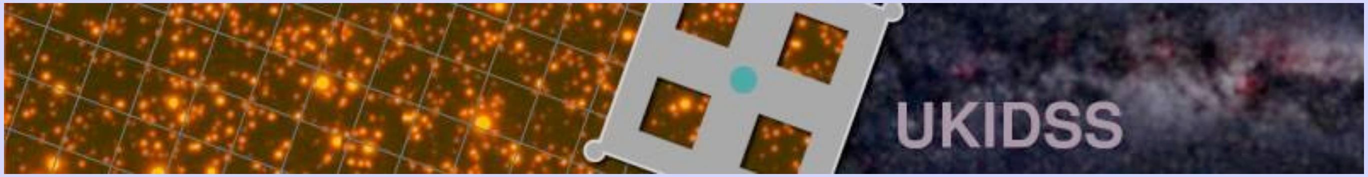
Hot Dust Poor Quasars

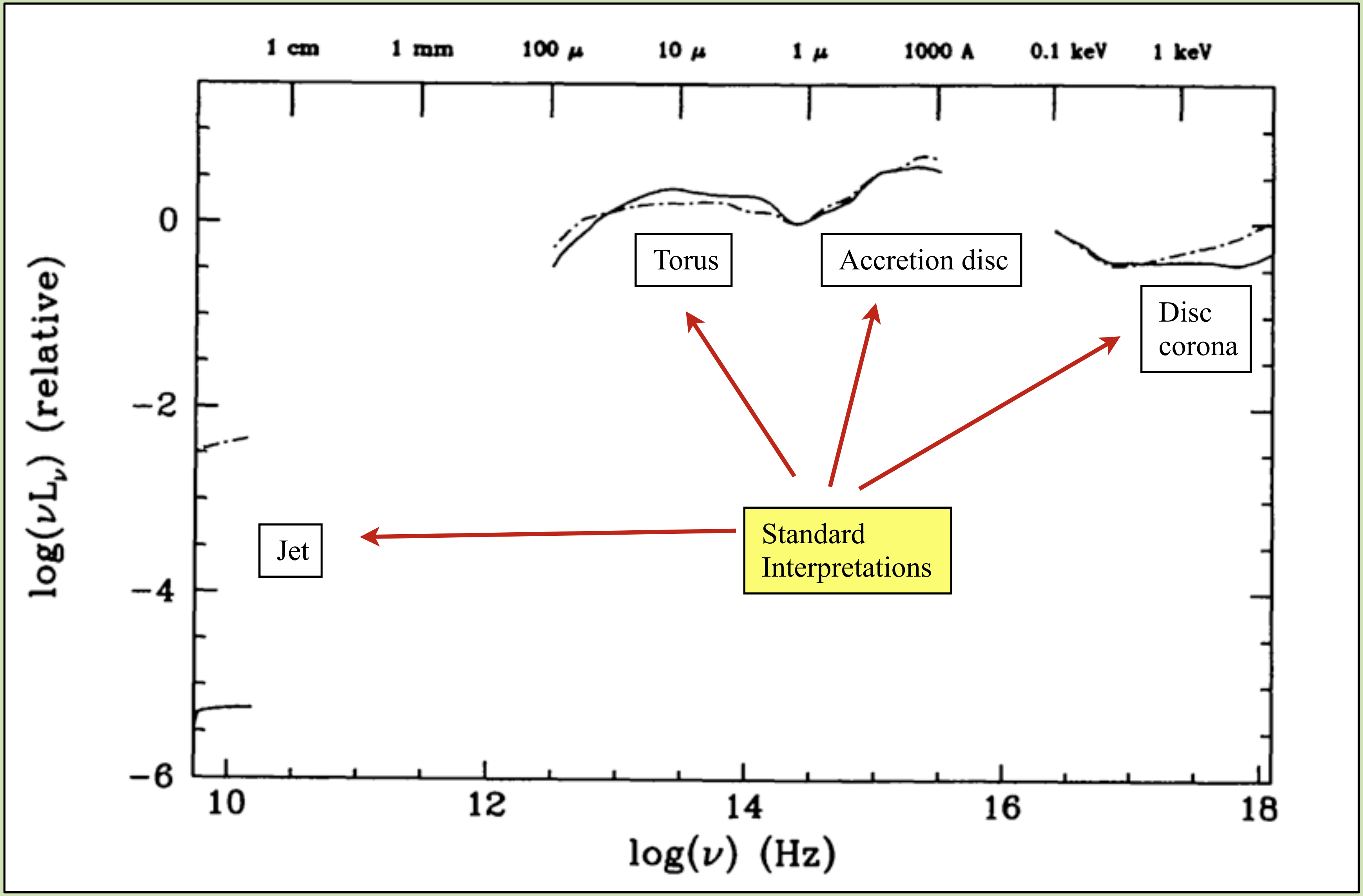
- Background
- COSMOS-XMM sample
- Optical-IR samples
- Possible explanation
- Future

