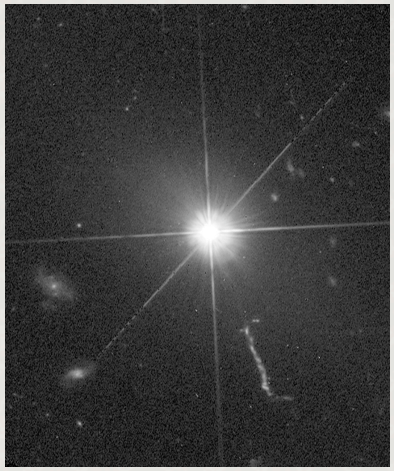
Nuclear Activity



3C 273

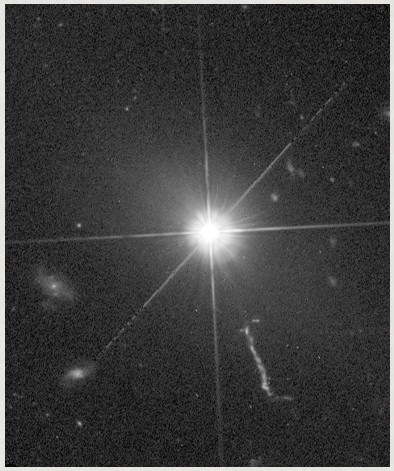
10^{47} erg/s

AGN span an enormous range in accretion rate.

SDSSJ0837+3124

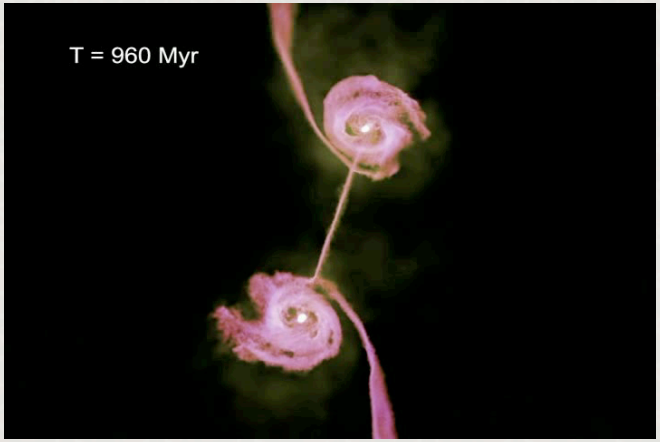
10^{43} erg/s

Nuclear Activity "Co-evolution" Star Formation



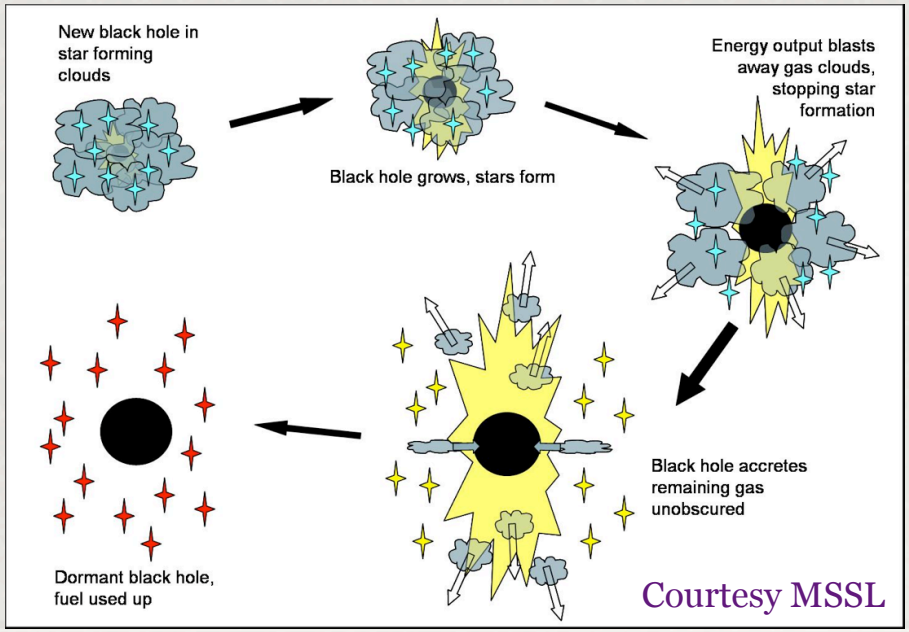
3C 273
10^{47} erg/s

Di Matteo+ 2005



AGN span an enormous range in accretion rate.

