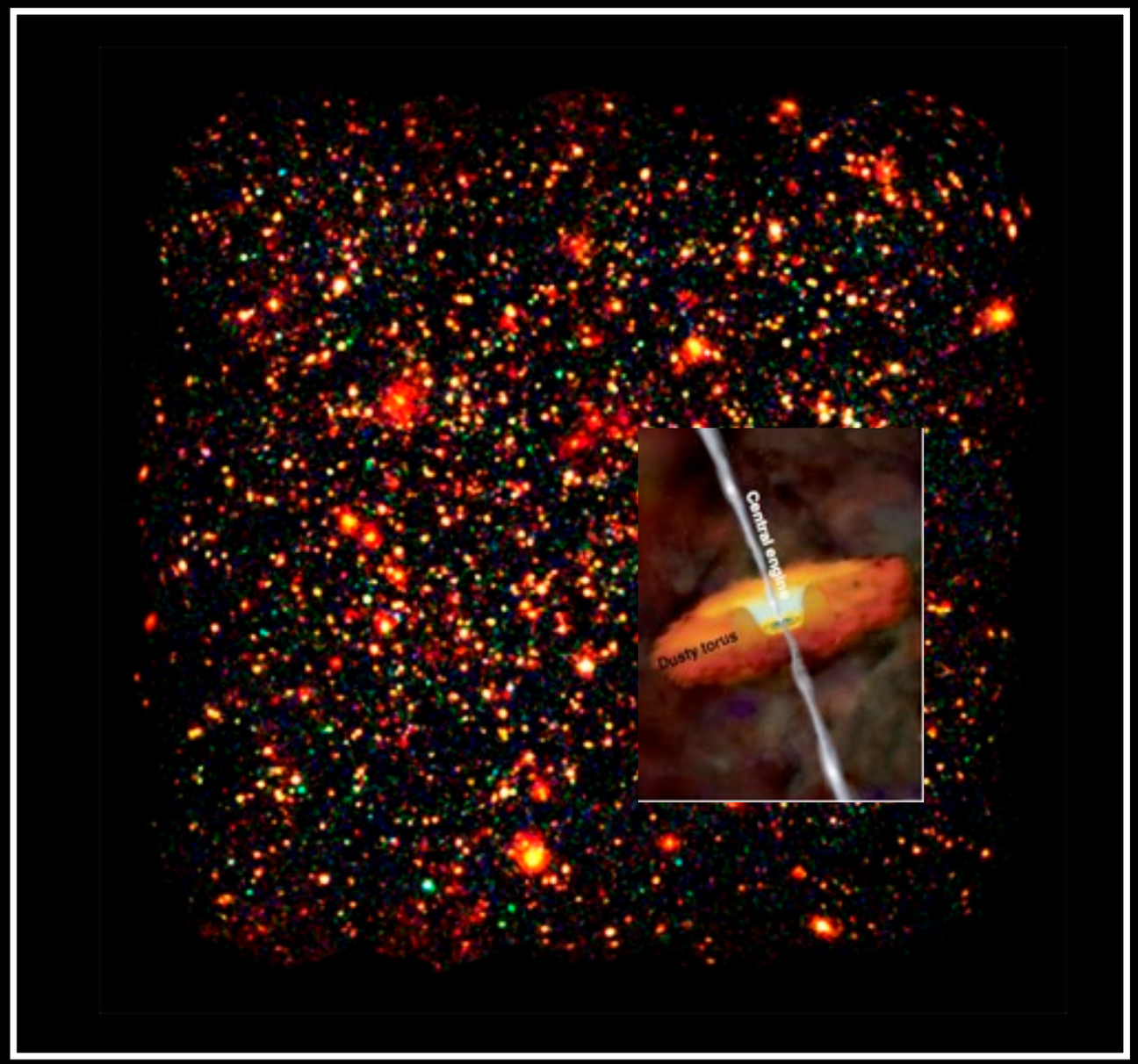


XMM view of the COSMOS field

The search for obscured AGN in COSMOS and CDFS

Marcella Brusa

MPE - High Energy Group

Results obtained in the framework of the COSMOS & CDFS/MUSIC teams:

Bongiorno, Brunner, Cappelluti, Comastri, Fiore, Fontana, Grazian, Hasinger, Merloni, Salvato, Santini, Zamorani and many others

(... definition of "obscured AGN"?)

- Unified vs. co-evolutionary models
  (geometry vs. time)

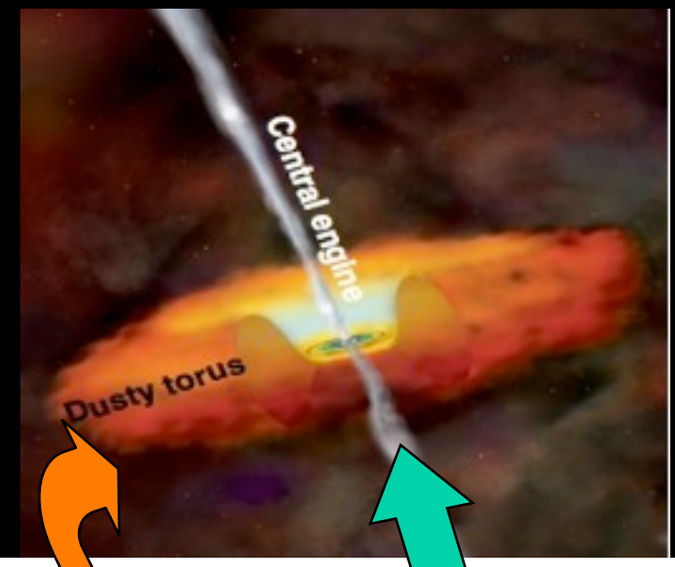
- Unified models:
  - "viewing angle"
  - AGN emission absorbed by torus (or "clumpy" system)
    BL vs. NL classification
    X-ray obscured vs. X-ray unobscured

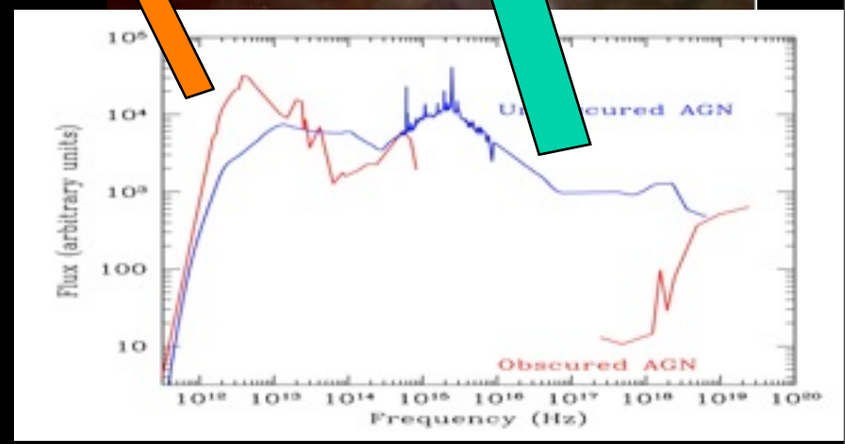
  - optical/X-ray classifications agree at 80% level

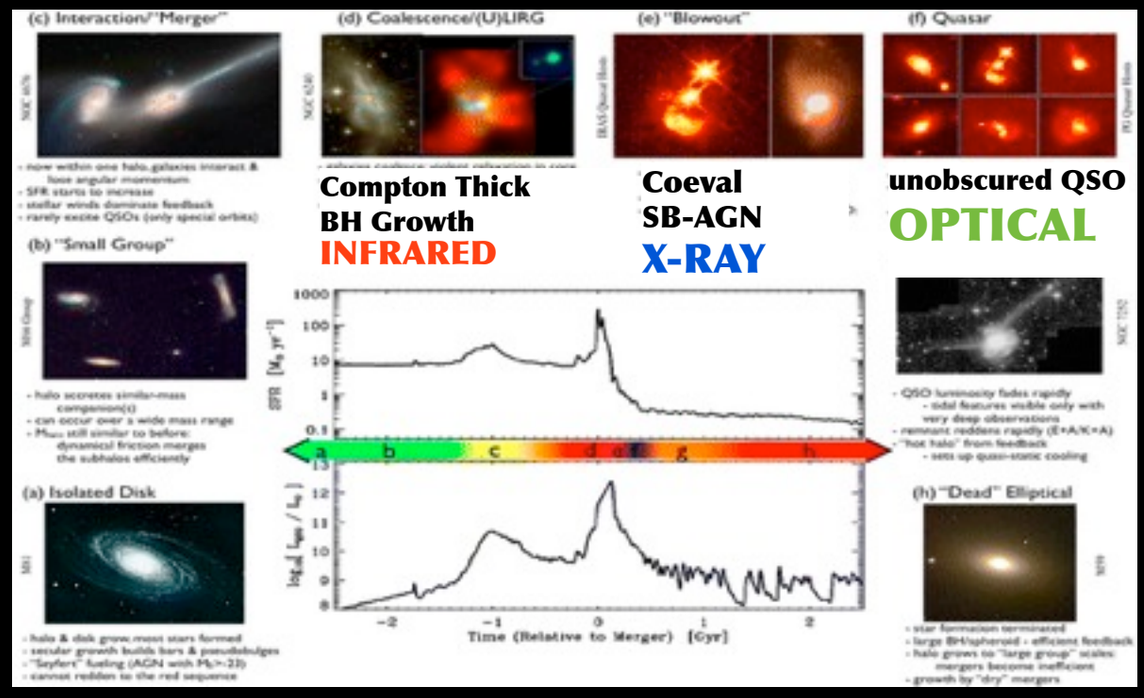
- Evolutionary models:
  - "phase"
  - AGN emission is obscured by host galaxy dust (and, maybe, absorbed by torus)

  - time critical (absorption more common at high-z)

Antonucci 1993







Hopkins et al. 2008

obscured AGN: why bother?

