UNIFICATION AND/OR EVOLUTION

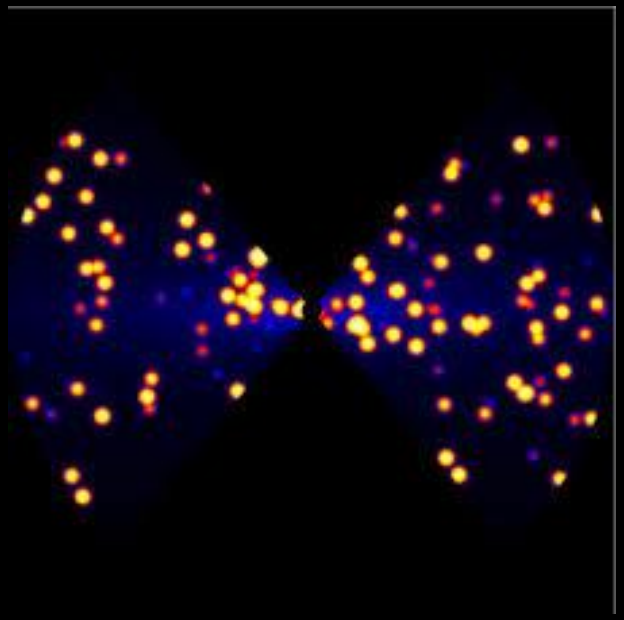
NEW INSIGHT ON AGN TORI FROM HERSCHEL AND WISE OBSERVATIONS OF THE MOST LUMINOUS AGNS AT Z=2-3.5

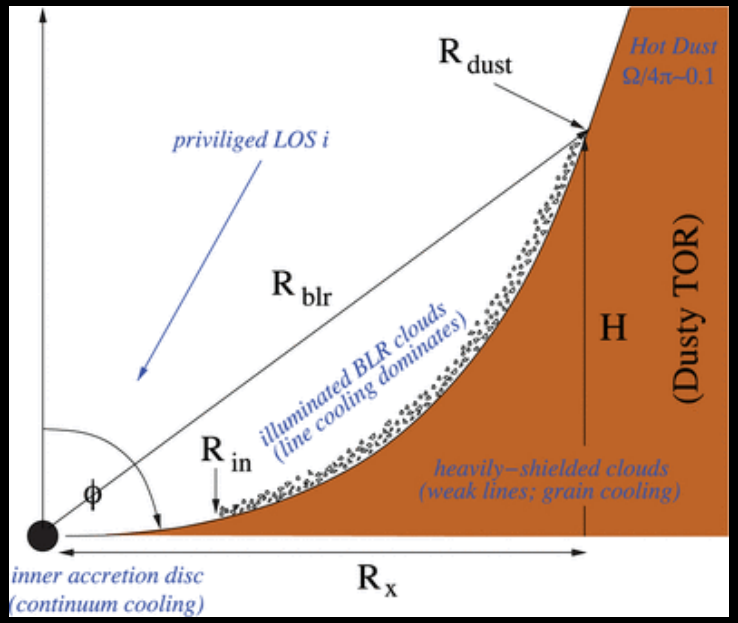
Hagai Netzer
Tel Aviv University

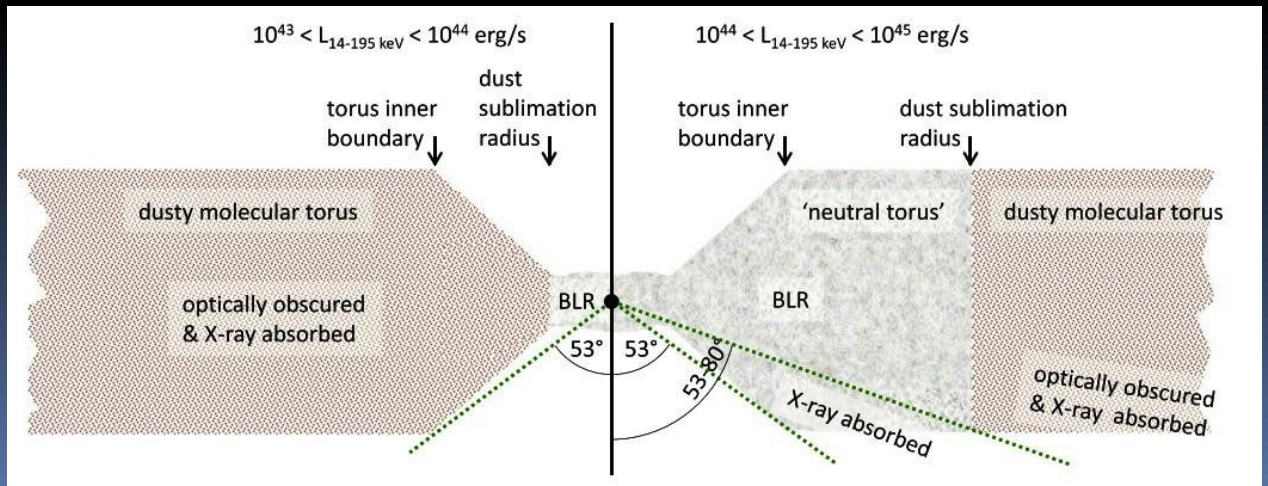
1. Star formation in the hosts of the most luminous AGNs
2. Torus SED in the most luminous AGNs
3. Covering factor at low and high redshift
4. Covering factor at low and high luminosity

Collaborators:
Caterina Lani, Raanan Nordon, Benny Trakhtenbrot, Paulina Lira, Ohad Shemmer