SDSSJ0837+3124
10^{43} erg/s



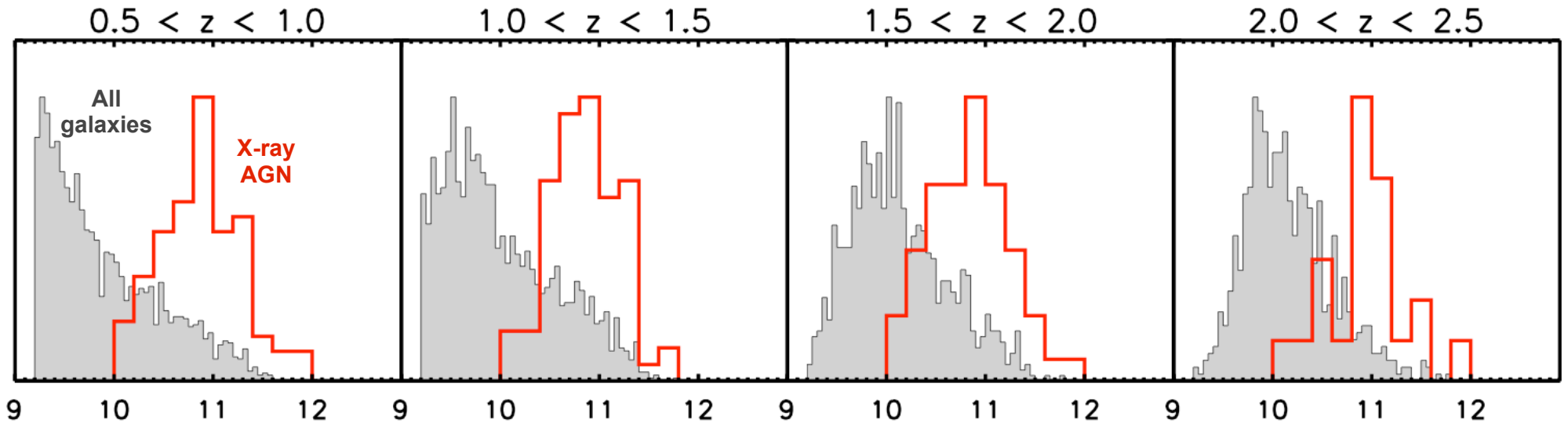
Star-Formation in Active Galaxies

A Multi-Faceted View

David Rosario
MPE, Garching; PEP Consortium

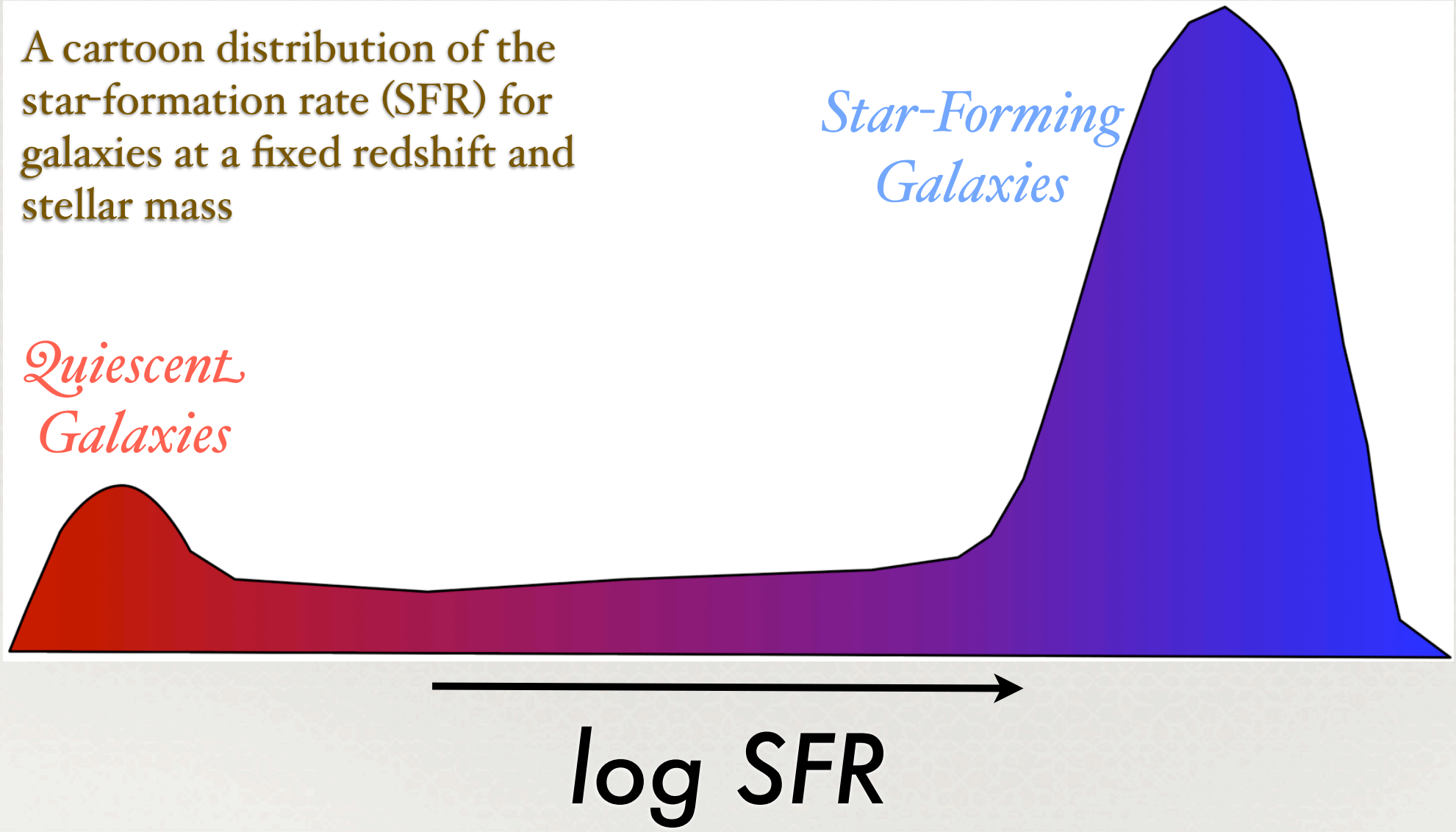