(see Comastri talk tomorrow morning)

- Obscured AGN are needed:

  - to reconcile the local BH mass function with mass accreted on BH
    (via Soltan argument, e.g. Fabian & Iwasawa 1999, Marconi+2004, Merloni&Heinz 2008, Shankar+2009)

  - to reproduce the X-ray background peak
    (Setti & Woltjer 1989, Comastri+1995, Gilli+2007, Treister+2005,2009)

  - (at high-z): to test evolutionary models and constrain growth phases
    (Hopkins+2008; Narayanan+2009, La Franca et al. 2005, Hasinger2008)

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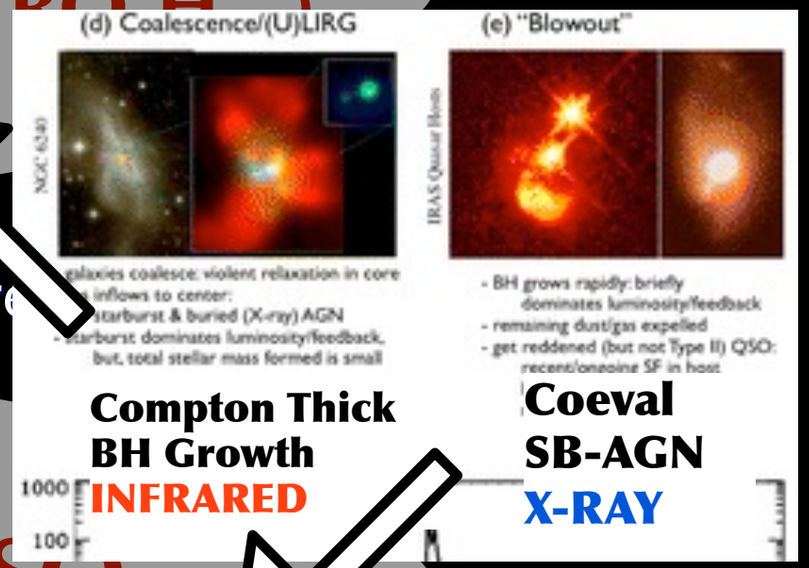
Compton Thick AGN

(IR selection - high z; Swift, Nustar,ASTRO-H...)

- to reproduce the X-ray background peak (Setti & Woltjer 1989, Comastri+1995, Gilli+2007, Tr



Compton thin AGN and QSO

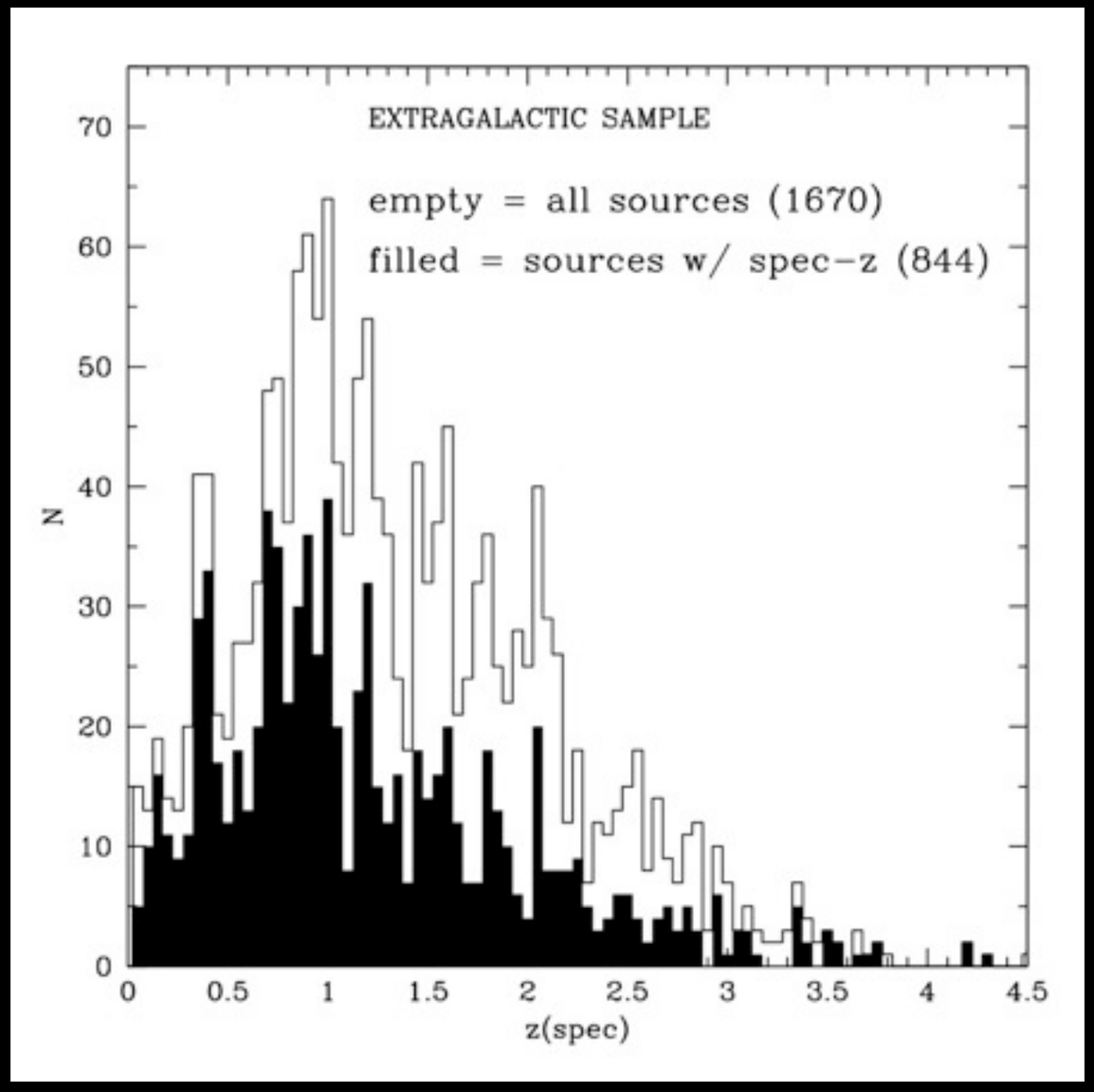
(Chandra&XMM + host galaxies studies)

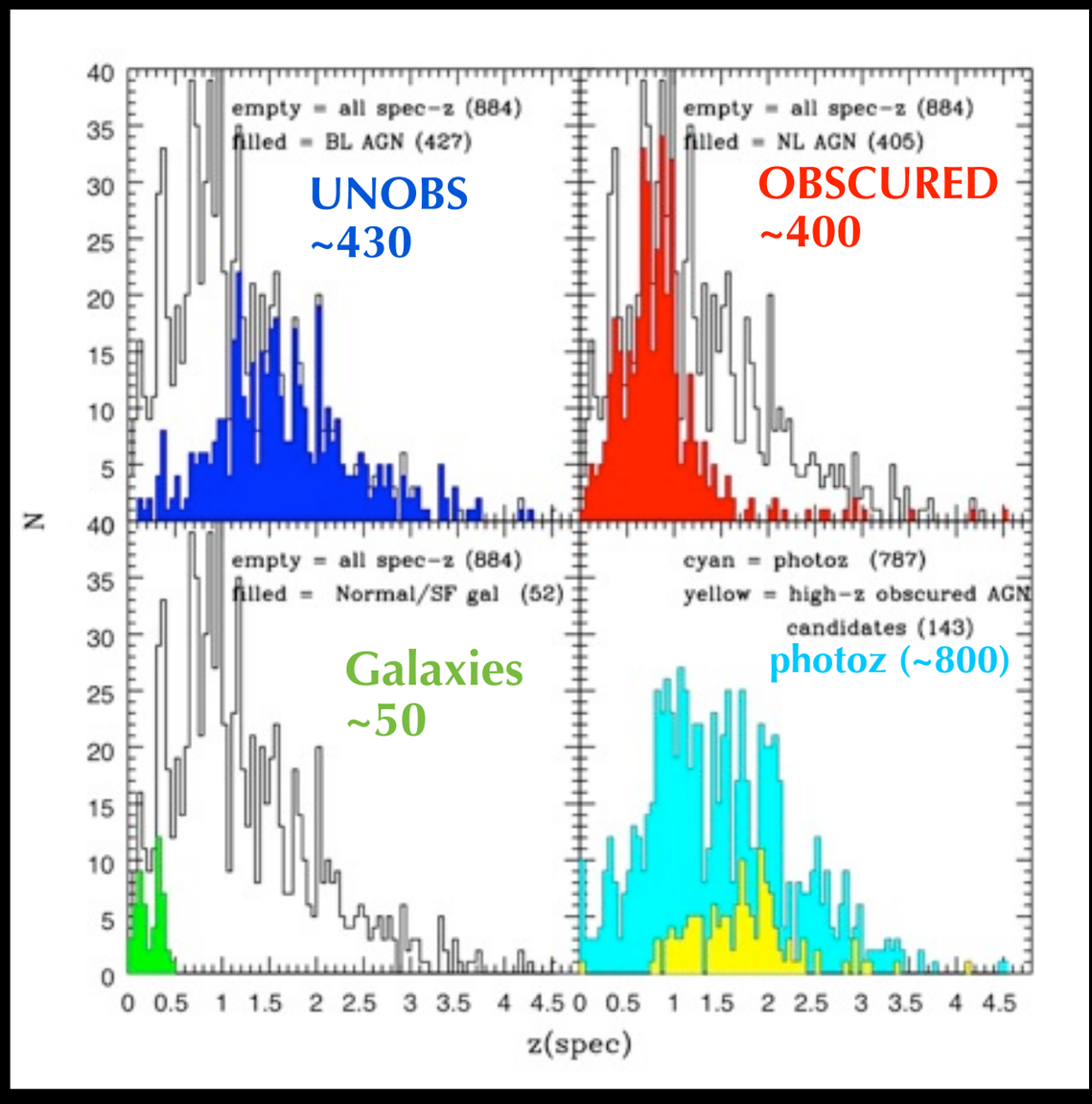
- (at high-z): to test evolutionary models and constrain growth r es (Hopkins+2008, Narayanan+2009, La Franca et al. 2005, Hasinger2008)