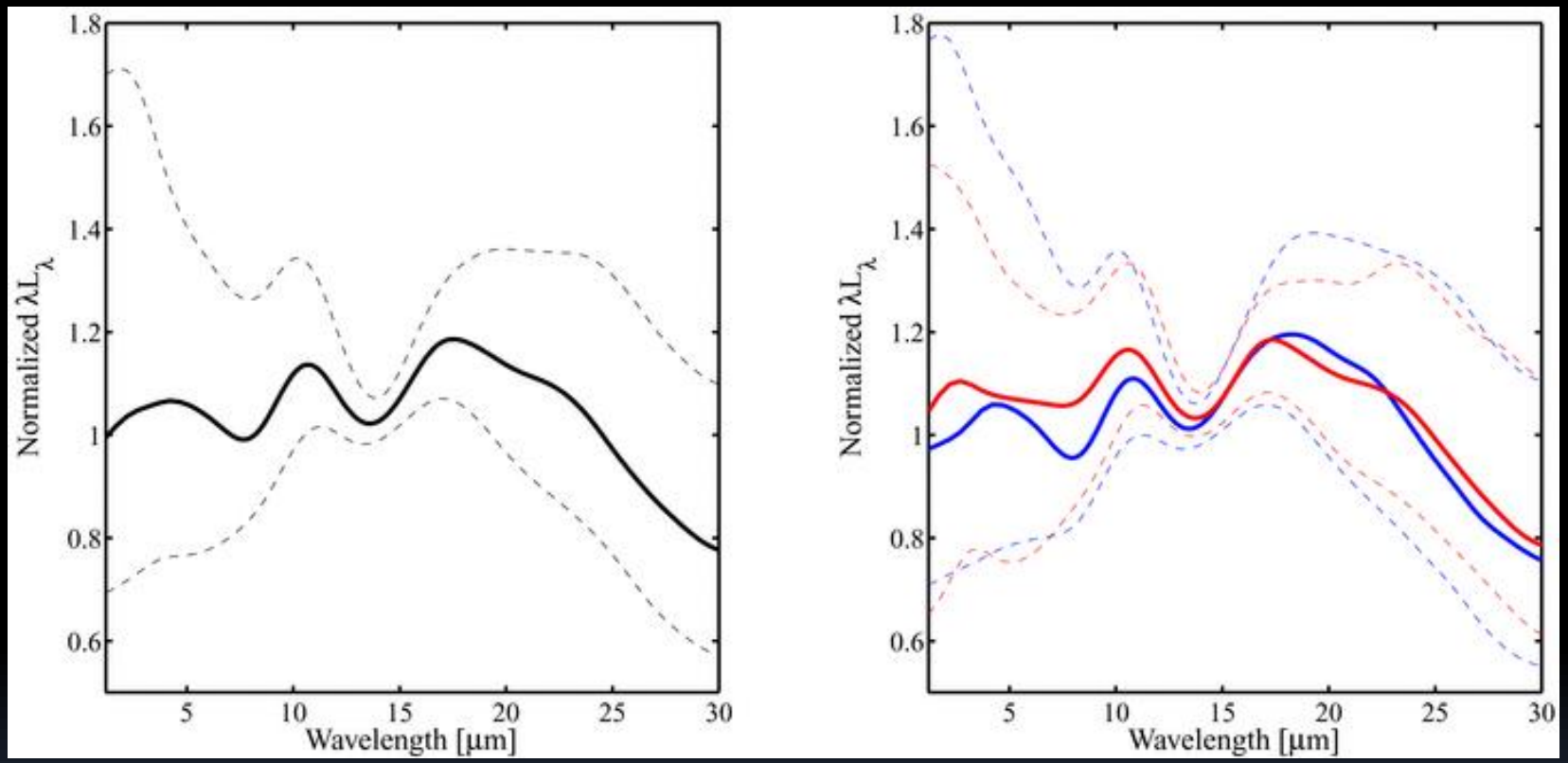
Torus and BLR geometry







Torus SED – Spitzer spectroscopy



Rivay Mor, and Hagai Netzer MNRAS 2012;420:526-541

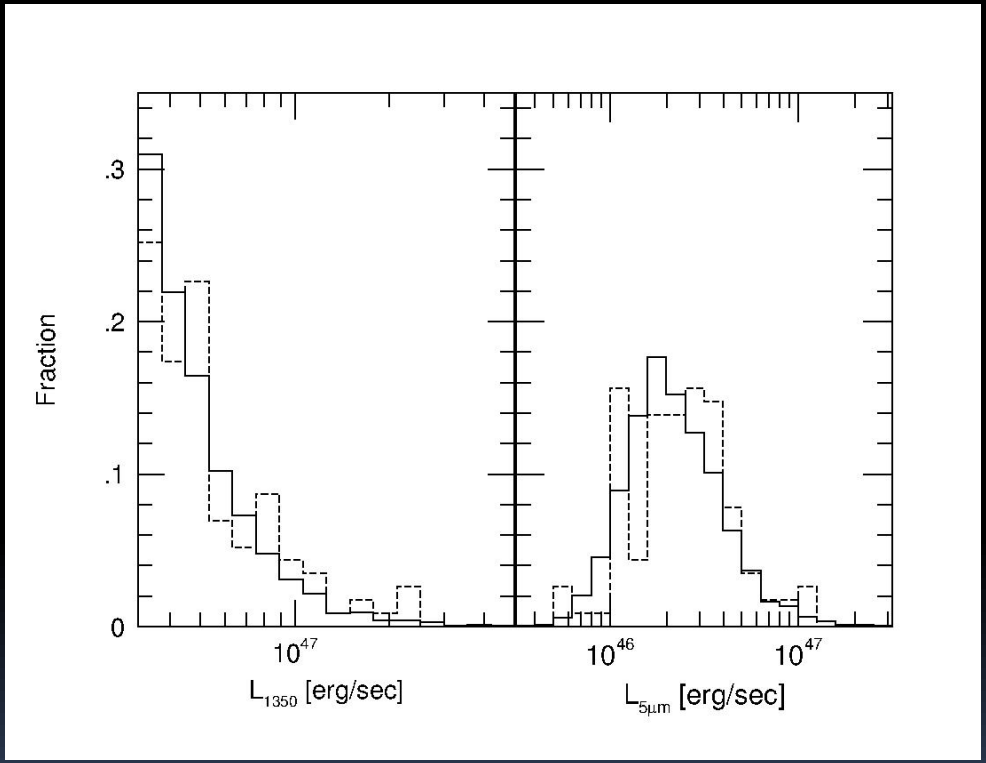
Intrinsic AGN SEDs. Right-hand panel: median intrinsic AGN SEDs for two subgroups of NLS1s (blue) and BLS1s (red). Left – adopted median SED

Key questions related to torus and AGN evolution

- Torus formation
  - Is it the same process in low and high luminosity sources?
  - Is it the same process in mergers and quiescent systems?
- Torus geometry
  - Is it the same structure and geometry regardless of the host properties?
  - Is it the same geometry regardless of the way it was formed?
  - Is it the same in DOGs?
- What is the best way to answer these questions?
  - Follow the evolution of the torus SED and covering factor in redshift and luminosity.

