The Evolution of AGN Obscuration

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Supermassive Black Holes

Many obscured by gas and dust

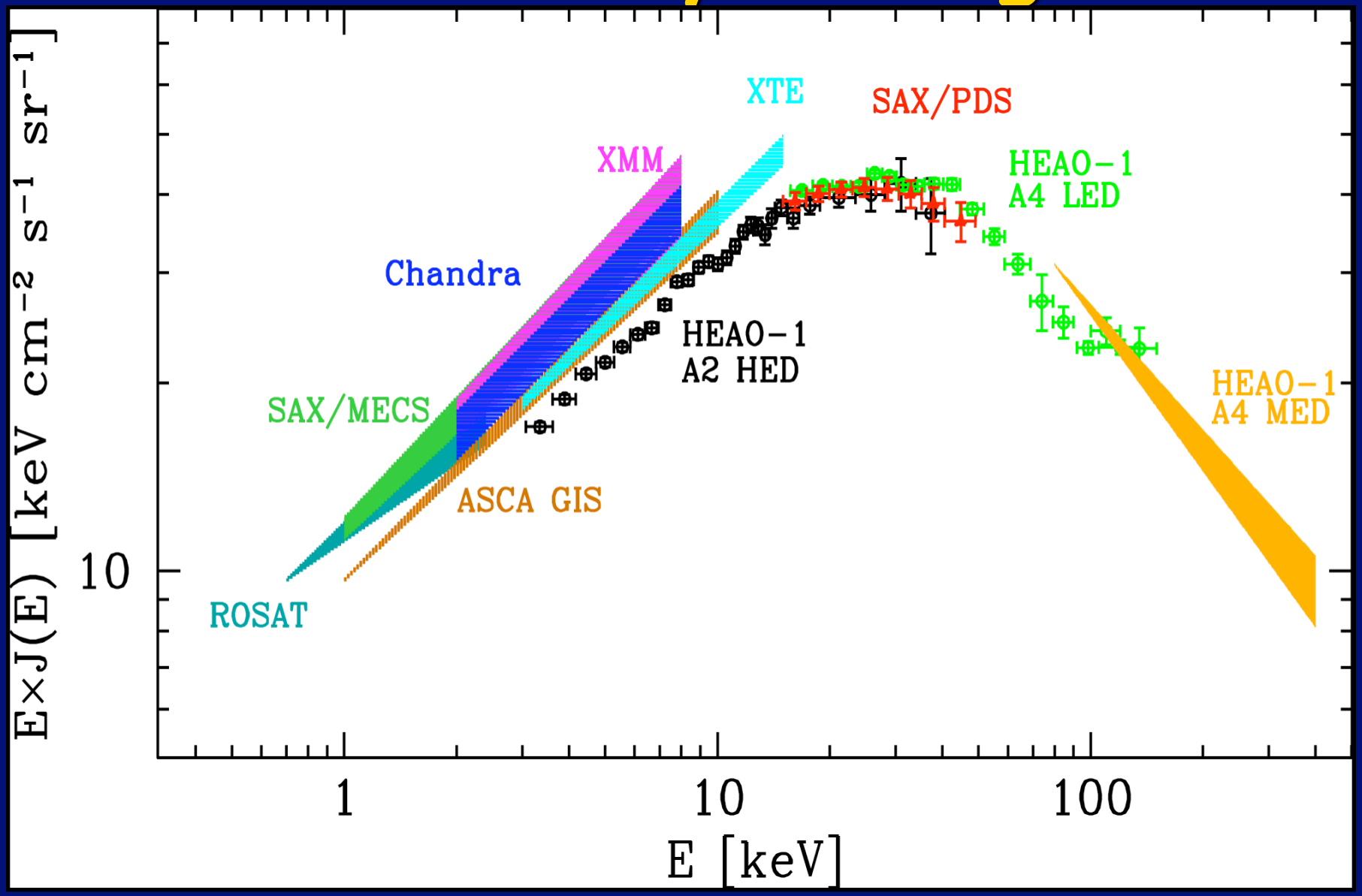
How do we know that?

→ Local AGN Unification

→ Explain Extragalactic X-ray "Background"

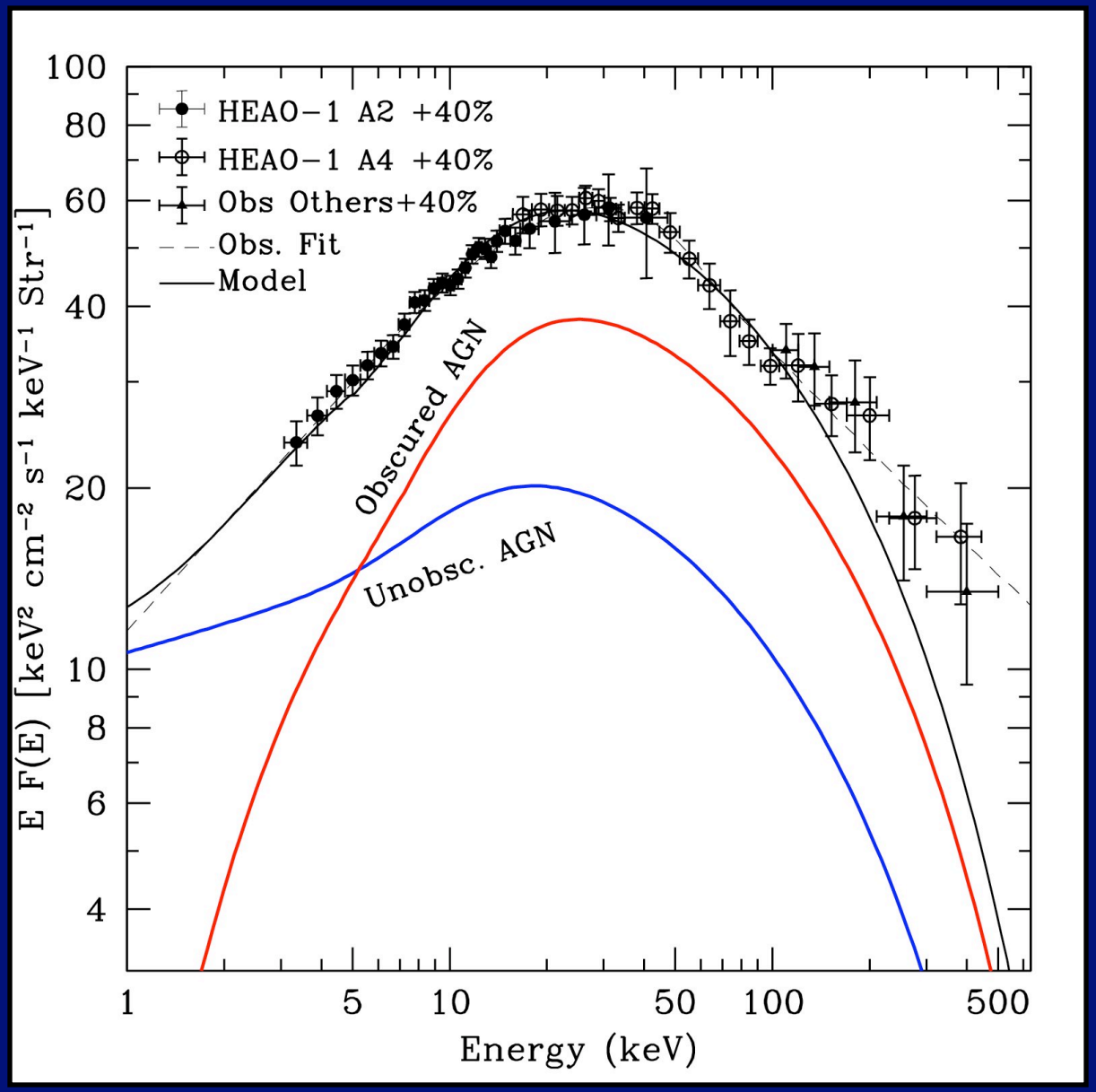
Credit: *ESO/NASA, the AVO project and Paolo Padovani*

Observed X-ray "Background"



Frontera et al. (2006)

X-ray Background

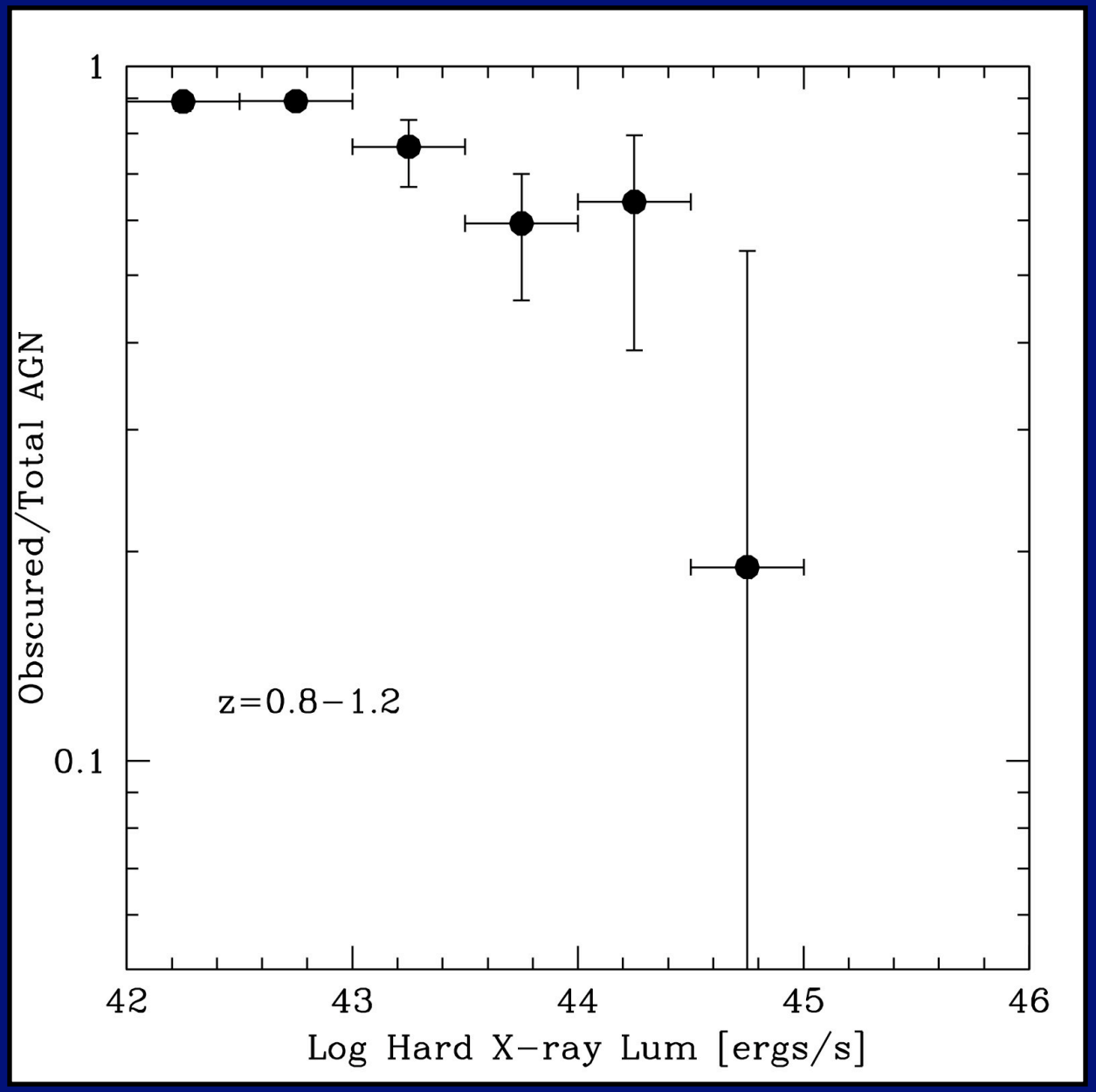


XRB well explained using a combination of obscured and unobscured AGN.