The X-ray selected obscured AGN population

High-luminosity, obscured AGN: XMM-COSMOS

Brusa et al. 2007, 2010, ApJ





~1800 pointlike sources down to 1e-15 cgs **(Hasinger+07, Cappelluti+07,09)**

~900 (~50%) "secure" spectroscopic redshifts

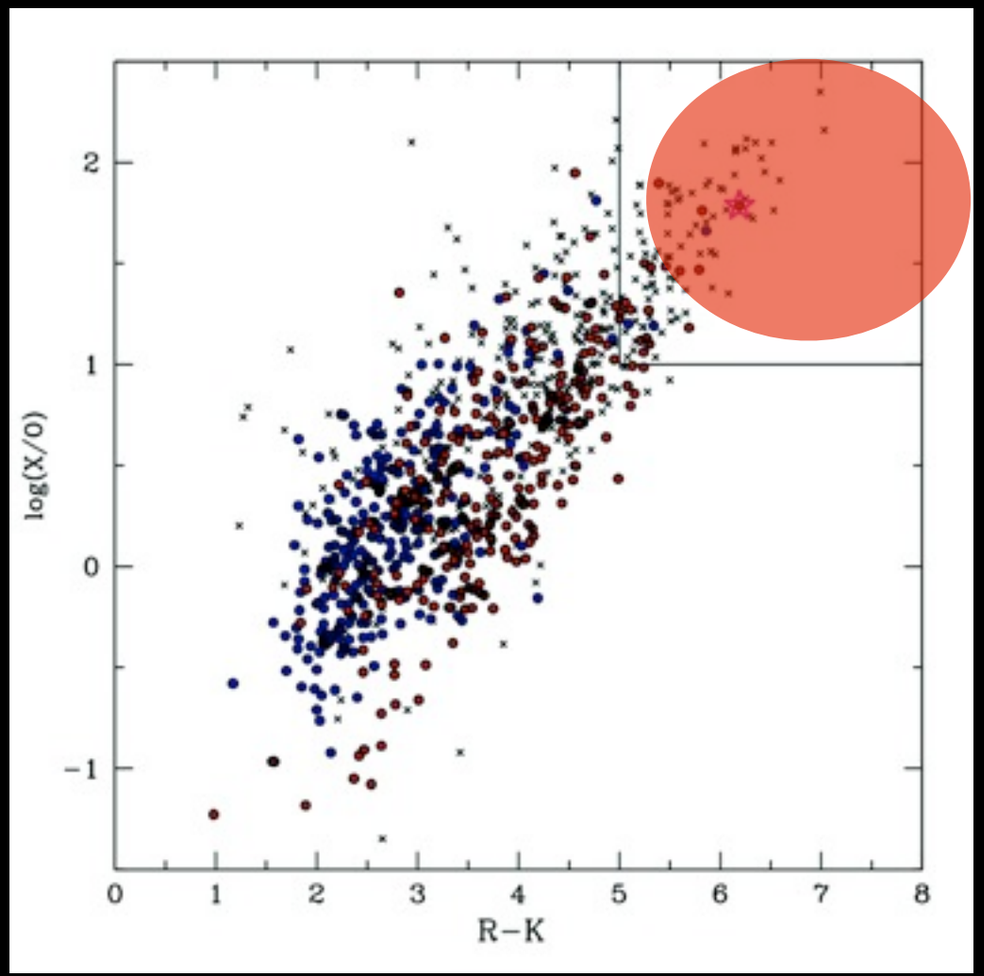
almost 100% complete including photoz (Salvato+09,11)

combined classification on the basis of

X-ray lum and optical spectra

efficiently isolating obscured QSO

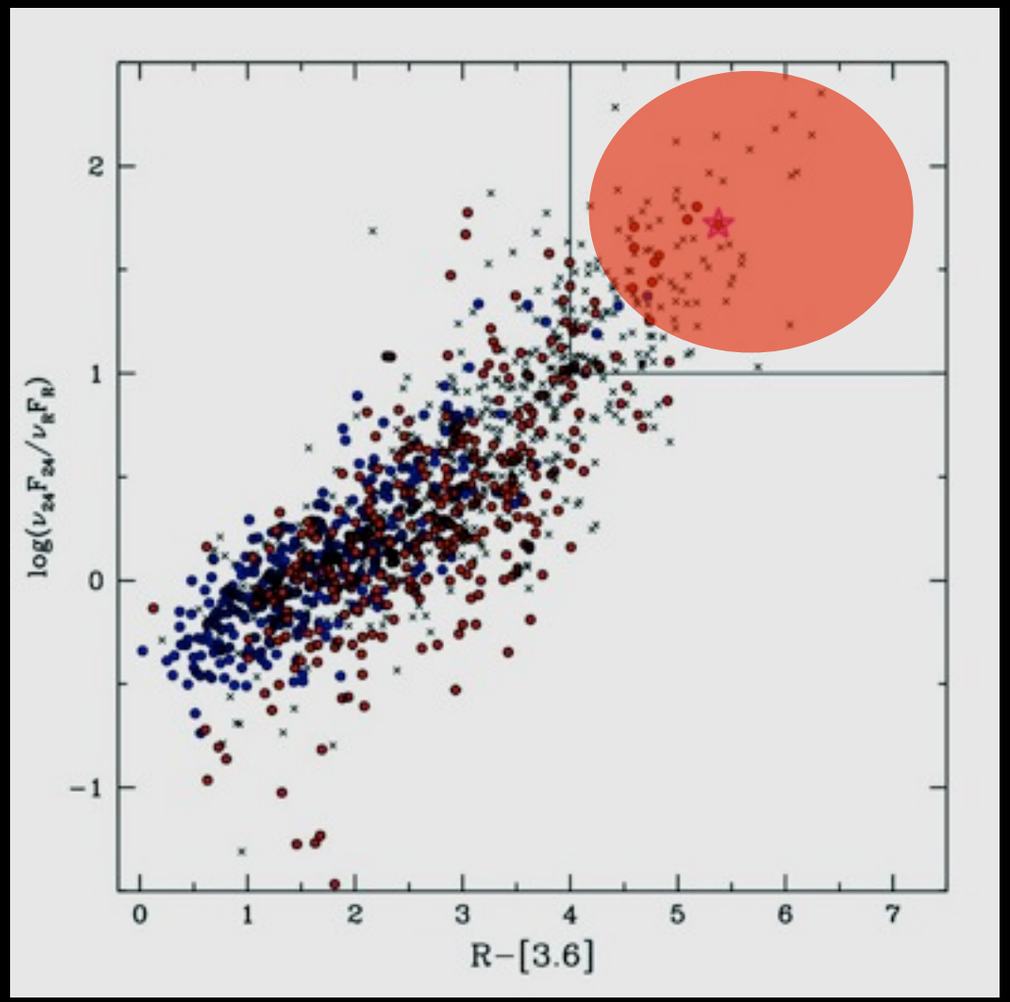
Use correlations between observables for the identified samples to isolate obscured AGN in the unidentified one



X/O vs. R-K
locus with obscured AGN
16 sources with zspec, 12/16 are Type (80%)

all the ones not identified are candidate obscured AGN

proposed by Fiore, MB+03; see also Brusa et a. 2005, Barger+05, Eckart+06 etc.

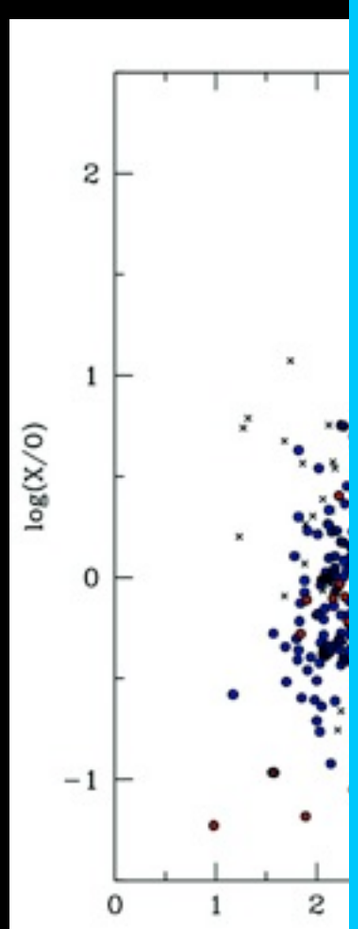


24 micron/R-band flux correlates with R-K

(Fiore+2008, 2009 - diagnostics for CT AGN in MIPS selected samples; see also Martinez-Sansigre+2005,Daddi+2007, Donley+2007, Georgakakis+09 etc.)

efficiently isolating obscured QSO

Use correlations between observables for the identified samples to isolate obscured AGN in the unidentified one