Heng Hao
Martin Elvis
Francesca Civano
Andy Lawrence

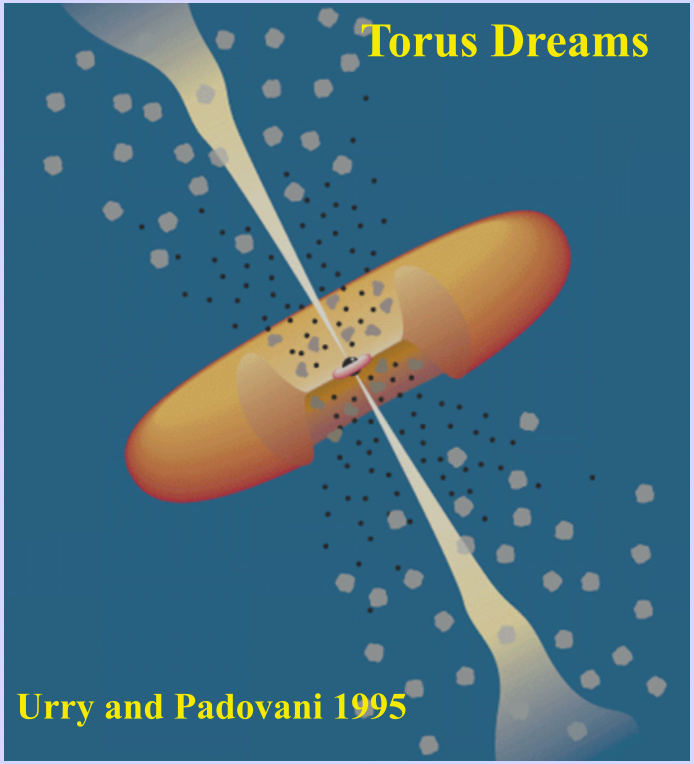


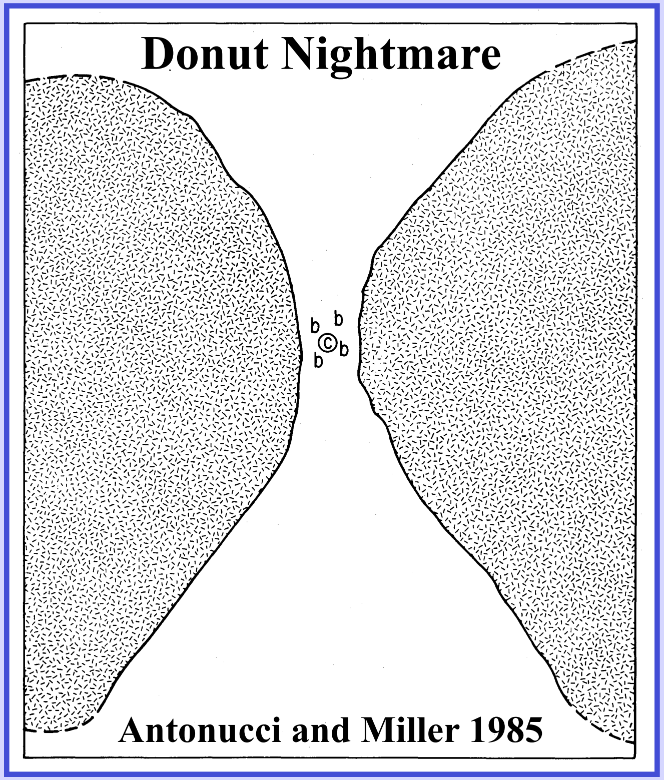
The quasar SED

Mean quasar SED Elvis et al 1994



Torus problems





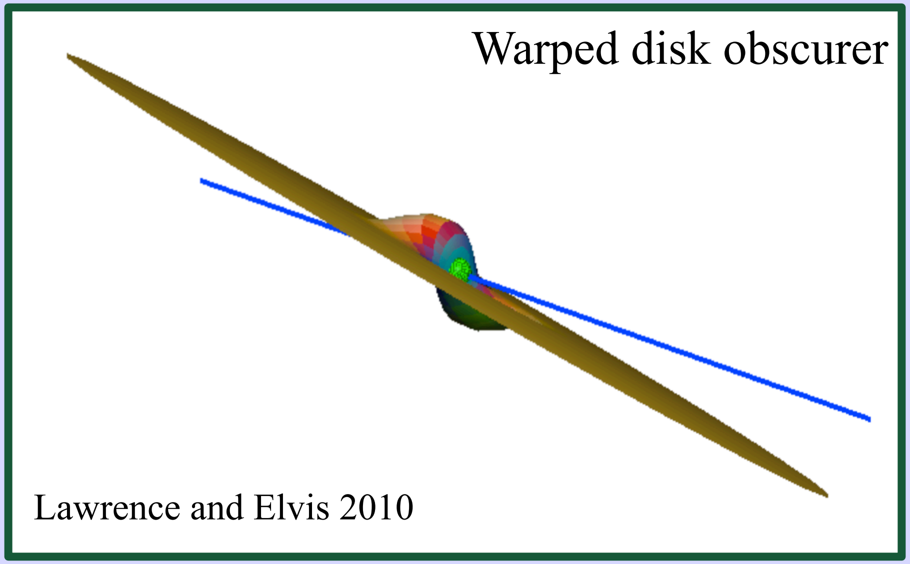
Issues :

- physically implausible

- properties arbitrary

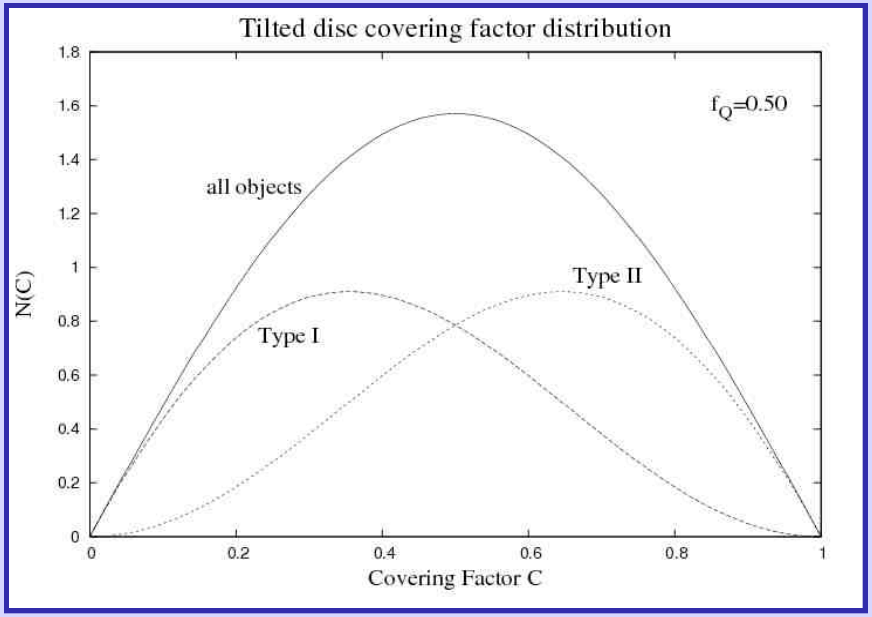
- some evidence against simple scheme

Warped disk alternative



- large covering factor arises naturally
- chaotic accretion at random angles
- tilts to align to BH at ~0.1pc

