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# Active Galactic Nuclei 13 : Beauty and the Beast

*October, 9-12 2018 - Milano*

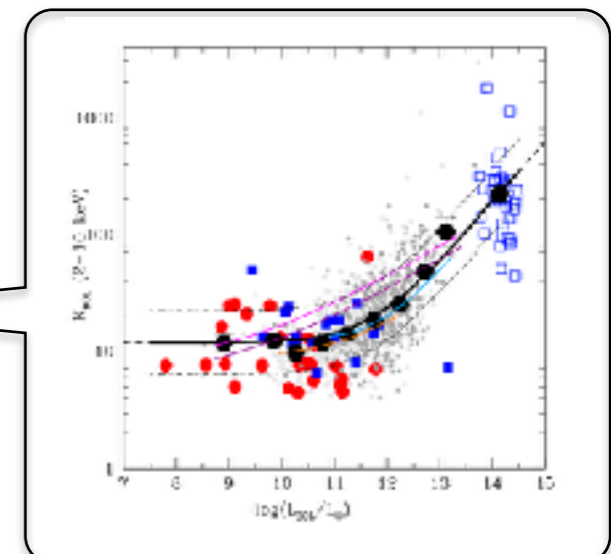
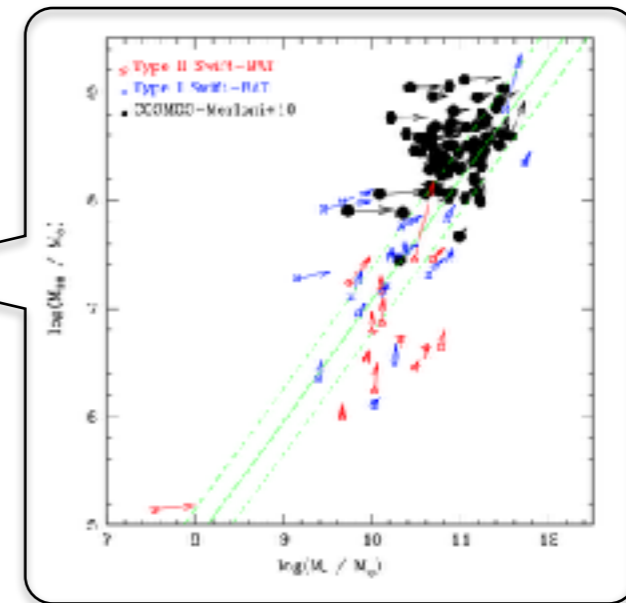
## Probing the AGN/galaxy coevolution in the widest dynamical range ever

F. Duras, A. Bongiorno, F. Ricci  
E. Piconcelli, F. La Franca, F. Fiore  
... and all the WISSH collaboration



# Simplifying the problem : the 5 W- questions

- **WHAT?** AGN/Galaxy co-evolution
- **WHO?** TWO complementary samples of AGN
- **WHEN?** at both high and low redshift
- **WHERE?** at the extremes of the AGN luminosity function
- **WHY?** because every galaxy is potentially an AGN!



The perfect sample to build up a **new hard X-ray bolometric correction valid over 5 orders of magnitude !**

# Two complementary samples

## The WISSH sample

TYPE I sources

high redshift

$$2 < z < 4$$

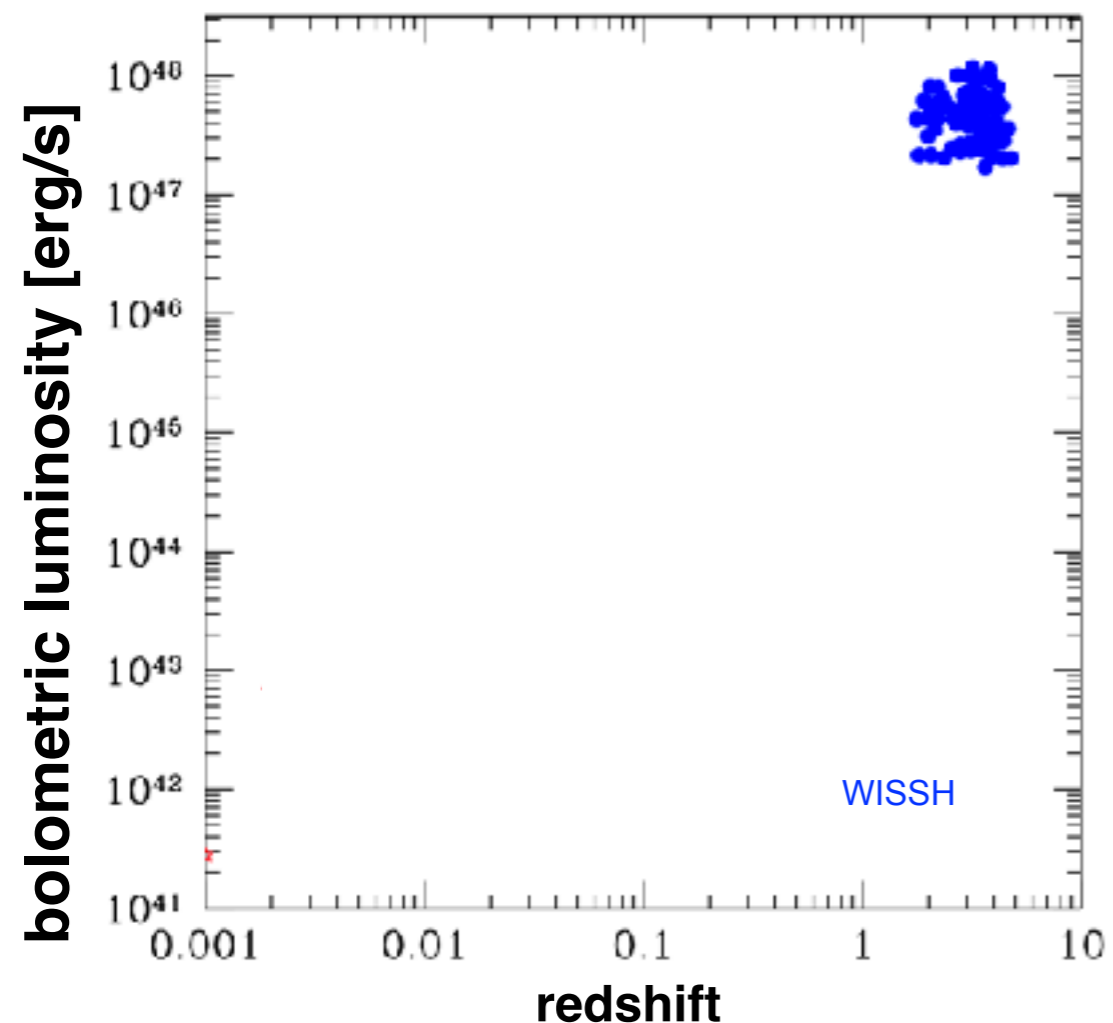
most luminous sources known

$$L_{\text{BOL}} > 2 \cdot 10^{47} \text{ erg/s}$$

evidence of **strong winds** see Bischetti+17 and Vietri+18

high BH masses

$$10^9 - 10^{10} \text{ solar masses}$$



## Two complementary samples

### The WISSH sample

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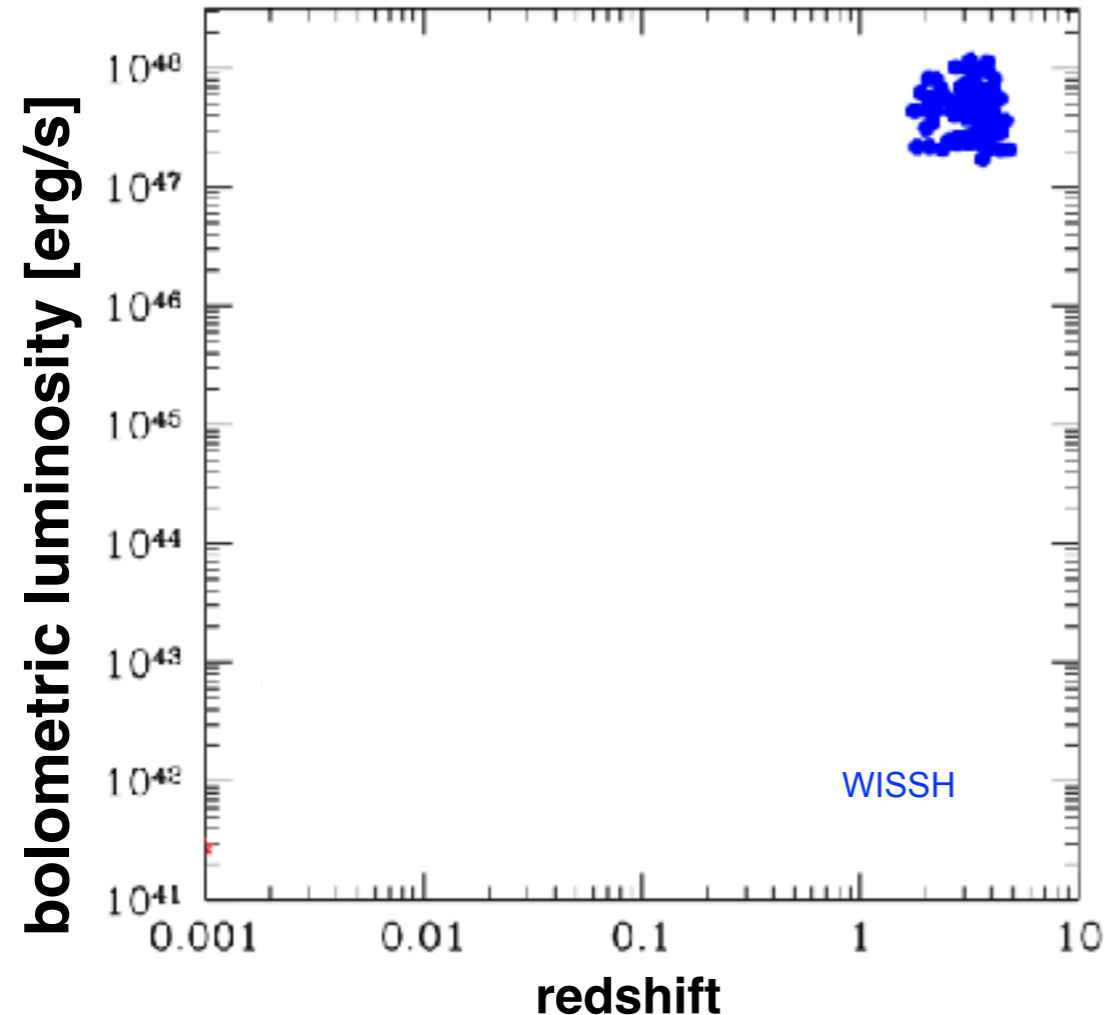
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### The SWIFT/BAT sample