Dieter Lutz, Hagai Netzer, Paola Santini, Reinhard Genzel, Li Shao

AGN hosts are massive galaxies



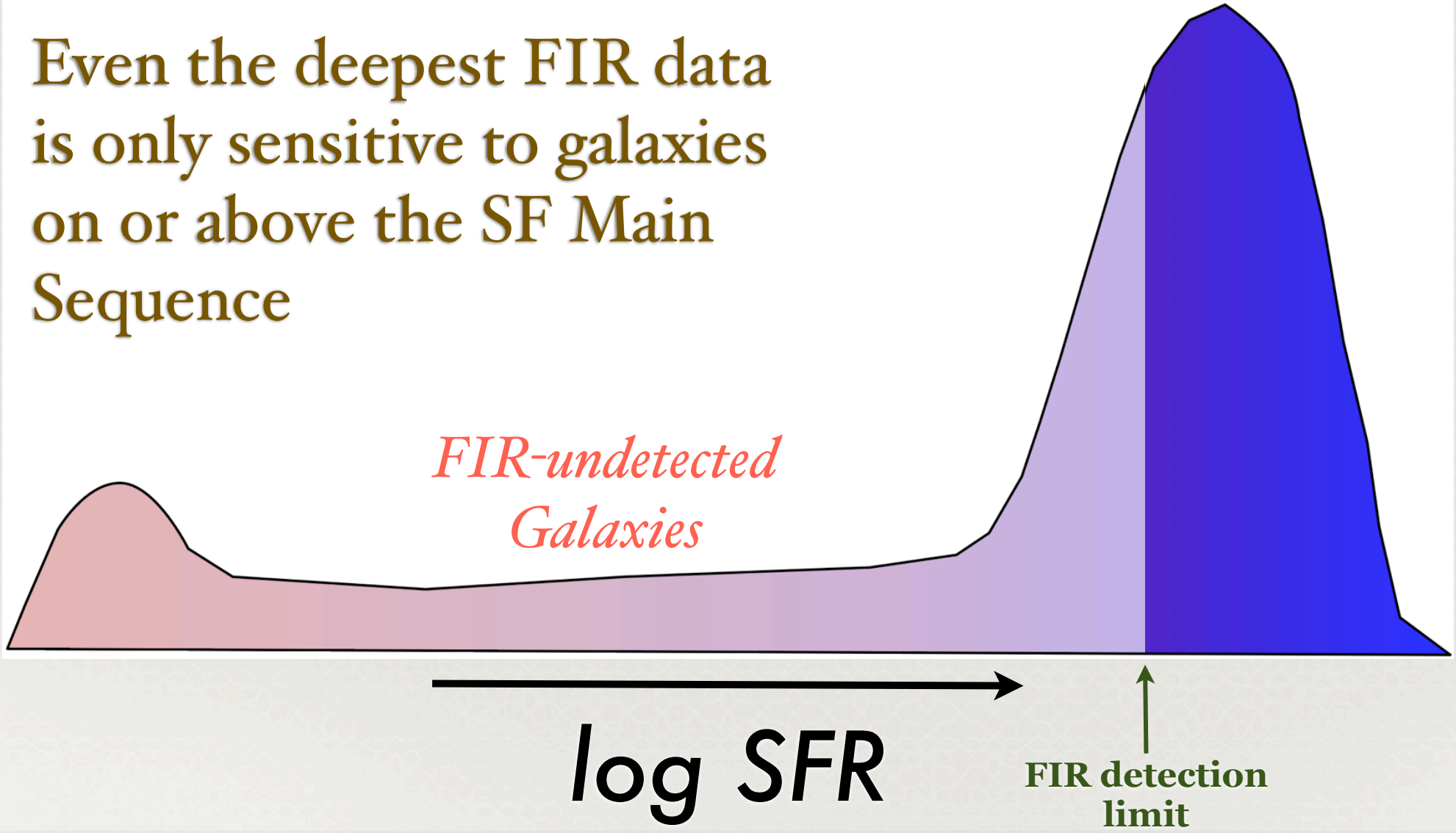
Detectable *AGN are rare.*
Their hosts are among the most massive galaxies at all redshifts.