- a prediction is a **range** of covering factors at all luminosities

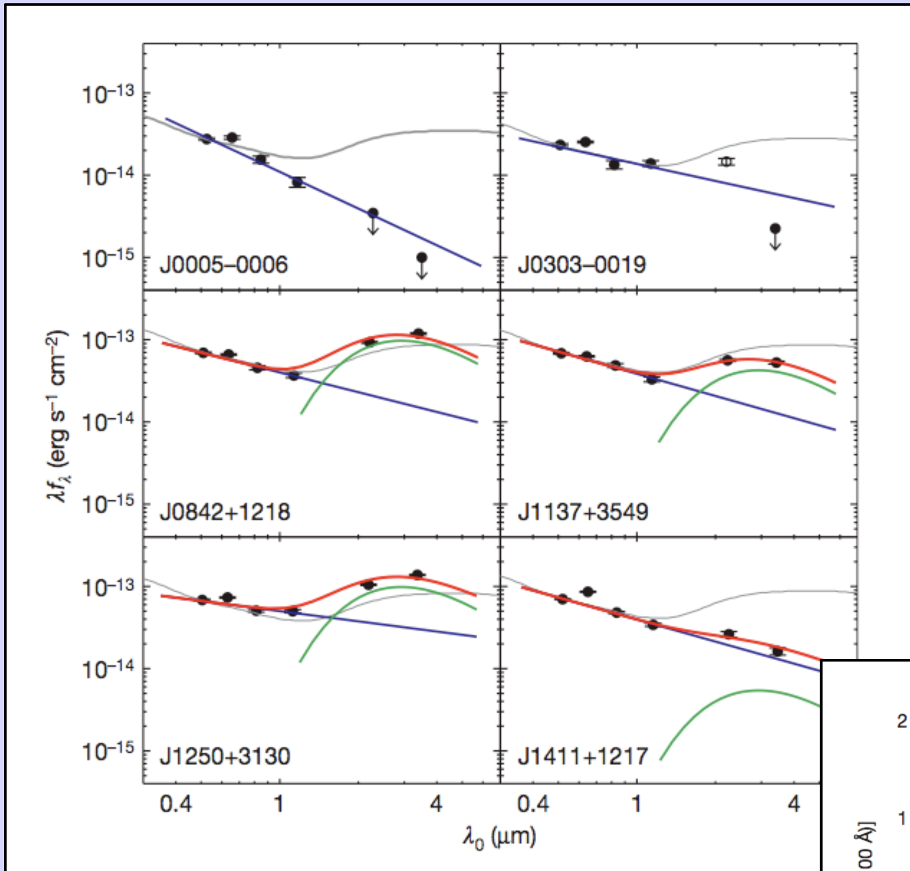


dust in hi-z quasars

- a long standing puzzle :

- high-z quasars have high metallicity and dust
- there is barely time to do this
- maybe the highest-z quasars should be dustless ?

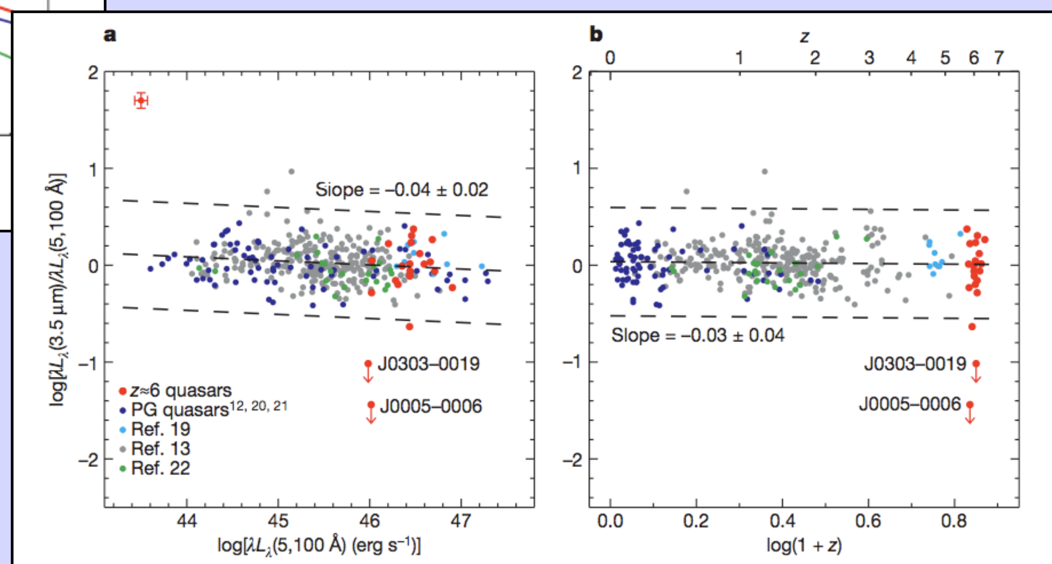
first dustless hi-z quasars ?



Spitzer obs of 23 z>6 SDSS Qs :

- most are normal

- but three have weak or no dust ?