TYPE I + TYPE II sources

low redshift

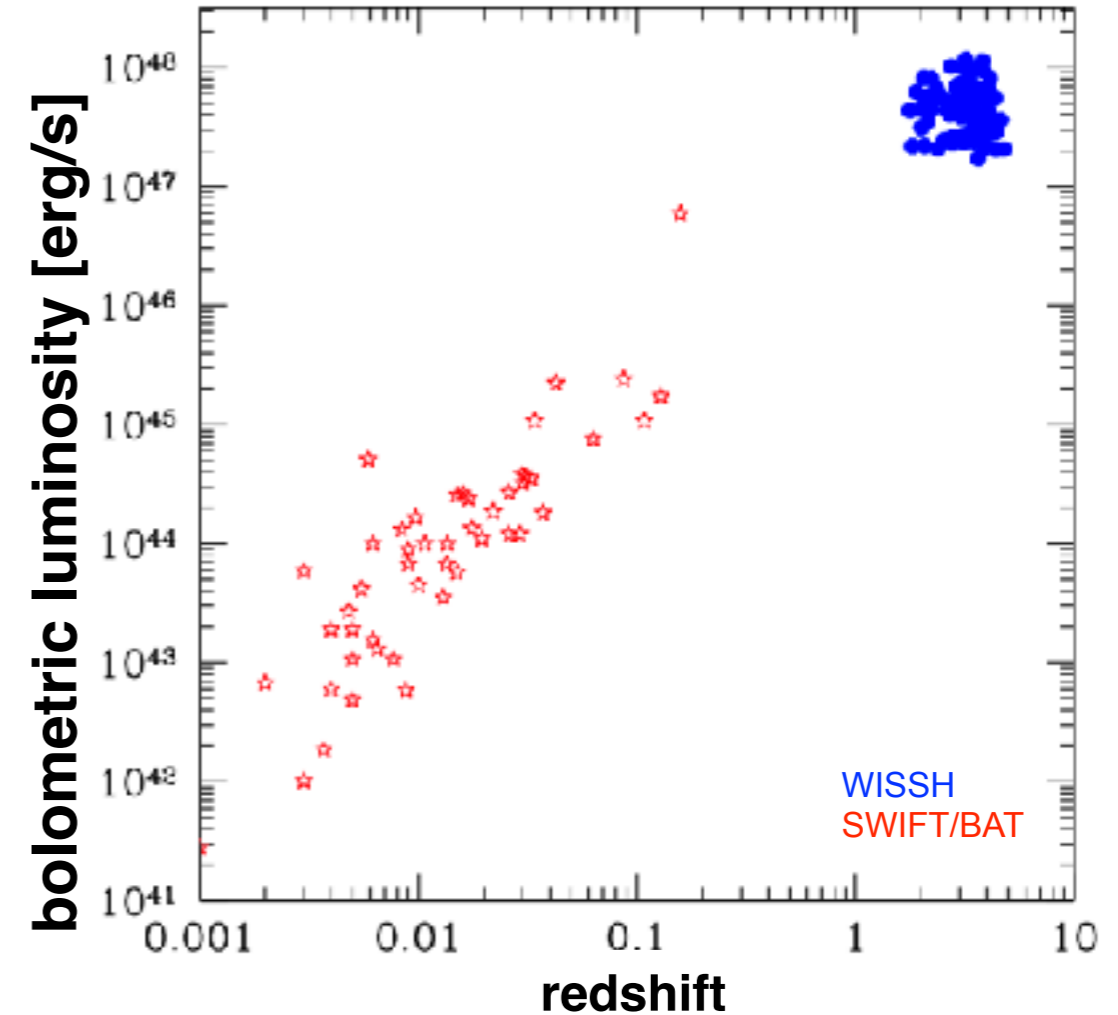
$$z < 0.1$$

low - luminous sources

$$L_{\text{BOL}} \sim 10^{42} - 10^{45} \text{ erg/s}$$

low BH masses

$$10^6 - 10^8 \text{ solar masses}$$

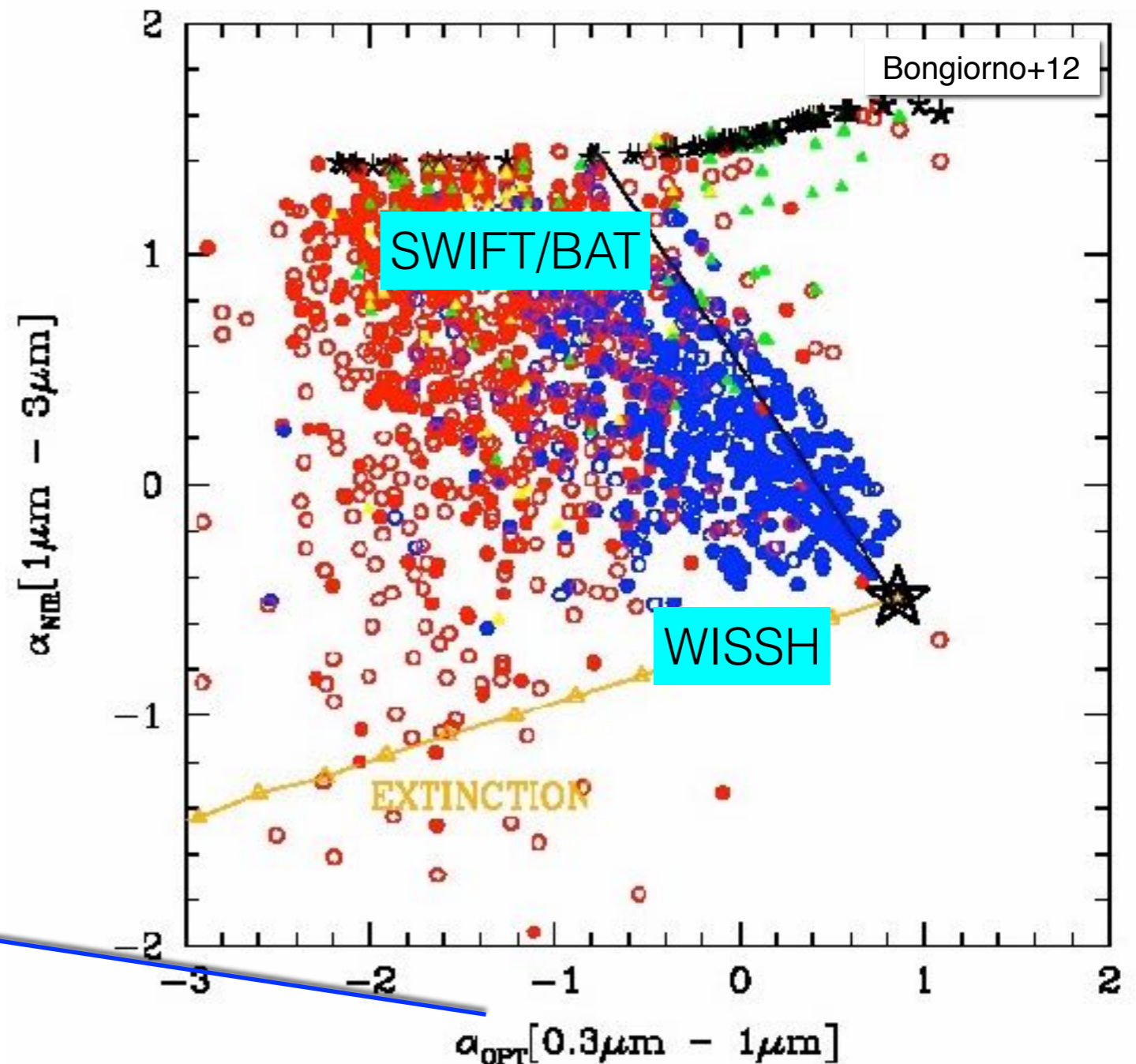
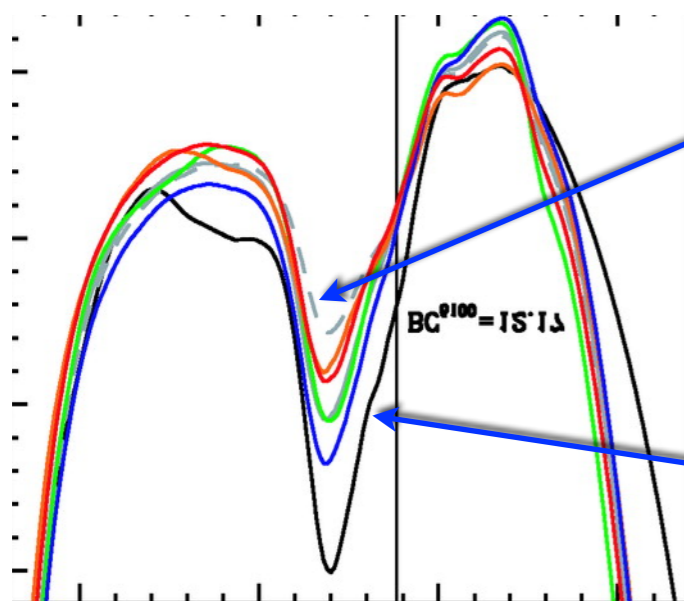


# The H question : SED-fitting procedure

- HOW? deriving the physical properties through the SED - fitting and studying how they correlate (or not) with each other

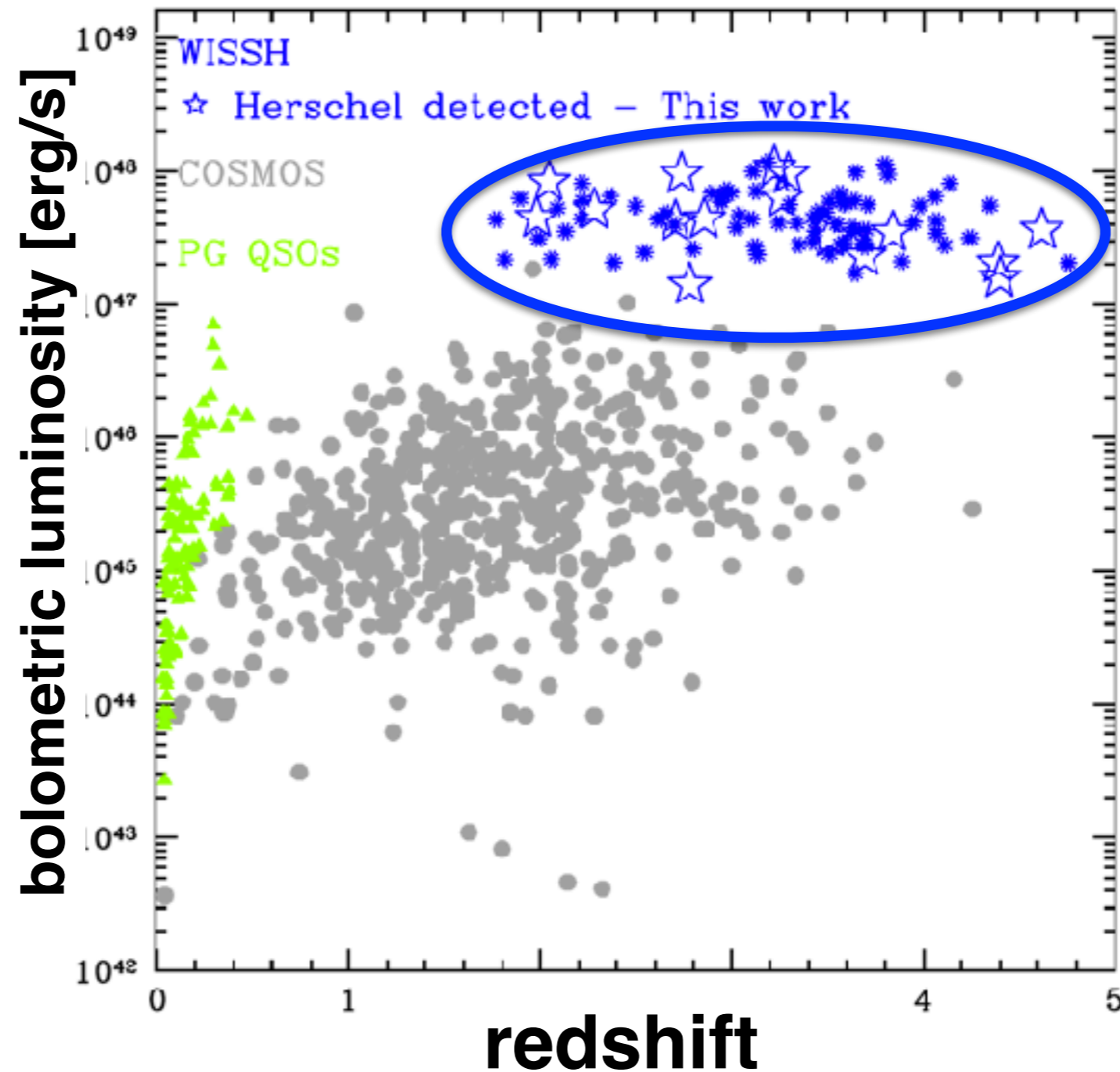
## But why can we do that?

Most of the SEDs can be explained as a combination of a pure AGN eventually ABSORBED and/or contaminated by the HOST GALAXY



# Studying the monsters : the WISSH sample

A focus on the 16 WISSH AGN with FIR data

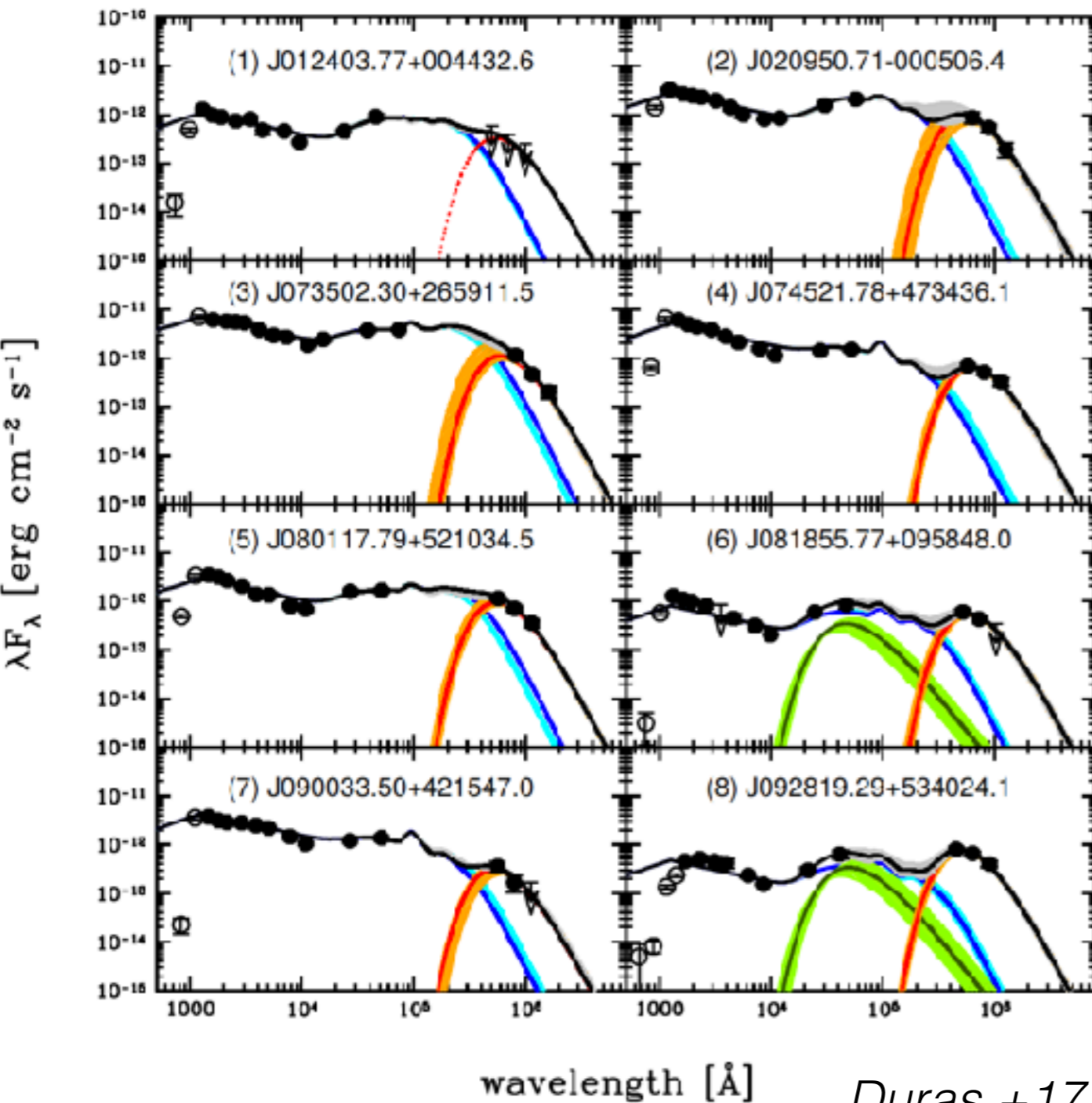


The 16 WISSH QSOs with Herschel data coverage are representative of the entire sample, being not previously pre-selected, and being **randomly distributed** within it both in **z** and **luminosity**

# Studying the monsters : the WISSH sample

A focus on the 16 WISSH AGN with FIR data

**AGN**  
**HOST GALAXY**  
**MIR EXCESS**



*Duras +17*

**Three fitting components**  
to describe the emission:

Accretion disk + Torus

Feltre+12, Stalevski+16

Cold dust in the FIR

excess in the MIR

(which turned out to be necessary in 30% of the cases) found in several works on luminous AGN

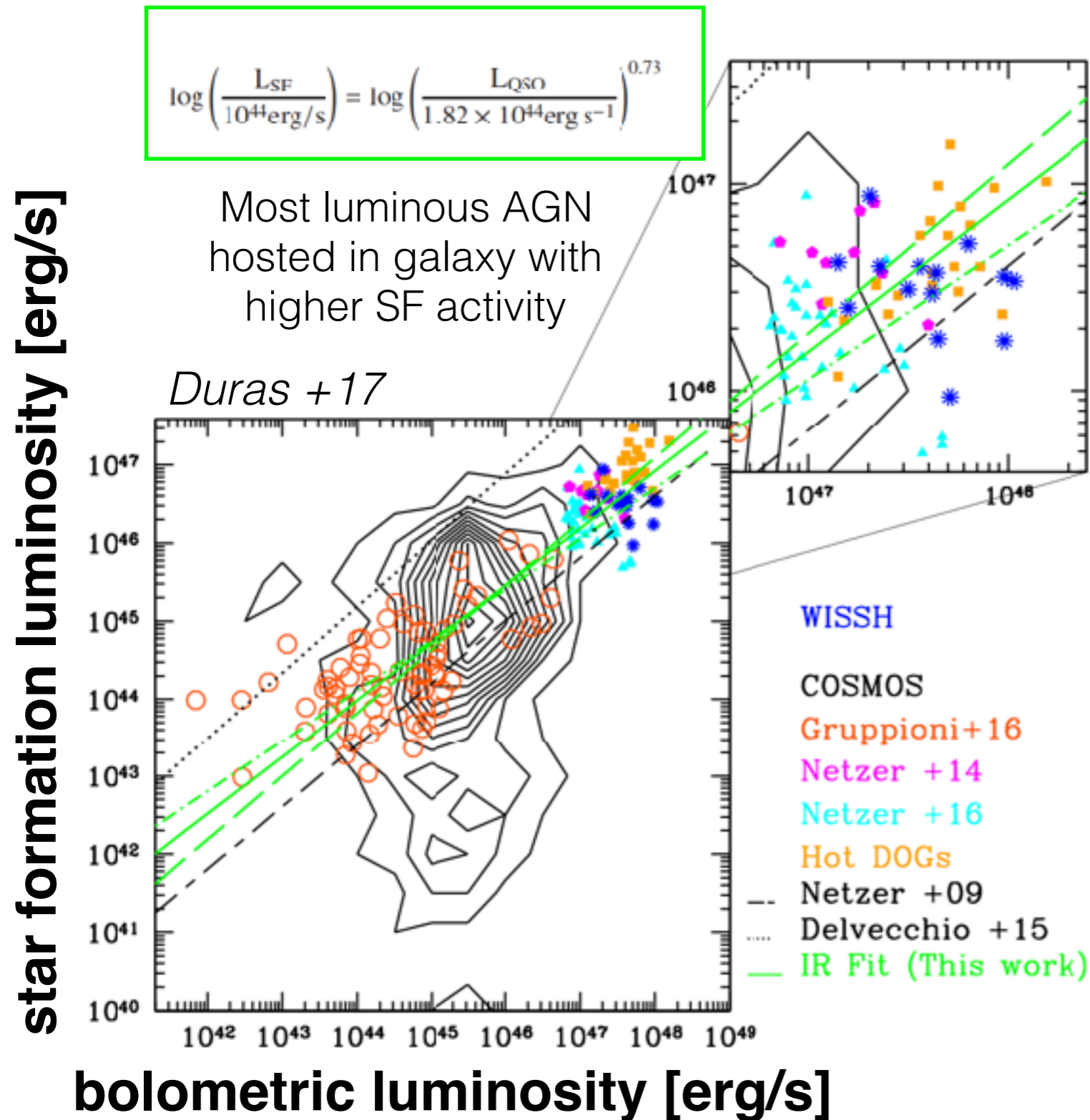
see Edelson&Malkan+86,  
Mor+09,  
Hernan-Caballero+16  
talk by Bisogni this morning