- **Setti & Woltjer 1989**
- **Madau et al. 1994**
- **Comastri et al. 1995**
- **Gilli et al. 1999,2001**
- **And others…**

Treister & Urry, 2005

Obscured AGN Fraction



Treister & Urry (2005)
Observational data from
Barger et al. (2005)

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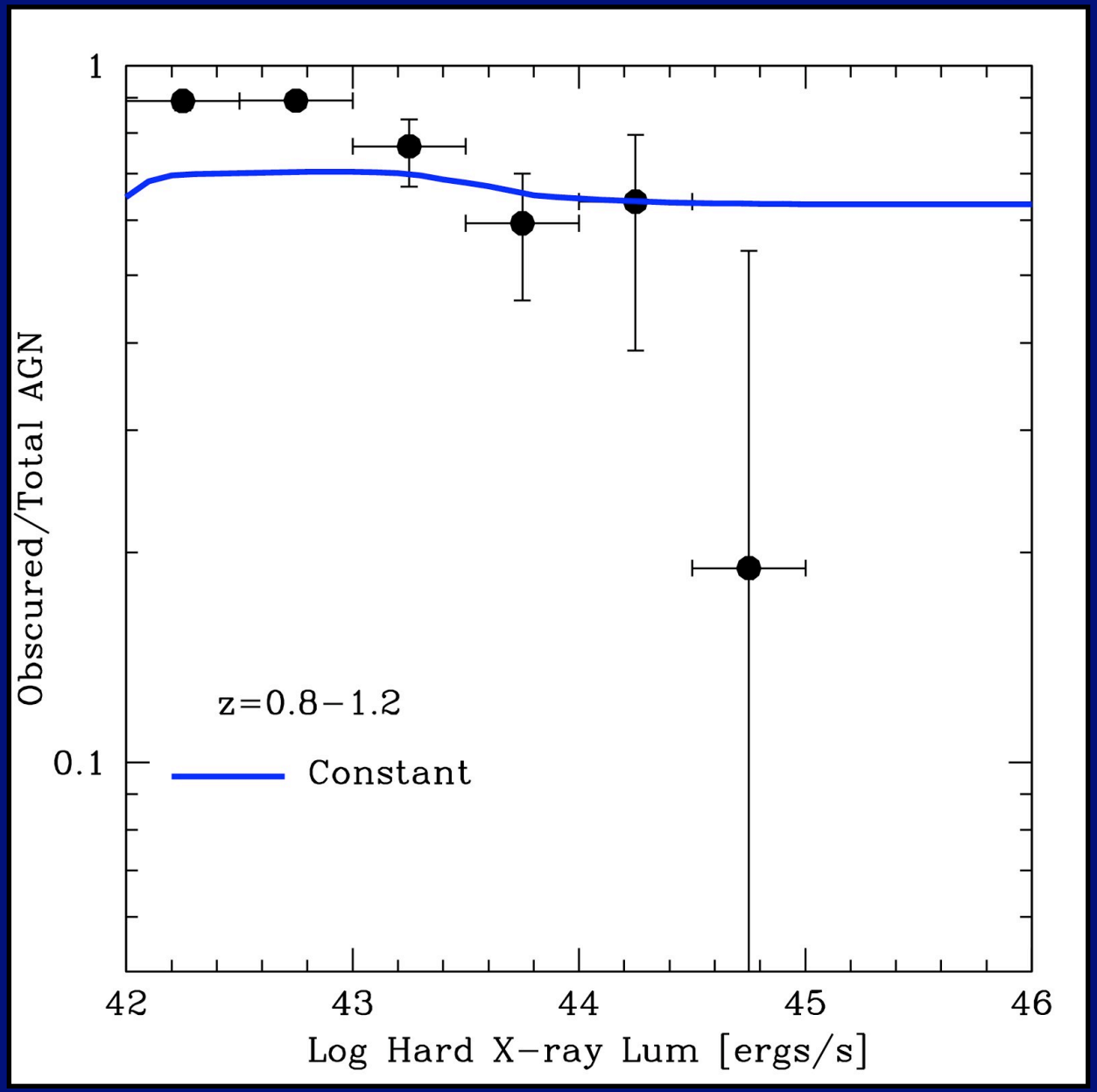

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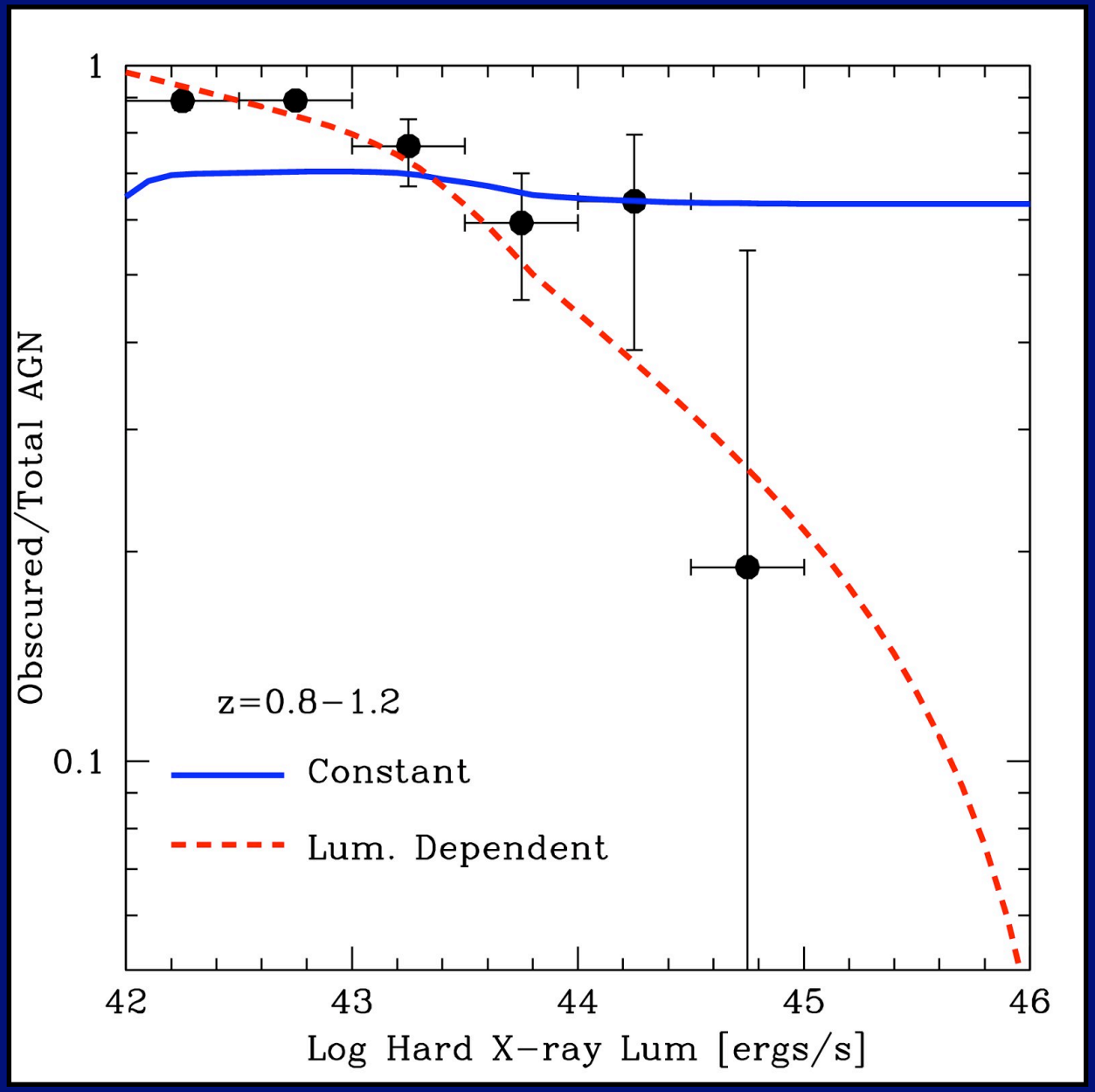

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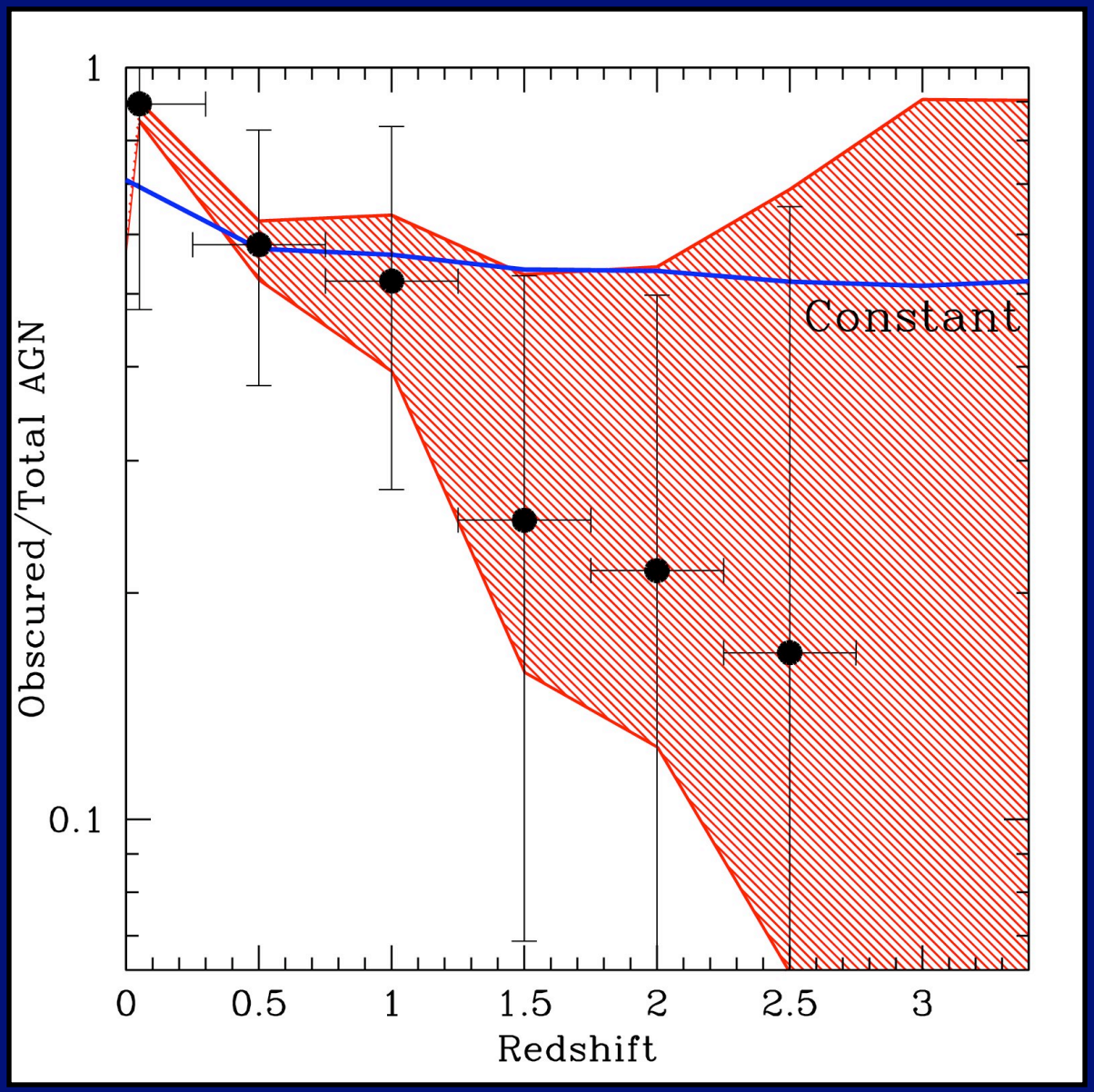
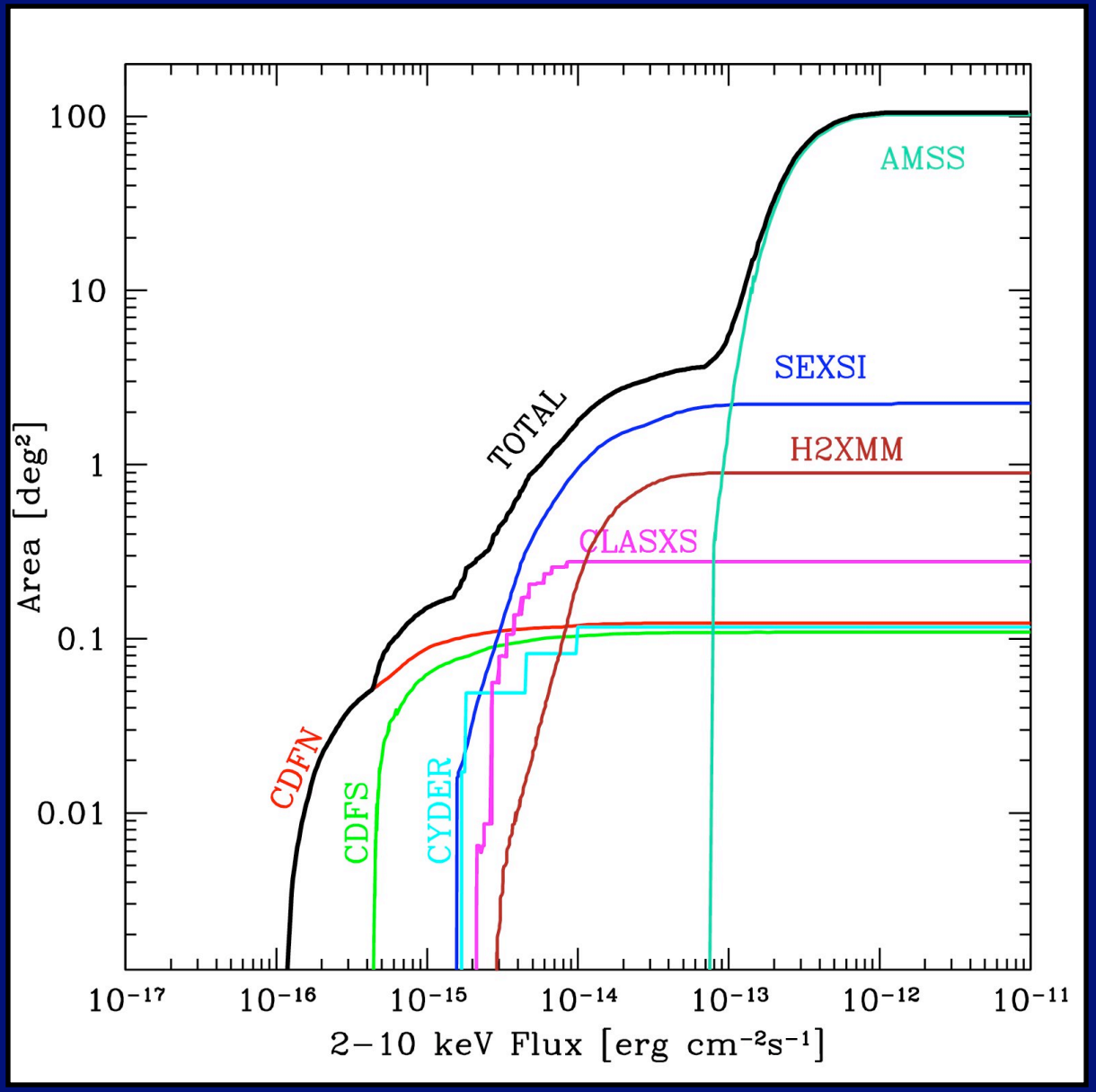
Redshift Dependence?