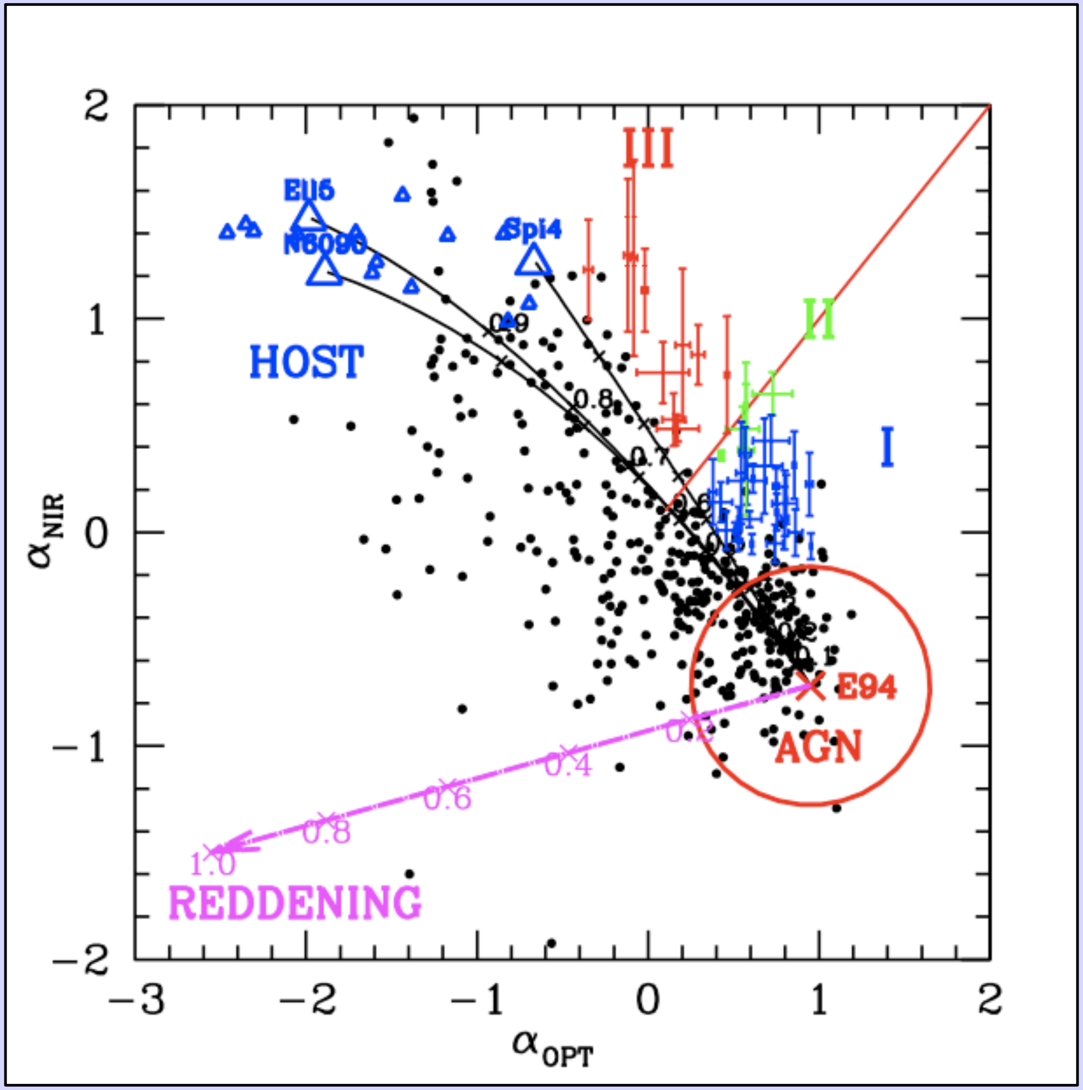


Jiang et al 2006,2010

Note 24μm is 3.5μm at z=6

COSMOS/XMM sample

408 X-ray selected AGN with optical, NIR, and MIR data



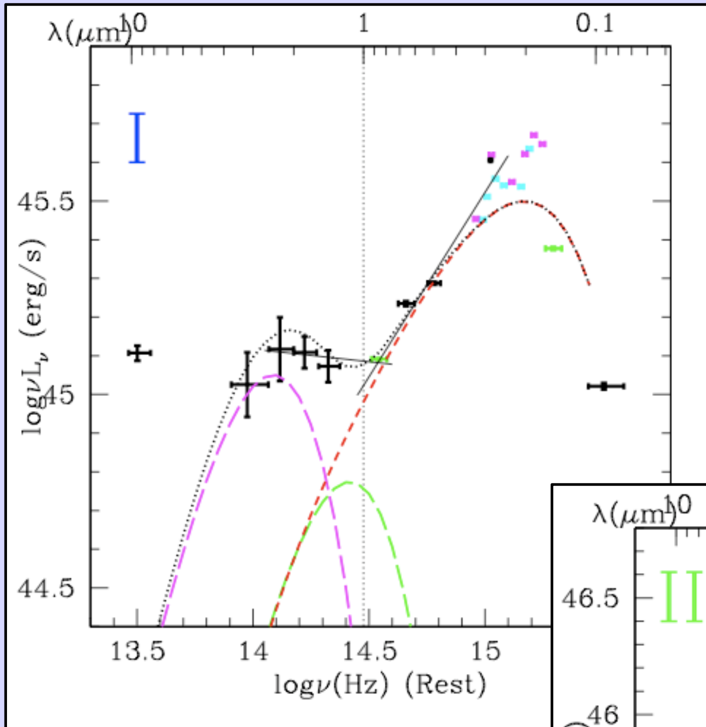
Hao *et al* 2010

Fit rest frame slopes at 0.3-1um and 1-3um

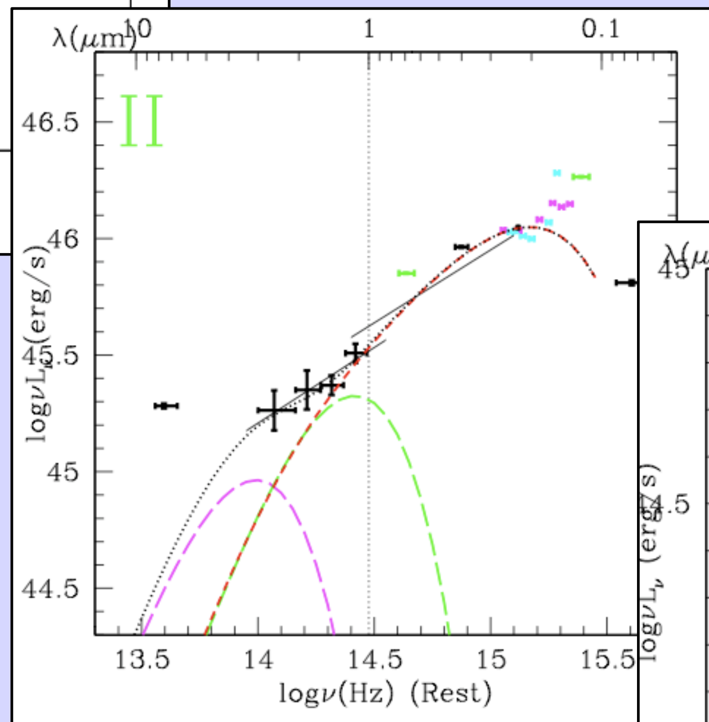
Most objects fall in triangle defined by mean SED, host colours, and reddening