Warm dust  
(pure graphite?) near the  
nucleus



# Studying the monsters : the WISSH sample

A focus on the 16 WISSH AGN with FIR data



# Studying the monsters : the WISSH sample

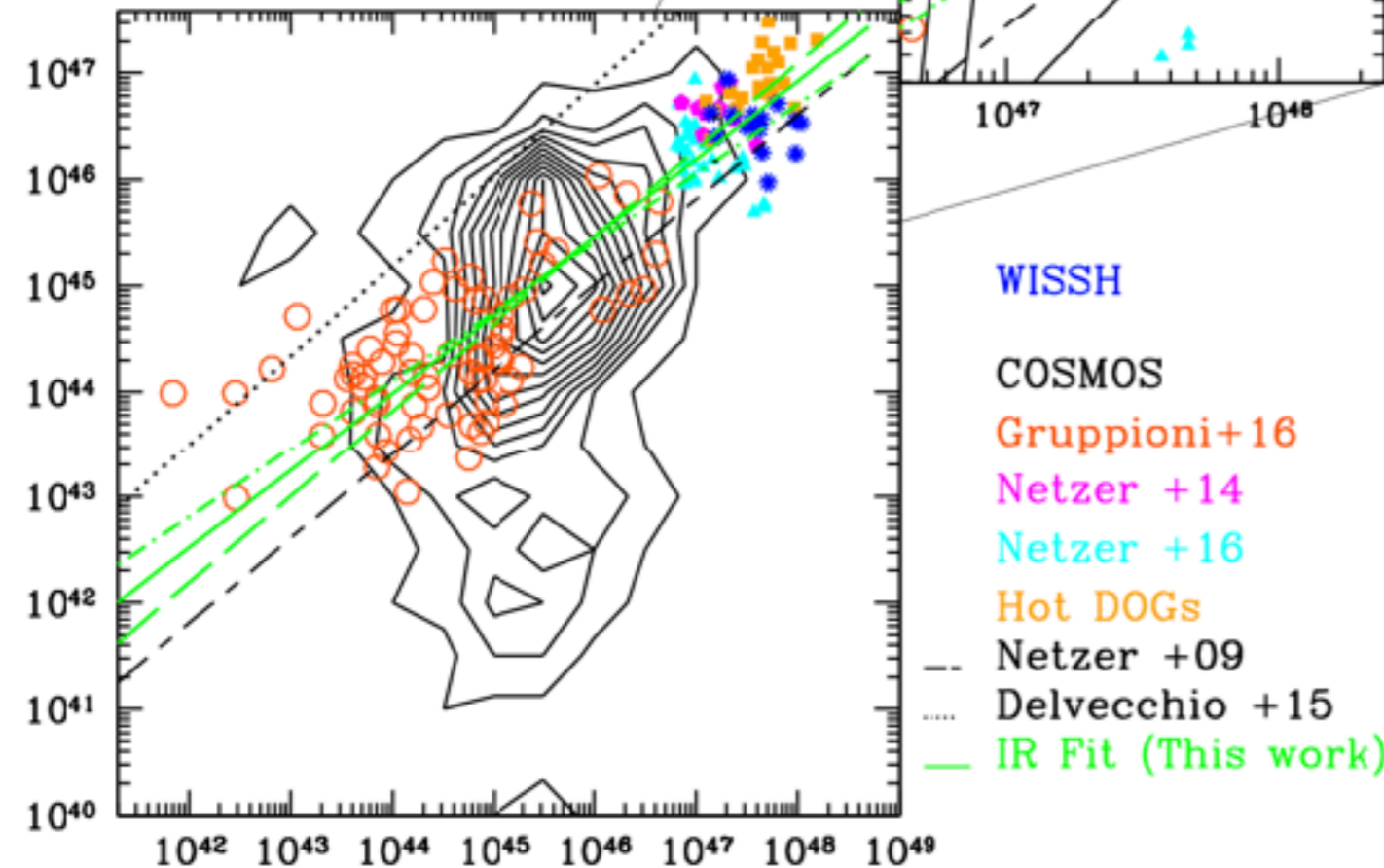
A focus on the 16 WISSH AGN with FIR data

star formation luminosity [erg/s]

$$\log\left(\frac{L_{SF}}{10^{44}\text{erg/s}}\right) = \log\left(\frac{L_{QSO}}{1.82 \times 10^{44}\text{erg s}^{-1}}\right)^{0.73}$$

Most luminous AGN hosted in galaxy with higher SF activity

*Duras +17*



bolometric luminosity [erg/s]

Really HIGH values of SFR  
(thousands Msun/yr)  
as usual in hyper-luminous AGN  
even accounting for the AGN contribution  
to the FIR  
(~50% NOT NEGLIGIBLE!)

see e.g., Symeonidis+16

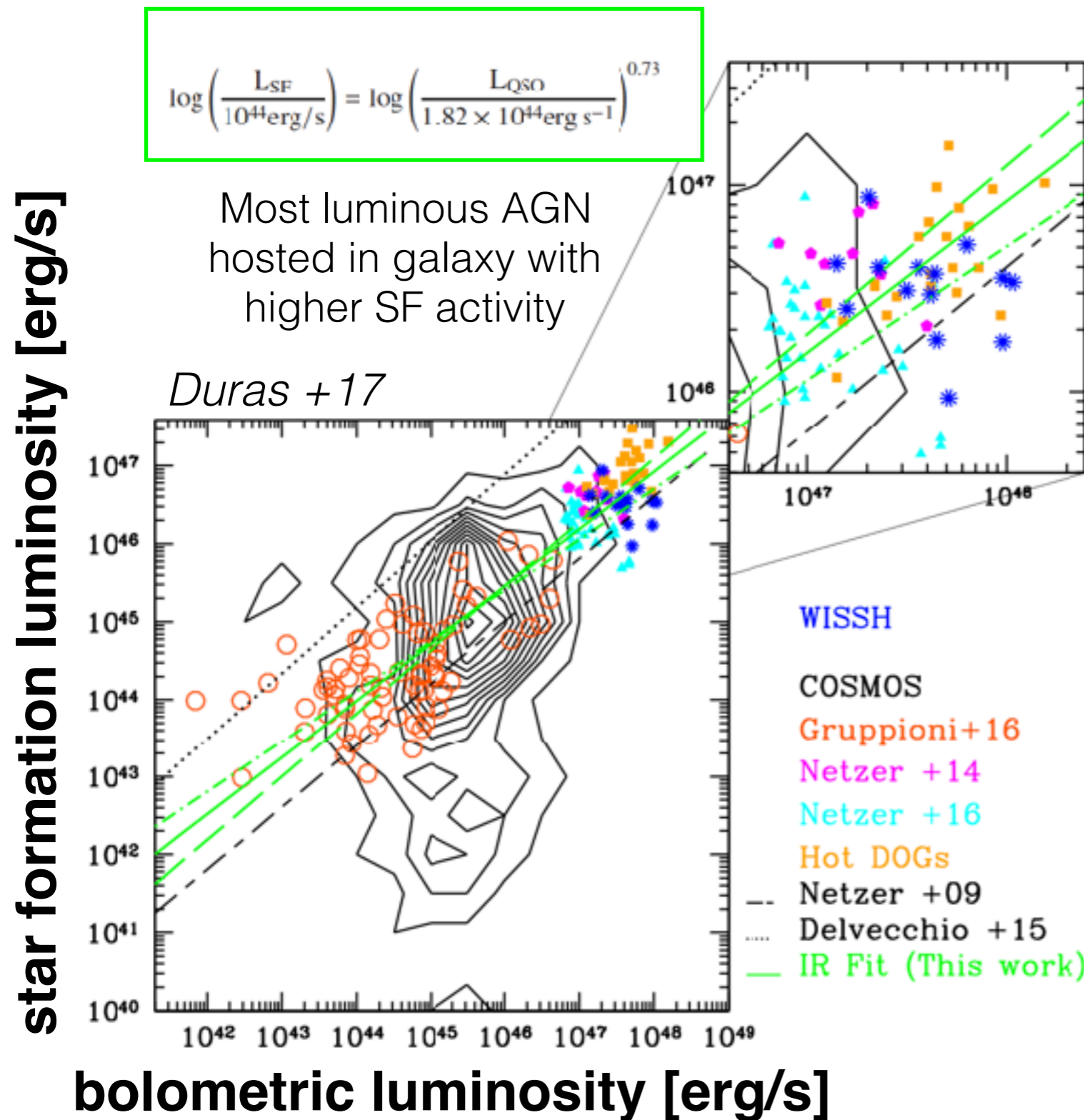
Radiative transfer (TRADING) code

Schneider+15

applied to the **least** (40% of AGN contribution) and the **most** (60% of AGN contribution) **luminous** sources of the sample

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Radiative transfer (TRADING) code

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applied to the **least** (40% of AGN contribution) and the **most** (60% of AGN contribution) **luminous** sources of the sample

**However :**  
we need to sample the FIR and sub-mm with higher angular resolution to avoid contamination not solved by Herschel (SPIRE PSF too big!)

see the recent  
Bischetti+18

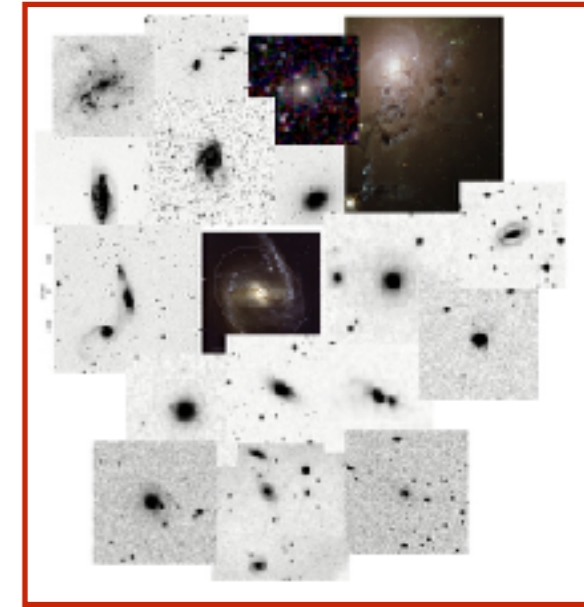
# Getting closer: the SWIFT / BAT sample

30 Seyfert2

20 Seyfert1

selected from the SWIFT/BAT 70-month catalog

see Baumgartner+13 for the entire catalog



## Type 2 AGN :

- no broad line component in the (rest-frame) optical  
AGN continuum obscured and/or contaminated by host galaxy

faint broad

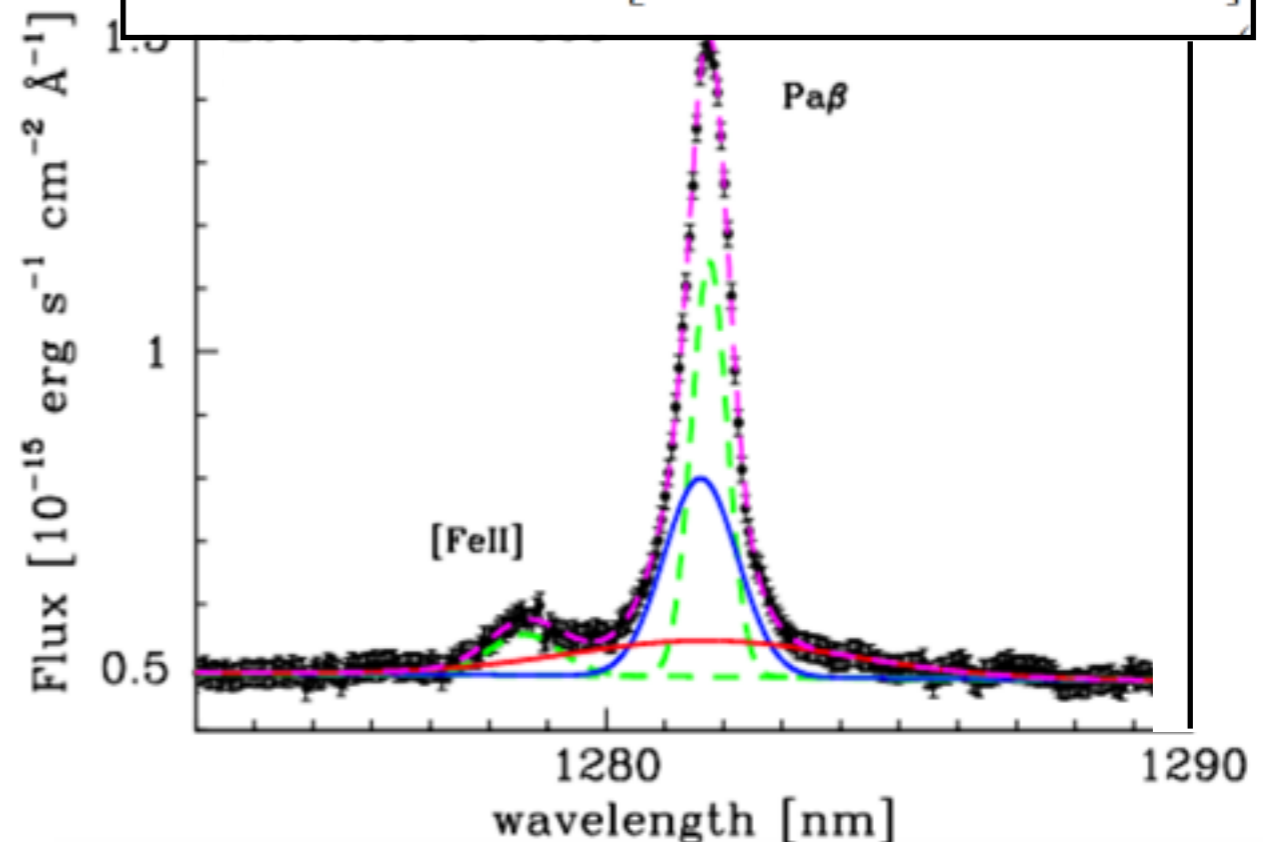
( $800 < \text{FWHM} < 3500 \text{ km/s}$ )