Incompleteness does not allow to rule-out intrinsically constant fraction of obscured AGN.

Treister & Urry (2005)
Observational data from Barger et al. (2005)

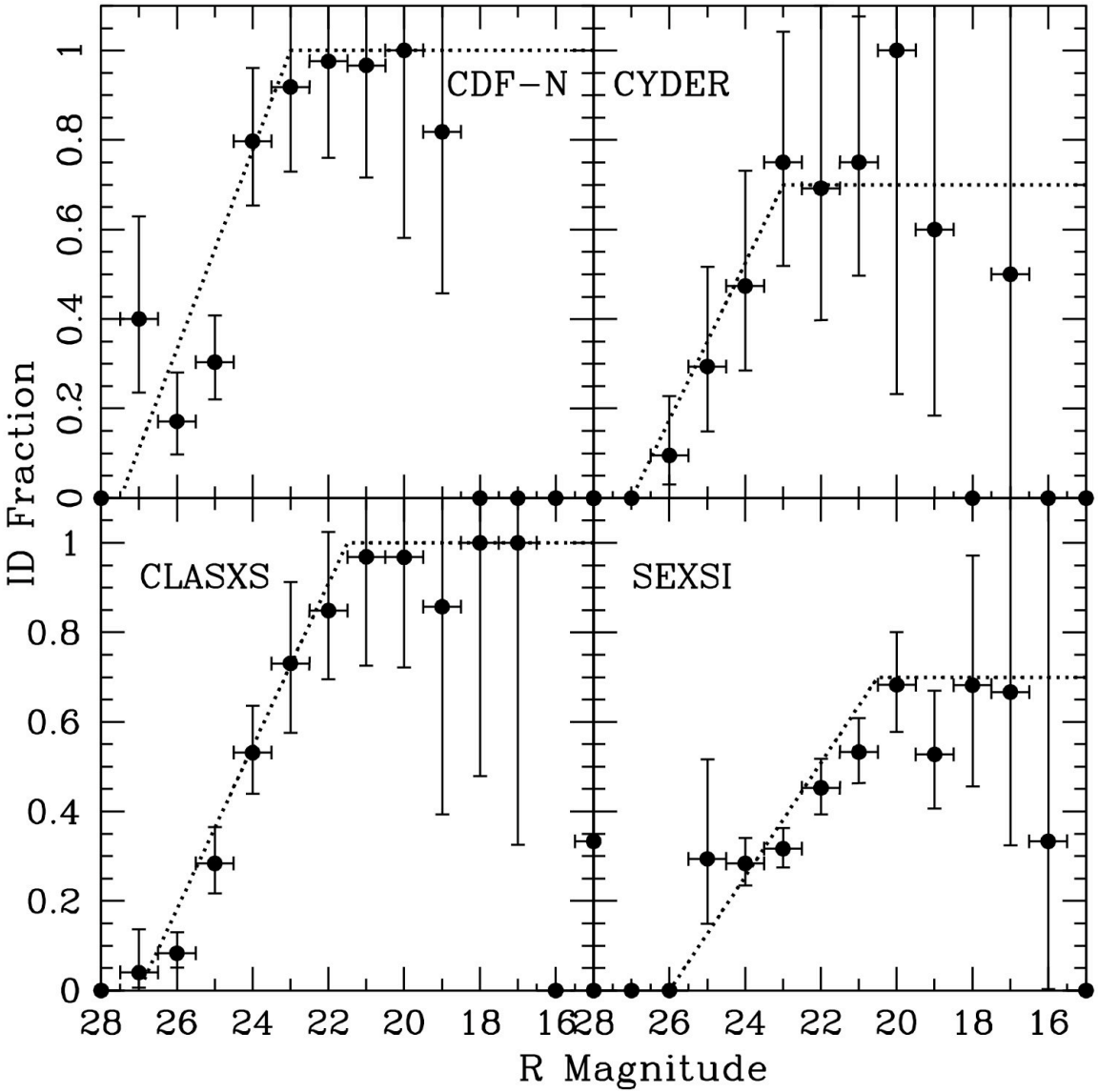
Meta-Survey



- 7 Surveys,
- 2341 AGN, 1229 w Ids
- 631 Obscured (no broad lines)
- $10^{42}<L_x<10^{46}$, $0<z<5$

Treister & Urry, 2006

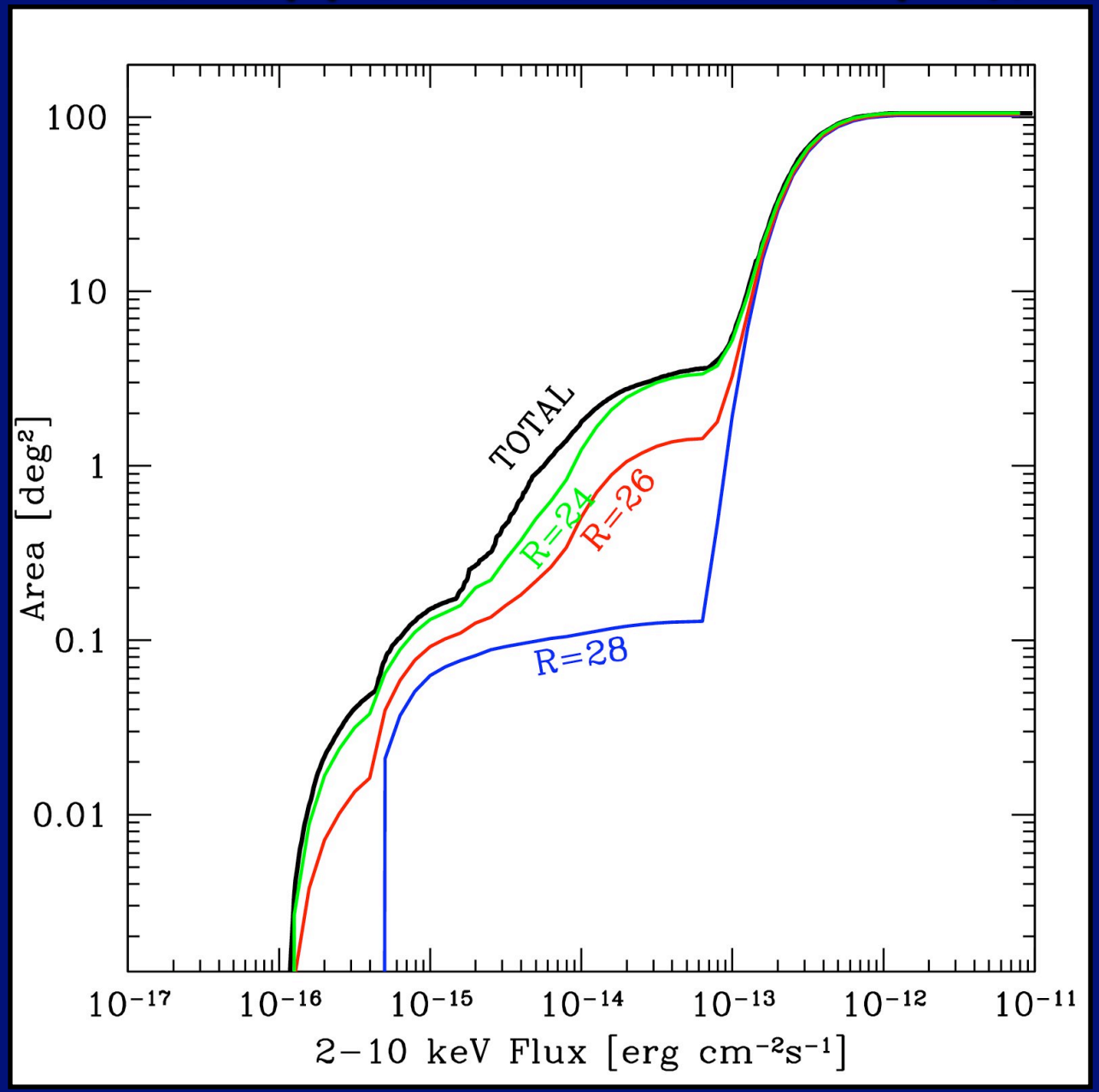
Bivariate X-ray and optical flux limits



Spectroscopic incompleteness is a strong function of optical magnitude.