A cartoon distribution of the star-formation rate (SFR) for galaxies at a fixed redshift and stellar mass

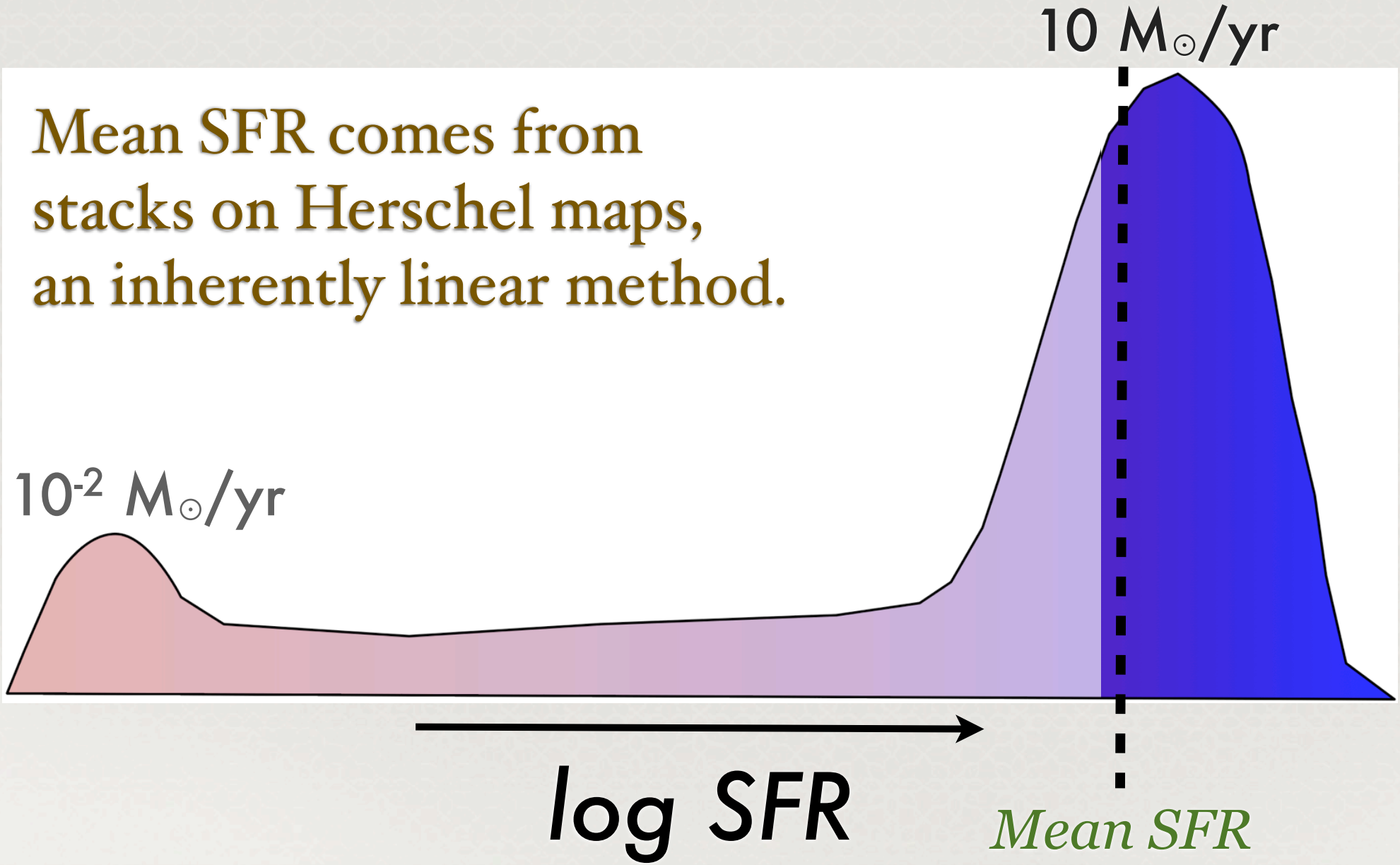