components found in **15**  
type2 AGN through deep  
NIR spectroscopy

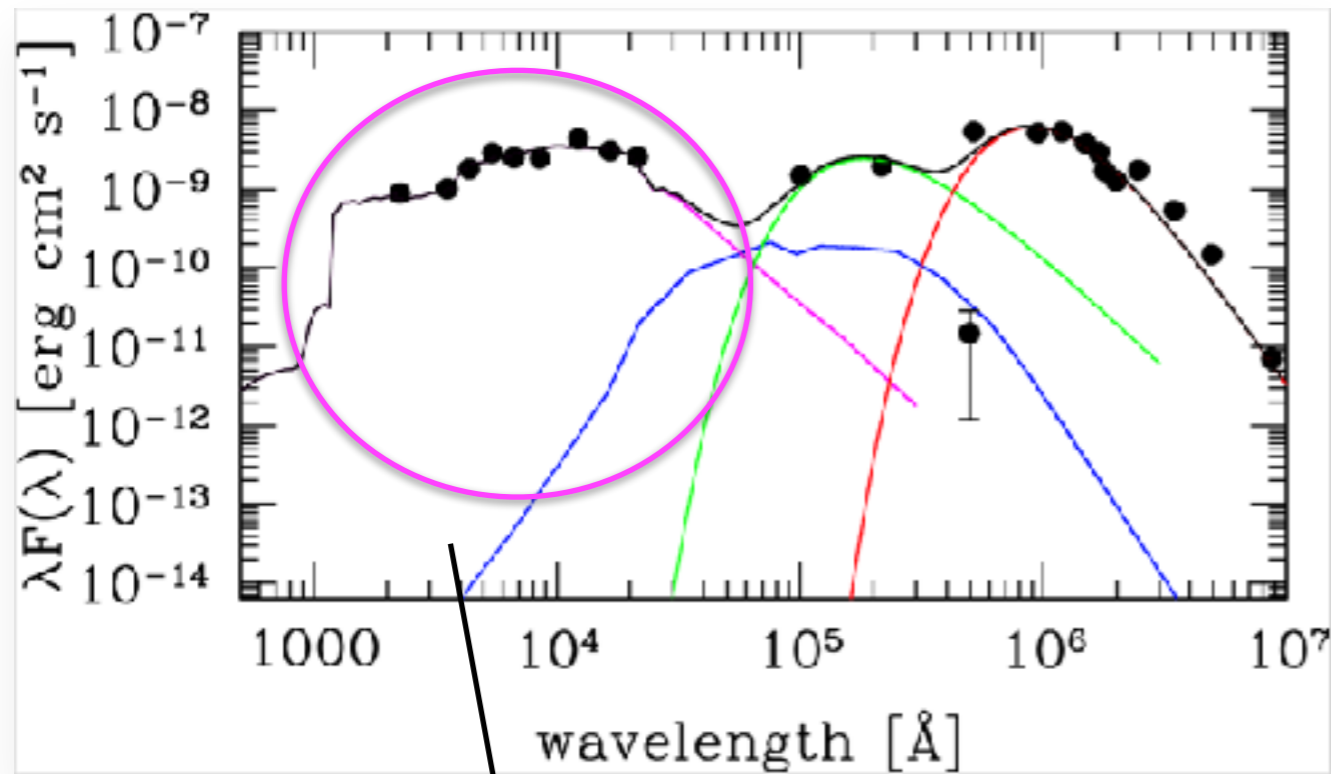
## BH mass estimation

see Onori+17 and Ricci,F.+17

$$\log \left( \frac{M_{\text{BH}}}{M_{\odot}} \right) = 7.75 + \log \left[ \left( \frac{\text{FWHM}_{\text{NIR}}}{10^4 \text{ km s}^{-1}} \right)^2 \left( \frac{L_{14-195 \text{ keV}}}{10^{42} \text{ erg s}^{-1}} \right)^{0.5} \right]$$

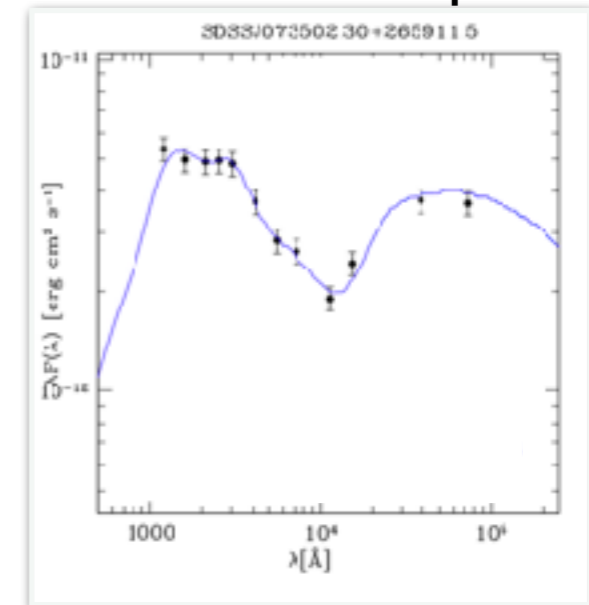


# Getting closer: the SWIFT / BAT sample



We can do more with  
the SWIFT/BAT AGN!

Strong presence of the emission from the galaxy, not hidden by the AGN emission as in the WISSH  
Pure AGN in the optical



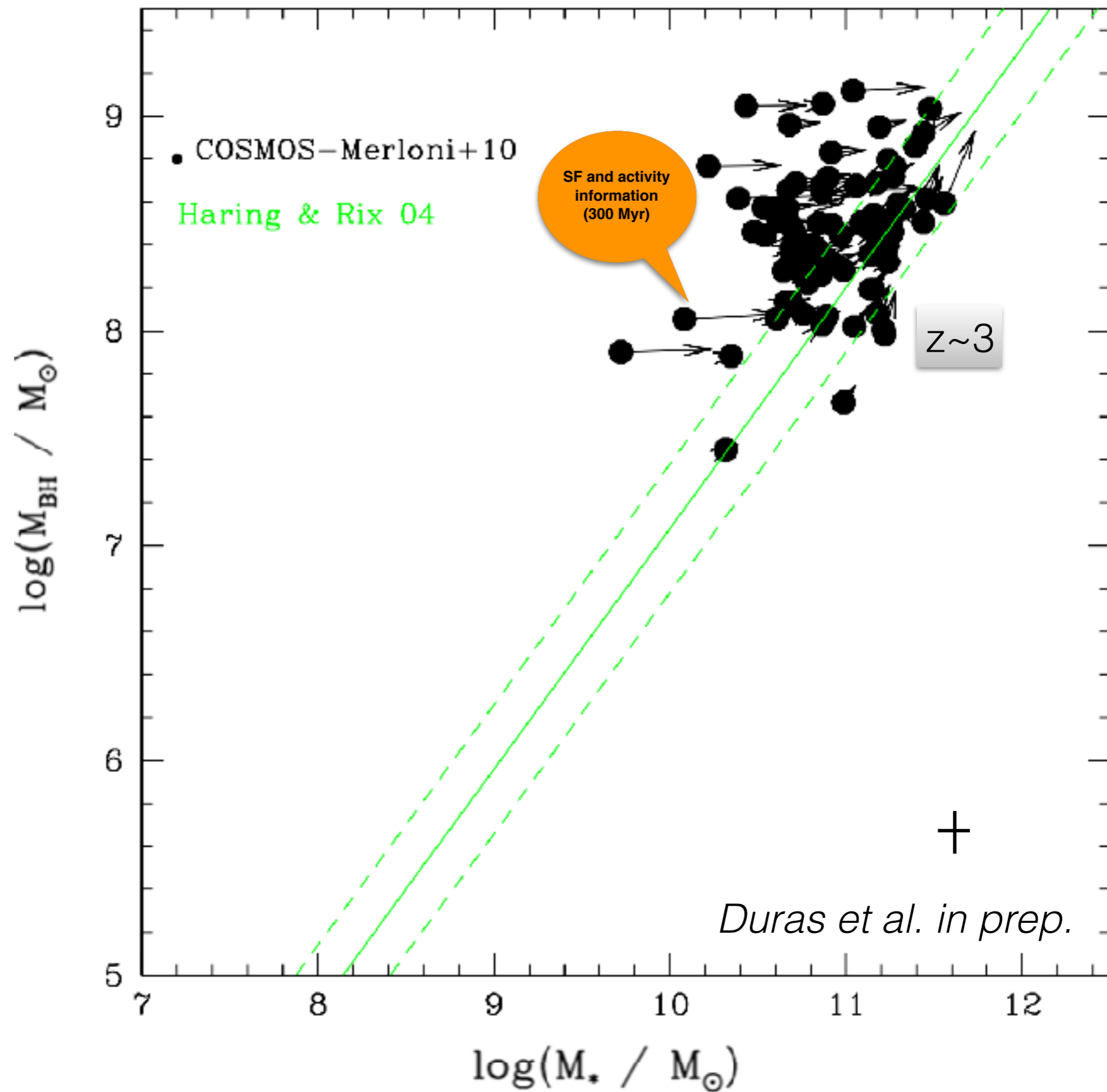
**STELLAR MASS** is here known from SED-fitting!

**SFR** is derived from the SED-fitting

**BH Accretion Rate** from LBOL (SED-fitting)

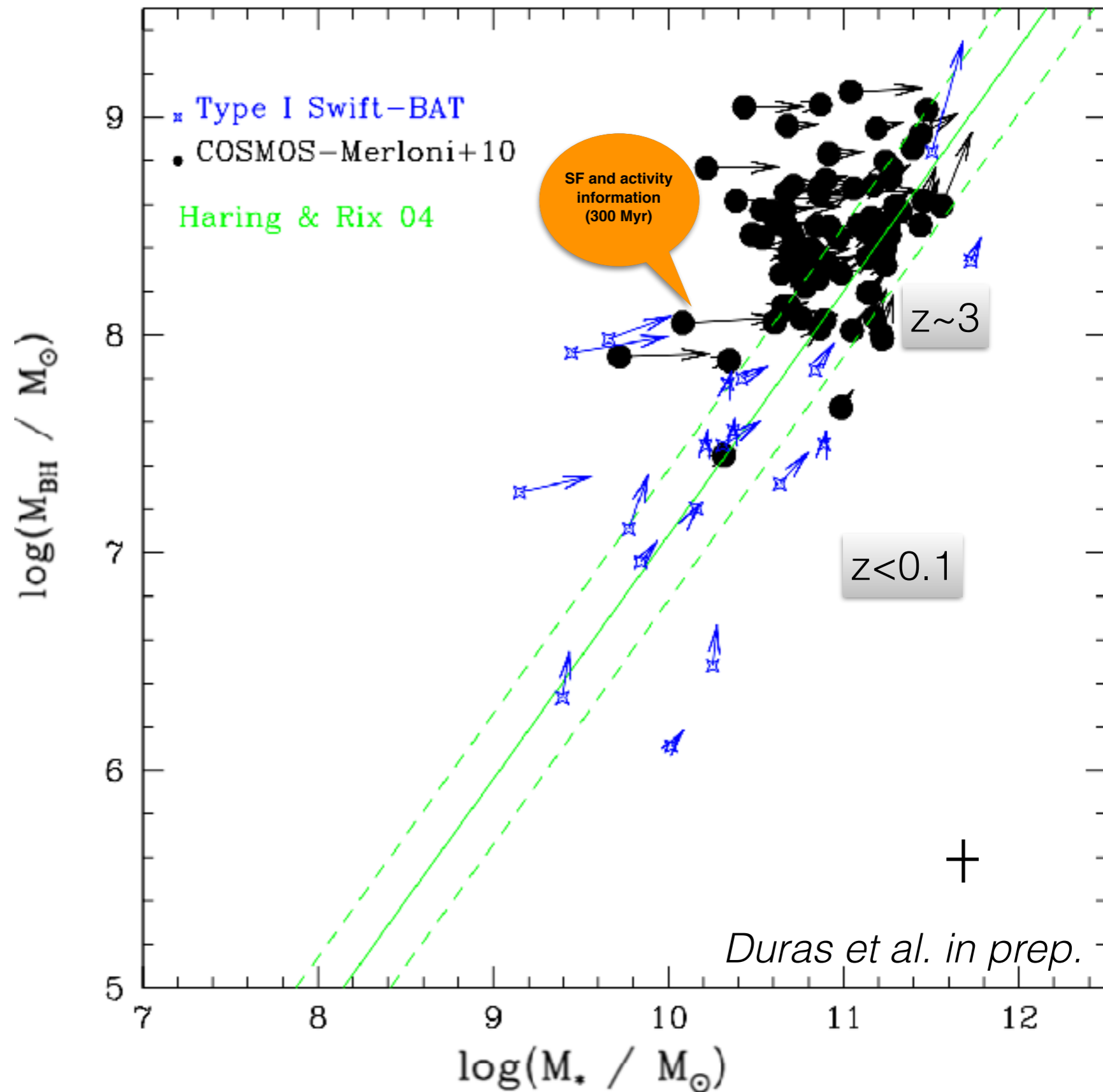
**BH MASS** known from RM & NIR spectroscopy

# BH/Galaxy co - evolution from local to high redshift



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More massive type1 AGN populate the typical region of the observed  $M_{\text{BH}}-M_*$  relation



# BH/Galaxy co - evolution from local to high redshift

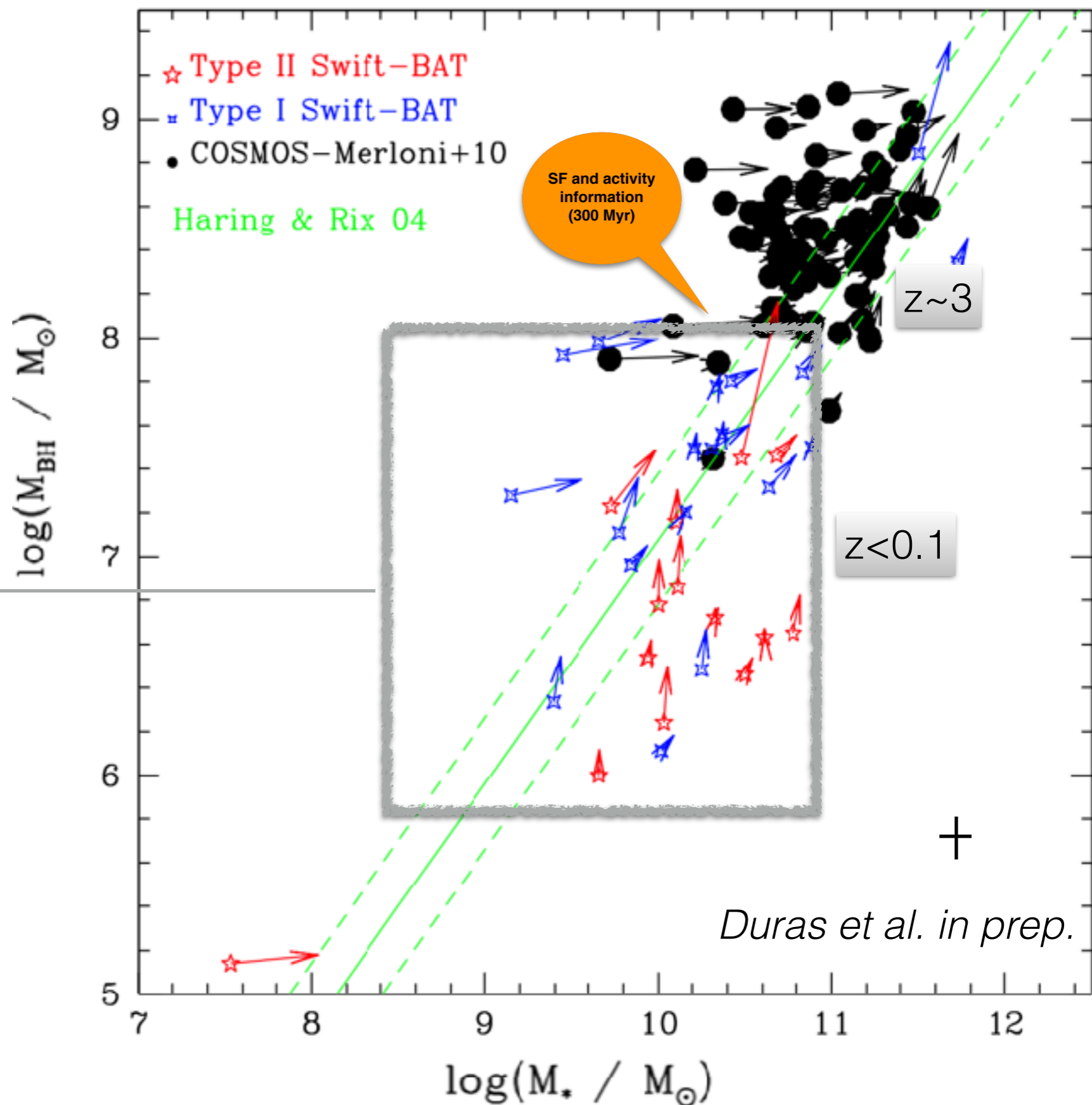
**More massive type1 AGN populate the typical region of the observed  $M_{\text{BH}}-M_*$  relation**

**Less massive type 2 AGN still on their way to reach the  $M_{\text{BH}}-M_*$  locus;**

**obscured AGN host less massive BHs compared to unobscured ones, given the same stellar mass**

## low-mass low-z regime

Constraining the BH-galaxy scaling relation over three orders of magnitudes in mass and following its evolution from  $z \sim 3$  to  $z \sim 0$ .