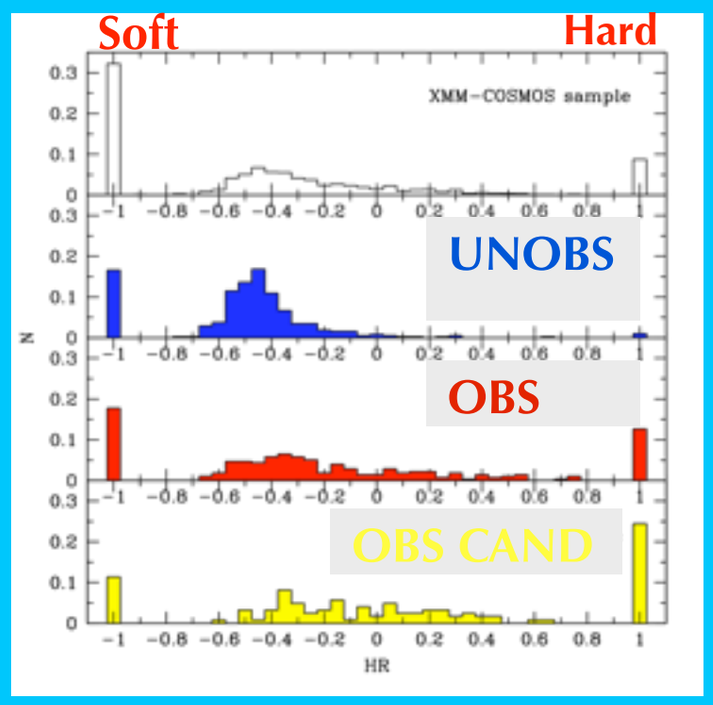


X/O vs. R-K
locus with obsc
16 sources with
(80%)

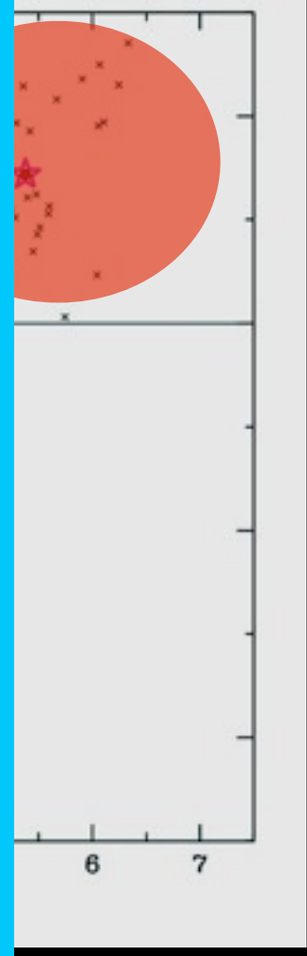
all the ones not
obscured AGN

Combining R-K, X/O and MIR/O selection:

~150 candidates obscured QSO at z>1



follow up with **DEIMOS/FMOS/LUCIFER/X-shooter**
ongoing or proposed
--> BH mass from Halpha in NIR, looking at these objects in scaling relation and complement the results on type 1 AGN (Merloni et al. 2010, Trump et al. 2010)

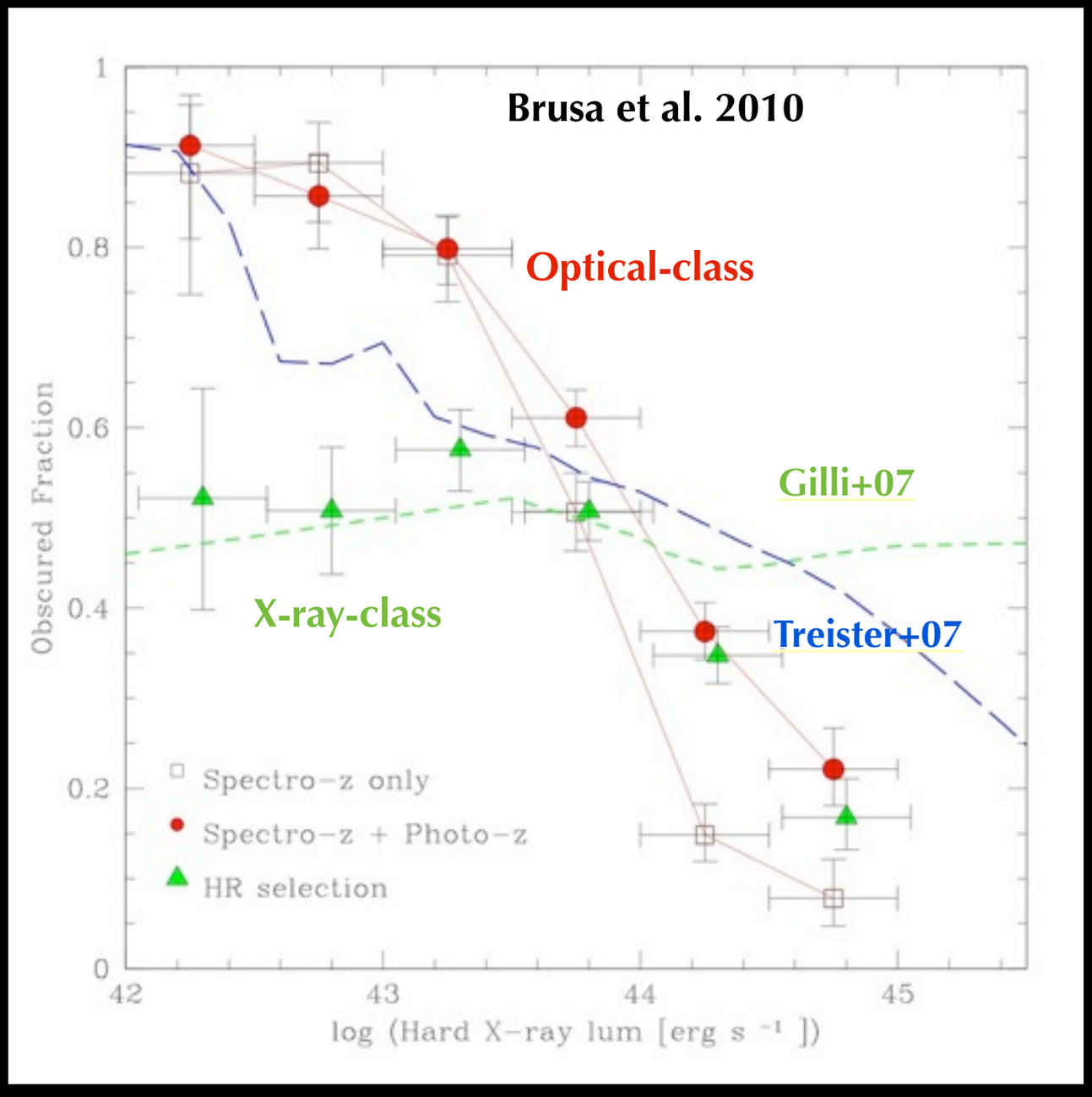


tes with R-K

cs for CT
s; see also
li+2007,
9 etc.)

proposed by Fiore, MB+03; see also Brusa et a. 2005, Barger+05, Eckart+06 etc.

What happens at lower luminosities? (Lx ~10^{42} - 10^{44} erg/s)



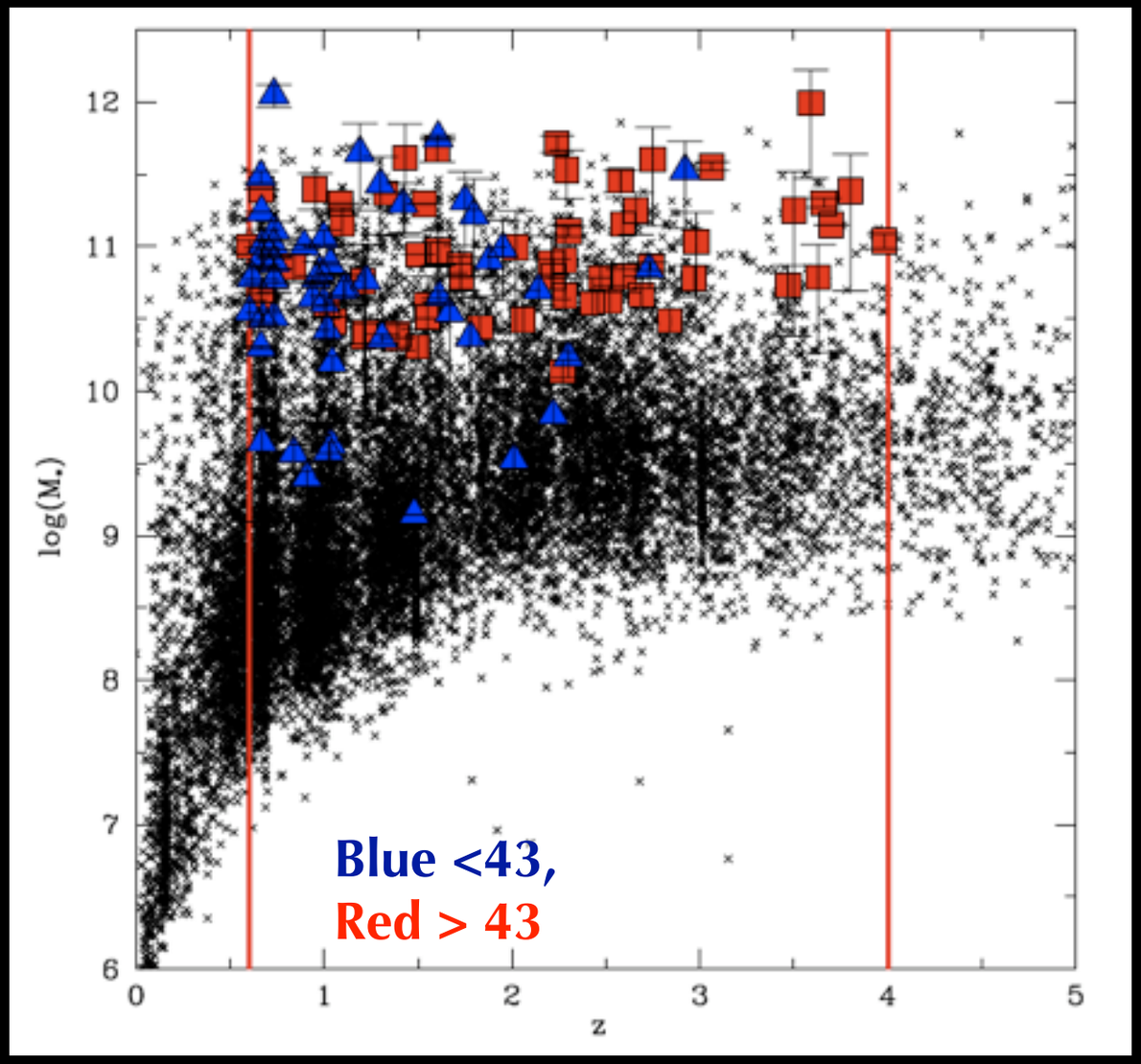
Type 2 AGN fraction, strong function of L: less luminous, most obscured

