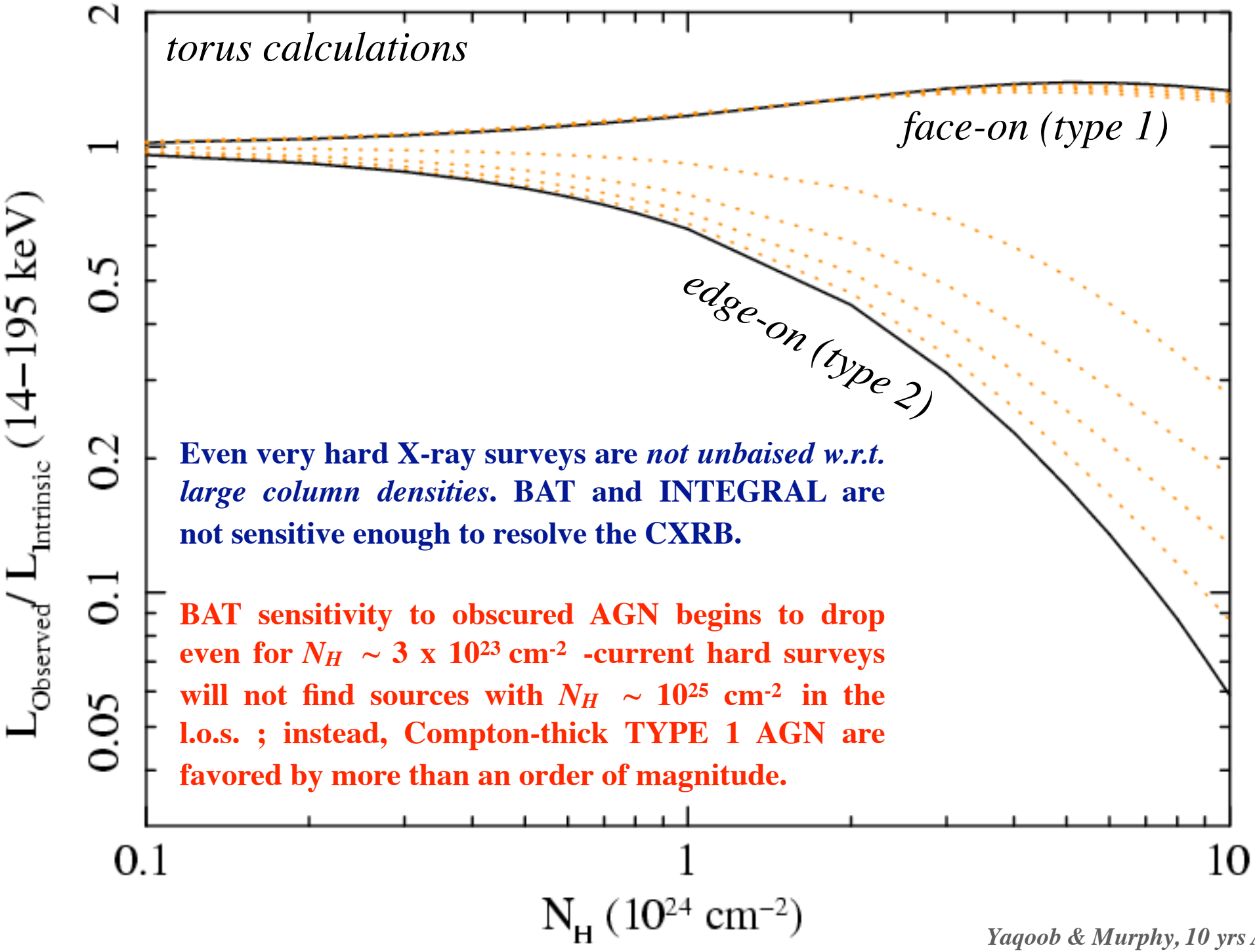
Where are the Compton-thick AGN?



Even very hard X-ray surveys are *not unbaised w.r.t. large column densities*. BAT and INTEGRAL are not sensitive enough to resolve the CXRB.

BAT sensitivity to obscured AGN begins to drop even for $N_H \sim 3 \times 10^{23}$ cm^{-2} -current hard surveys will not find sources with $N_H \sim 10^{25}$ cm^{-2} in the l.o.s. ; instead, Compton-thick TYPE 1 AGN are favored by more than an order of magnitude.