The high luminosity optically selected z=2-3.5 sample

log L_{1350}(erg/sec)>46.5

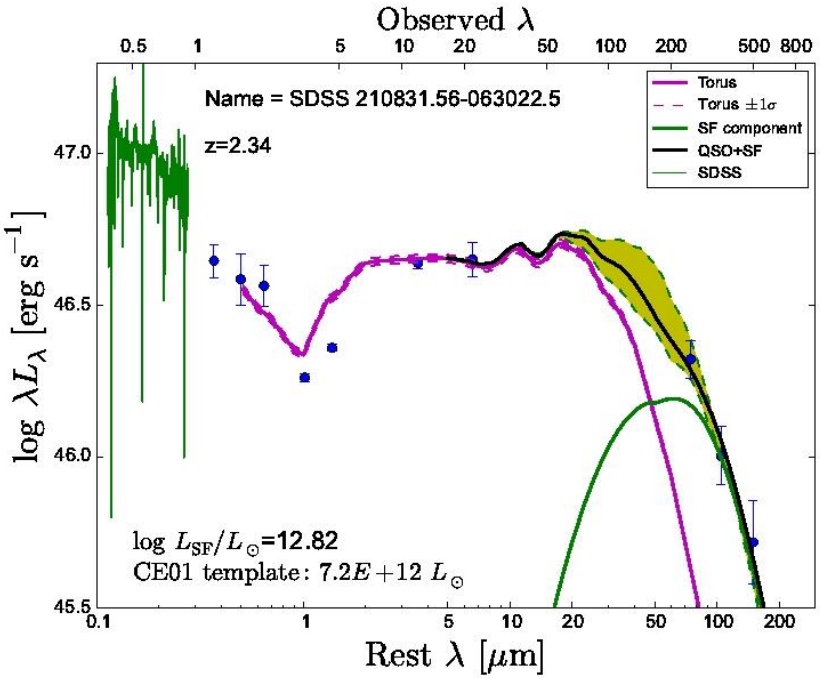


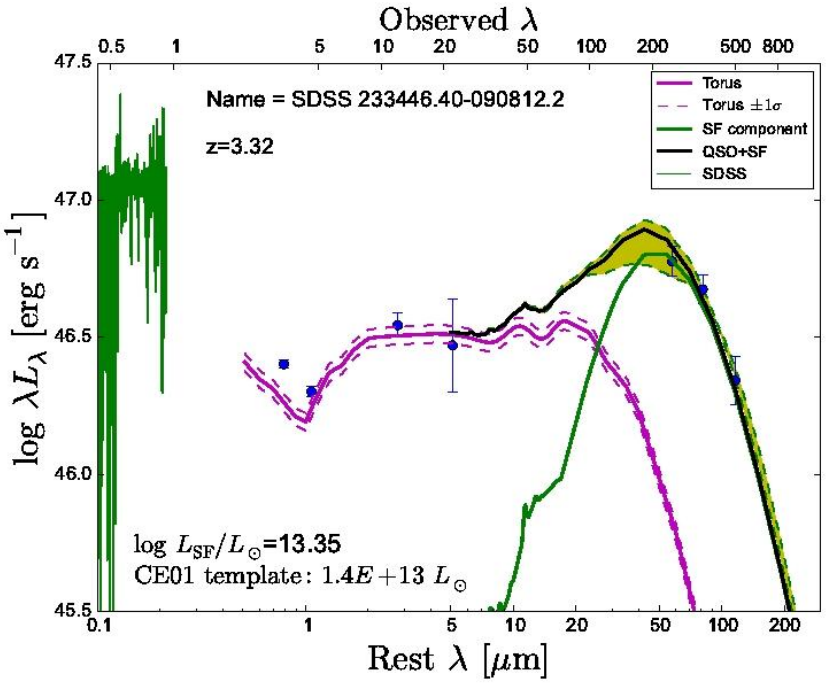
Netzer et al (submitted to ApJ)

35 Herschel/SPIRE detections

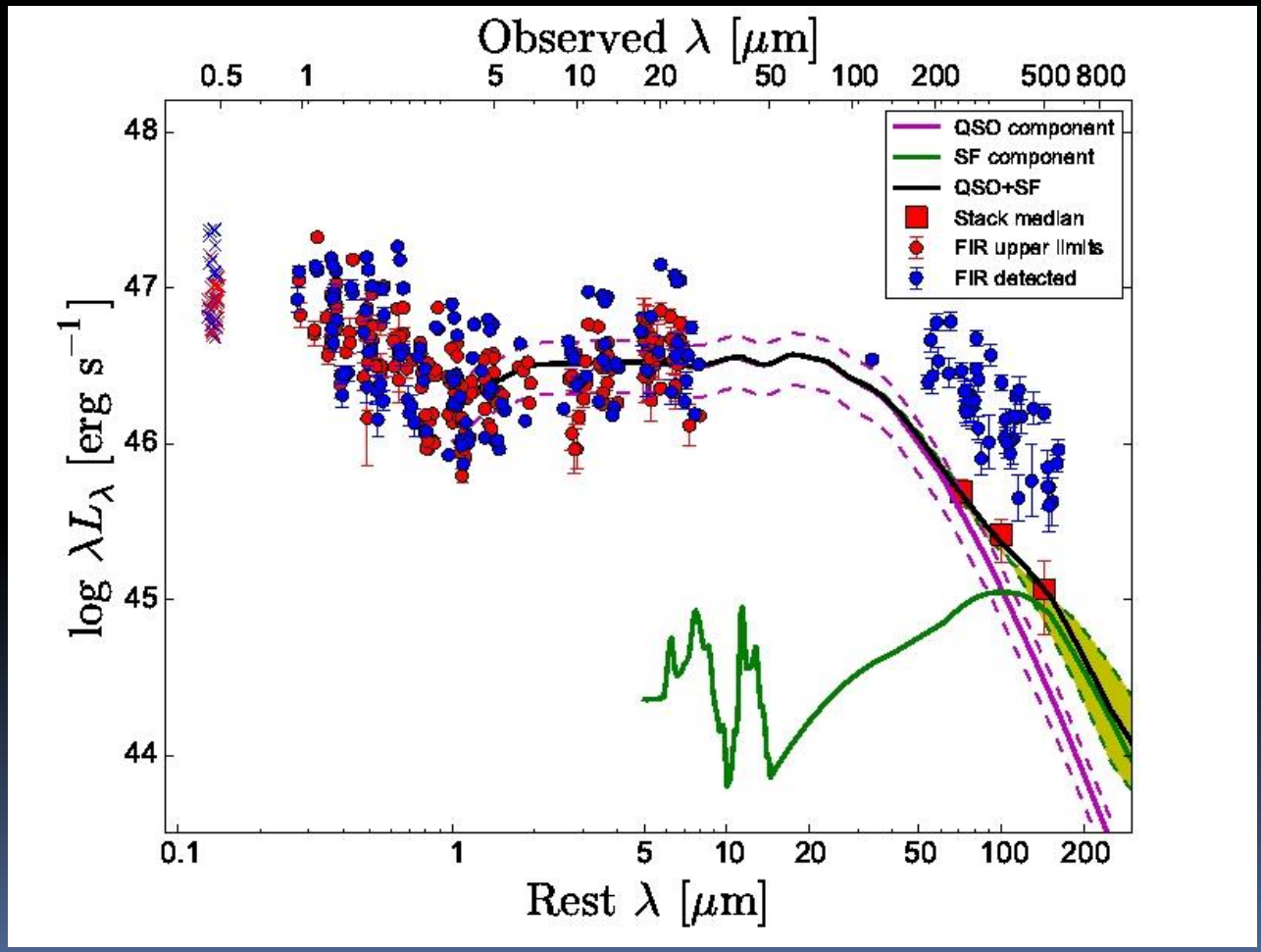
78 Herschel/SPIRE upper limits (statistically significant stacks)