Same results in DIFFERENT bands (Simpson+05, Maiolino+08, Hasinger 2008, Bongiorno+10, Burlon+11, Brightman+11)

Receding torus scenario: most luminous more efficient in cleaning the environment (see also clumpy models, e.g. Nenkova et al. 2008)

Low-L:
Relative contribution of AGN and host:
"extra" obscuration from host galaxy at low-L(optical and X-ray classification do not agree)

low luminosities obscured AGN: CDFS/MUSIC

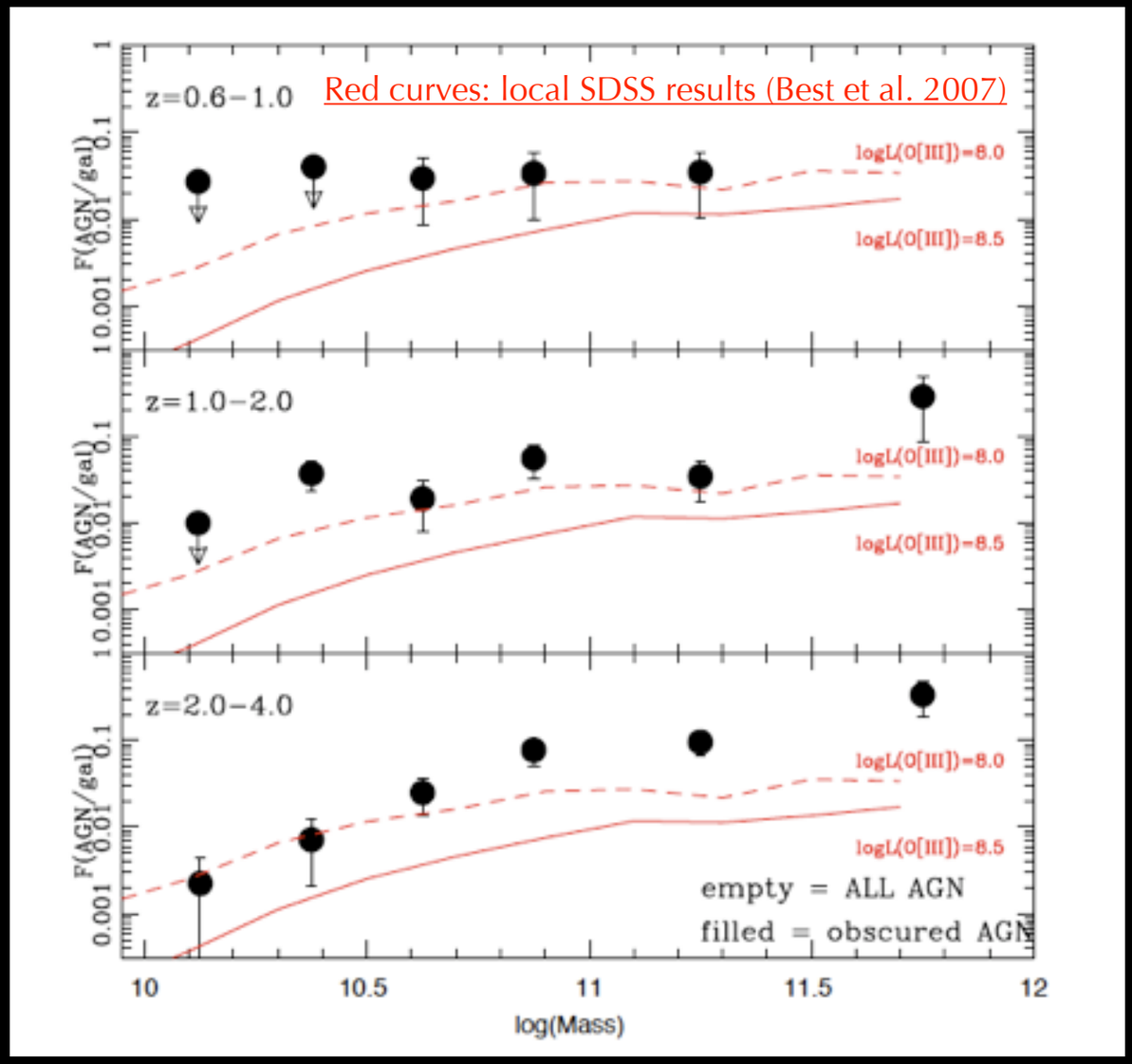


1Ms CDFS/MUSIC sample

~110 obscured AGN (BL AGN removed)

Most X-ray selected obscured AGN live in massive galaxies

Brusa et al. 2009 (CDFS+MUSIC)



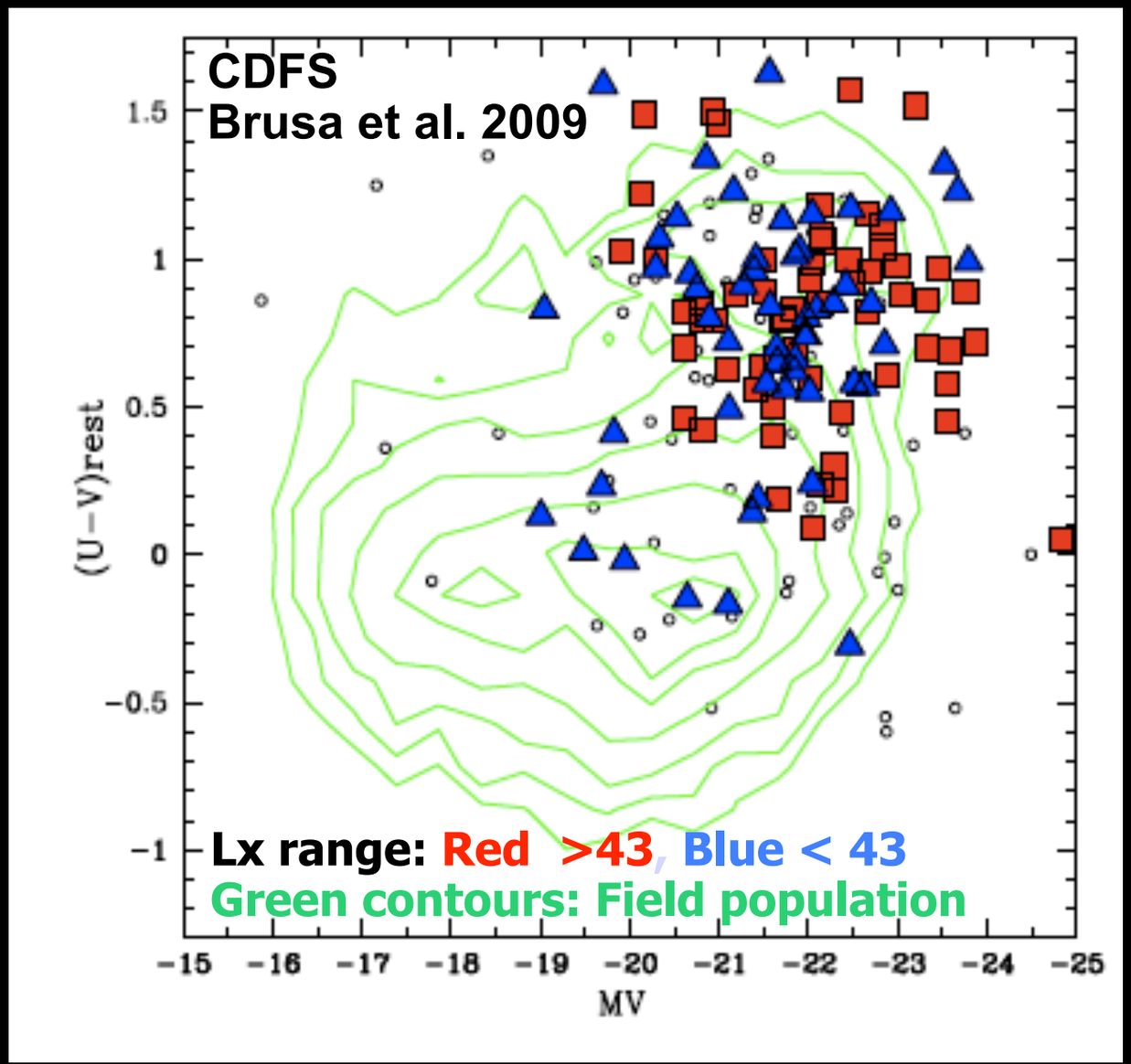
(see also Yamada+09, Bundy+08, Silverman+08, Bluck+11, Aird talk)