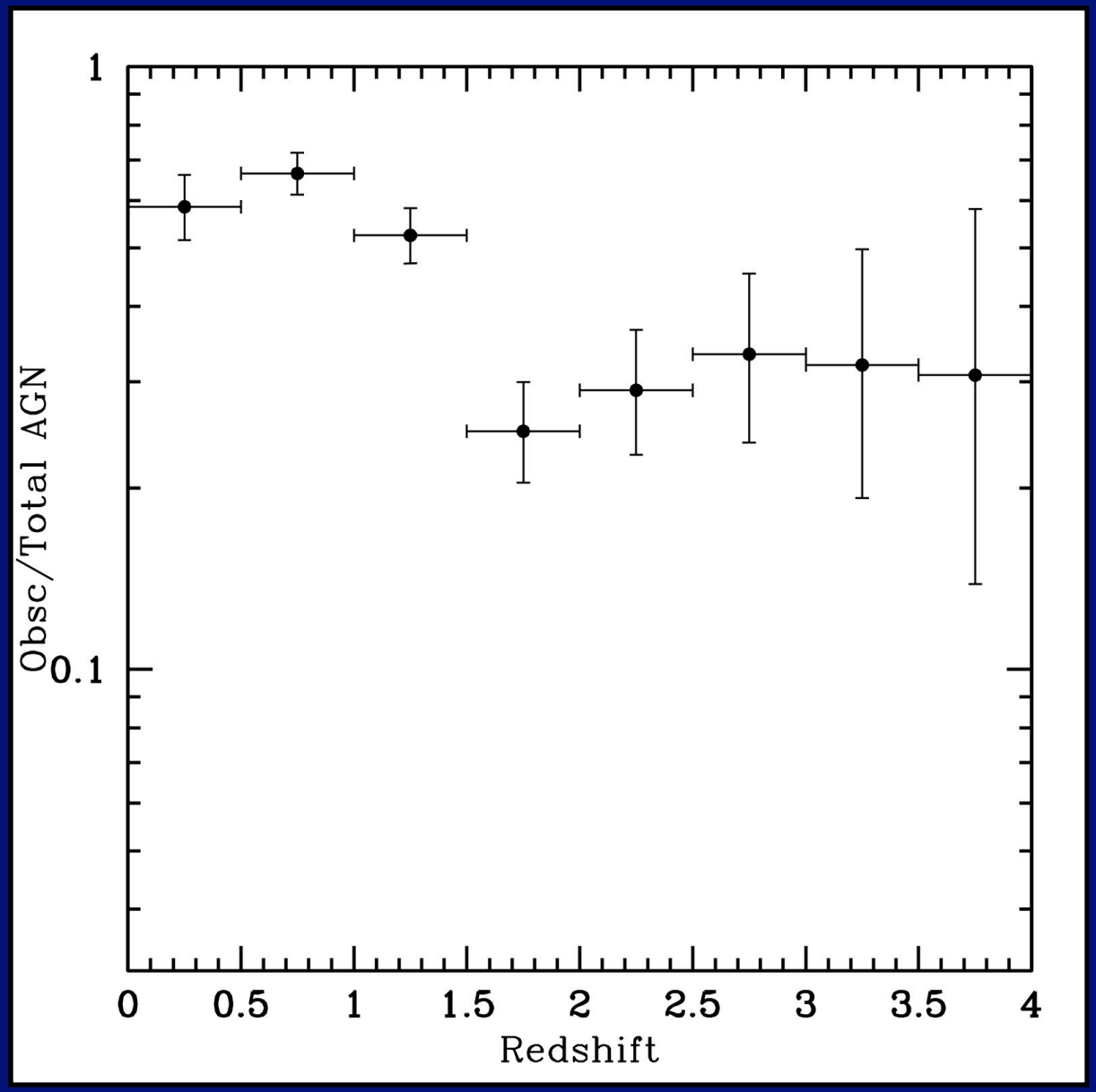
Treister & Urry, 2006

Total effective area of meta-survey



Treister & Urry, 2006

Ratio vs Redshift



Treister & Urry, 2006

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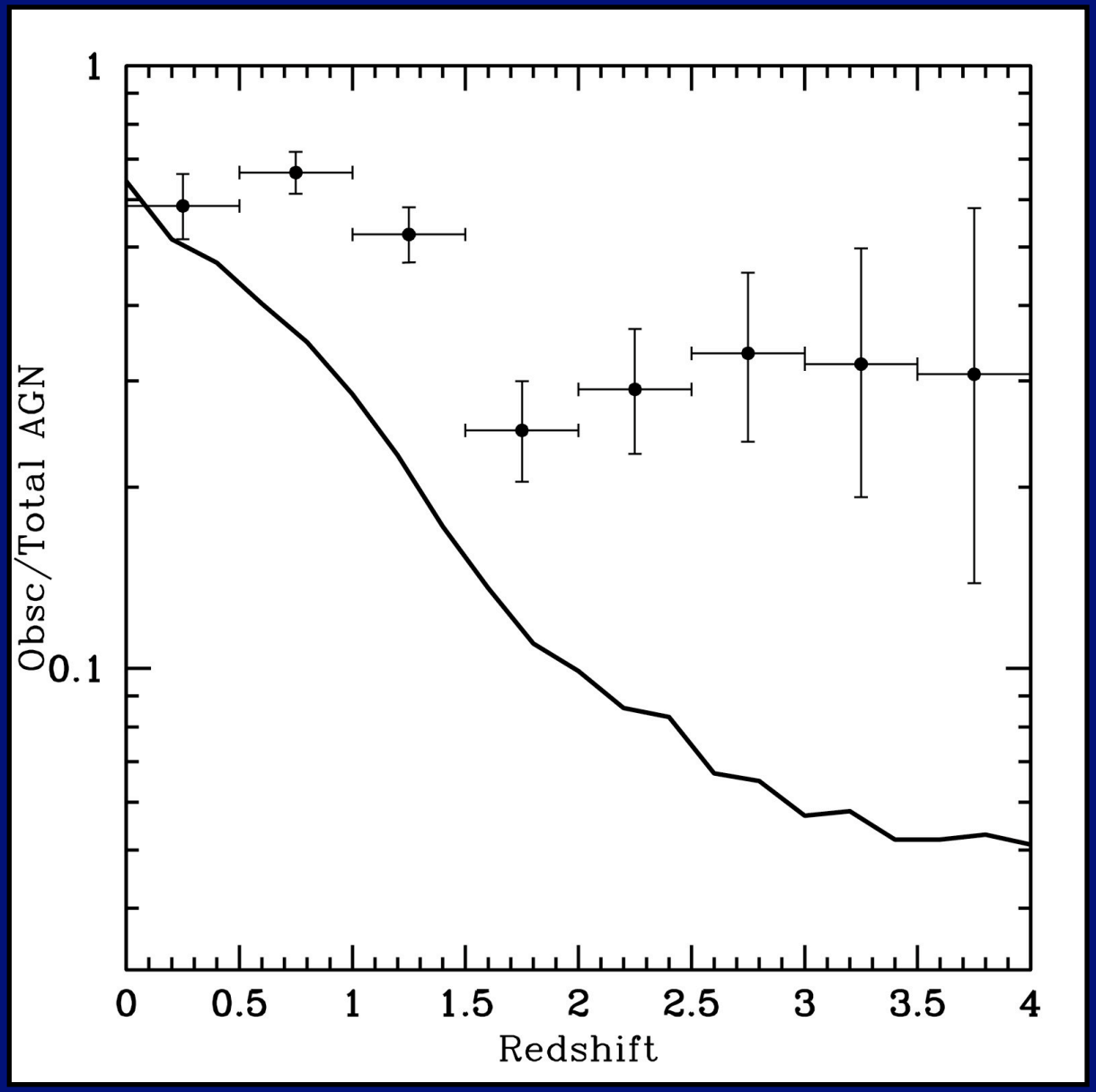

Treister & Urry, 2006

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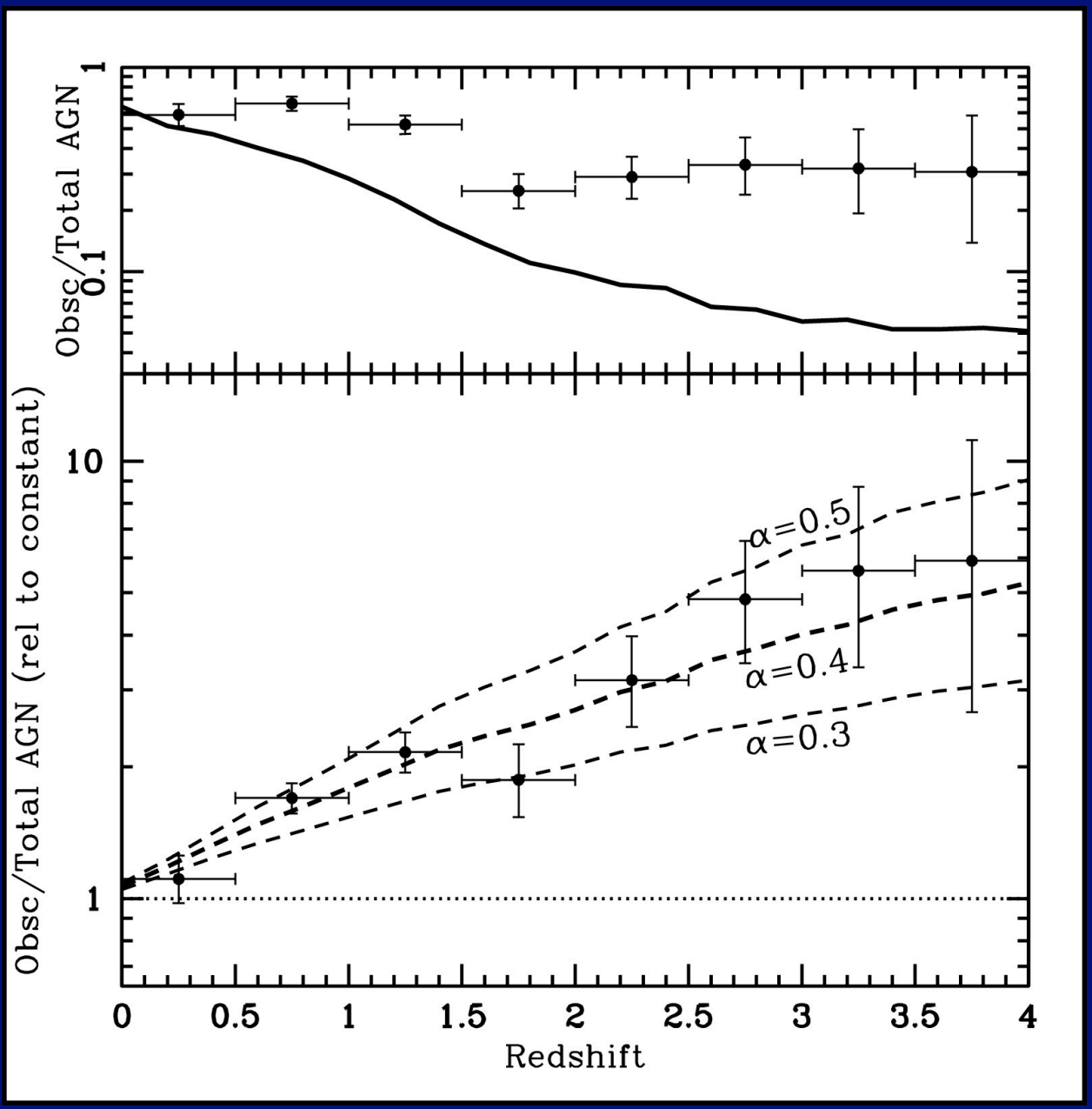
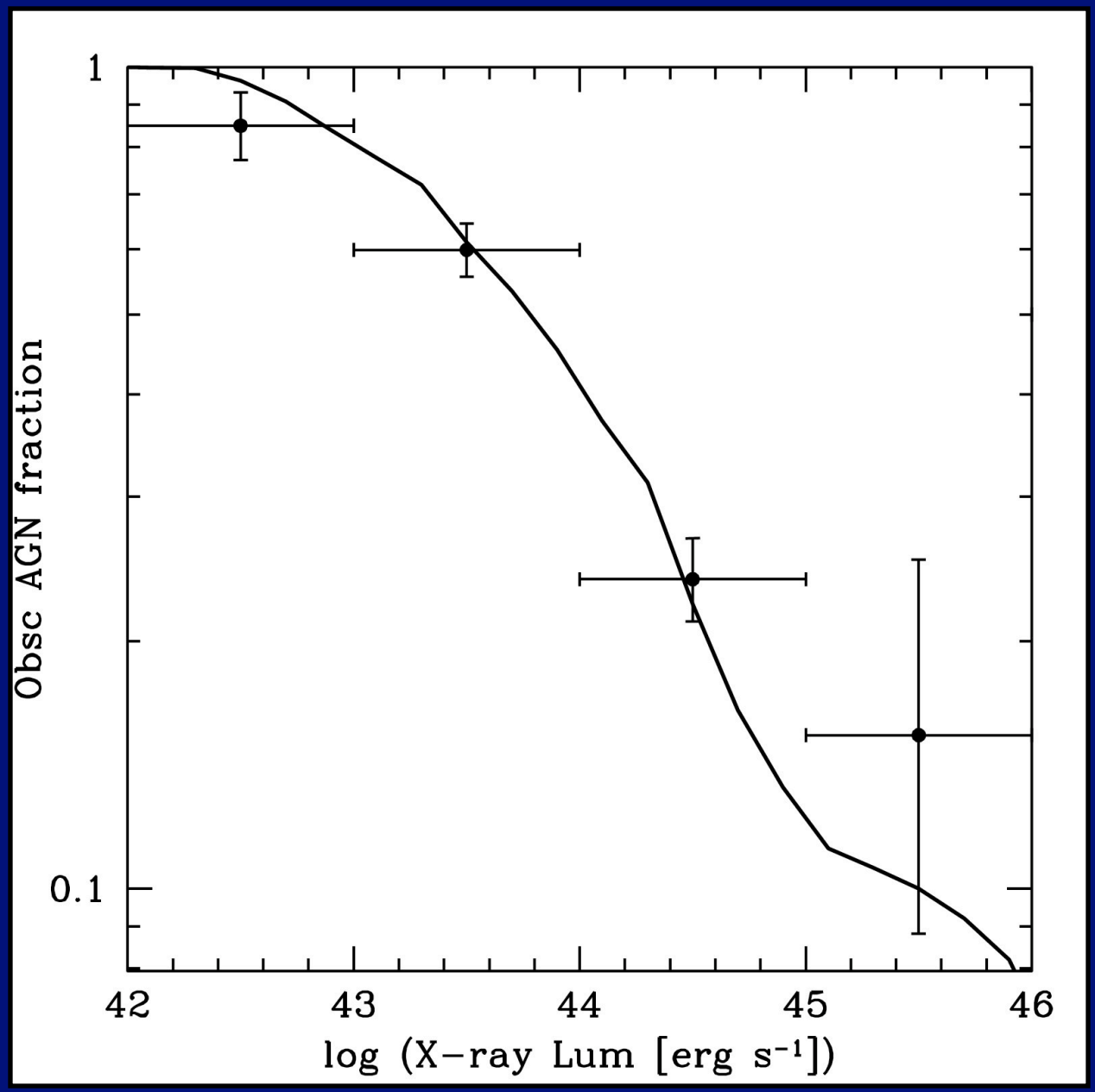


Evolution independent of choice of host Galaxy (only really Important parameter).