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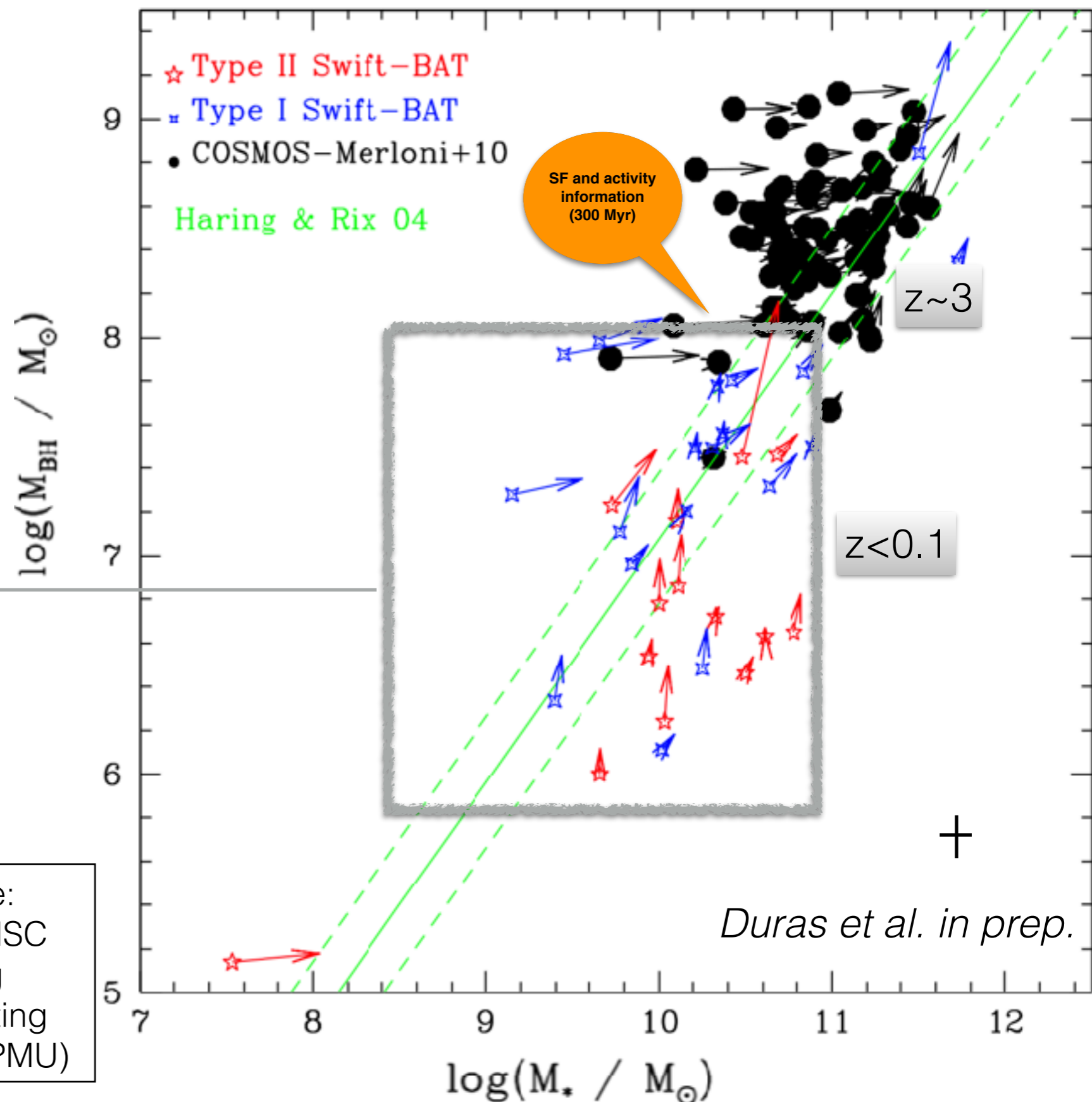
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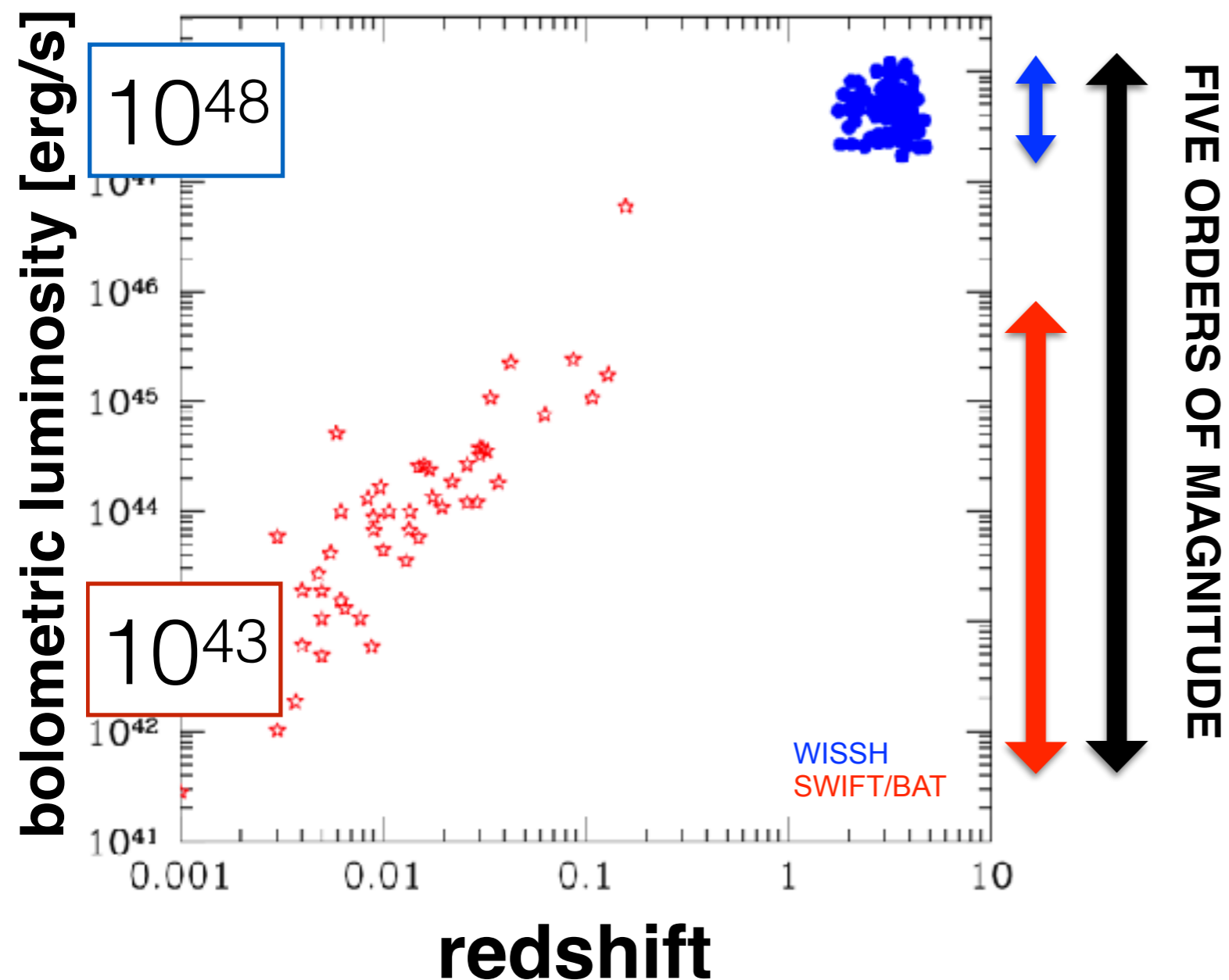
Constraining the BH-galaxy scaling relation over three orders of magnitudes in mass and following its evolution from  $z \sim 3$  to  $z \sim 0$ .

More information in the next future: study of a sample of galaxies with HSC data, analysed both with imaging decomposition (GalFIT) and SED-fitting (in collab. with J.Silverman @KAVLI IPMU)



# A new hard X - ray bolometric correction for type1 and type2 QSOs

WIDE RANGE  
OF BOLOMETRIC  
LUMINOSITY



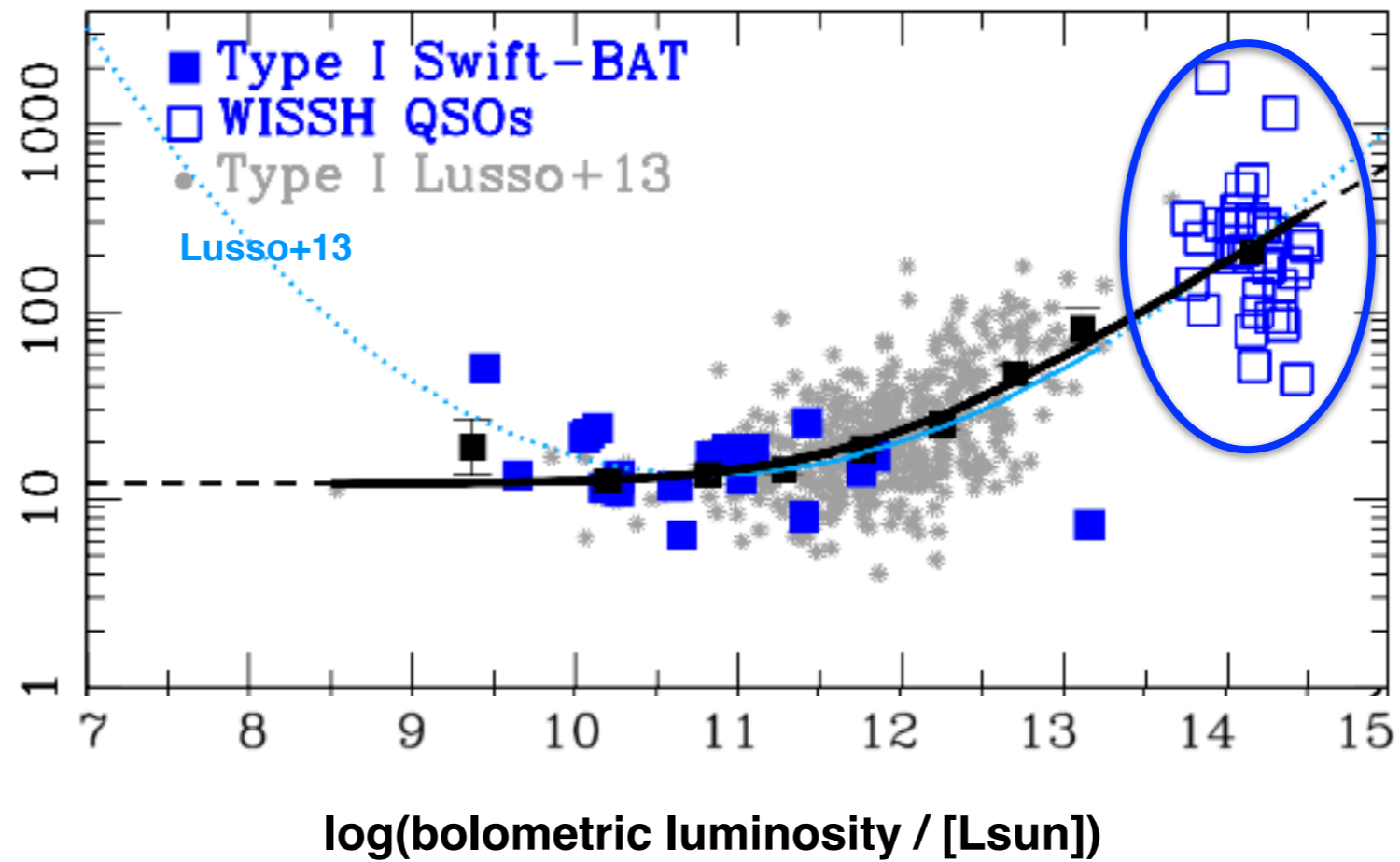
The perfect collection to  
build up a new  
bolometric correction