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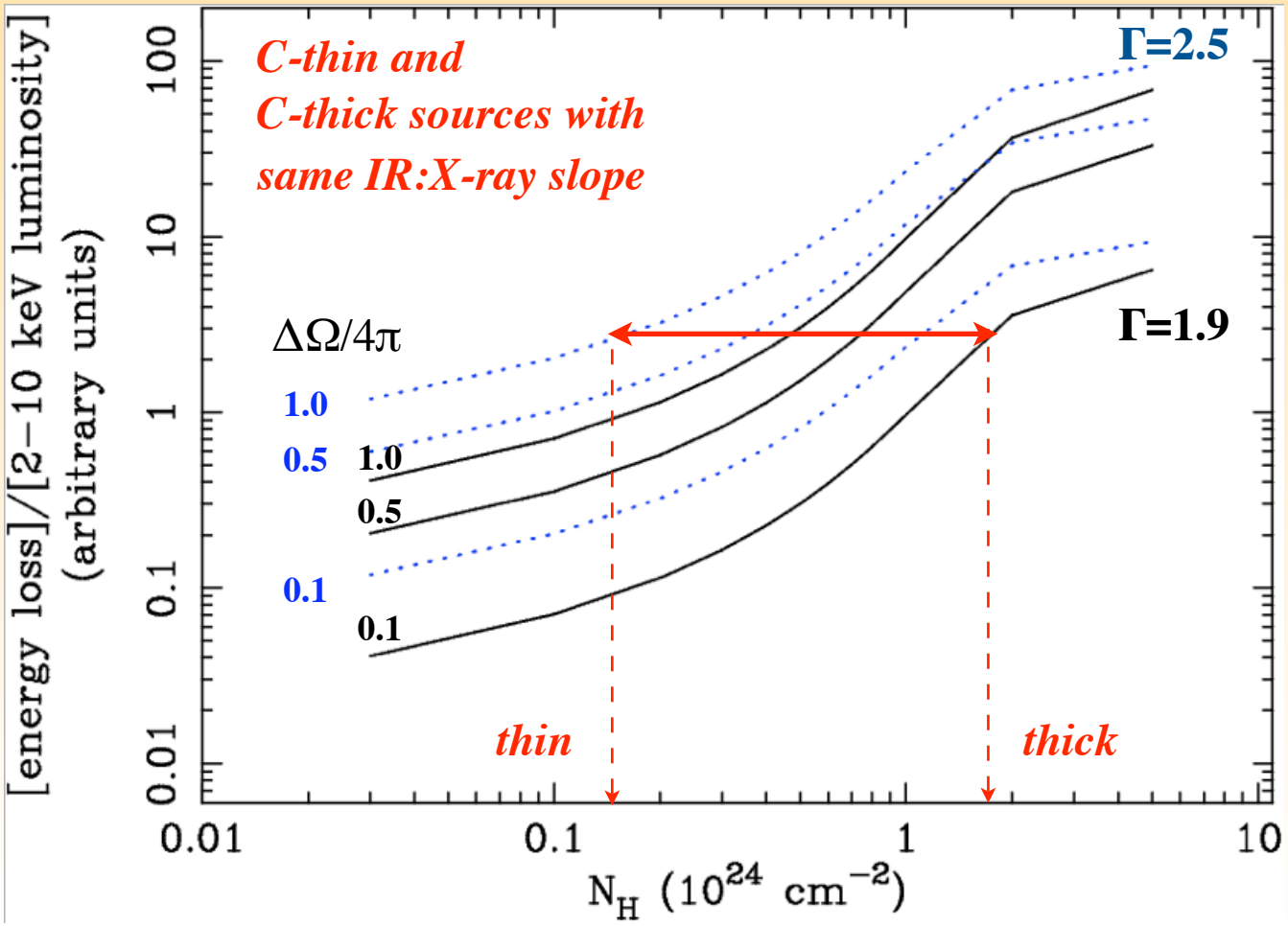
Degeneracy of the IR:X-ray signature

How do we measure/estimate N_H for weak sources (e.g. in deep surveys)?

★ X-ray spectroscopy unfeasible

★ Hardness ratios degenerate

★ Optical to X-ray ratio? Large uncertainties.