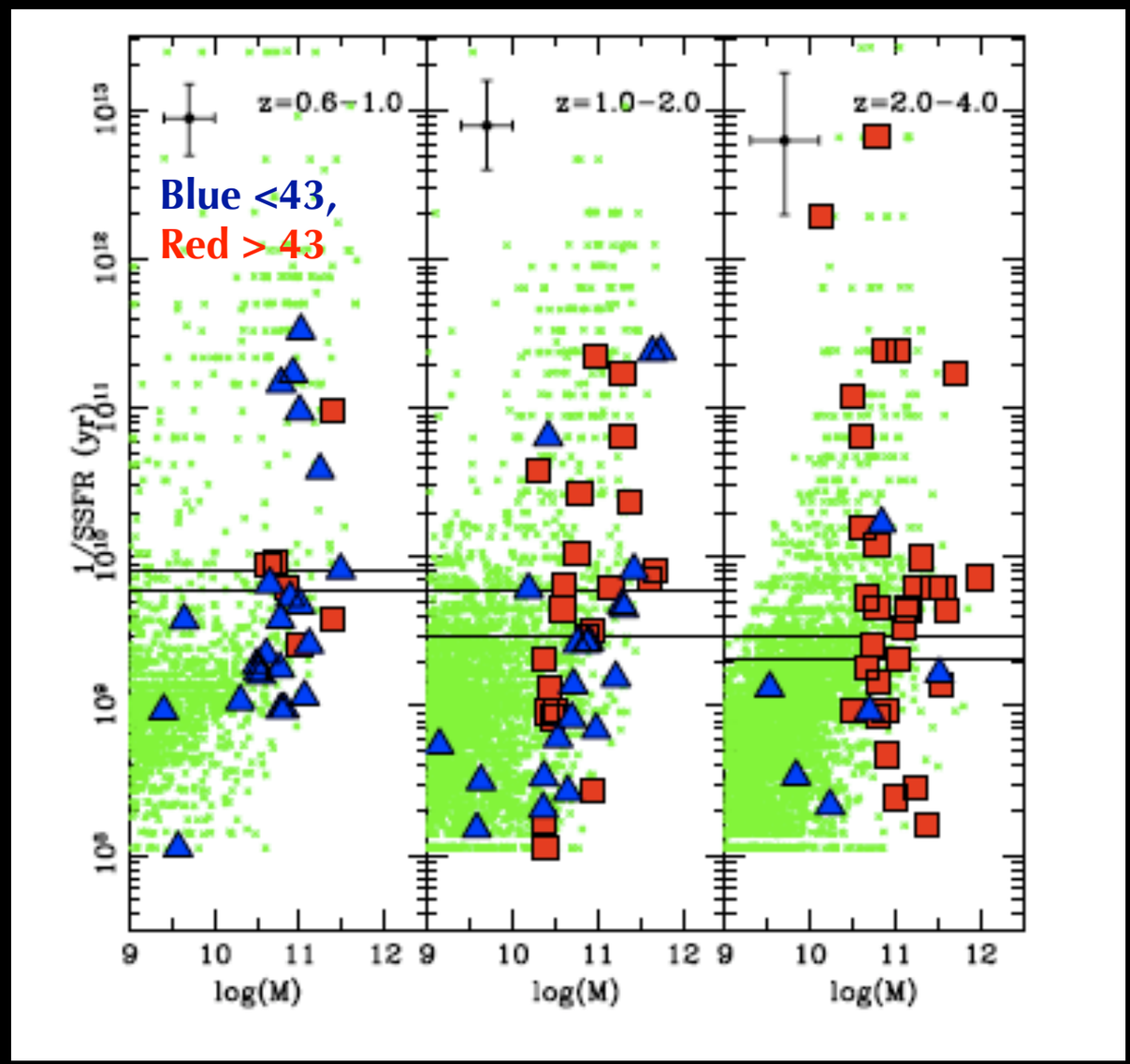
AGN fraction increases with stellar mass

Trend similar to what observed in the local Universe; higher normalization suggest higher AGN duty cycle?

obscured AGN host galaxies: colors and SFR

Masses and SFR from Santini+09





Host of obscured AGN are RED and optically luminous

No clear trend with Lx (see also Nandra et al. 2007, Cardamone+2009, Silverman+2009)

relative contribution of host/AGN

50% X-ray selected obscured AGN live in STARFORMING galaxies (>20 Msun/year or 1/SSFR<t(Hubble))

works being extended also in XMM-COSMOS sample (Mainieri+11, Lusso+11)

See Mainieri & Lusso talks / Bongiorno poster)

Pre- or Post ?

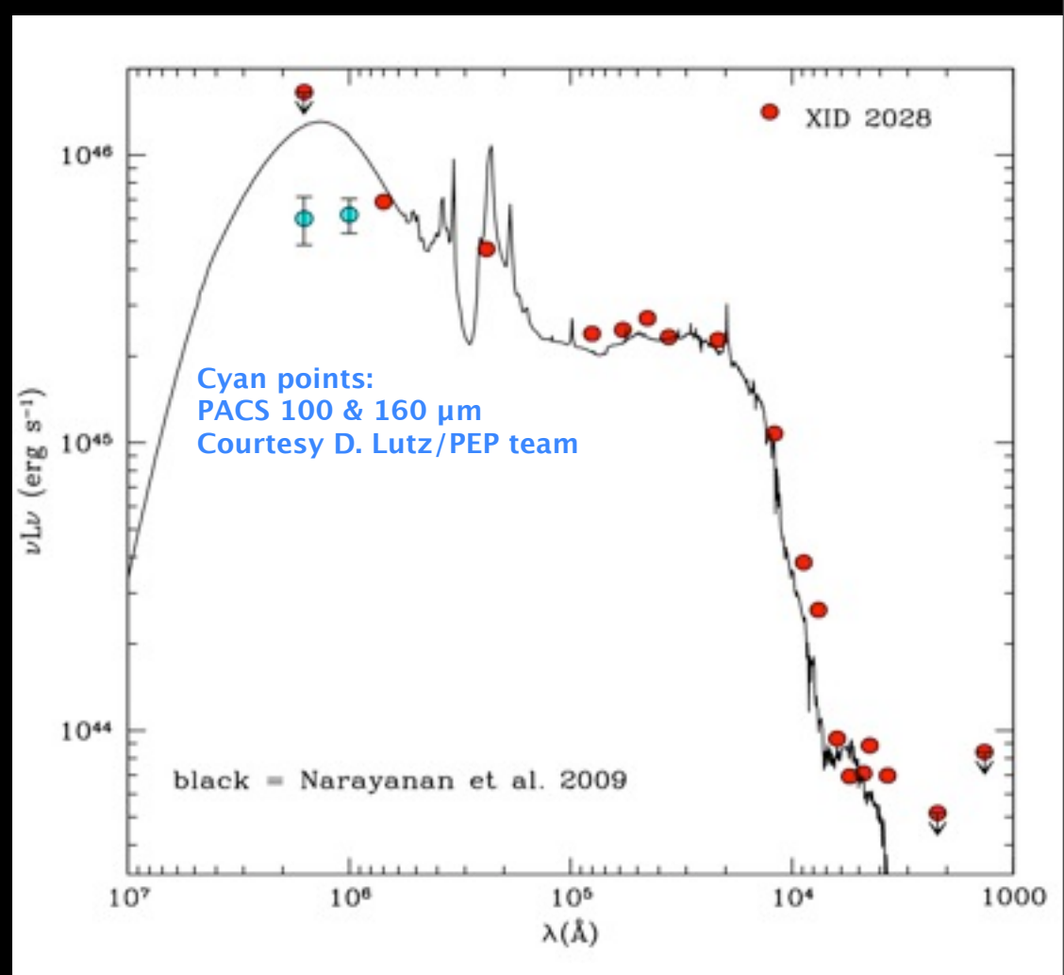
Obscured X-ray selected sources at z>1 are red
--> effect of (negative) feedback efficient in stopping star formation, or AGN is in dusty environment?

Evidences for ***both*** !

Host galaxies both **passive ellipticals** or **dusty star-forming** from morphological analysis and/or SED fitting (see also Mainieri talk yesterday)

--> **different phases/timescales are sampled!**

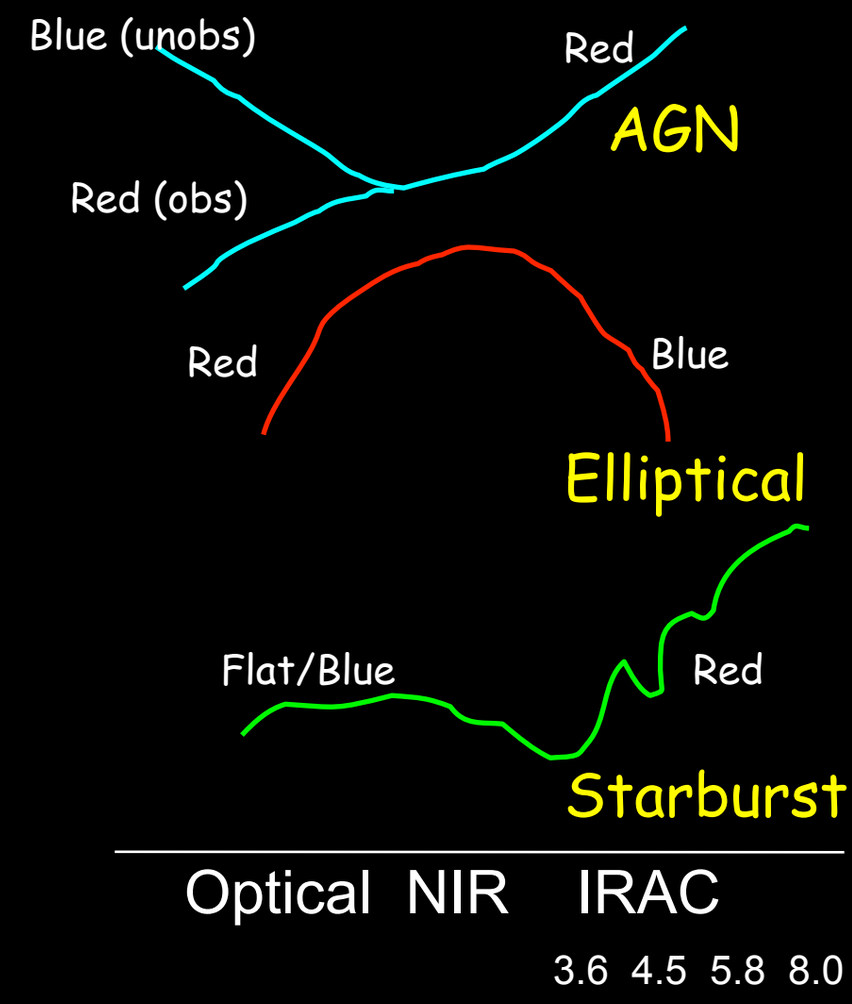
Essential role of Herschel in disentangling SB and AGN components
(see also Shao et al. 2010, Gruppioni et al. 2011)