See Also:
La Franca et al. 2005
Ballantyne et al. 2006
Akylas et al. 2006

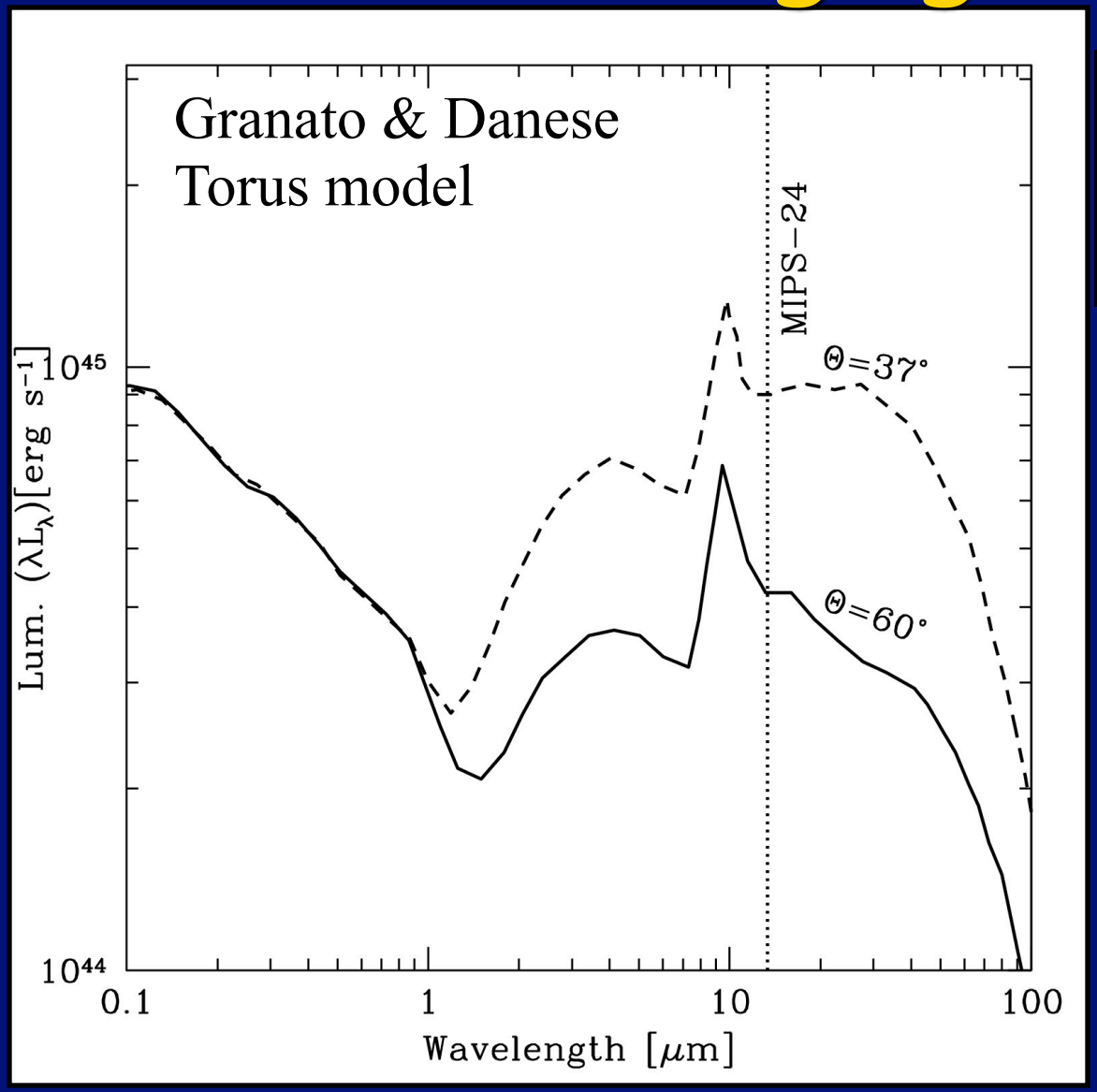
Treister & Urry, 2006

Ratio vs Luminosity



Treister & Urry, 2006

A Changing Torus?



A change in the IR/NUV flux ratio may indicate a change in torus geometry.

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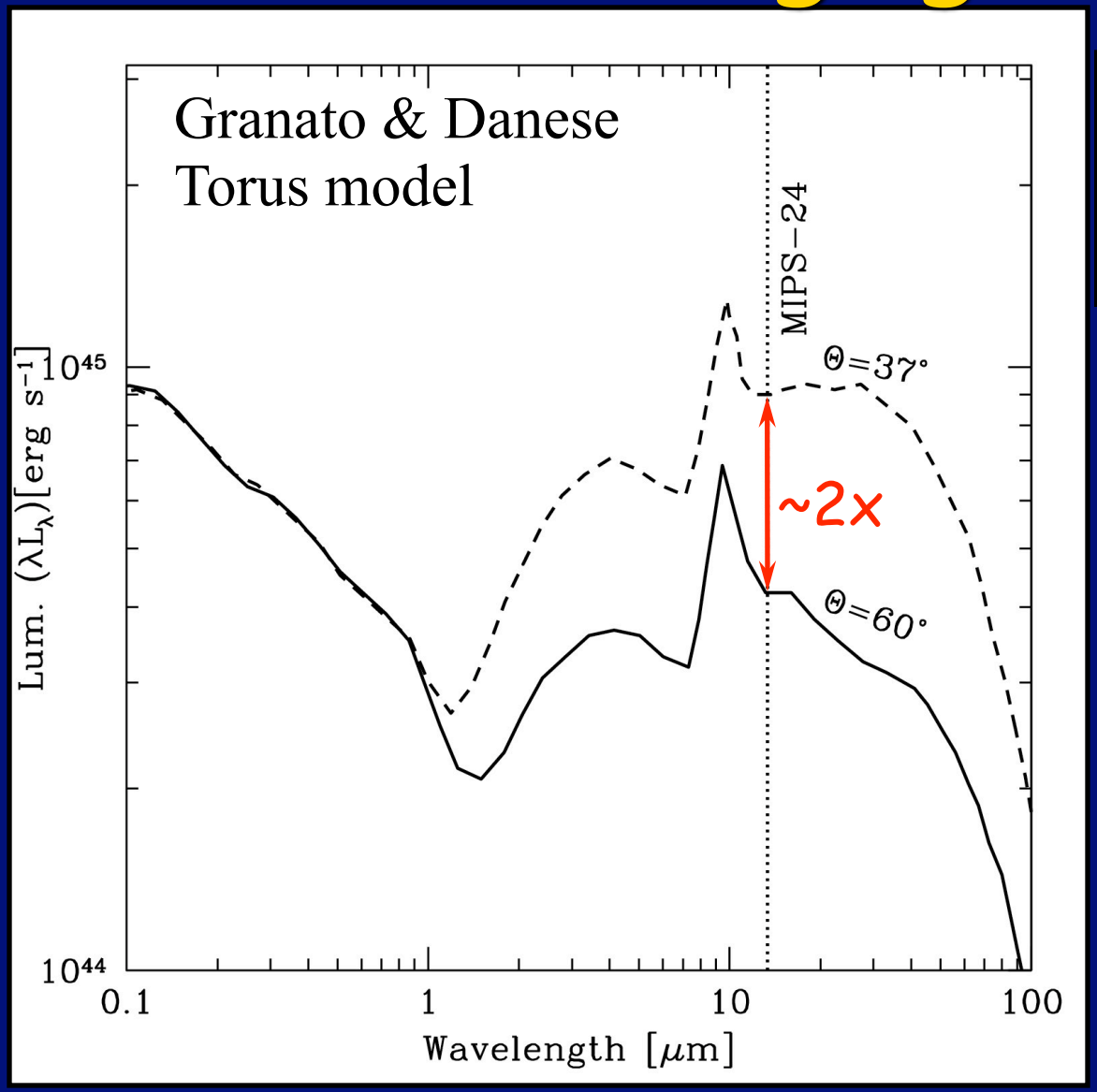

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A Changing Torus?

- Completely unobscured AGN
- Narrow redshift range, $0.8<z<1.2$
- Wide range in luminosity
- Data at 24 μm from Spitzer

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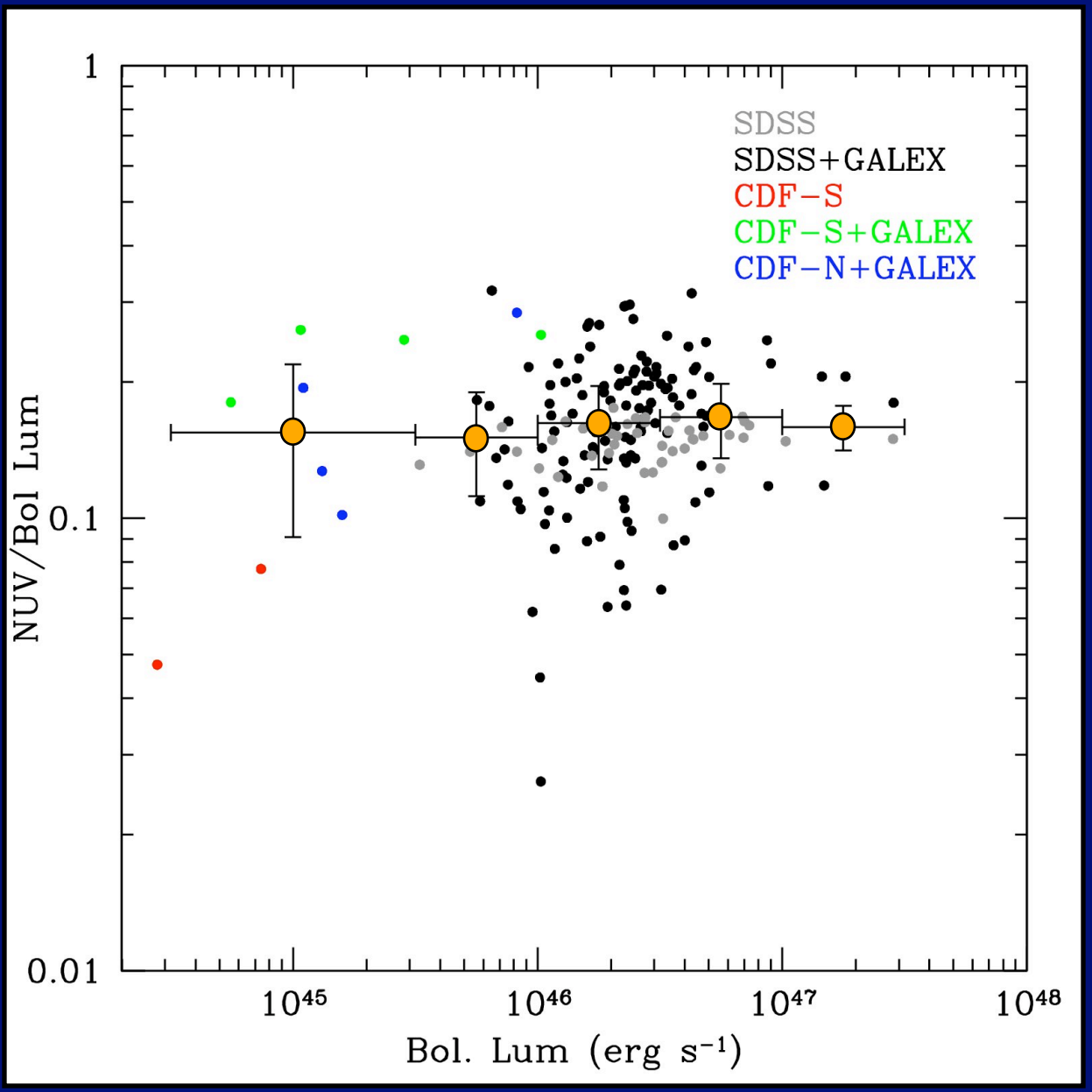
Low L

- GOODS: North+South fields
- 10 unobscured AGN
- All with Spitzer 24 μm photometry
- 8 with GALEX UV data

High L

- SDSS DR5 Quasar sample
- 11938 quasars, 0.8<z<1.2
- 192 with Spitzer 24 μm photometry
- 157 of them with GALEX UV data

A Changing Torus?