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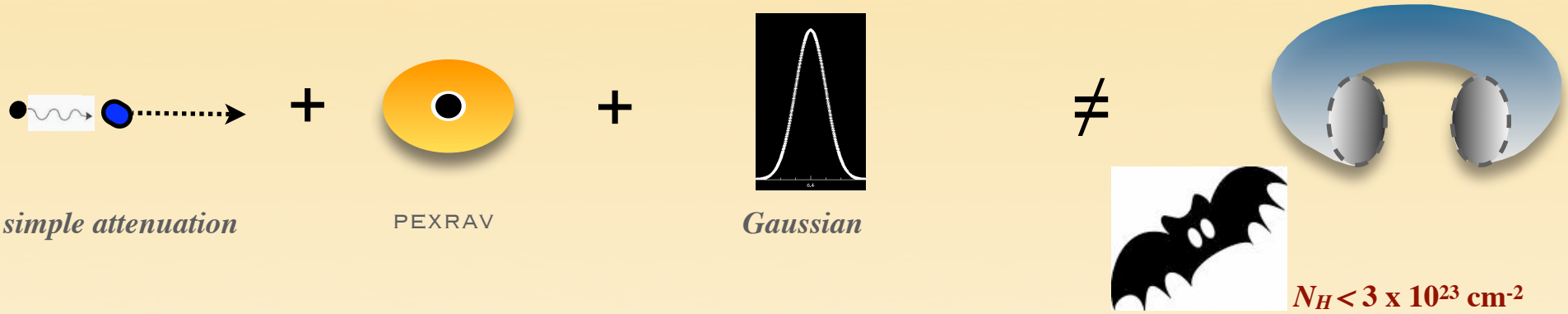
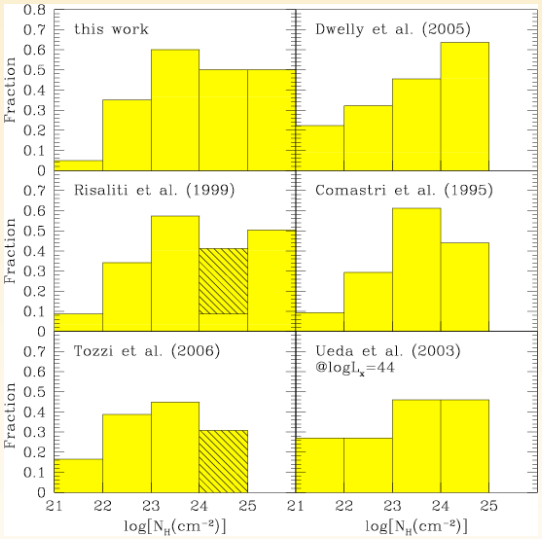
Summary



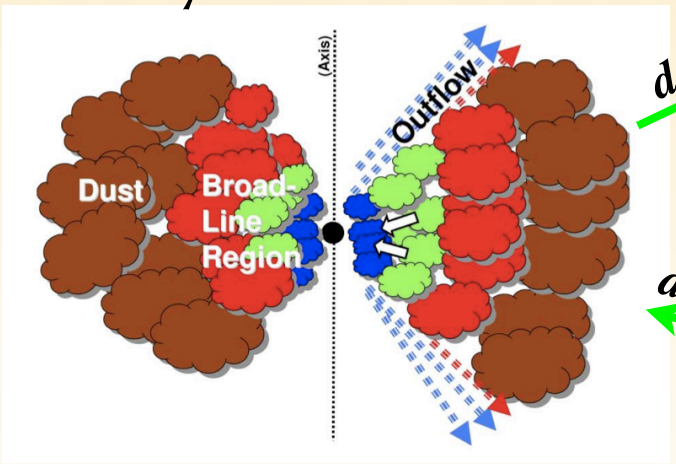
$N_H < 3 \times 10^{23}$ cm^{-2}

hardness ratios ⇏ N_H distribution



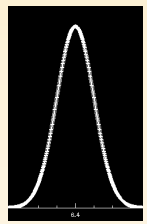
Gilli et al. 2007

heavy obscuration



Gaskell et al. 2008

does not require large Fe Kα EW



does not require large IR/X

O III]/X

The optically-thin environment of Compton-thick AGN is critical to their observational appearance.

CT AGN may actually be observationally unimportant.

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Thank you!