FIR-detected Galaxies

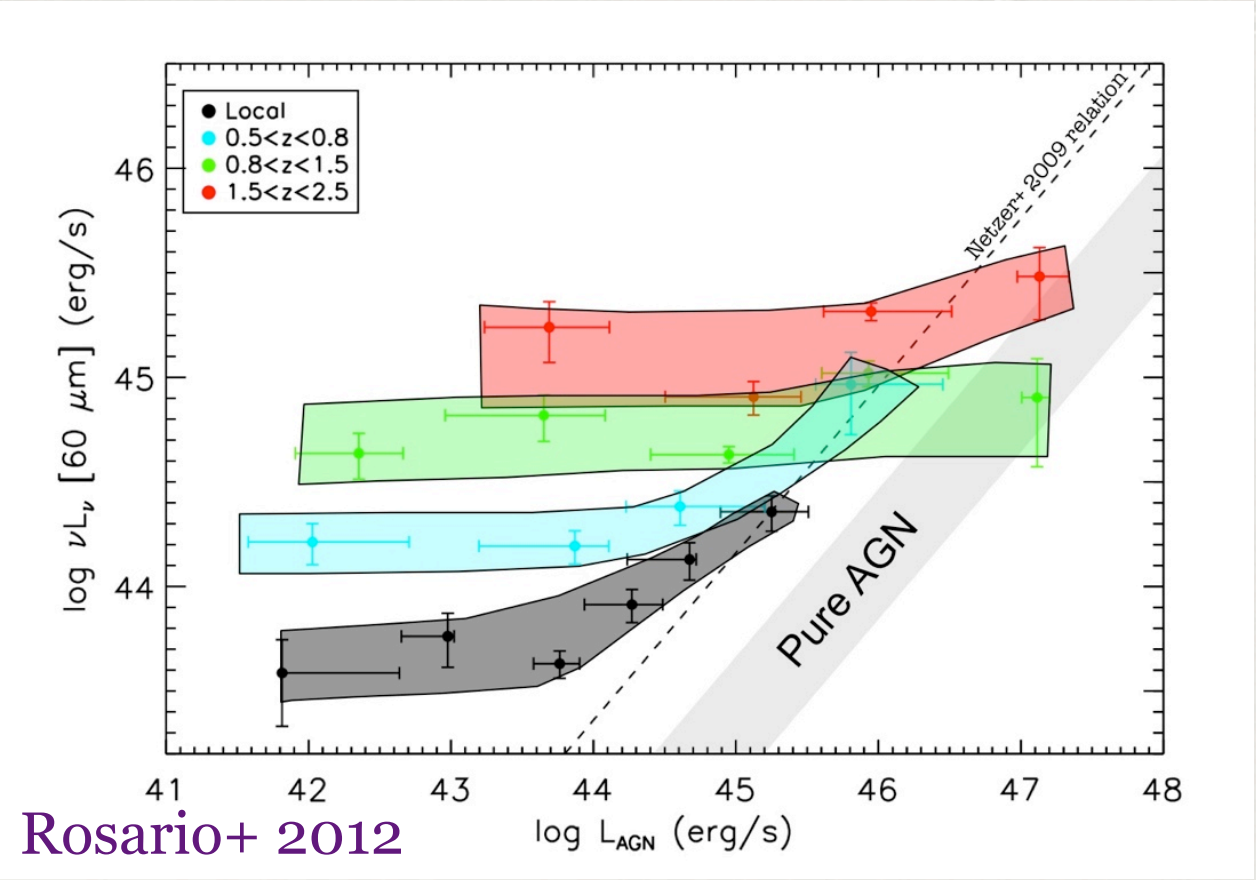
Even the deepest FIR data is only sensitive to galaxies on or above the SF Main Sequence