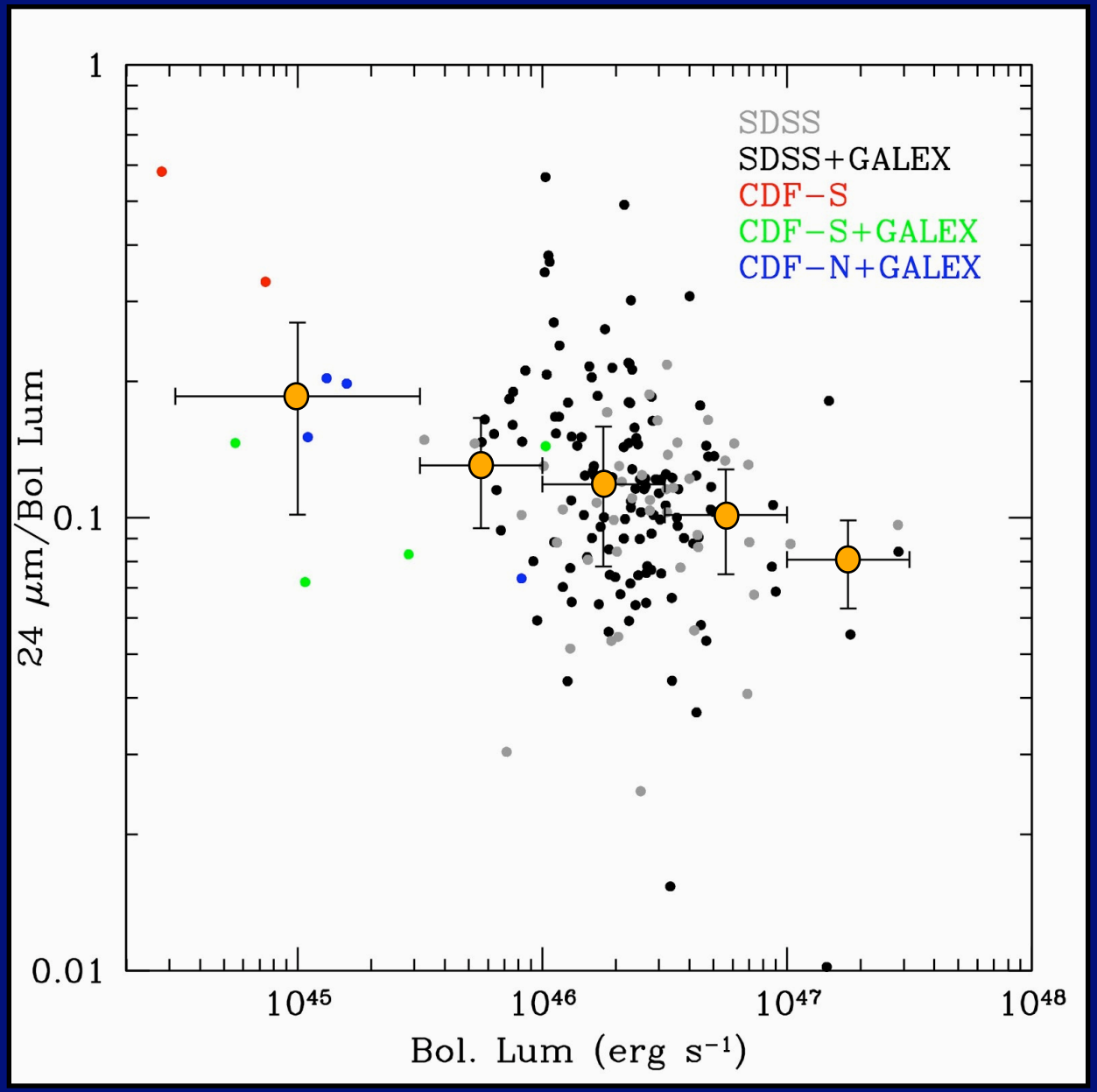


Bolometric luminosity constructed from NUV to mid-IR.

No change in NUV/Bol ratio with luminosity!

Treister & Krolik, in prep.

A Changing Torus?



Change in 24 μm/Bol ratio with luminosity!

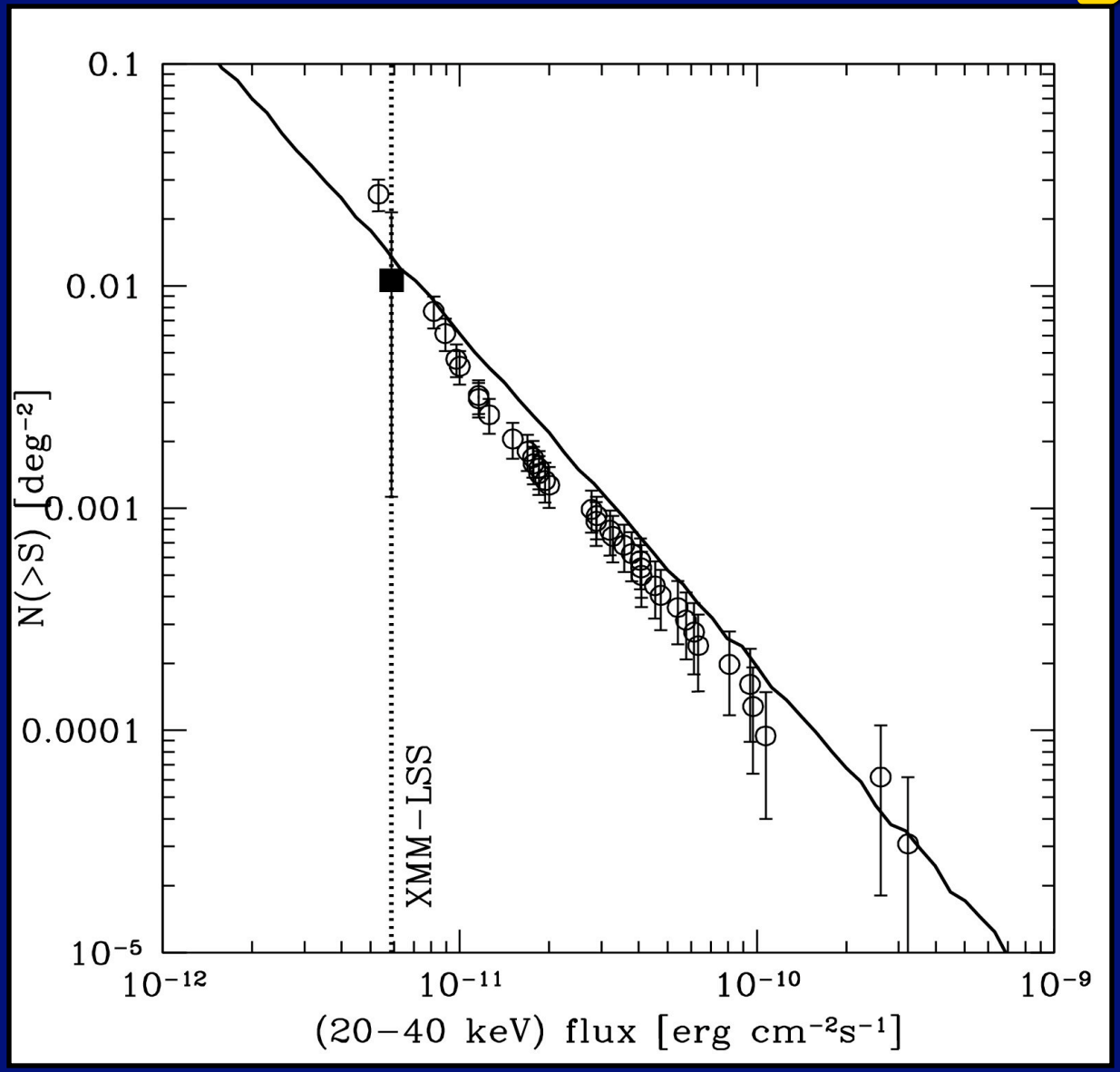
Lower ratio at high L → Consistent with larger opening angles at higher luminosities.

Treister & Krolik, in prep.

Compton Thick AGN

- Defined as obscured sources with $N_H > 10^{24}$ cm^{-2}.
- Very hard to find (even in X-rays).
- Observed locally and needed to explain the X-ray background.
- Number density highly uncertain.
- High energy (E>10 keV) observations are required to find them.