The IR selected obscured AGN population

Alternative approach: INFRARED

- AGN (unobs and obs) are expected to have warm power-law sed at >1micron (≠ from elliptical/starburst)



Alternative approach: INFRARED

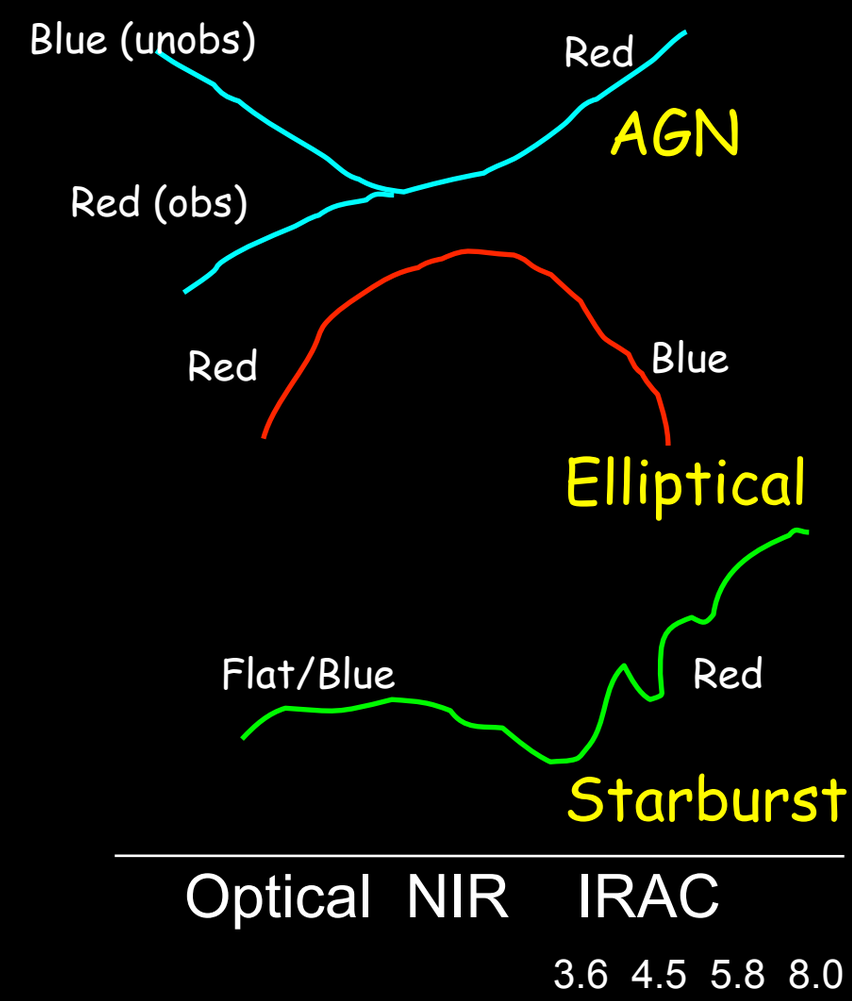
- AGN (unobs and obs) are expected to have warm power-law sed at >1micron (≠ from elliptical/starburst)

AGN (both type 1 and 2) can be isolated in NIR/MIR diagrams and they are ~ same order of magnitude of X-ray selected obscured AGN

(Lacy et al. 2004, Hatziminaouglou et al. 2005, Stern et al. 2005, Donley et al.2008, Pope et al. 2008, Fiore et al. 2008, Luo et al. 2011)

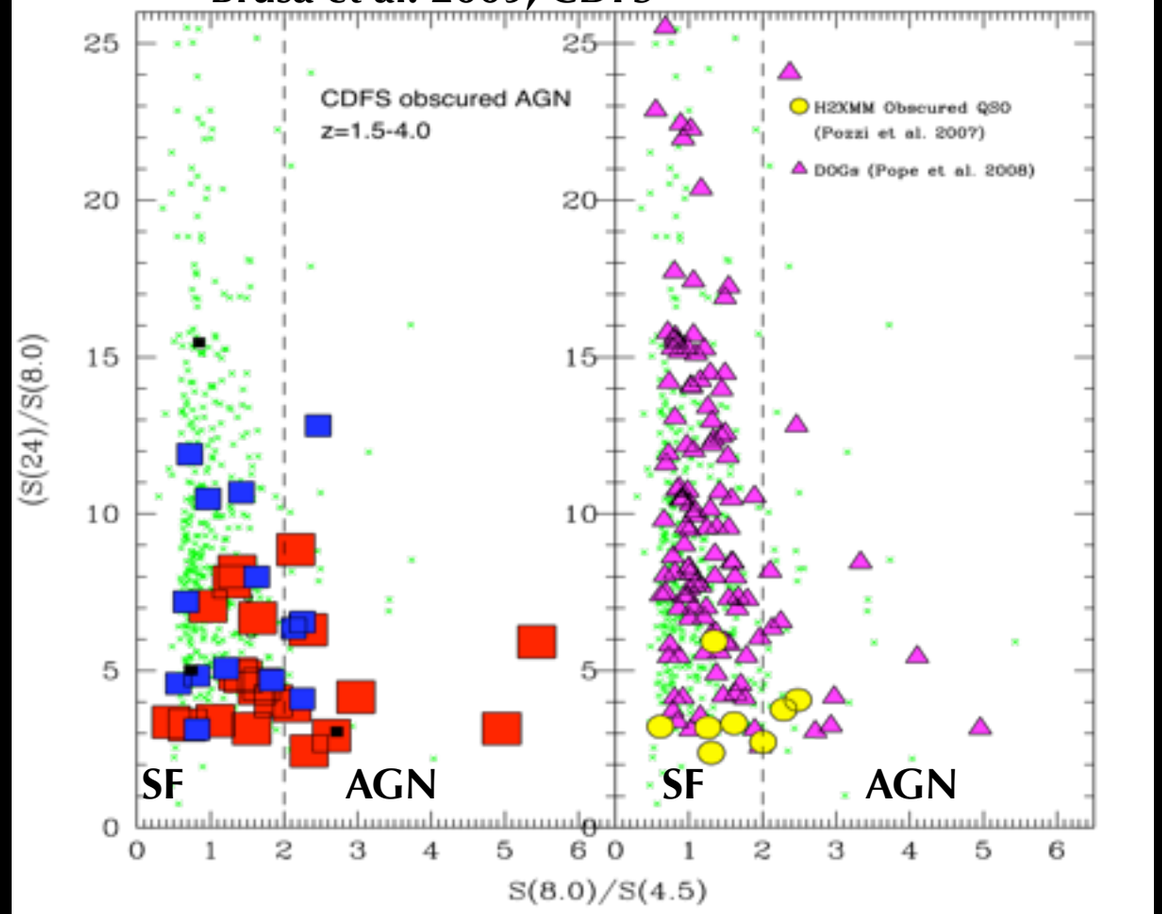
Main issues:

reliability (are only AGN selected?)
completeness (are all AGN selected?)

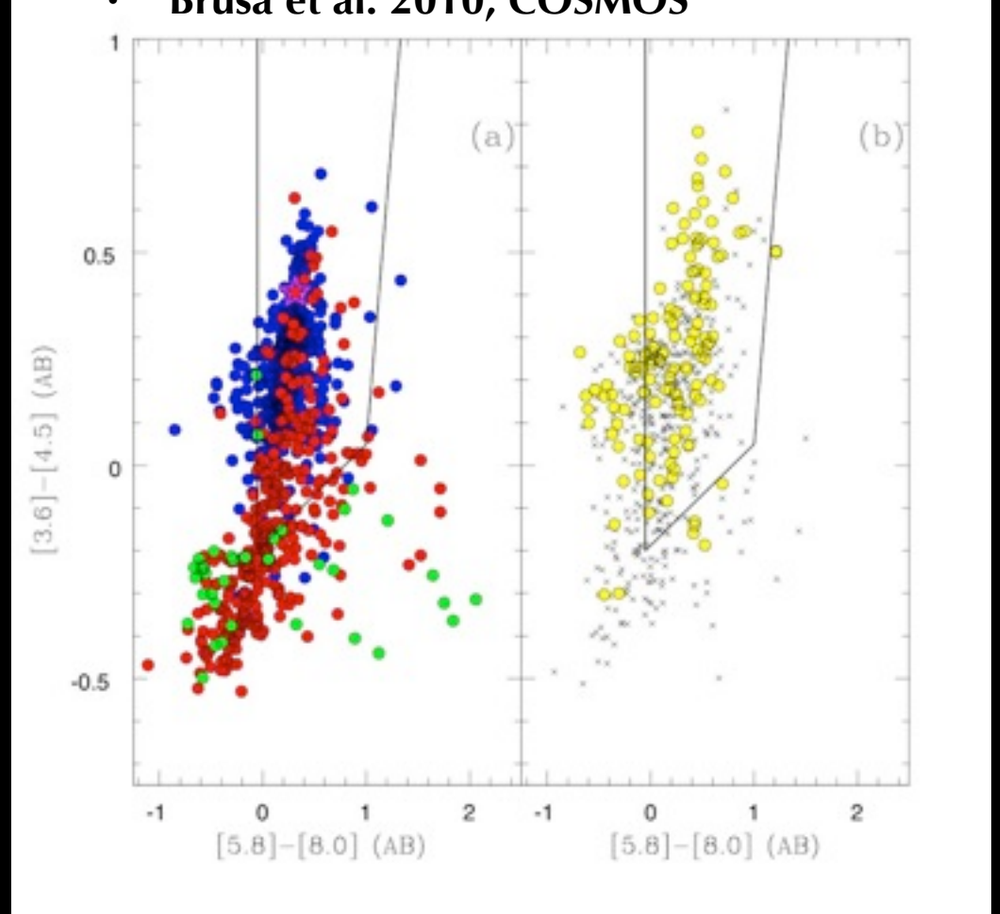


Completeness issues (1)