But some lie outside and so have weak hot dust emission

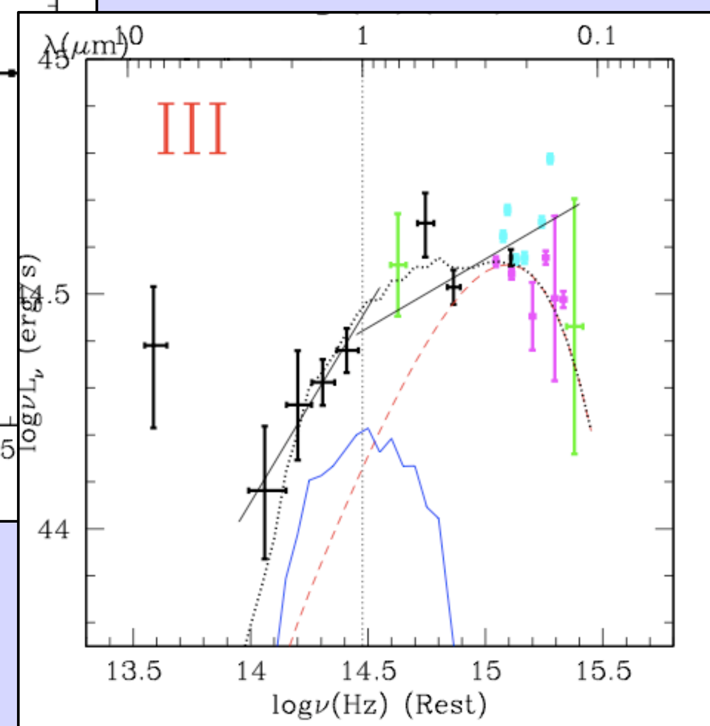
Hao *et al* classes



I = turning up but weaker than normal

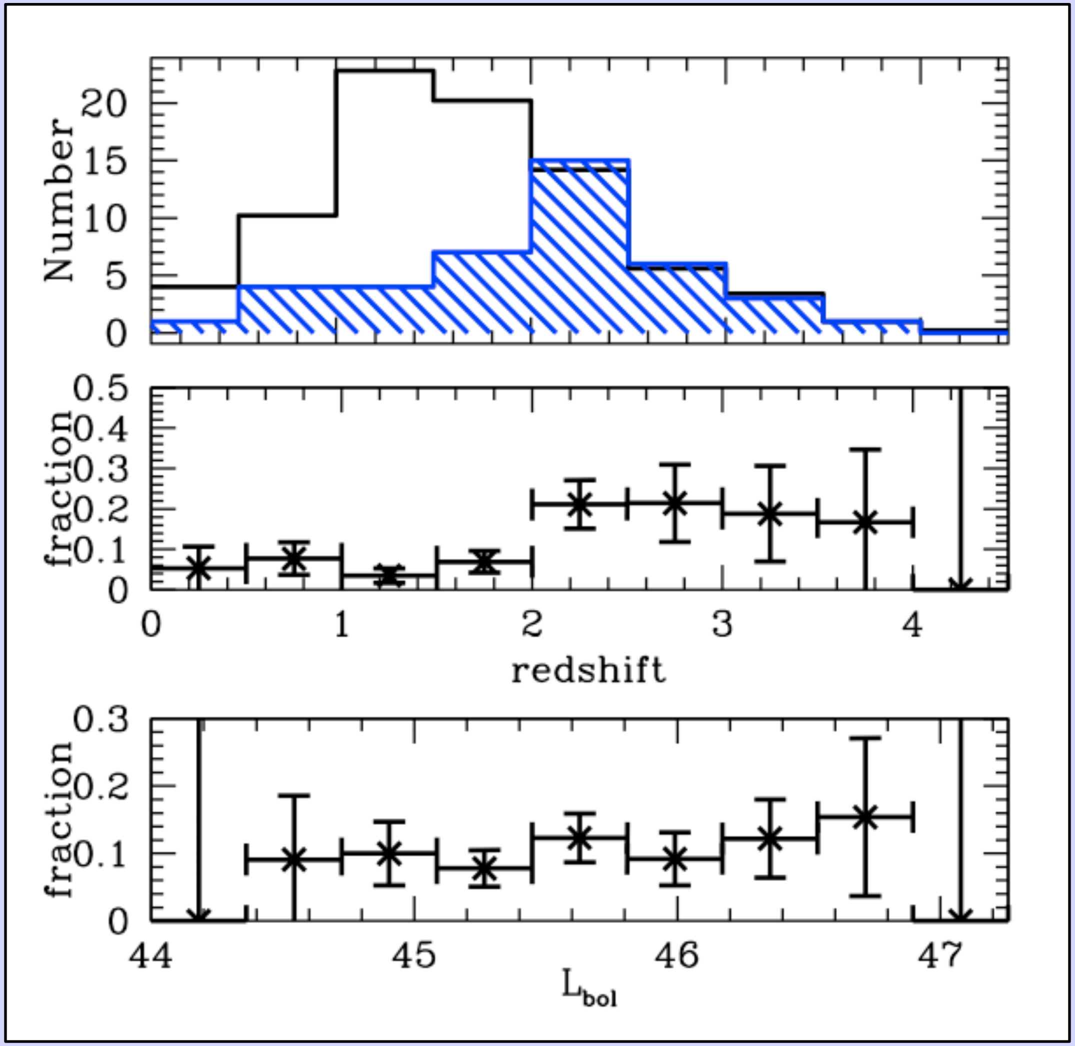


II = single power law



III = turning down

Dependence on L and z



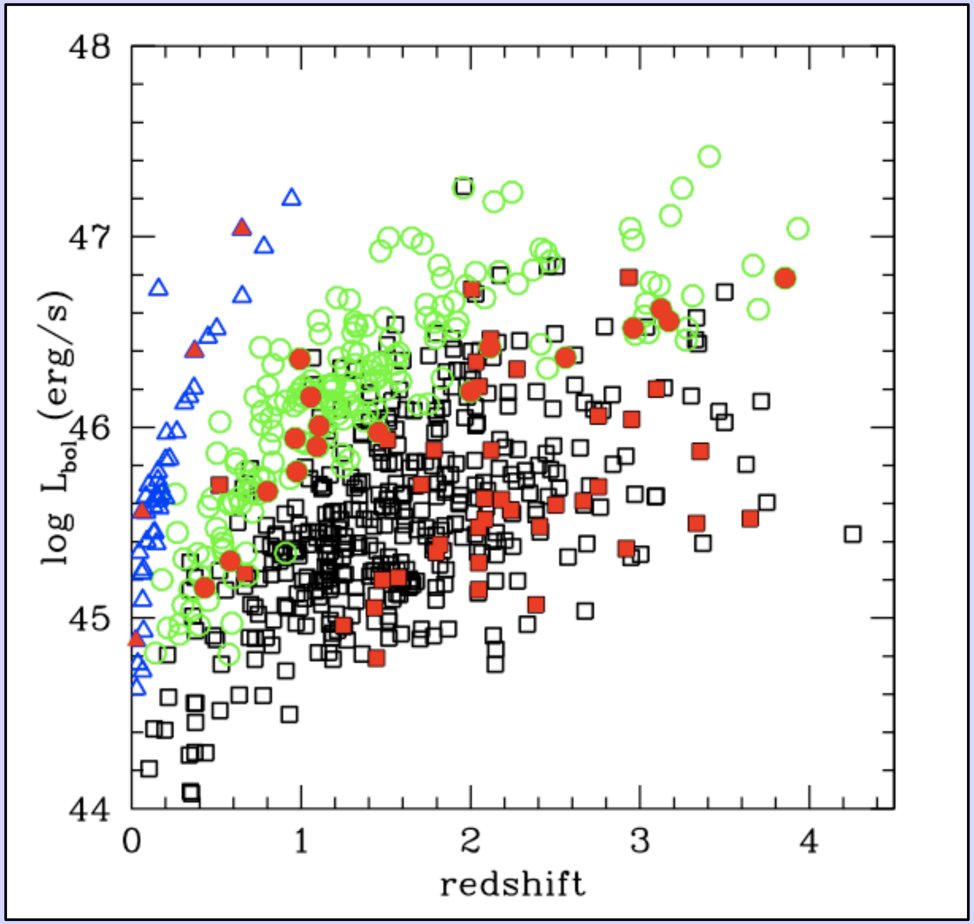
Weak dust emission occurs at **all** luminosities and redshifts, in about 10% of cases.