Herschel observations
Examples of combined SED fits

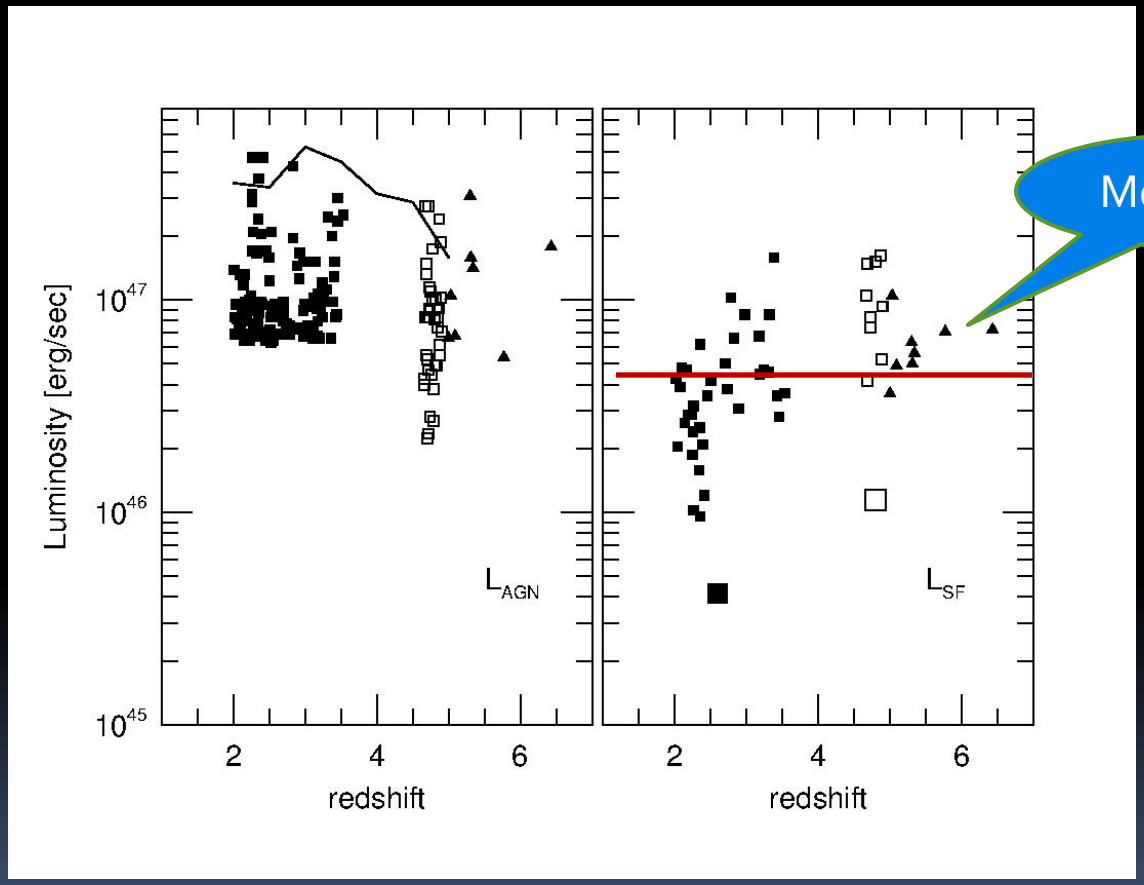




High luminosity group
log L_{1350} (erg/sec)>46.7

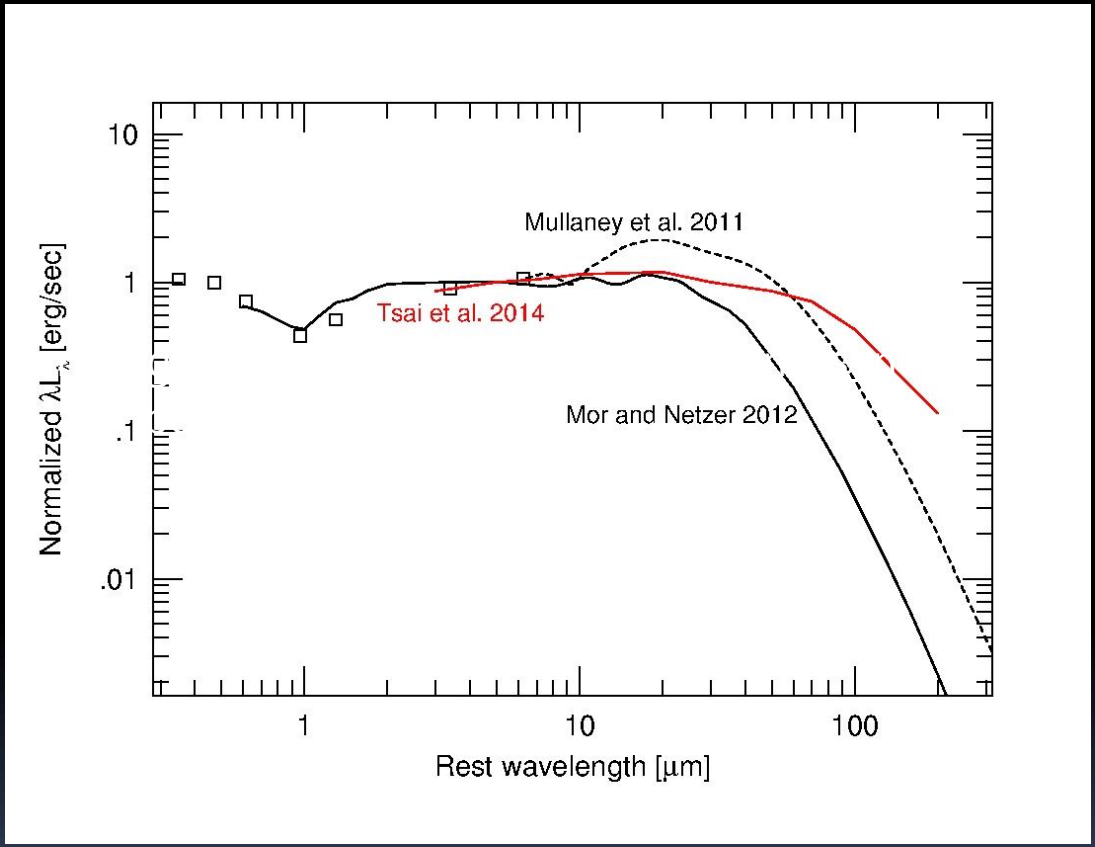


Time evolution of BH accretion rate and SFR in the most luminous AGNs



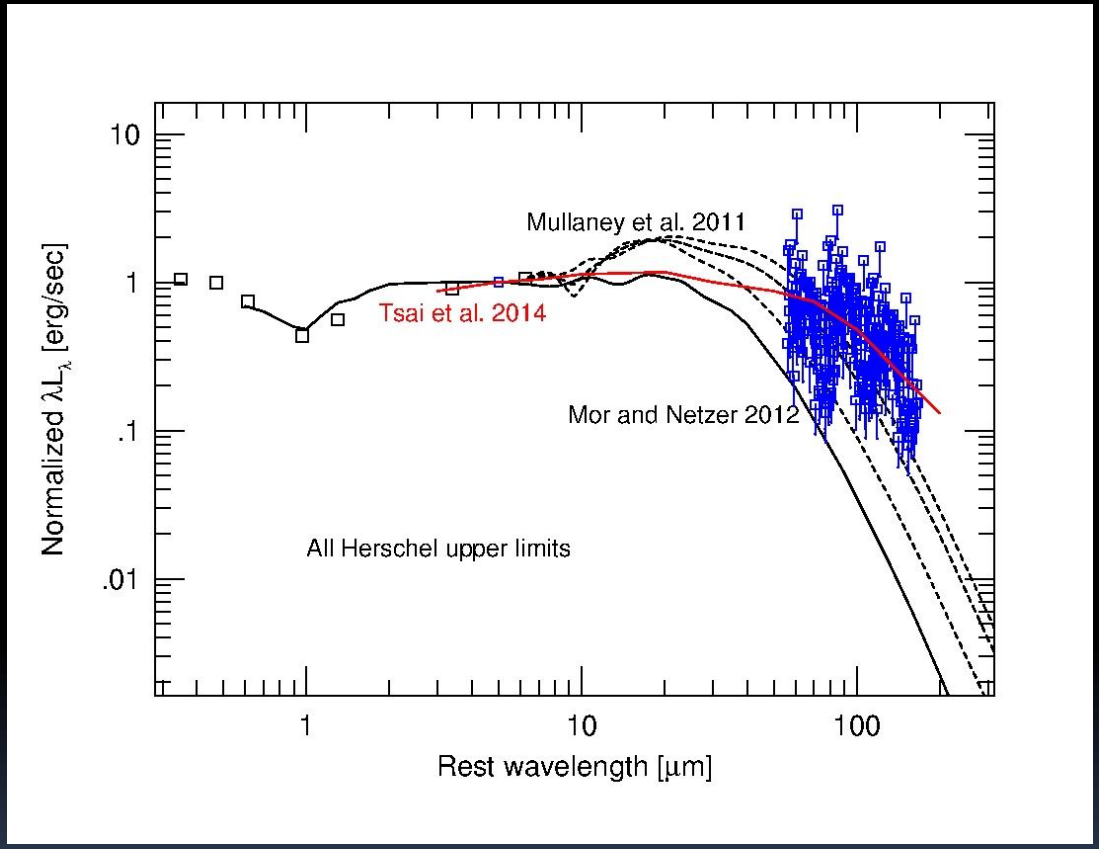