$$k_{band} = \frac{L_{bol}}{L_{band}}$$

... in the hard X-ray band

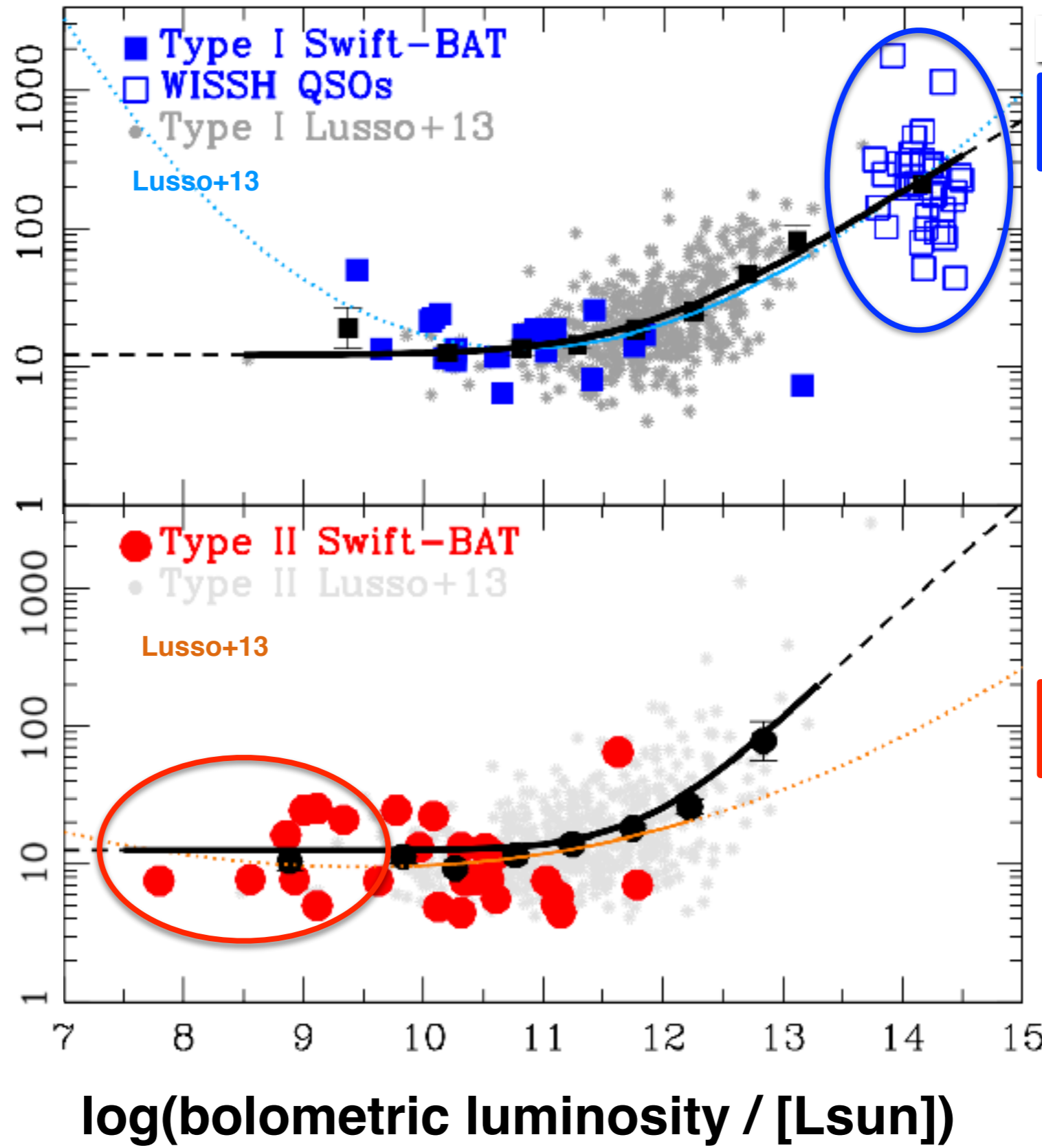
# A new hard X - ray bolometric correction for type1 and type2 QSOs

X-ray bolometric correction (2-10 keV)



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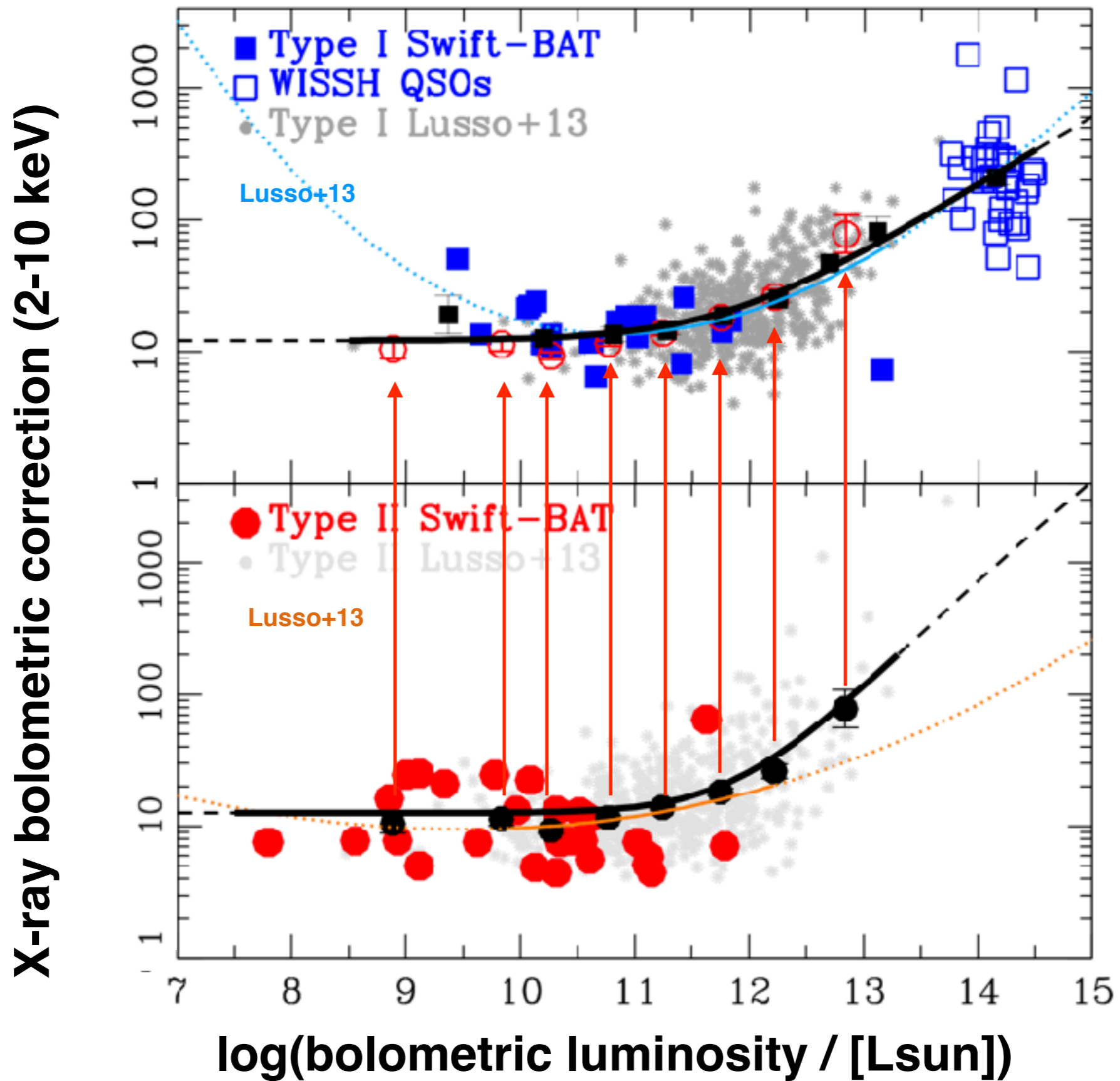


see Martocchia+17

constraining the tail at high luminosities

and at low luminosities

# A new hard X - ray bolometric correction for type1 and type2 QSOs



**<kbol> (in bin of LBOL) of type2 sources lie ON the fit for type1 sources**

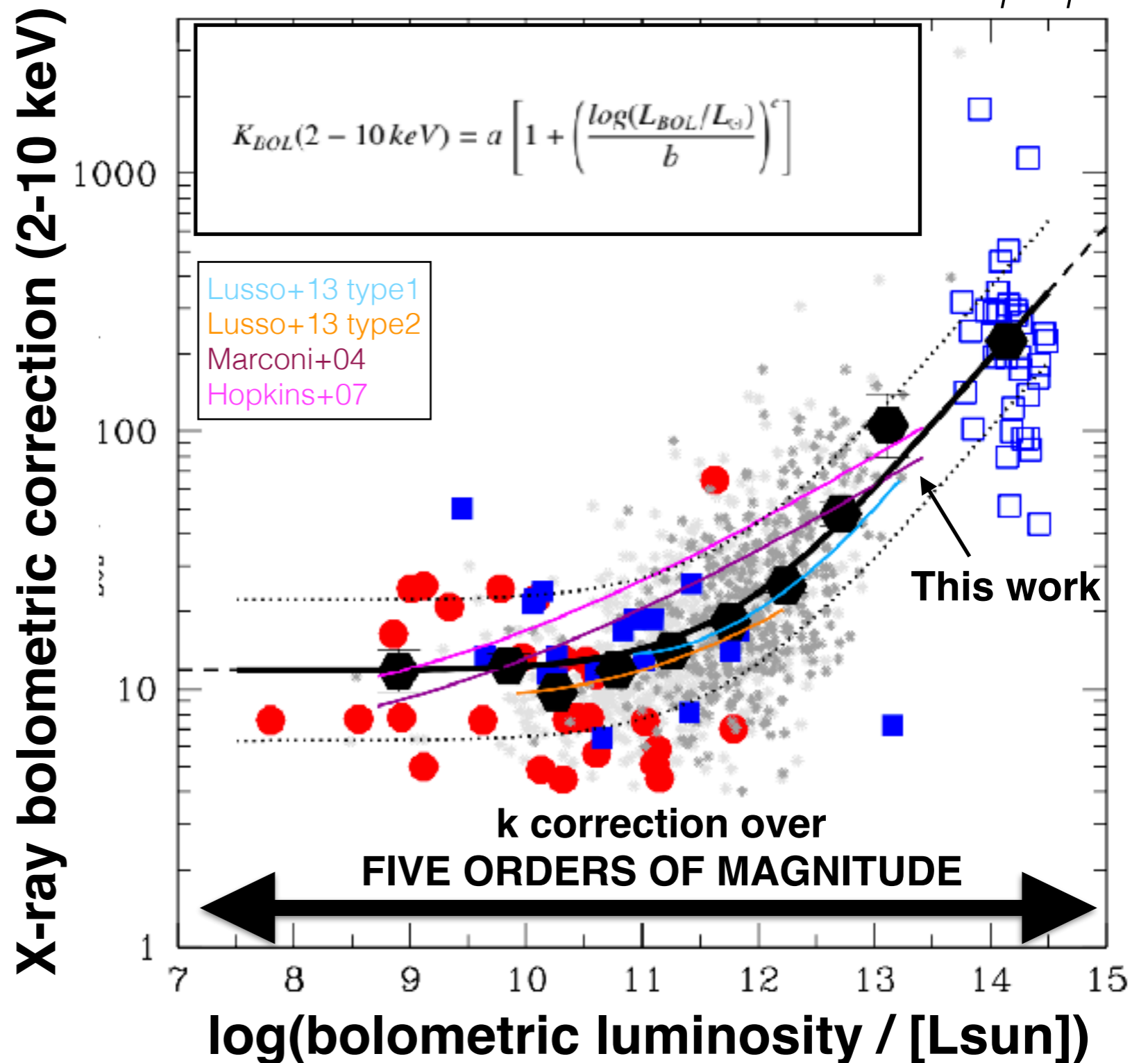
# A new hard X - ray bolometric correction for type1 and type2 QSOs

General bolometric correction for the entire population of AGN

*Duras et al. in prep.*

**STATISTICALLY  
REPRESENTATIVE  
(F-test confirmed)**

OF BOTH **TYPE1**  
AND **TYPE2**  
POPULATIONS



# Summary

TWO complementary samples of sources at the bright and the faint end of the AGN mass and luminosity function

## WISSH QSOs

Type 1  
 $2 < z < 4$   
 High luminous and massive

16 sources with Herschel coverage

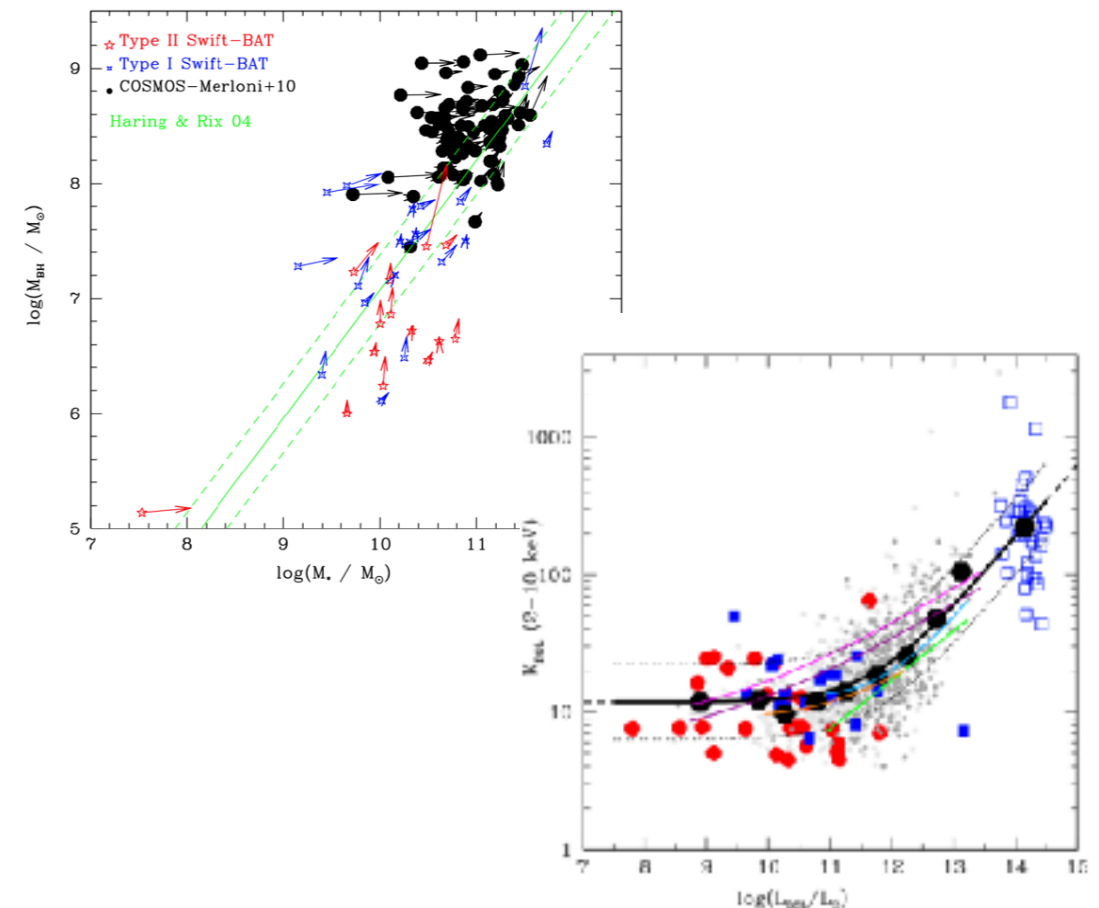
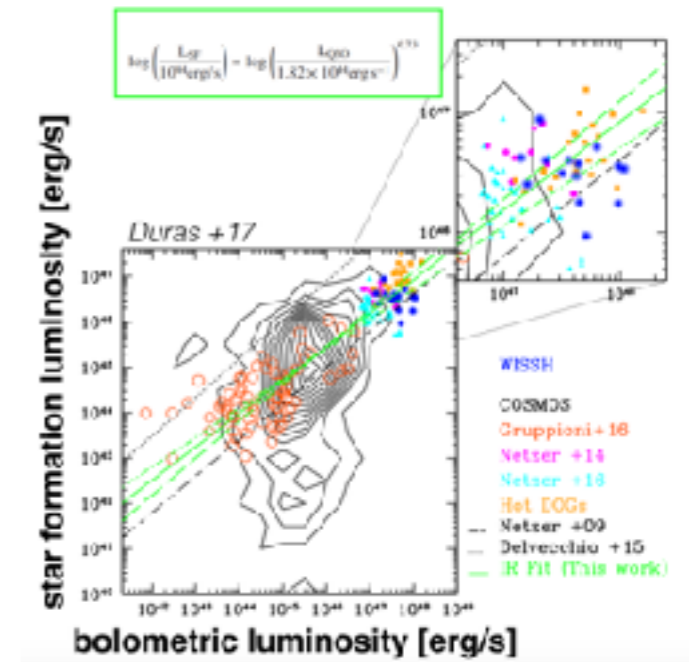
- ★ Extremely high SFR (**500 - 4000  $M_{\text{sun}}/\text{year}$** ) even counting for the AGN contribution to the FIR (~50%) - **BUT** - need for high-resolution IR and sub-mm data!