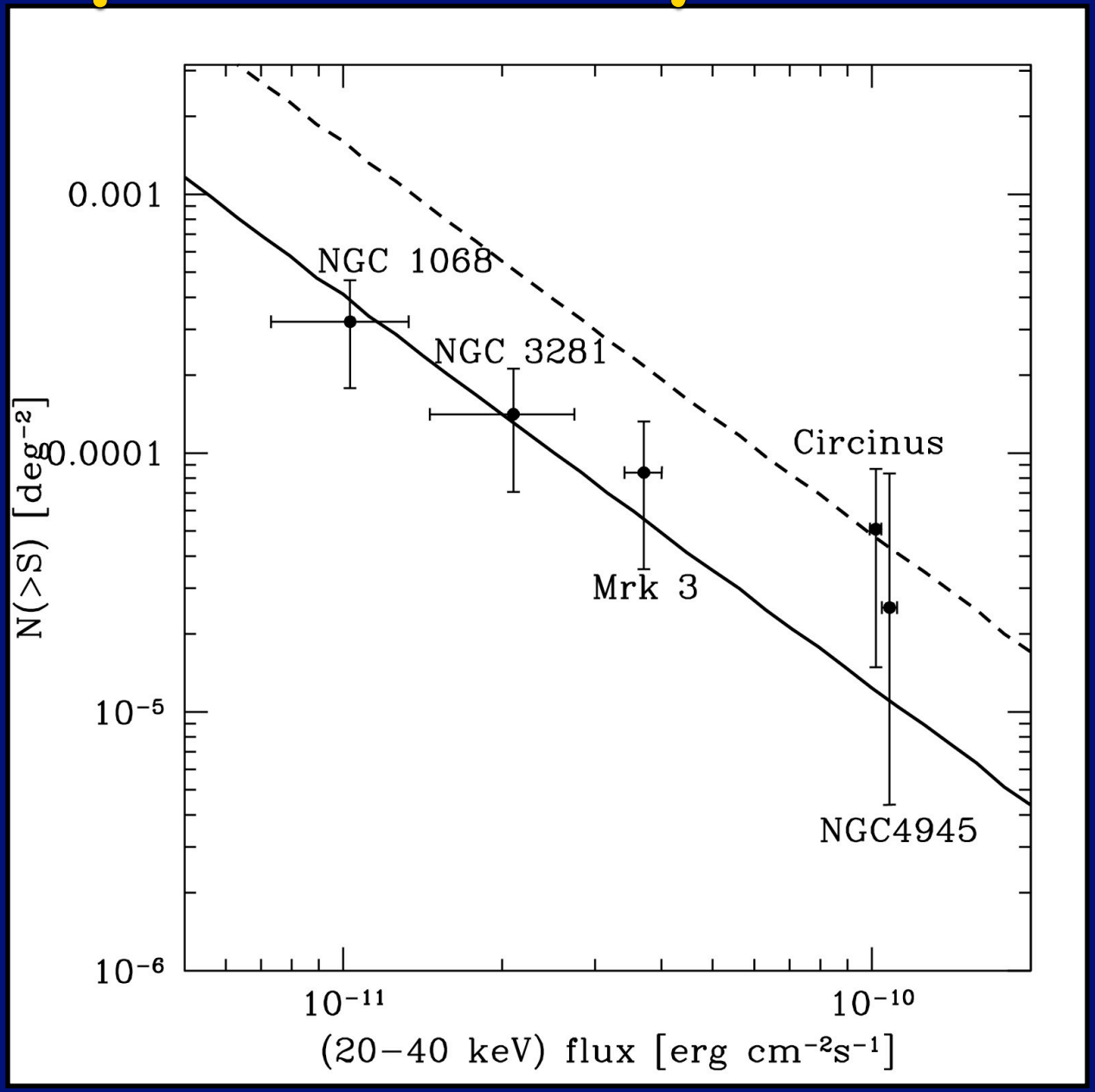
INTEGRAL AGN logN-logS



Data points from Beckmann et al. 2006

Treister et al, submitted

Space Density of CT AGN



Treister et al, submitted

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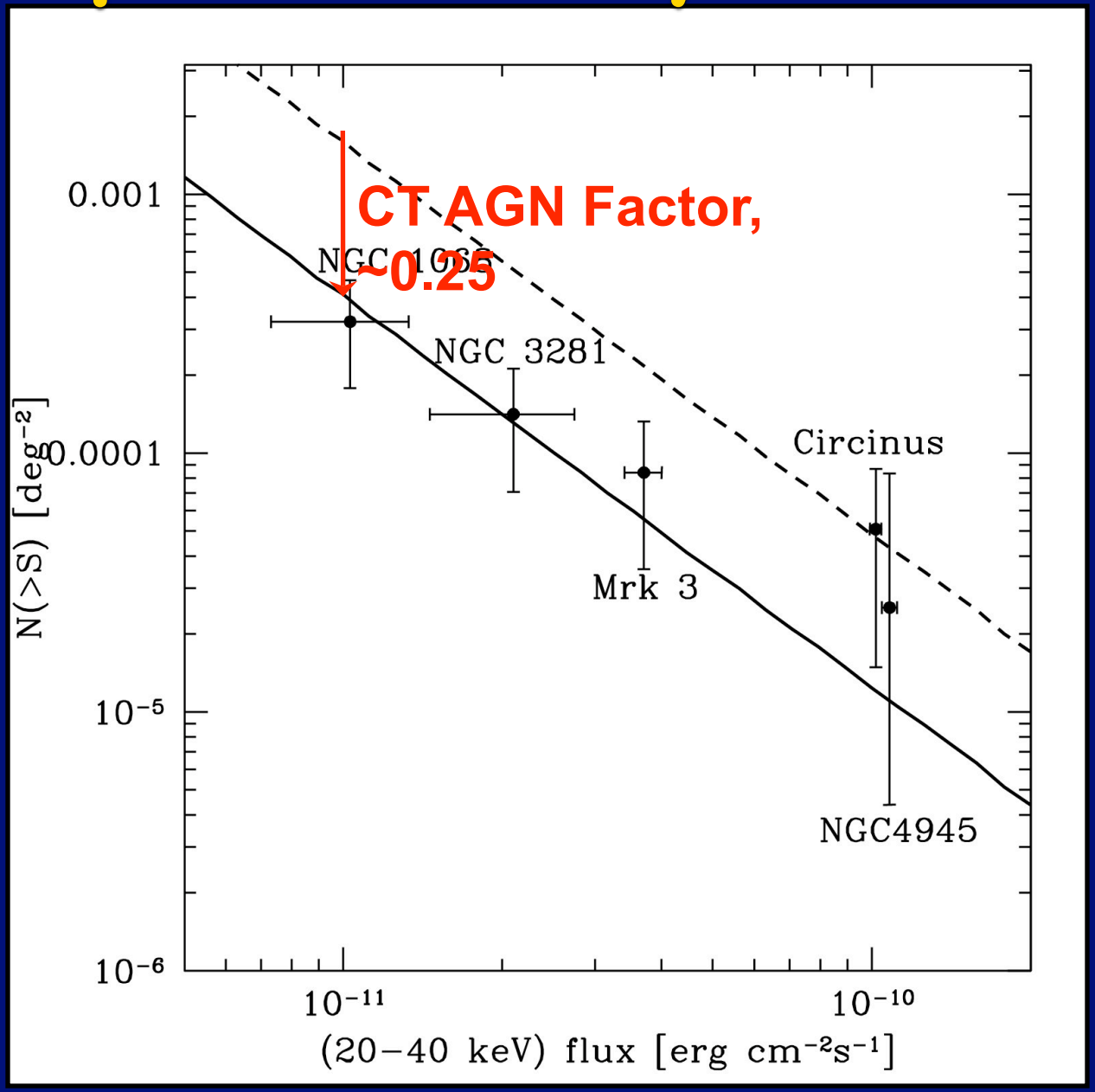
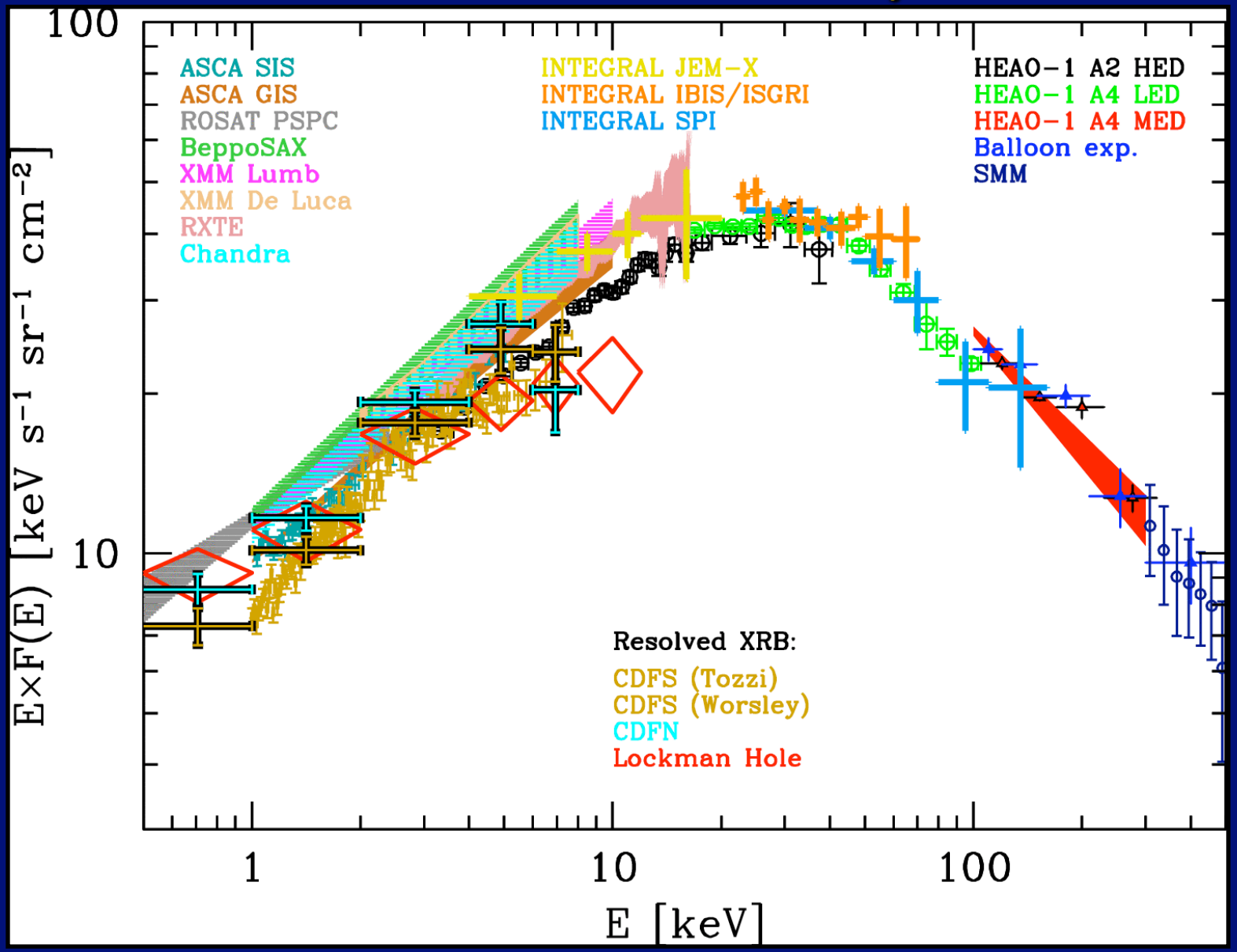
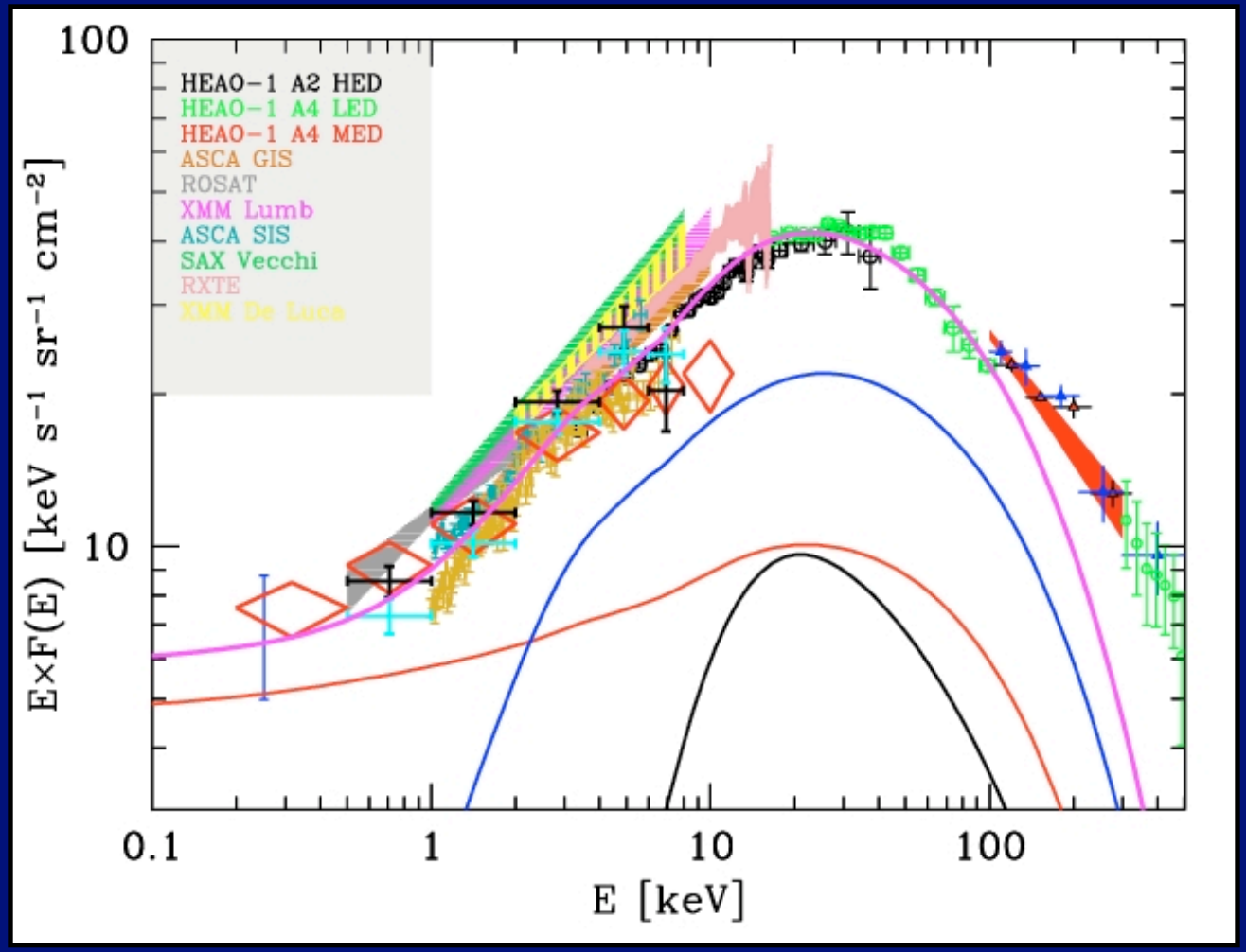