- but there is a suggestion of increased prevalence at z>2

need more samples :
- decouple L and z
- selection at other lamdas

Hao et al 2010

Optical-IR samples



Square=COSMOS/XMM
Circle= Richards+UKIDSS
Triangle=PG/E94

Red=HDP - well spread over L-z plane

Add

(i) nearby Qs from Elvis et al 1994 (42 objects)

(ii) Richards et al 2006 sample Spitzer+SDSS sample

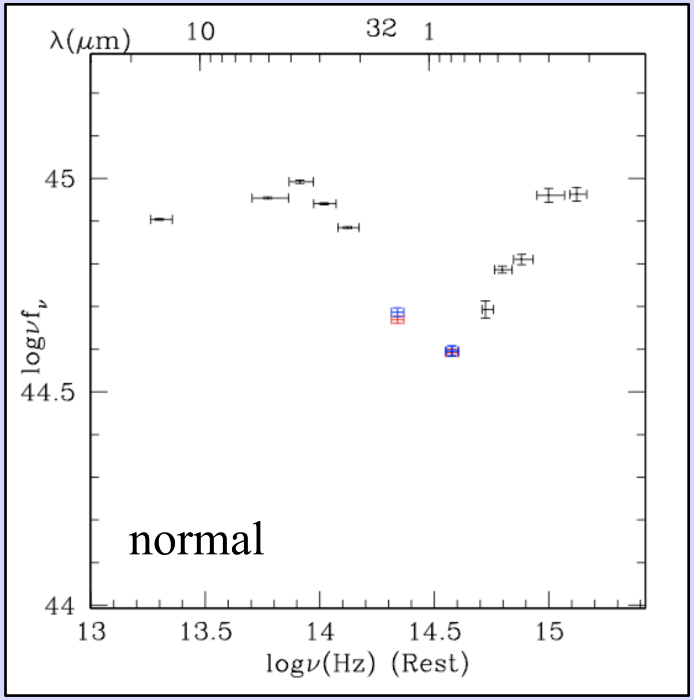
259 SDSS quasars in XFLS, E-N1, E-N2, Lockman