Time difference between peaks ~ 1Gy

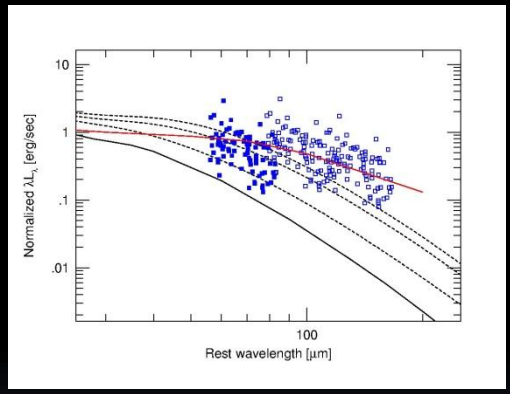
Suggested torus SEDs



How to calculate L(Torus)?
What is the long wavelength SED?

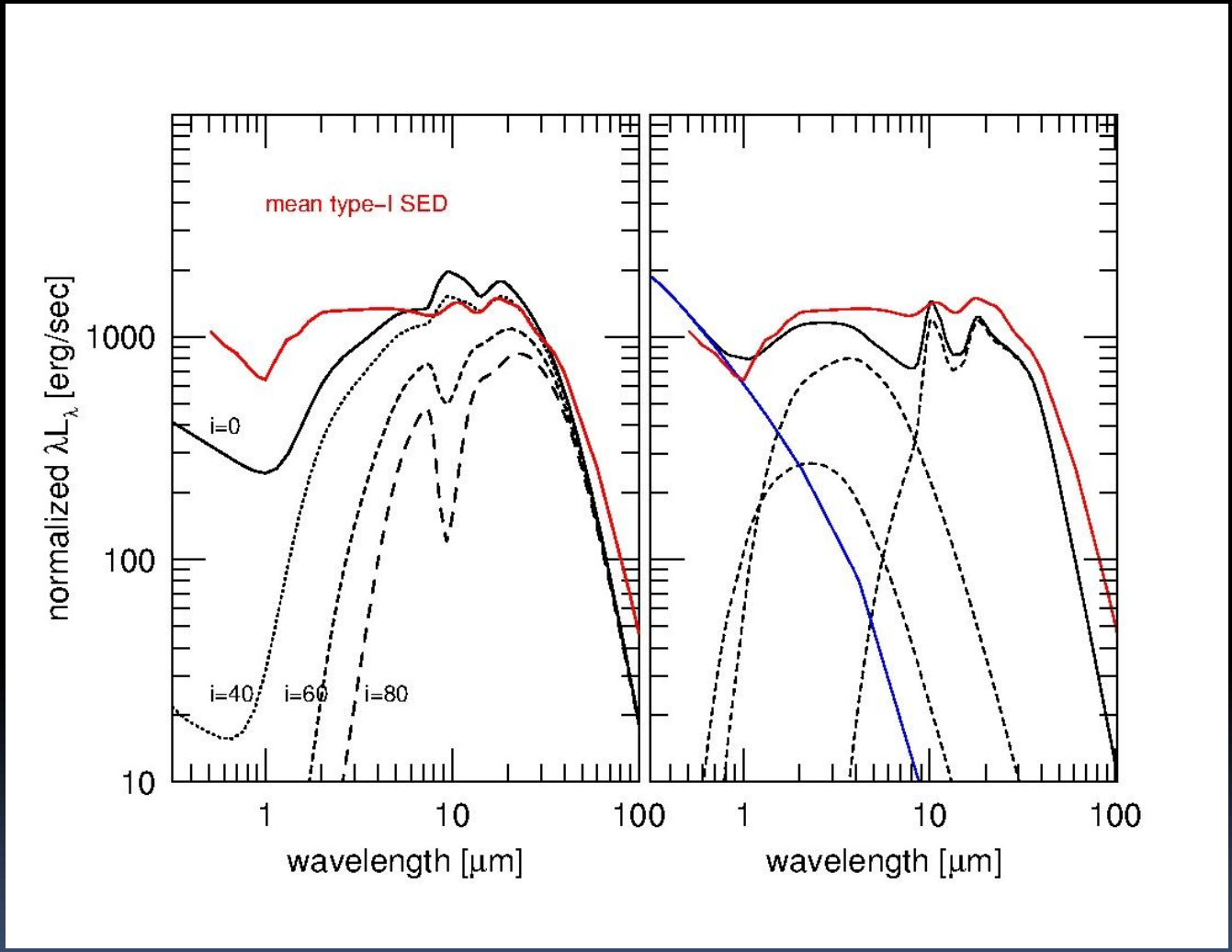
The “best” torus SED
(inferred from Herschel/SPIRE upper limits)