Treister et al, submitted

XRB Intensity



X-ray Background

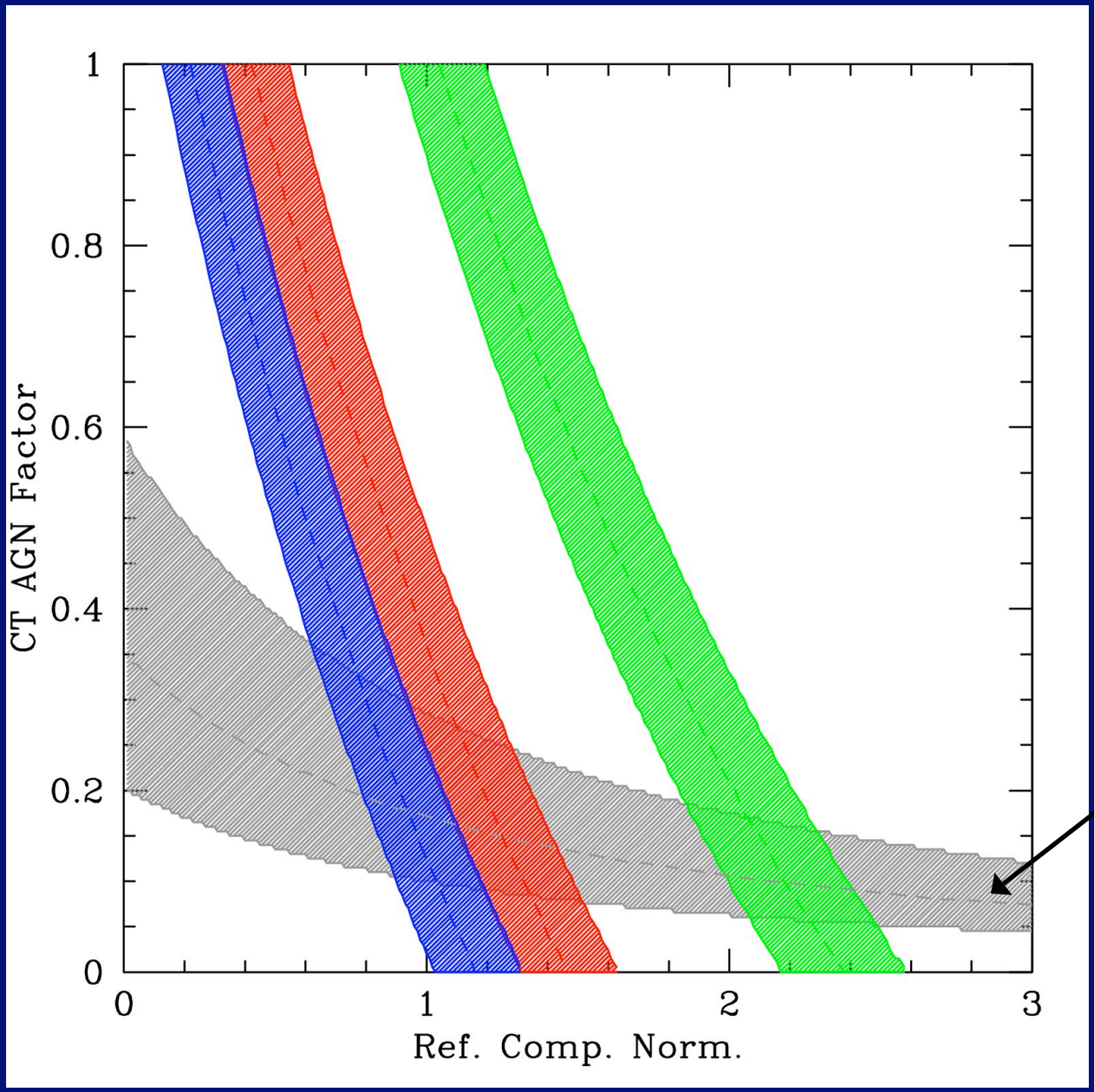


- Spread in Γ
- Original XRB normalization

➔Strong degeneracy between XRB intensity and density of CT AGN

Gilli et al, 2006

Compton Reflection Component

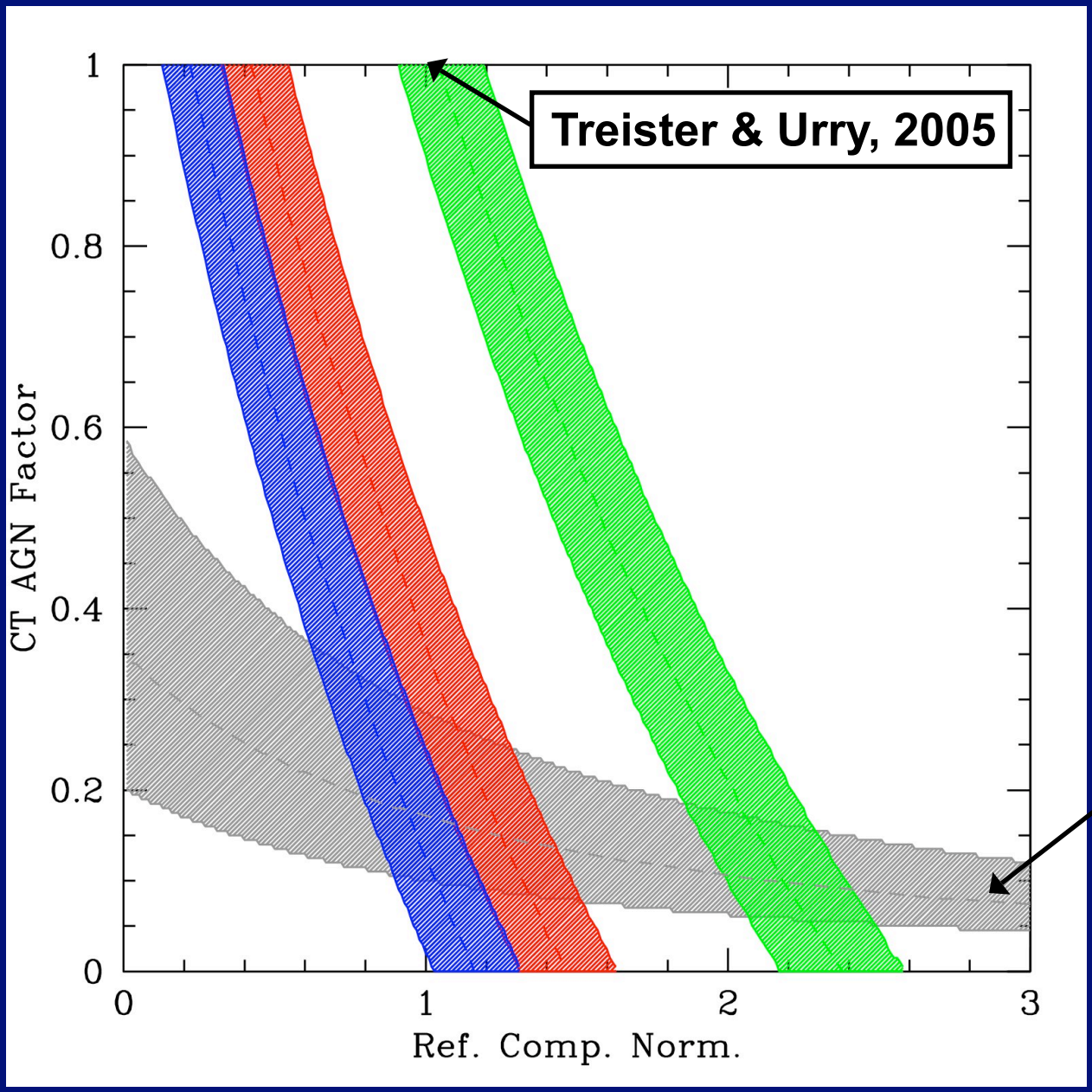


XRB Intensity
HEAO-1 Original
INTEGRAL
HEAO-1 +40%

CT AGN Space Density

Treister et al, submitted

Compton Reflection Component



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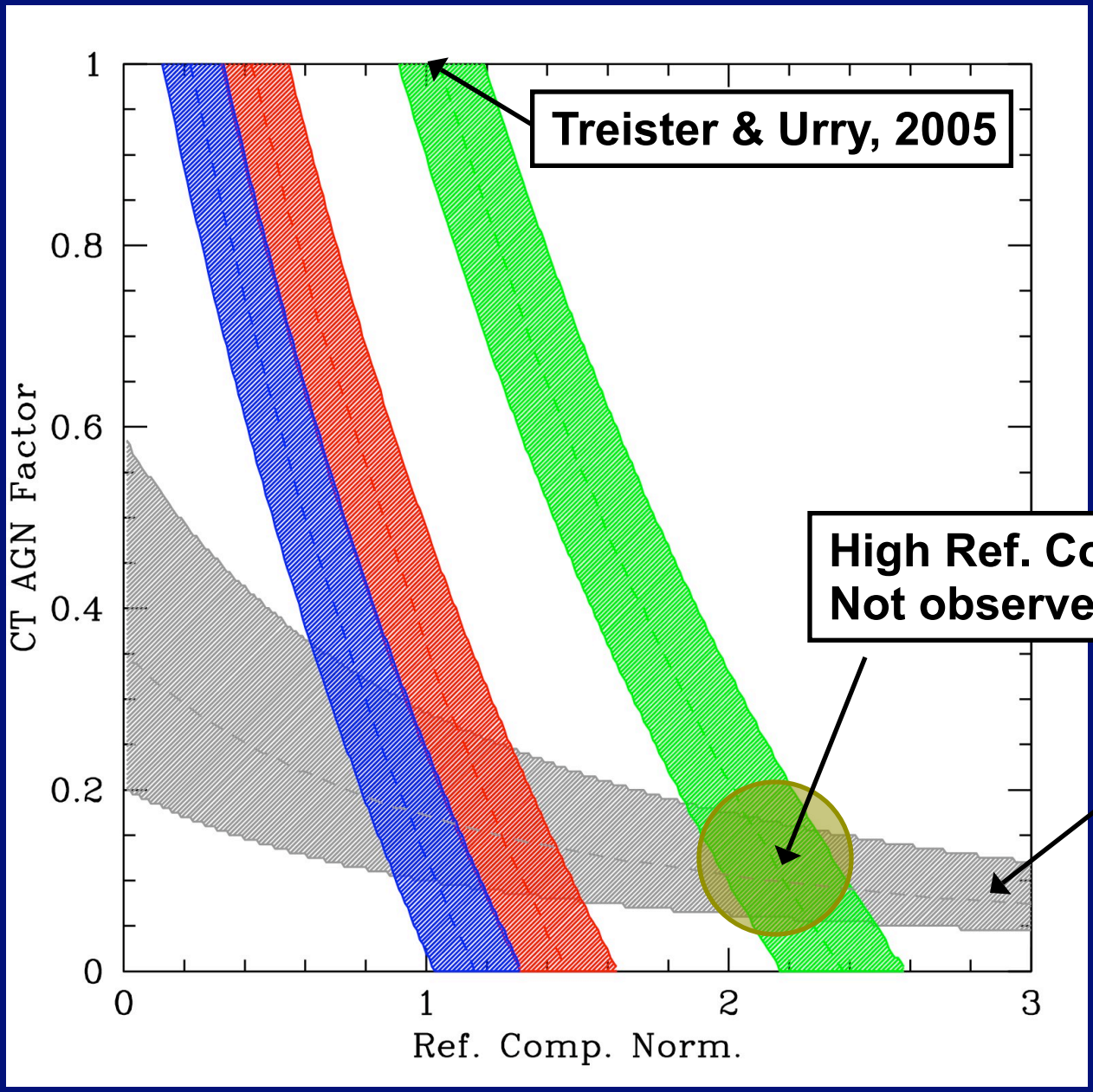

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High Ref. Component, ~2.
Not observed on individual AGN

CT AGN
Space Density

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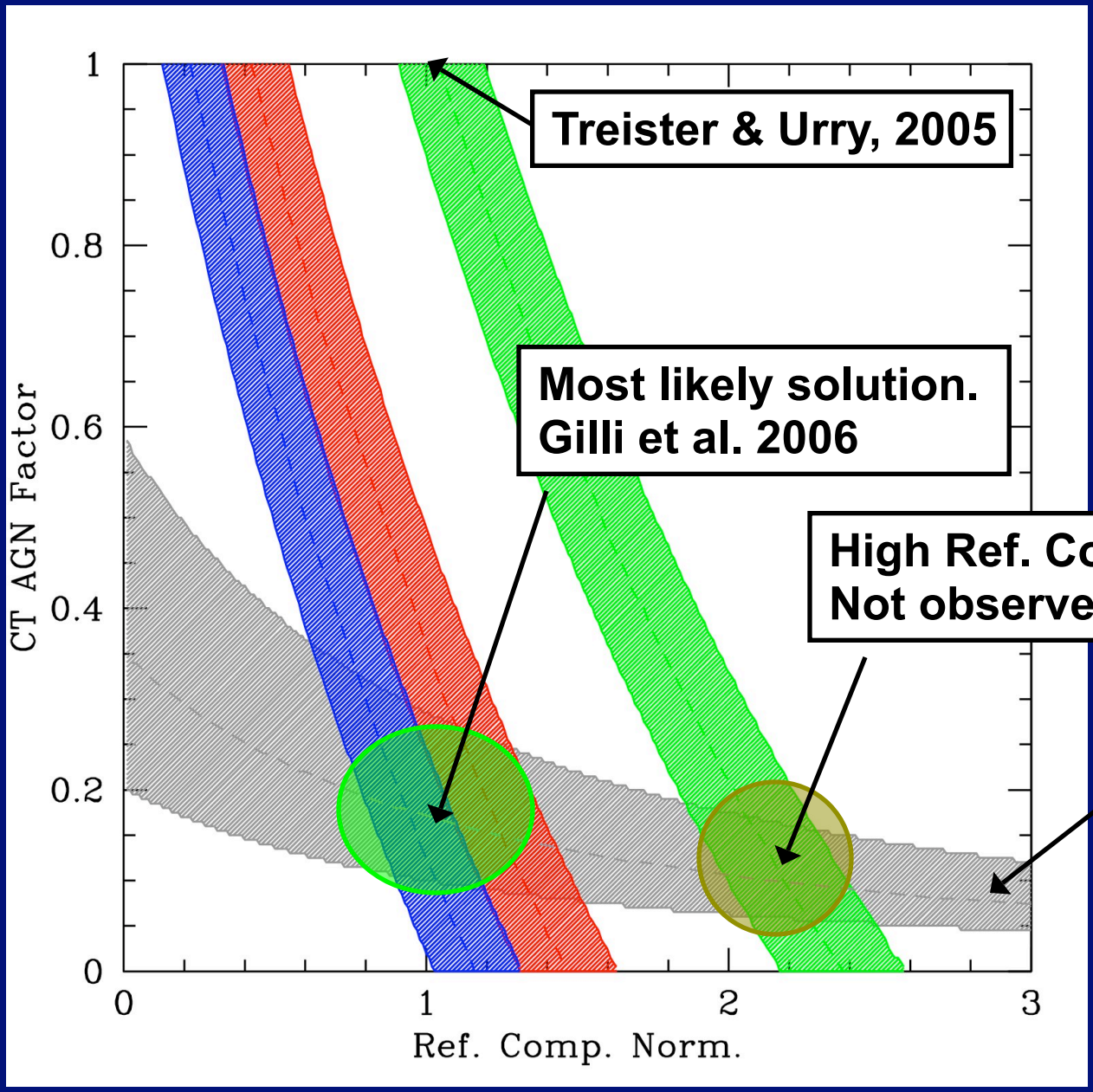

Treister et al, submitted

Summary

- ✓ The obscured AGN fraction decreases with increasing luminosity.
- ✓ Ratio of IR to Bolometric luminosity in unobscured AGN suggest this is due to a change in opening angle.
- ✓ The obscured AGN fraction increases with redshift as $(1+z)^{0.4}$.
- ✓ Observed spatial density of CT AGN and individual sources favors the original HEAO-1 XRB intensity with a Compton reflection component of ~1.

u-z SDSS QSO Colors