## SWIFT/BAT

Local ( $z < 0.1$ )  
 Low luminous and low massive  
 Mass estimation from IR spectroscopy

- ★ Populating the low region of the MBH- $M^*$  plane: **obscured AGN** with **less massive BHs** than the **unobscured ones**, are moving towards the local scaling relation

- ★ NEW general hard X-ray bolometric correction over five order of magnitude for both type1 and type2 sources



Active Galactic Nuclei 13 :  
Beauty and the Beast

*October, 9-12 2018 - Milano*

**Stay tuned for news  
and ...  
THANK YOU !**

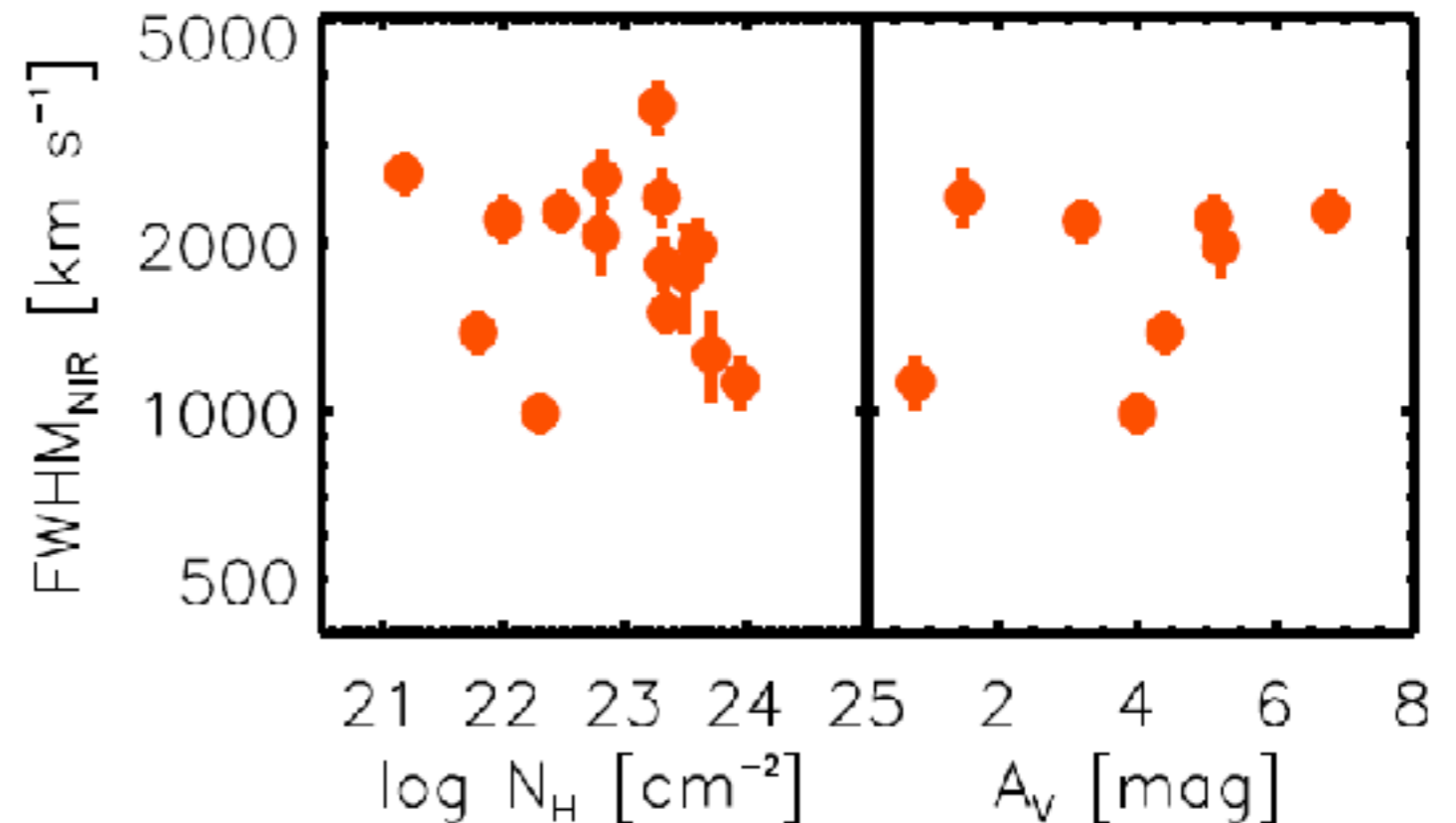




# POSSIBLE BIASES ON THE BH MASS ESTIMATION

## REDDENING / EXTINCTION

Are the broad lines we see from an outer part of the BLR in which there's less dust?



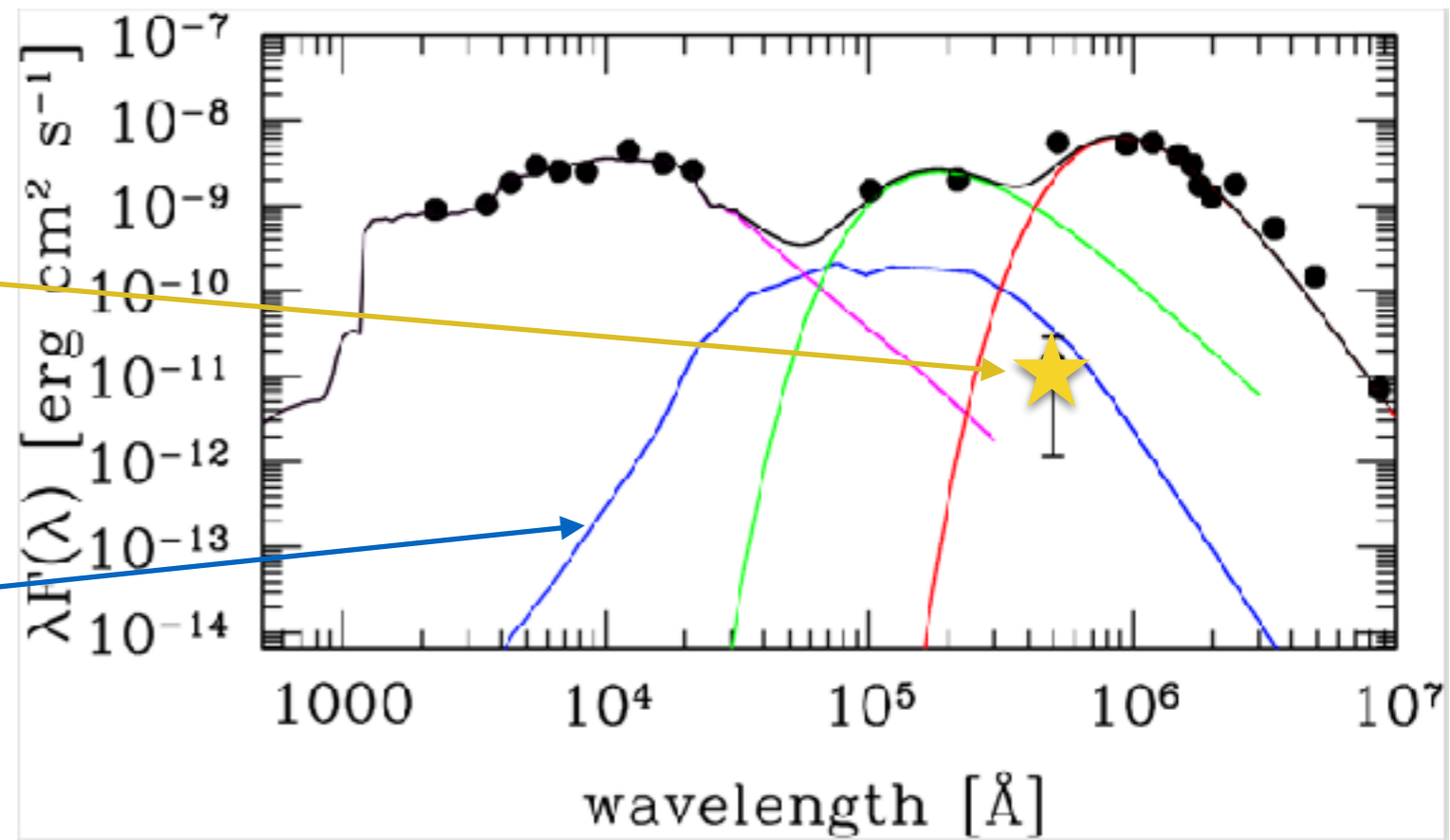
We should see the largest values of FWHM in the less absorbed sources