Torus SEDs for the most luminous AGNs at z=2-3.5 are indistinguishable from SEDs of z=0, 10^3 times less luminous AGNs.
No noticeable differences between mergers and quiescent systems.

SED: What does it tell us about the torus geometry?

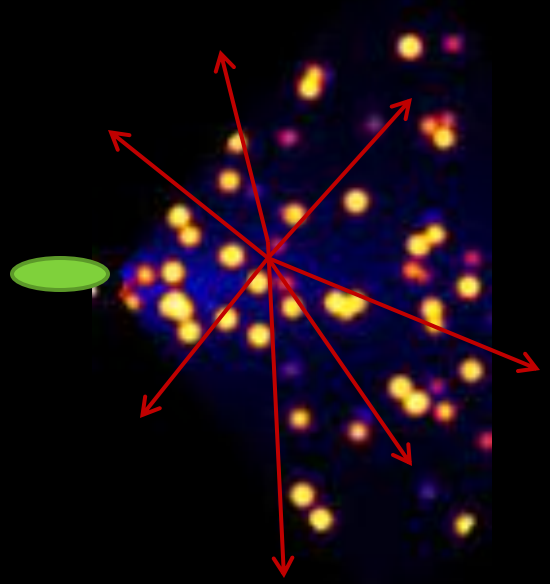


Left: Stalevski set of models.

Right: Netzer - three individual clouds

From observed SED to covering factor

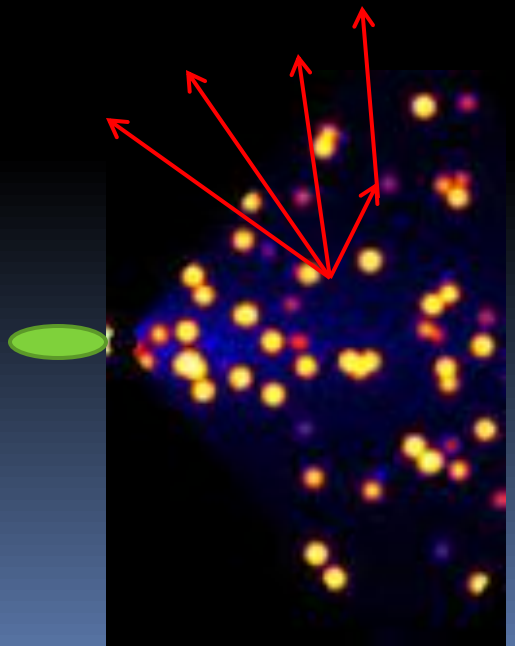
- Torus optical depth
- Isotropic emission
- Complete anisotropy



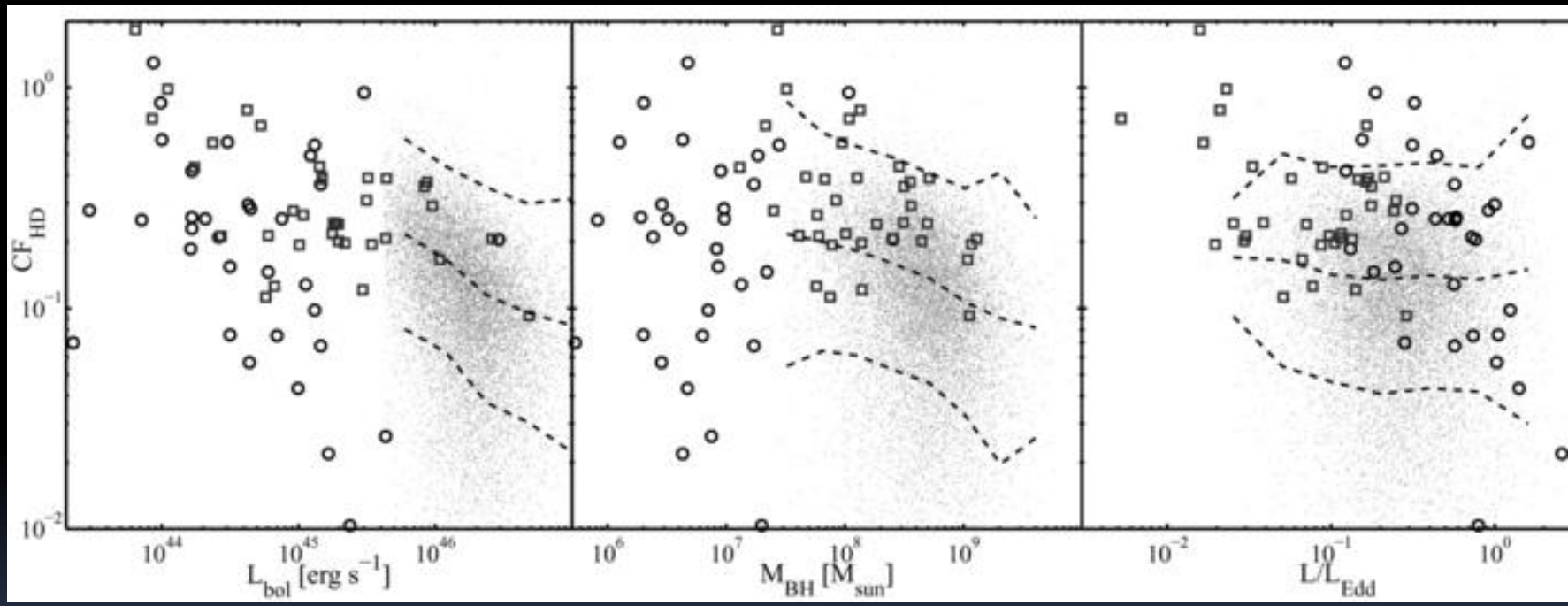
$$\frac{L_{dust}}{L_{AGN}} = \frac{1-bf}{1-f} f$$

$$f = \text{covering factor}$$

$$b = b(\tau_\lambda)$$



Torus covering factor from L(torus)/L(AGN)