Mean SFR comes from stacks on Herschel maps, an inherently linear method.



Star-formation across AGN luminosity



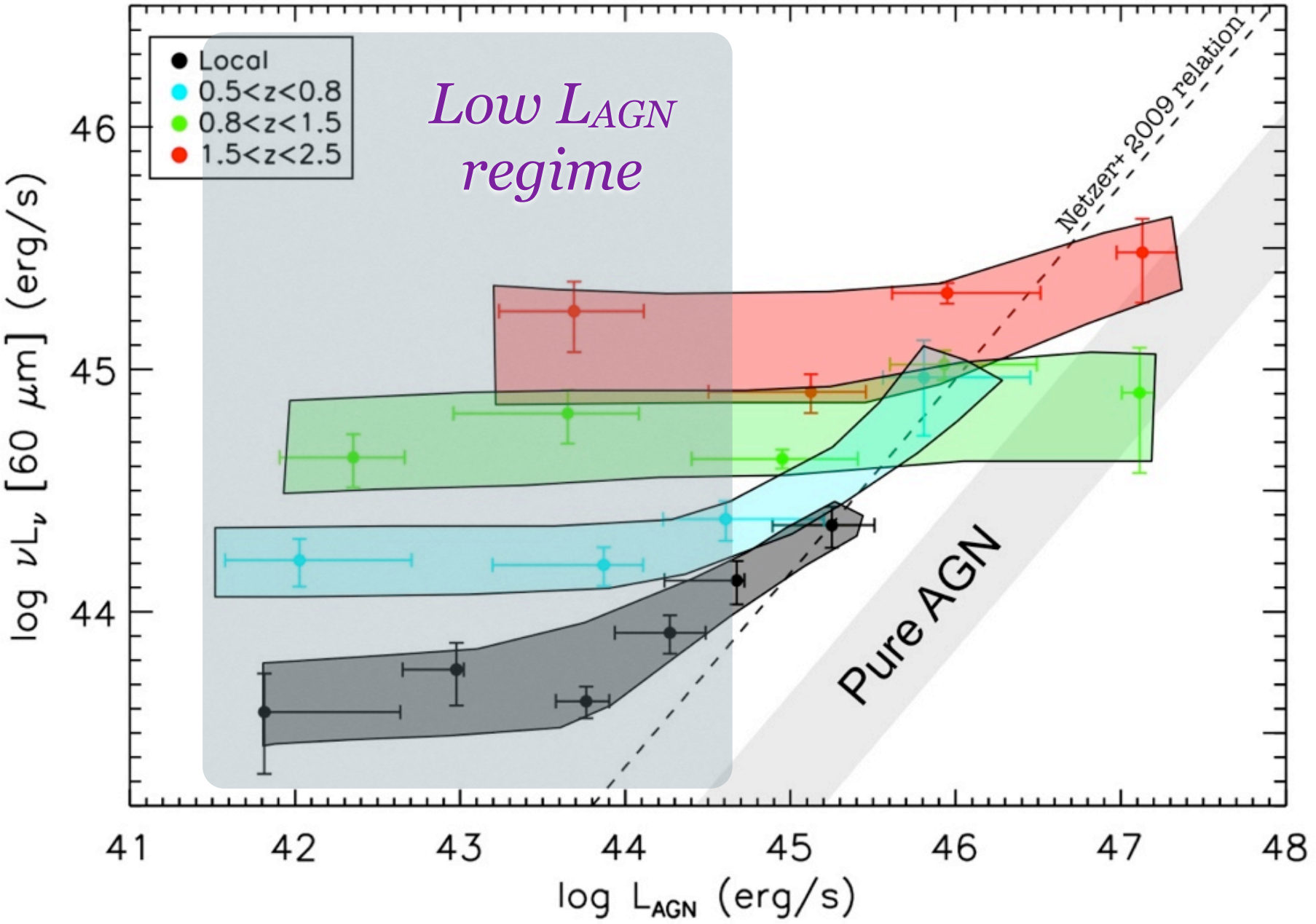
Rosario+ 2012

Also see Lutz+ 2010, Shao+ 2010, Hatziminaoglou+ 2010, Pozzi+ 2012

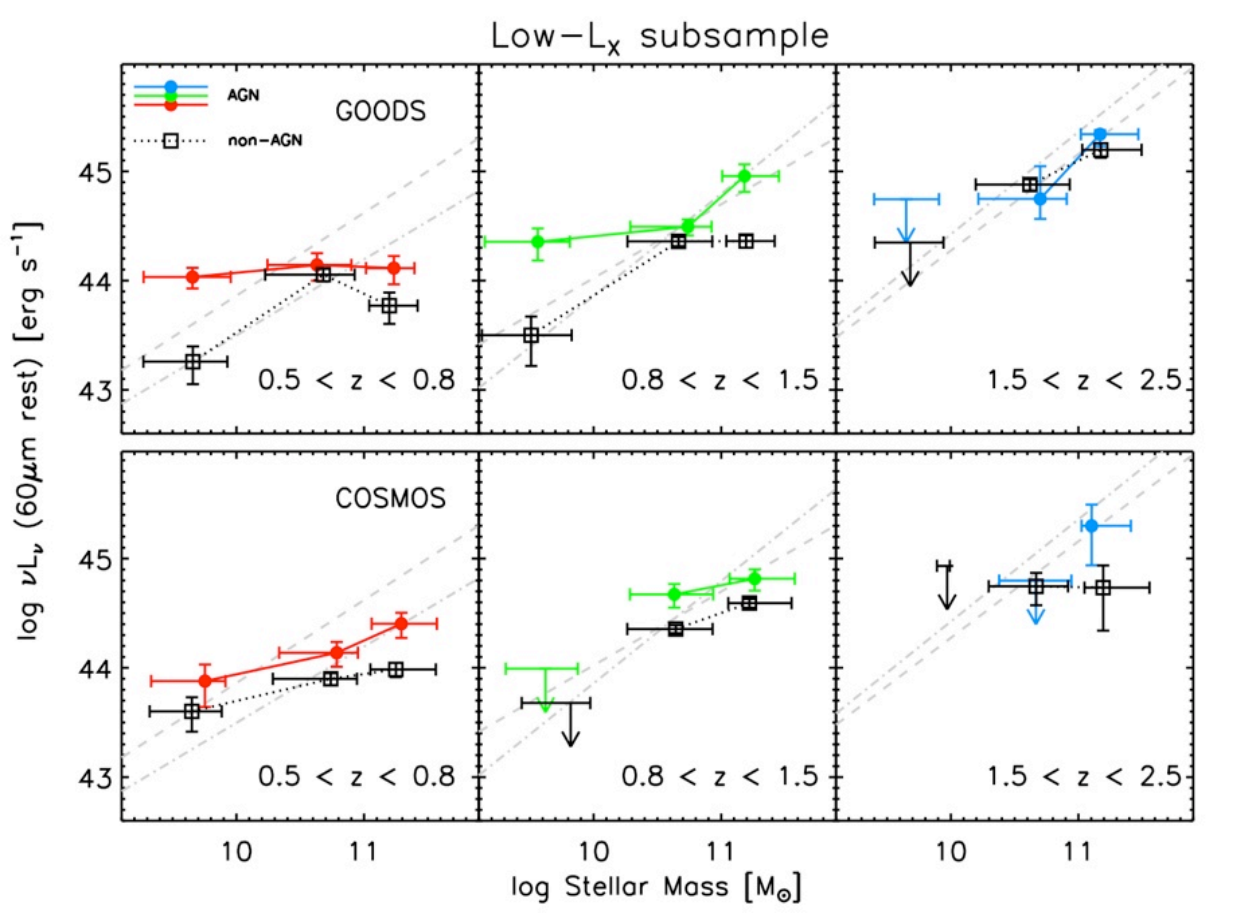
A correlation between AGN power and SFR is seen among X-ray AGN only at low redshifts and high luminosities.

The correlation may weaken or disappear at high redshifts.

Page+ 2012/Harrison+ 2012 for uncertainties and role of cosmic variance.