- Brusa et al. 2009, CDFS



- Brusa et al. 2010, COSMOS



Pope et al. (2008) diagram

>50% of obscured AGN lie outside the AGN

locus in the starburst region

Stern+2005, Lacy+2005 diagrams:

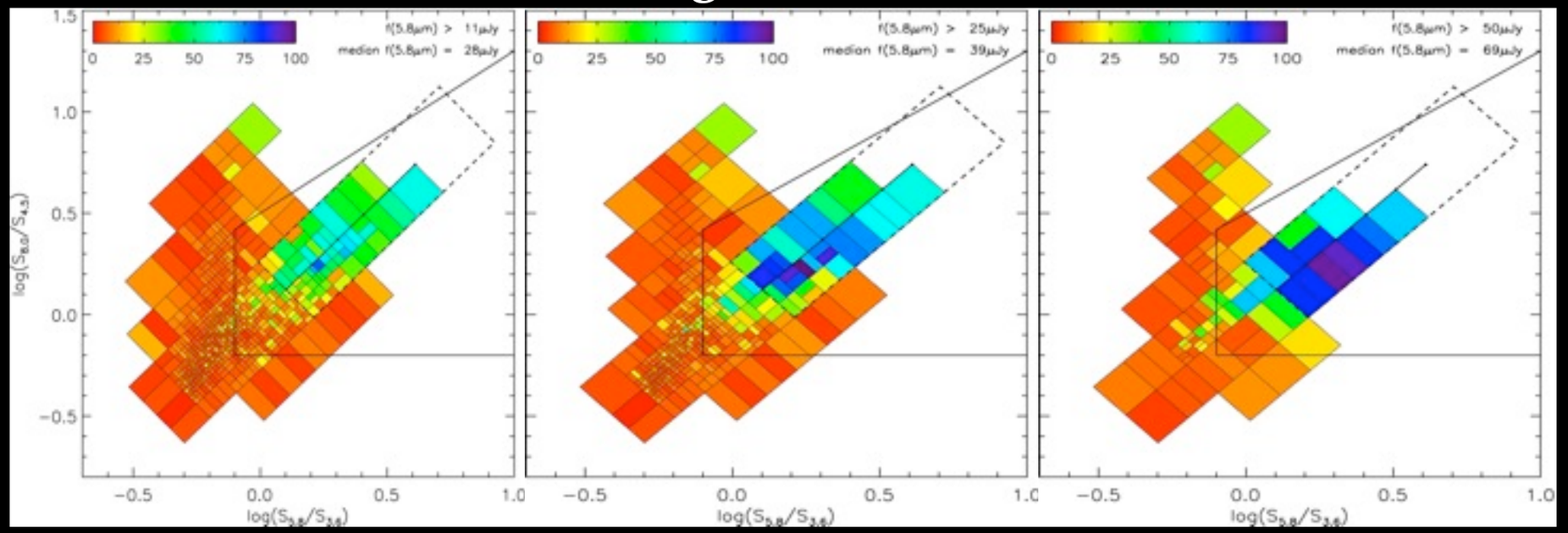
~50% of obscured AGN lie outside the AGN

wedges (~20% of the most luminous..)

- **Importance of combined X-ray / IR/MIR coverage to isolate obscured accreting black holes**
- **strong luminosity dependence for the efficiency**

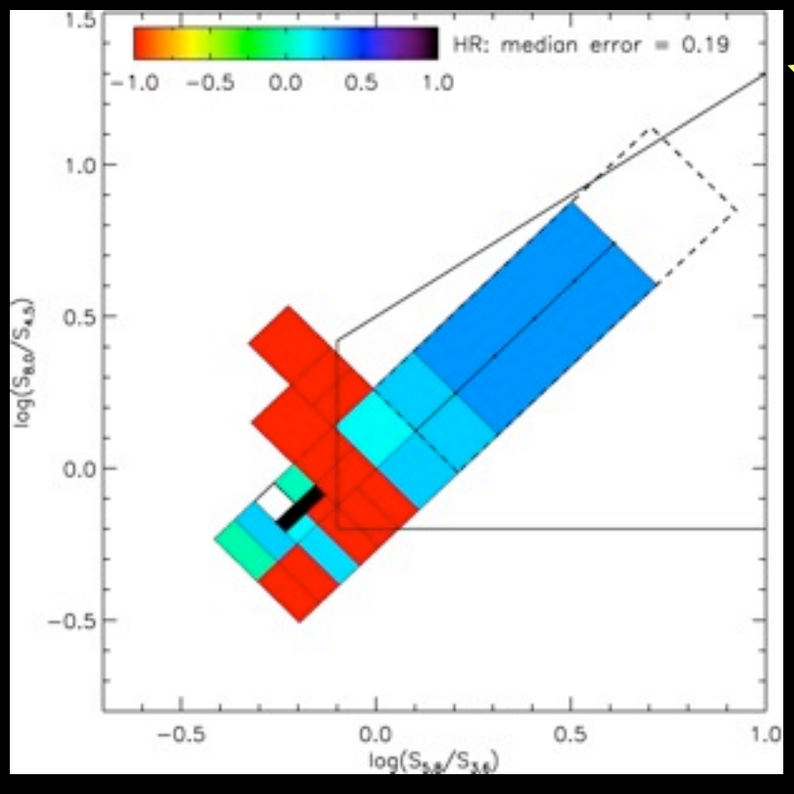
Reliability issues (2)

Increasing IRAC flux -->



Lacy et al. wedge

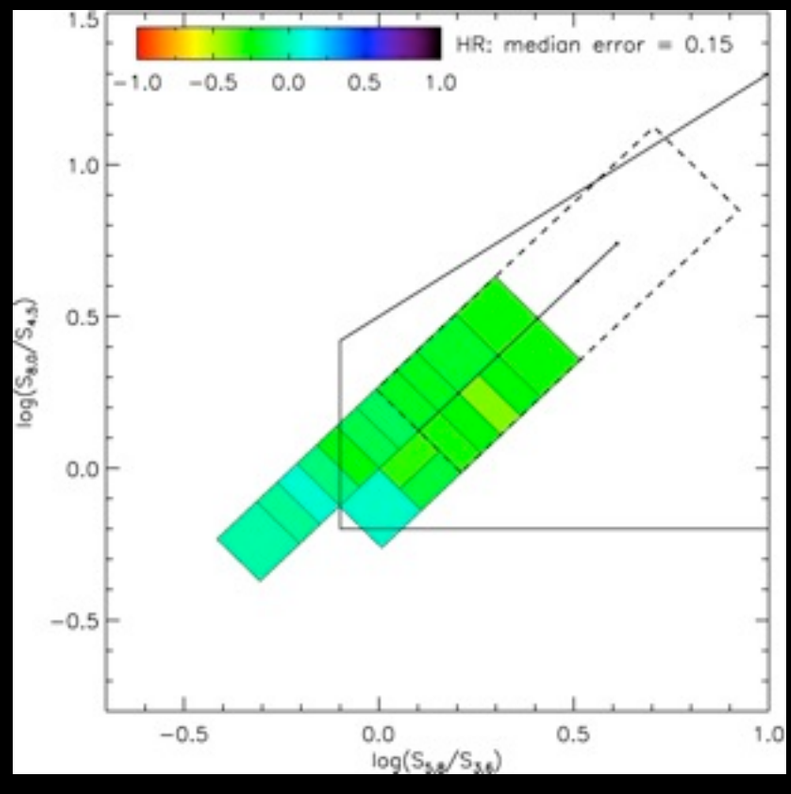
fraction of X-ray detected sources increases with IRAC flux



Average (stacked) HR in X-ray undetected population

is higher than

average (measured) for X-ray detected sources



Donley, MB et al. subm

Summary & Future

X-ray selected luminous, obscured AGN are can be efficiently isolated in X-ray surveys from multiwavelength diagnostics (3 bands!)

Host galaxies of z>1 obscured AGN show both high, dust obscured starforming galaxies and passive ellipticals (different phases, during and right after major accretion?)

IR criteria suffer from severe contamination as you approach faint fluxes / completeness is also an issue

What's next ?

"complete" AGN luminosity function (joining IR + Xray samples)

Complete census of ***accretion*** (BH mass and Mdot) and star ***formation*** (Mstar and SFR) needed to get the full picture

→ A truly multiwavelength approach and a better statistics is mandatory
(Herschel, ALMA, WFC3, IR spectrographs …)

Obscured, Luminous sources in the "transition" phase are rare --> large are and bright X-ray surveys (prospects for eROSITA!)

Thanks !

related poster/talks (among others):

J. Aird (talk 27.6) --> Stellar masses of AGN host galaxies
V. Mainieri (talk 27.6) --> Host galaxies properties of QSO2 in COSMOS
A. Comastri (invited 29.6) --> obscured AGN in X-ray surveys
D. Burlon (talk 30.6) --> Type 2 AGN fraction in Swift/BAT samples
E. Lusso (talk 30.6) --> Type 2 AGN SED and bolometric corrections

I. Balestra (poster # G01) --> SED of obscured AGN in CDFS
A. Bongiorno (poster # G02) --> SED fitting decomposition and AGN hosts mass function
E. Rovilos (poster #G40) --> Star formation properties of osbcured AGN

other COSMOS talks/posters:

V. Allevato (talk 30.6) --> Bias evolution and clustering prperties in XMM-COSMOS
F. Civano (poster #G07) --> High redshift (z>3) AGN in C-COSMOS
M. Salvato (poster #G41) --> Photometric redshifts for Chandra & XMM COSMOS AGN