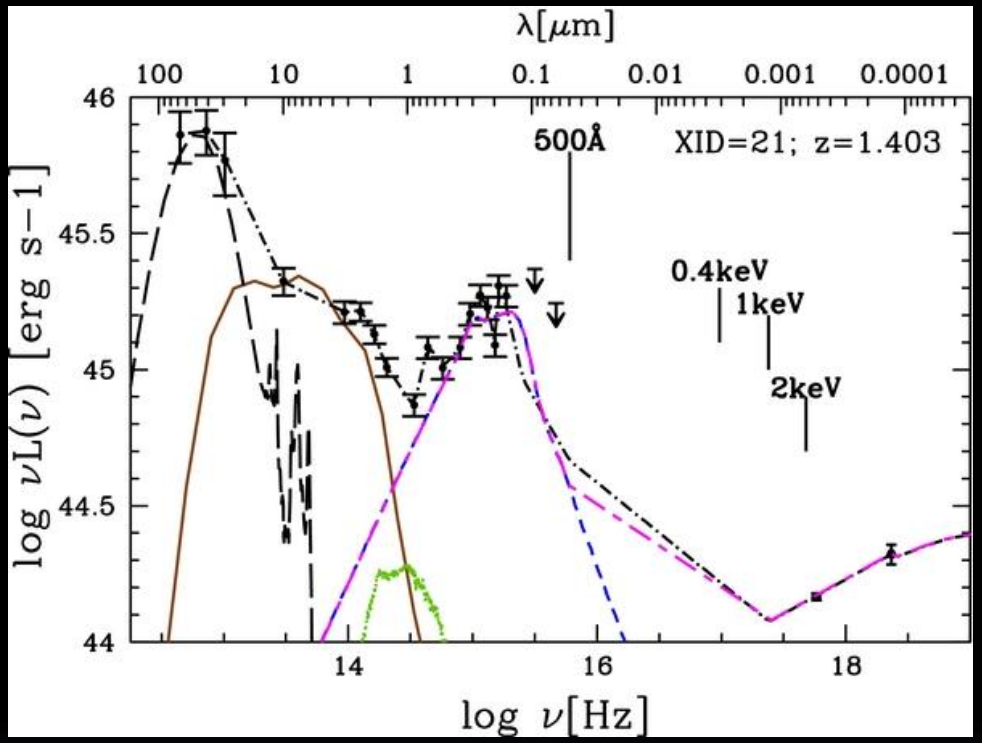


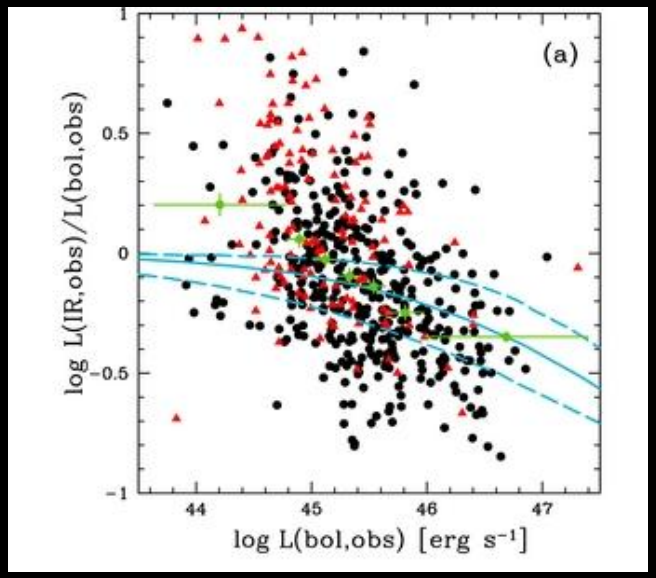
Mor and Netzer 2012

Selected figures from

The Obscured Fraction of Active Galactic Nuclei in the XMM-COSMOS Survey

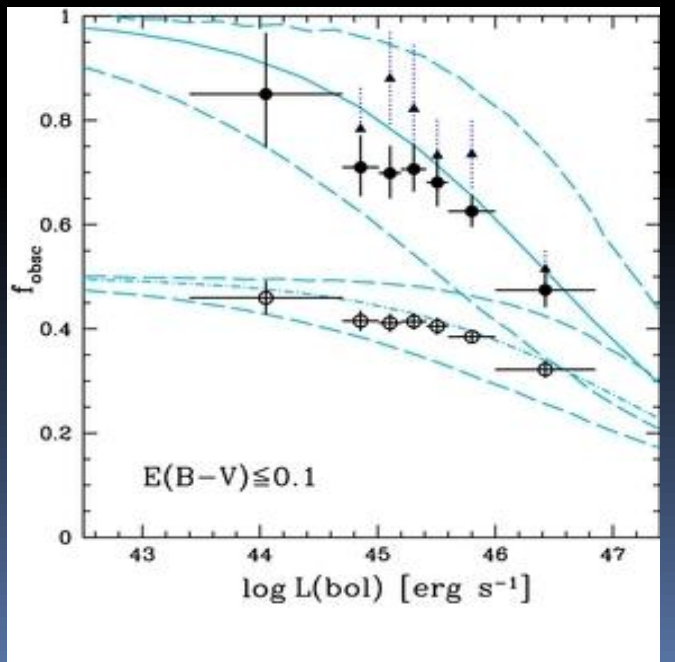
E. Lusso et al. 2013 ApJ 777 86 d



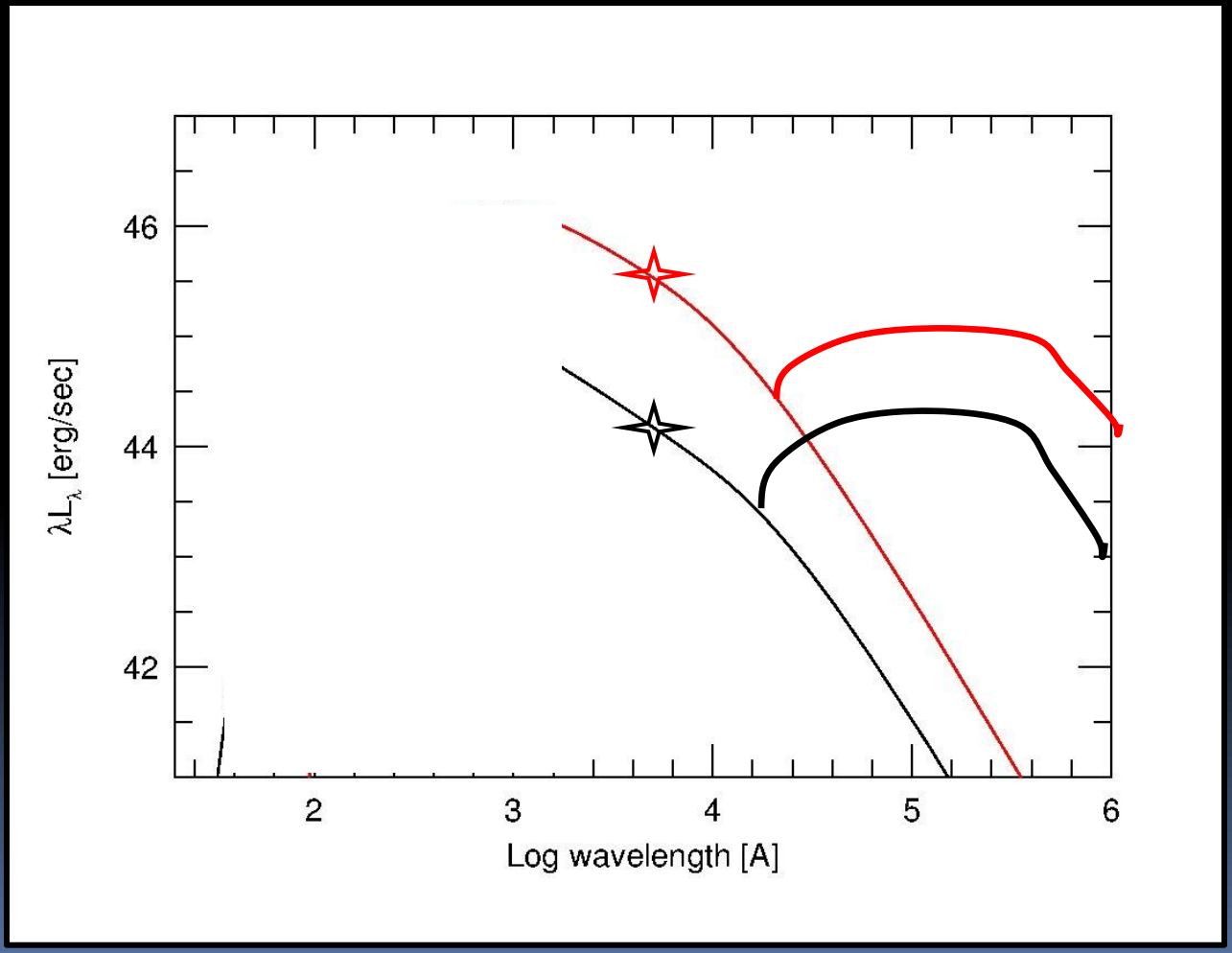


$$\frac{L_{dust}}{L_{AGN}} = \frac{1-bf}{1-f} f$$

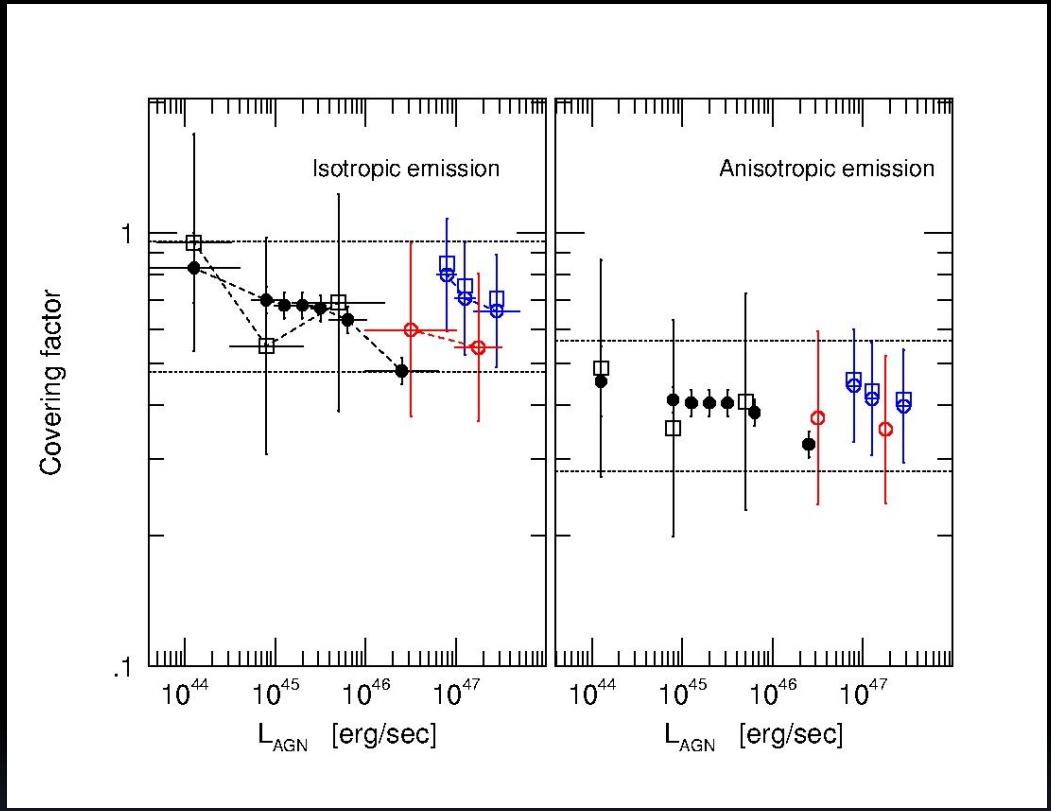
How to calculate L_{AGN}?



The covering factor illusion



Torus covering factor



Conclusions:

Torus covering factor is not changing over 3.5 orders of magnitude in luminosity

Torus covering factor is (probably) not sensitive to large scale dynamics (mergers)

No indication for a receding torus

Fure survey are likely to find type-II AGNs at high redshift

Conclusions

- AGN accretion rate and star formation rate in the most luminous AGNs show different redshift evolution
- Upper limits on SFR put strong constraints on the torus SED
- SED is basically identical in low and high luminosity sources, and in merger and quiescent systems
- IR-based torus covering factors are basically the same over 4 orders of magnitude in L(AGN)