**NO TREND BETWEEN FWHM and THE EXTINCTION!**

# X-RAY INFORMATION CONVERTED INTO A VIRTUAL PHOTOMETRIC POINT

PREDICTION  
from the X-ray  
Luminosity

Silva+04 SEDs for the  
description of the AGN  
emission



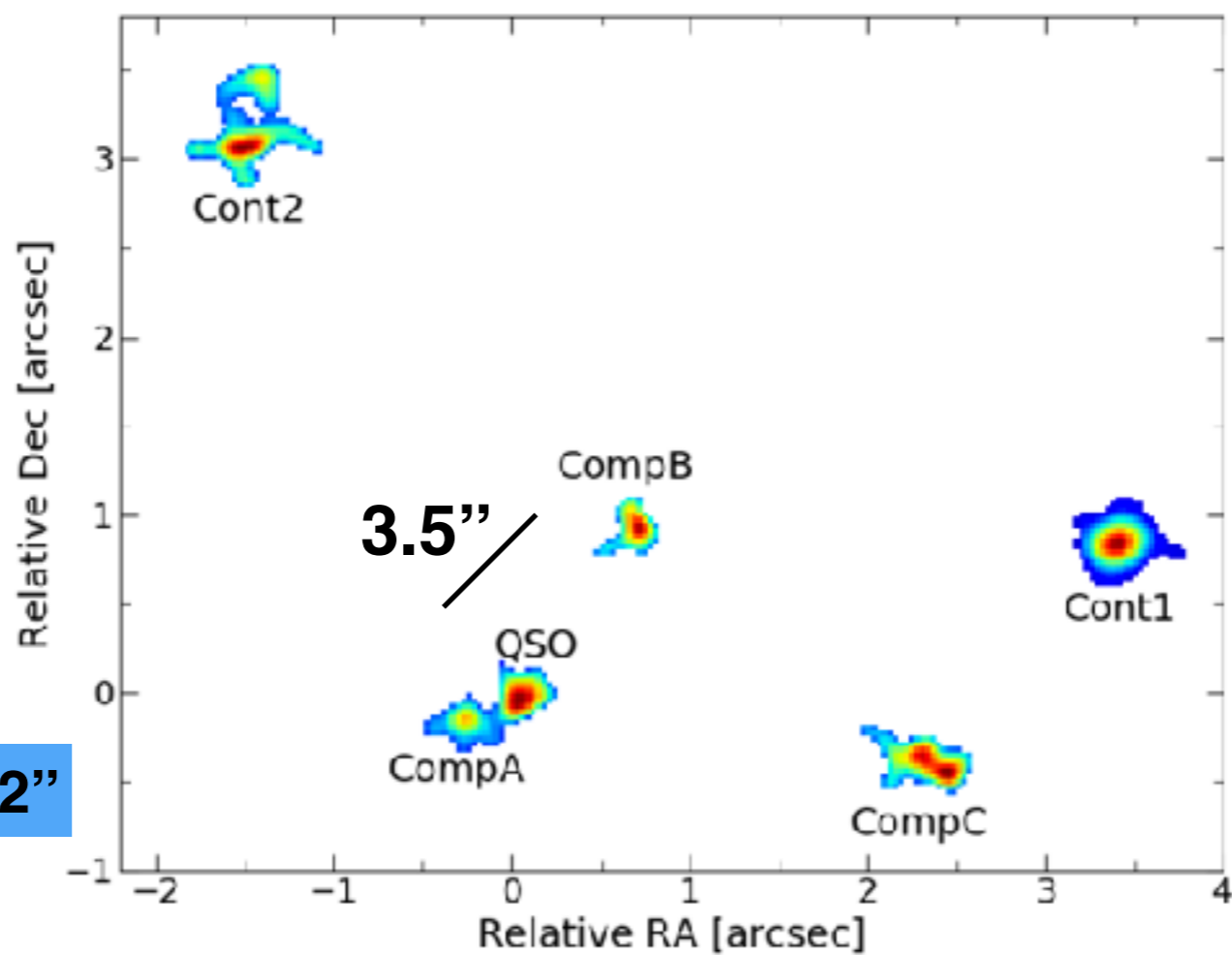
14-195 keV  
X-ray luminosity

Baumgartner+13

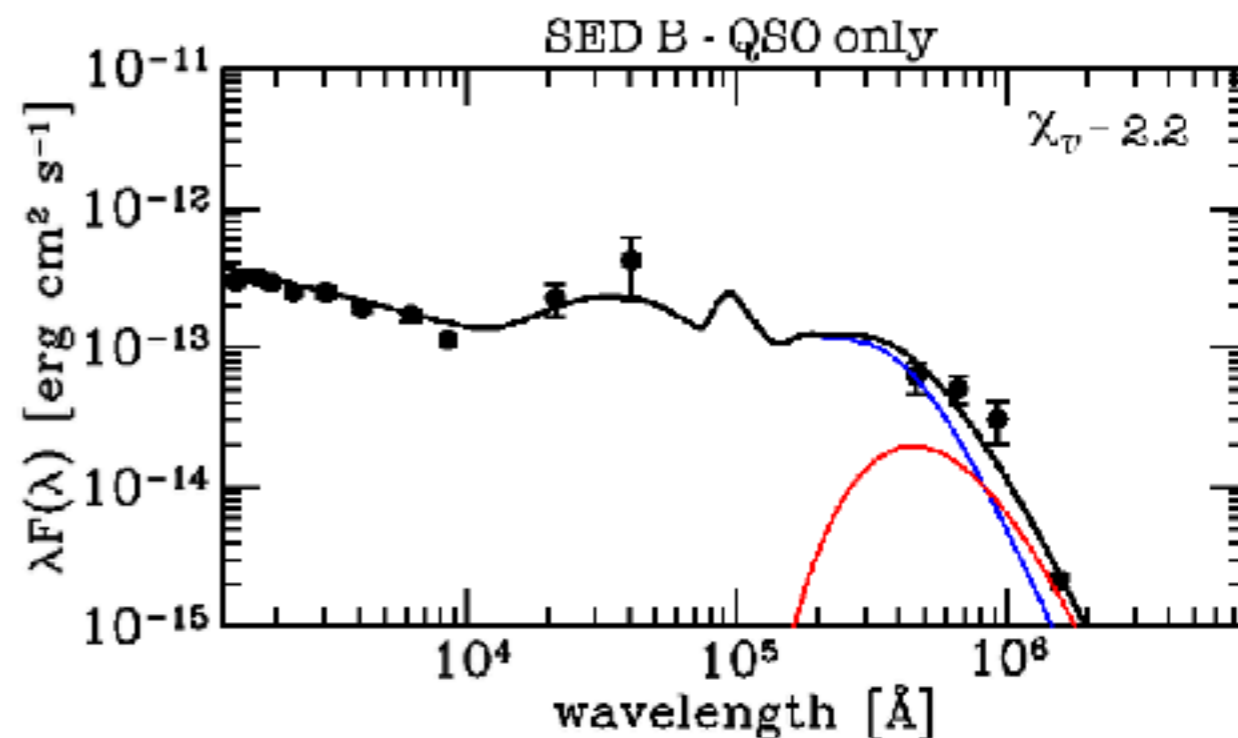
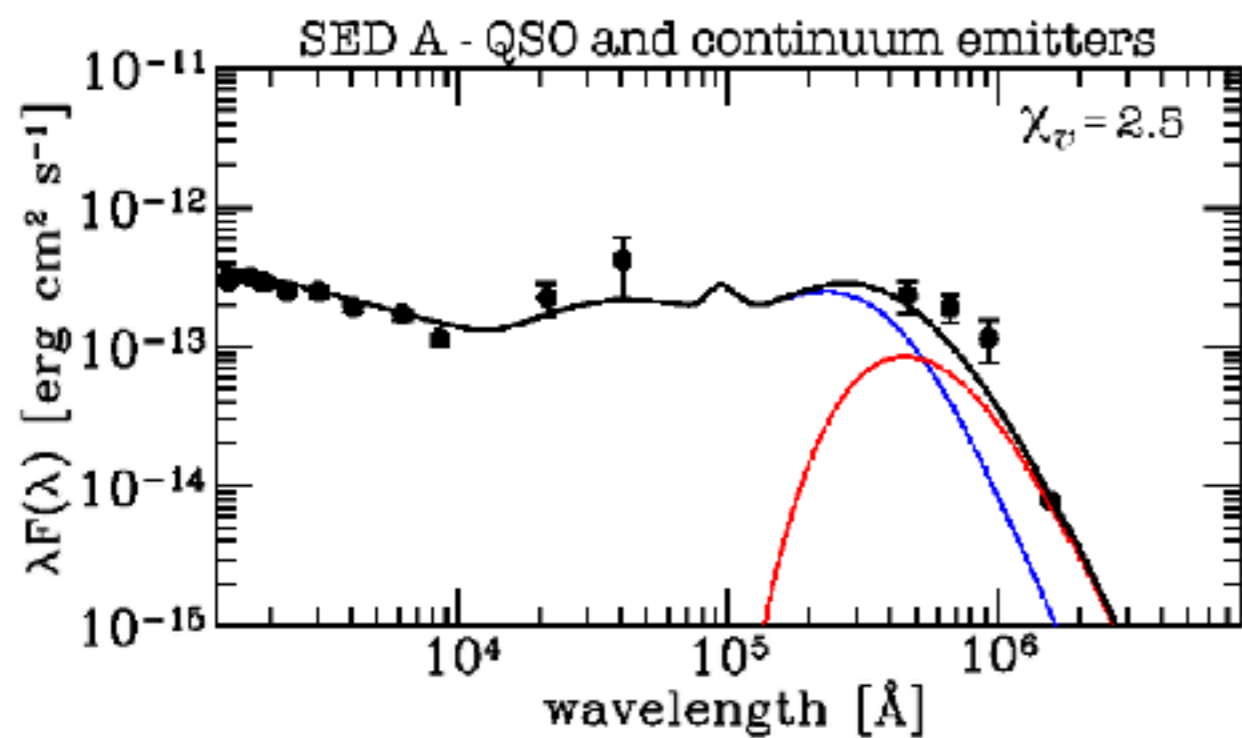
converted in a  
virtual photometric point  
connected to the sole AGN



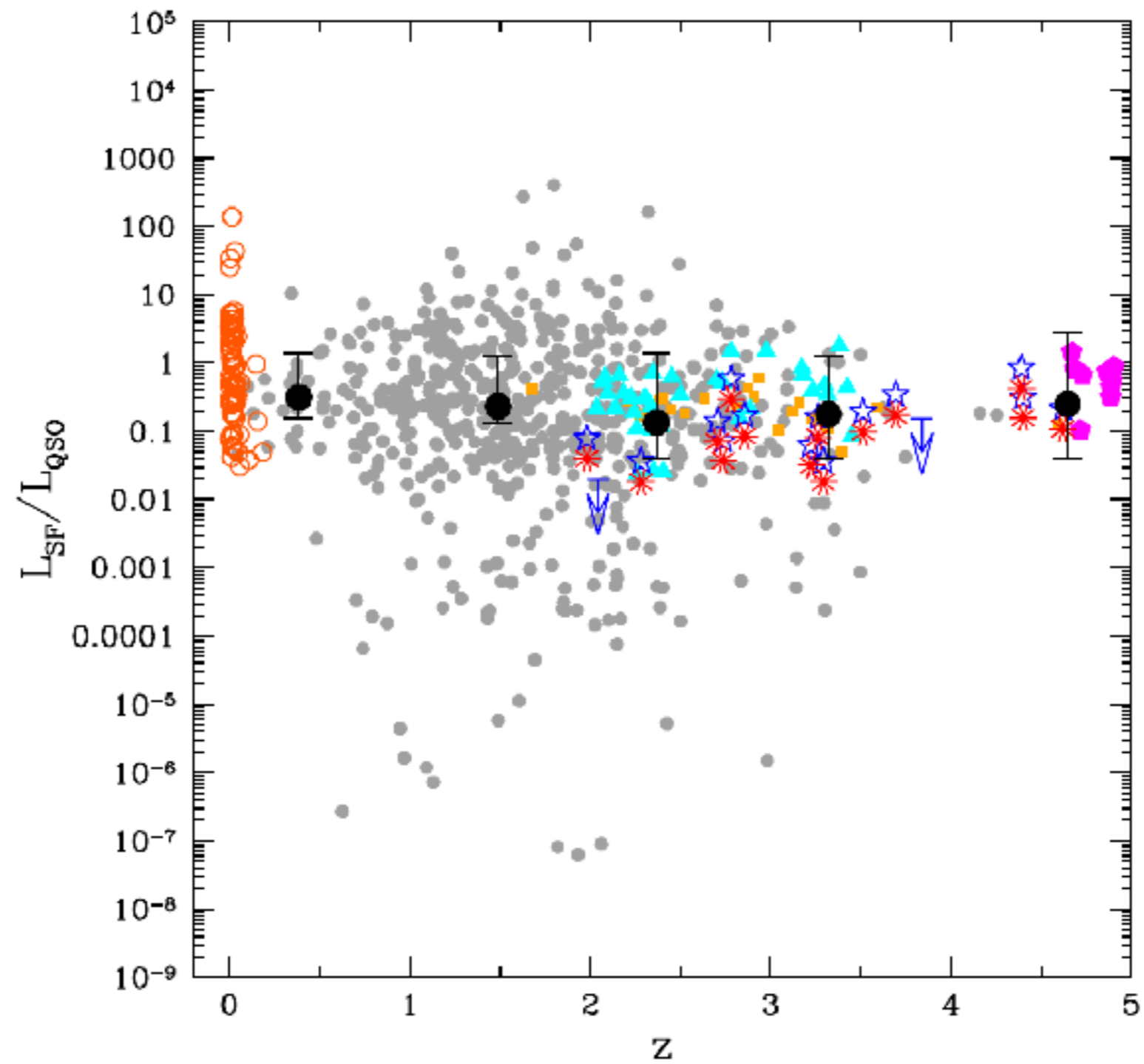
The hard X-ray is NOT  
contaminated by the host.  
It represents a  
**PURE INFORMATION**  
of the AGN emission



SPIRE PSF 17.5'' - 35.2''

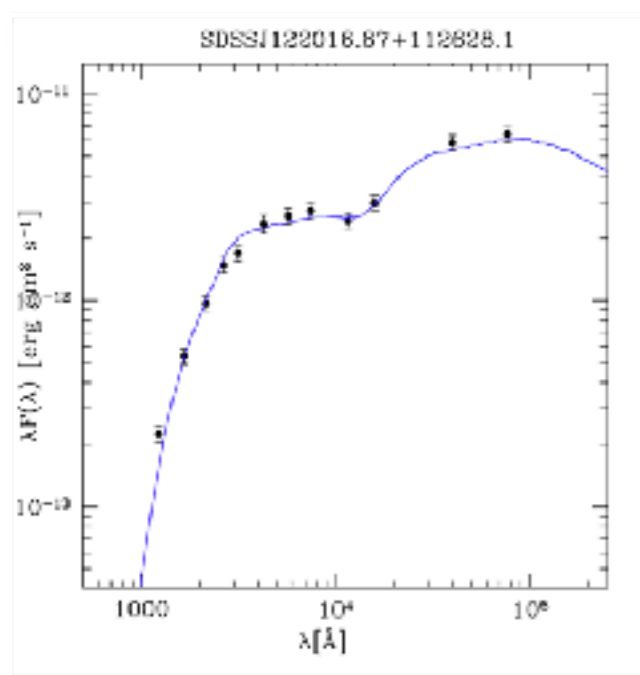
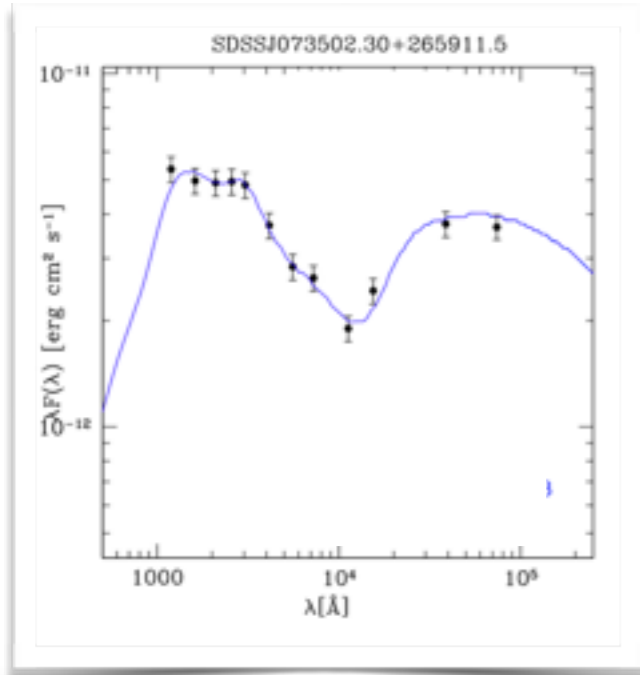


LSF vs LBOL :  
no redshift dependence

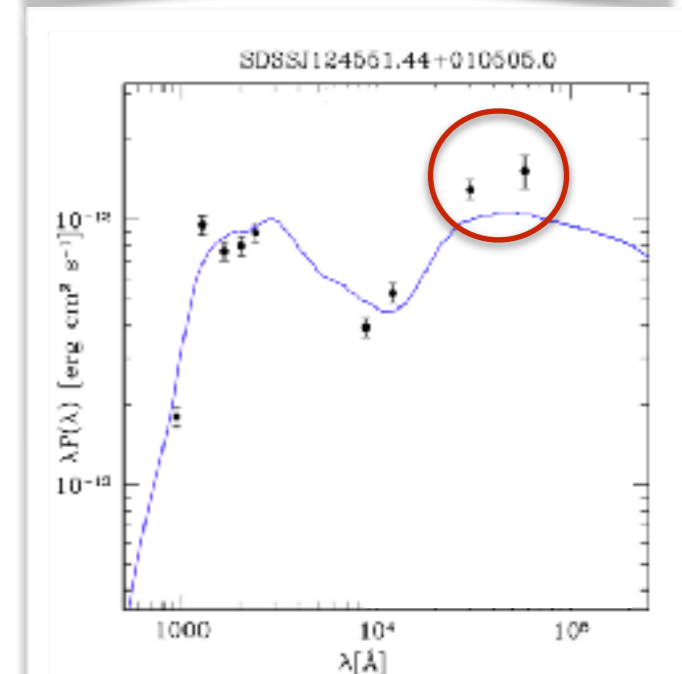
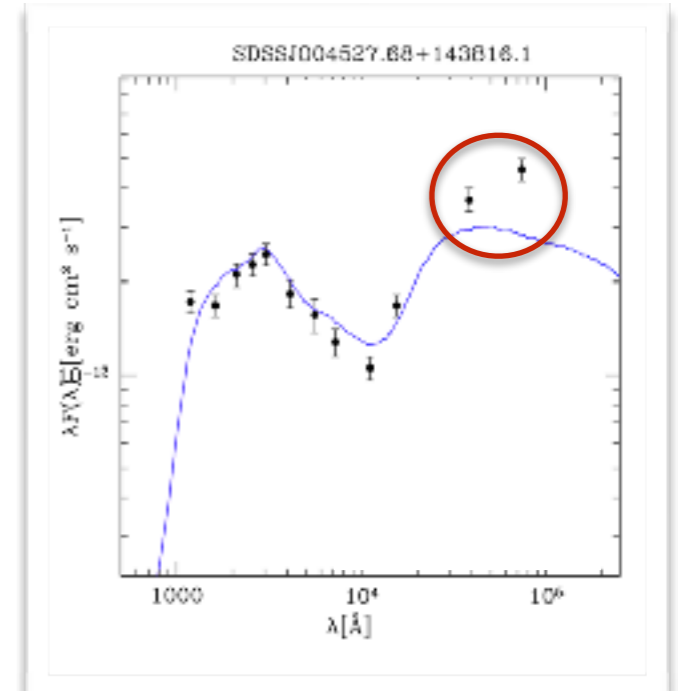


# EXCESS IN THE MIR : WHAT IS IT?

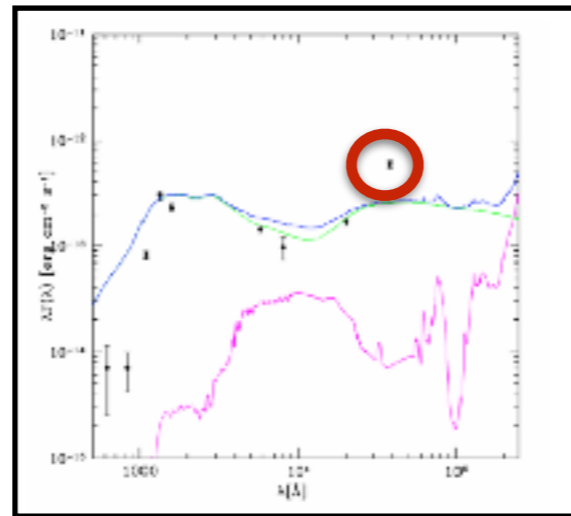
Examples of perfect matches between templates and photometric points



Examples of MIR excess of the photometric point with respect to the template



- NOT due to the lack of a PAH component in the fitting code



- NOT due to unreliable images in the WISE catalog (only 5%)

$$\lambda L(\lambda) \propto \lambda^0 \quad 0.01 < \lambda \leq 0.1 \quad (\mu\text{m})$$

Stalevski et al. 2012

Overestimation of the bolometric luminosities of a factor of  $\sim 2$  using Stalevski's AD model

Feltre et al 2012

$$\lambda L(\lambda) \propto \lambda^{0.8} \quad 0.05 < \lambda \leq 0.125 \quad (\mu\text{m})$$