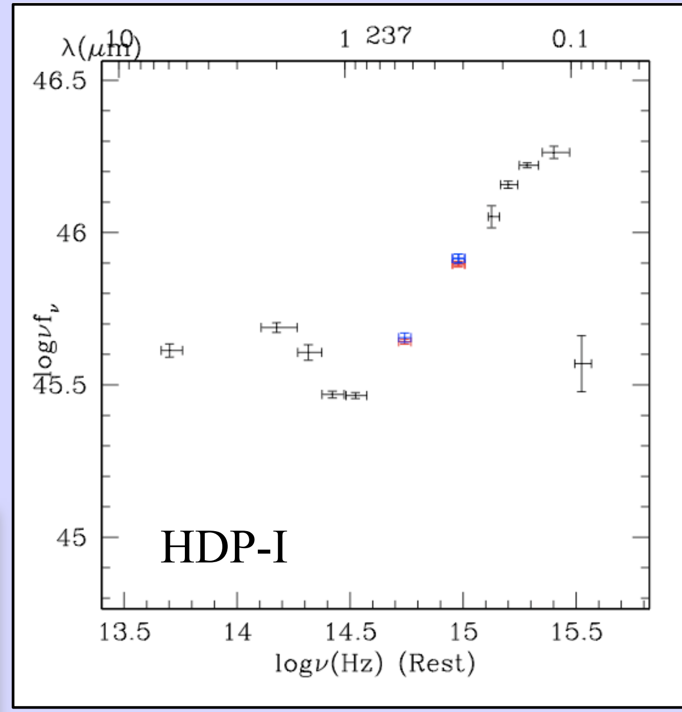
only 44 have 2MASS JHK

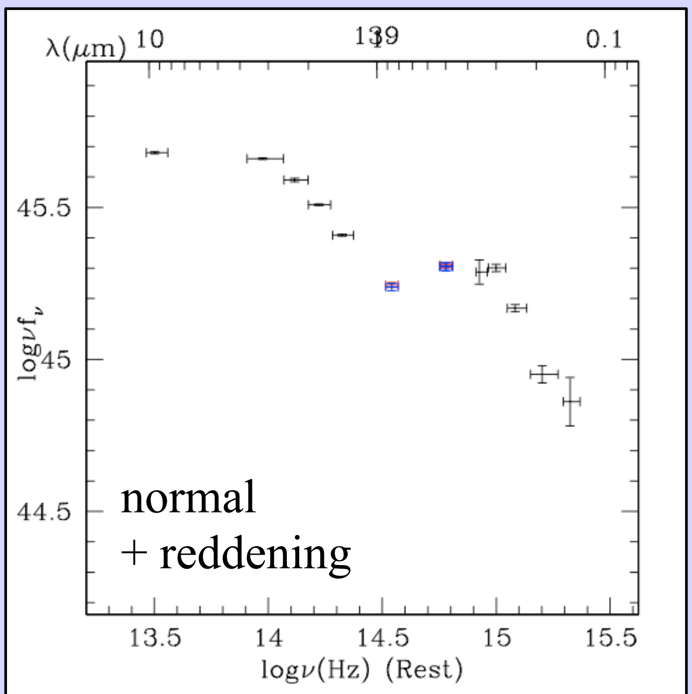
use DXS data in E-N1 and LH

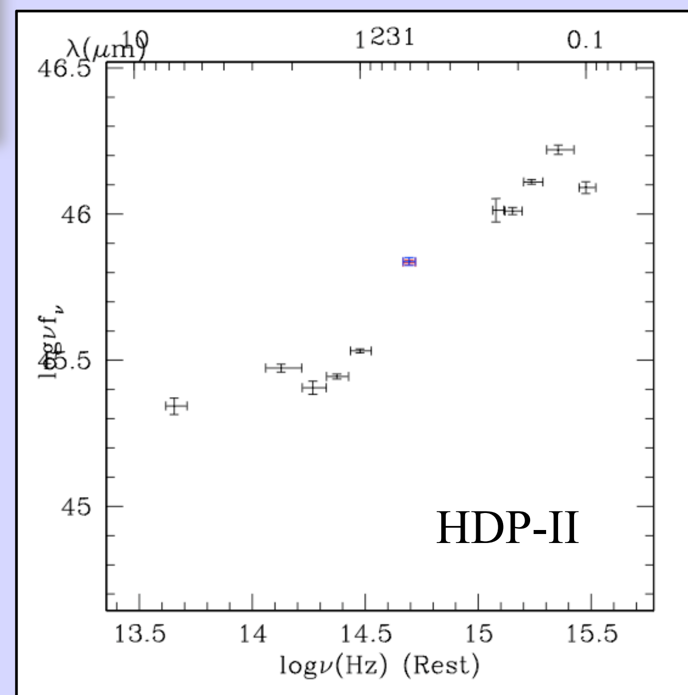
==> sample of 195

Example SEDs

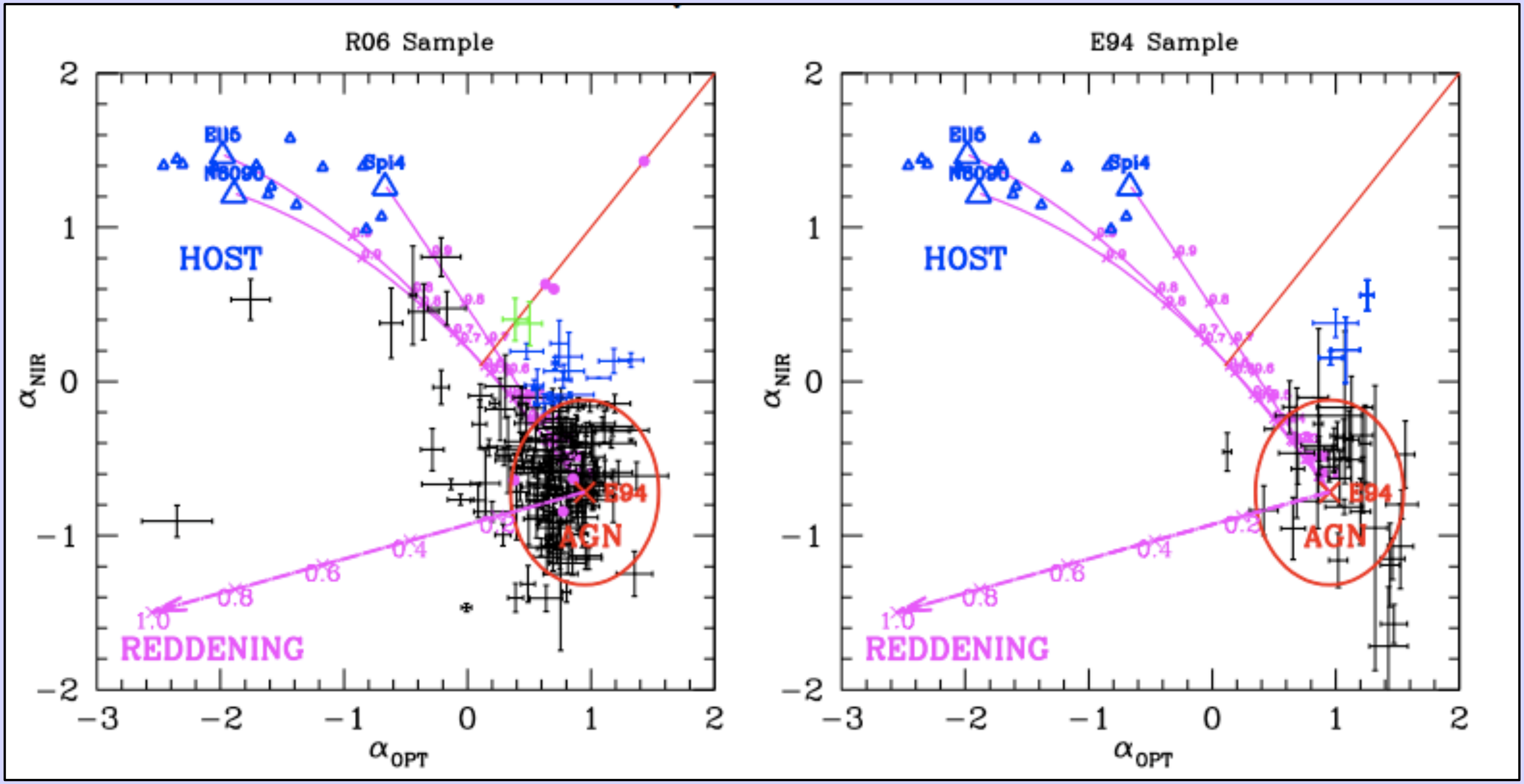








Mixing diagrams

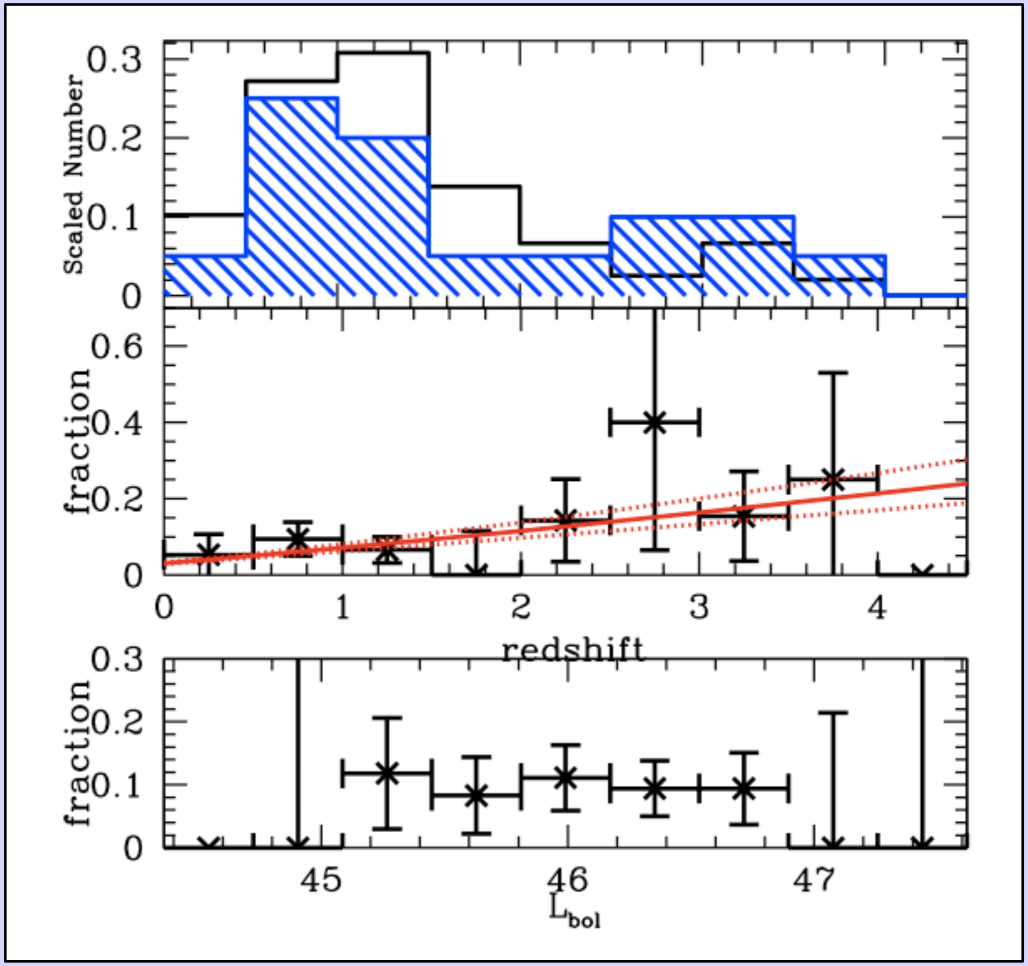


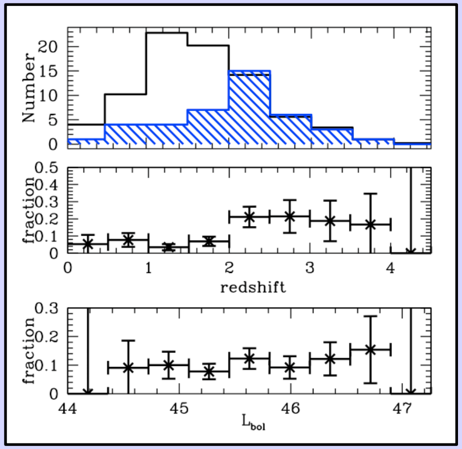
Richards sample :
HDP= 8.7±2.2%

E94 sample
HDP= 9.5±5%

cf COSMOS sample
HDP=10.0±1.6%

N(z) in Richards sample





COSMOS sample

z<2 6.3± 2.1 %
z>2 19.4±8.0%

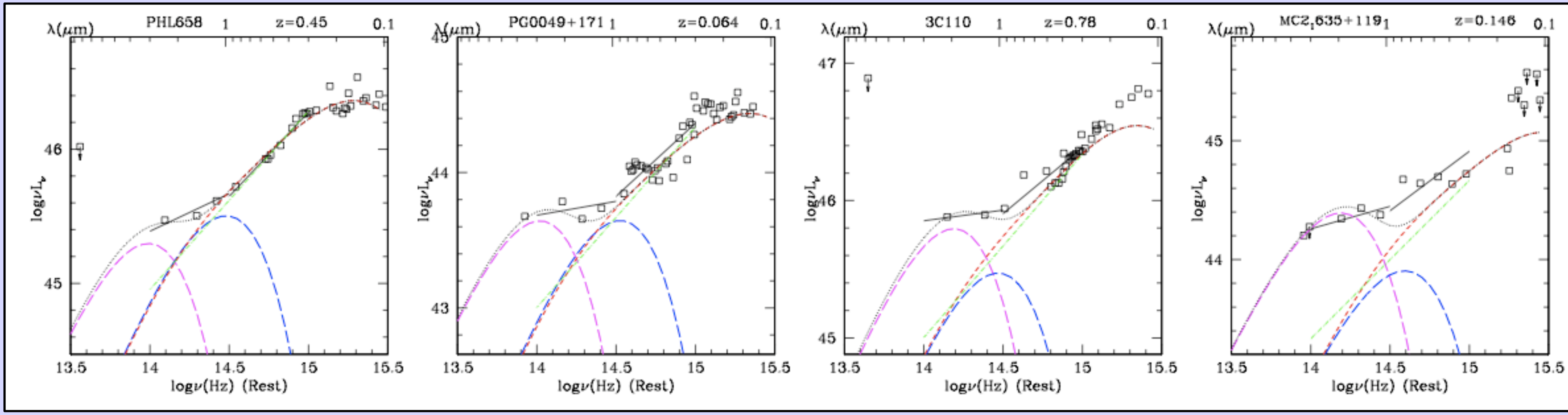
1.6σ difference

Jiang *et al* result z~6
f= 13.0±8.0%

red=fit from Hao et al 2010 : (1+z)**1.2

covering factors

accn disc + simple hot dust component

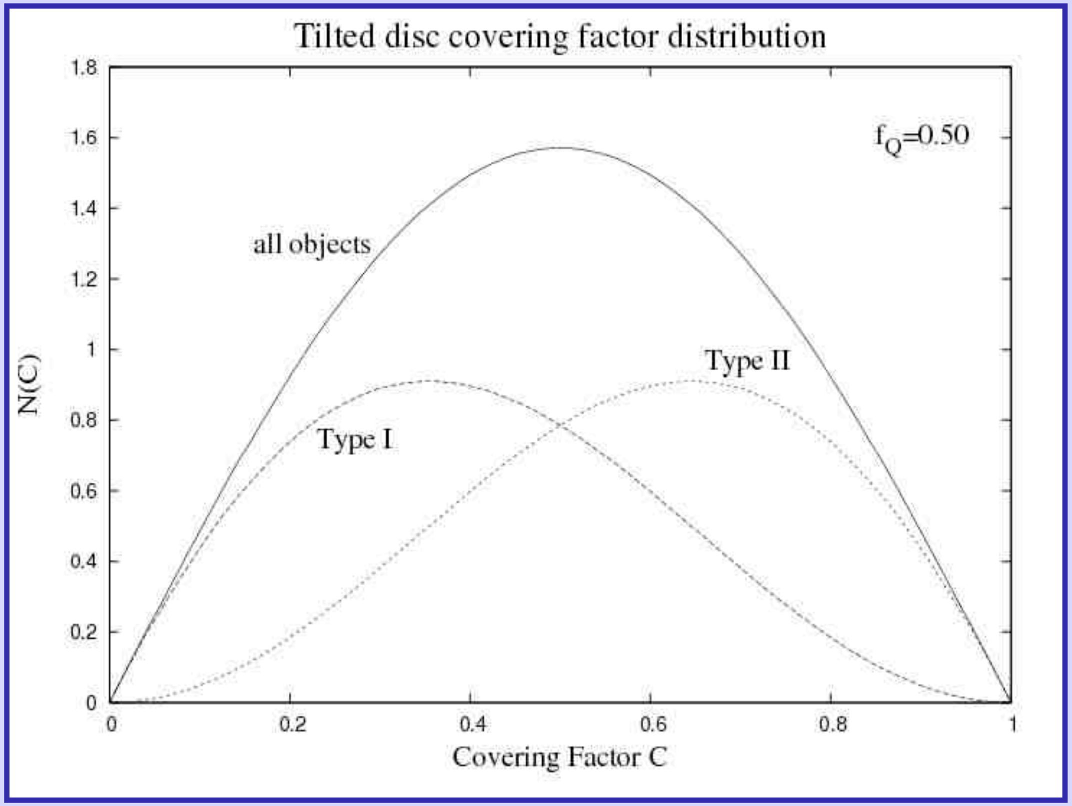


C=5.4% C=9.2% C=19.1% C=23.6%

cf usual belief that need C=75% to explain obscured fraction
but note Lawrence and Elvis 2010 claim f(obsc)=55%

modelling of SWIRE SEDS : (Rowan-Robinson et al 2009)
- mean C=40%
- occasional objects with C~few %

tilted disc N(C)



Naturally makes range of covering factors.

Predictions

mean (all objects) : C=50%

mean (Type Is) : C=35%

fraction with C<20%
is f=14%

two possible evolution effects

Appearance of dust : main effect is z>5

Black hole growth rate : main effect z>2

z<2 M(fuelling event)<<M(BH)
does not affect spin
incoming disc has to align with BH
large warp

z>2 M(fuelling event)>M(BH)
BH aligns with incoming disc
minimal warp

Next steps

Low-z : N(C) test
ideally want full MIR-UV coverage for good modelling

mid-z : BH growth test
z=2 1μm => 3 μm
need 10μm to measure hot dust

high-z : dust growth test
z=6 1μm => 7 μm ; Ly-α in i-band
need JHK to measure blue bump strength

in all cases need large MIR-NIR-optical sample
WISE + LAS/UHS + SDSS/PS1