Local
0.5<z<0.8
0.8<z<1.5
1.5<z<2.5
Low L_{AGN} regime
Netzer+ 2009 relation
Pure AGN
log νL_ν [60 μm] (erg/s)
log L_{AGN} (erg/s)
46
45
44
41
42
43
44
45
46
47
48

Most star-forming AGN are on the Main Sequence (?)



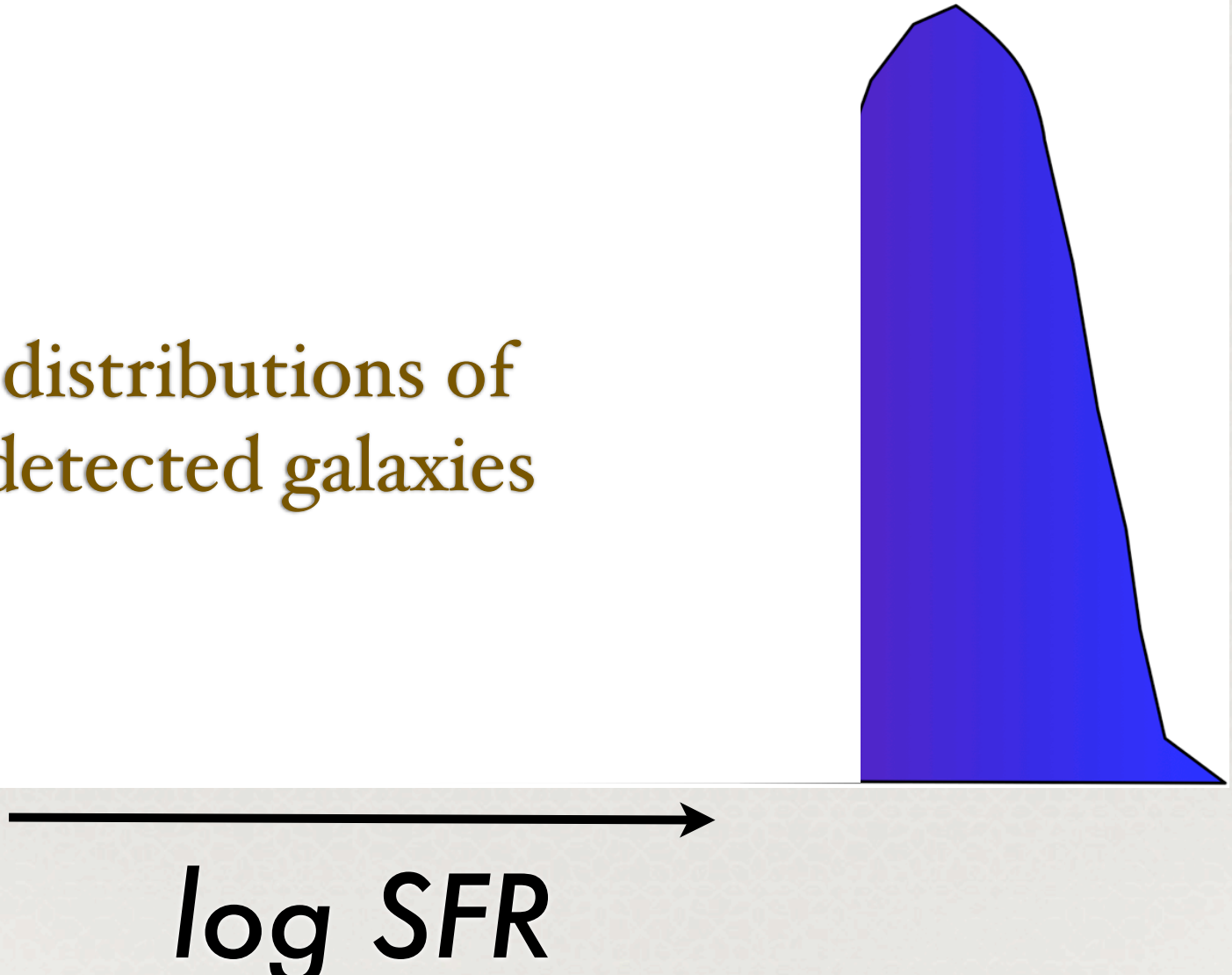
The mean SFR of low and moderate luminosity AGN are enhanced over equally massive inactive galaxies.

However, this is not due to higher SFRs among star forming AGN.

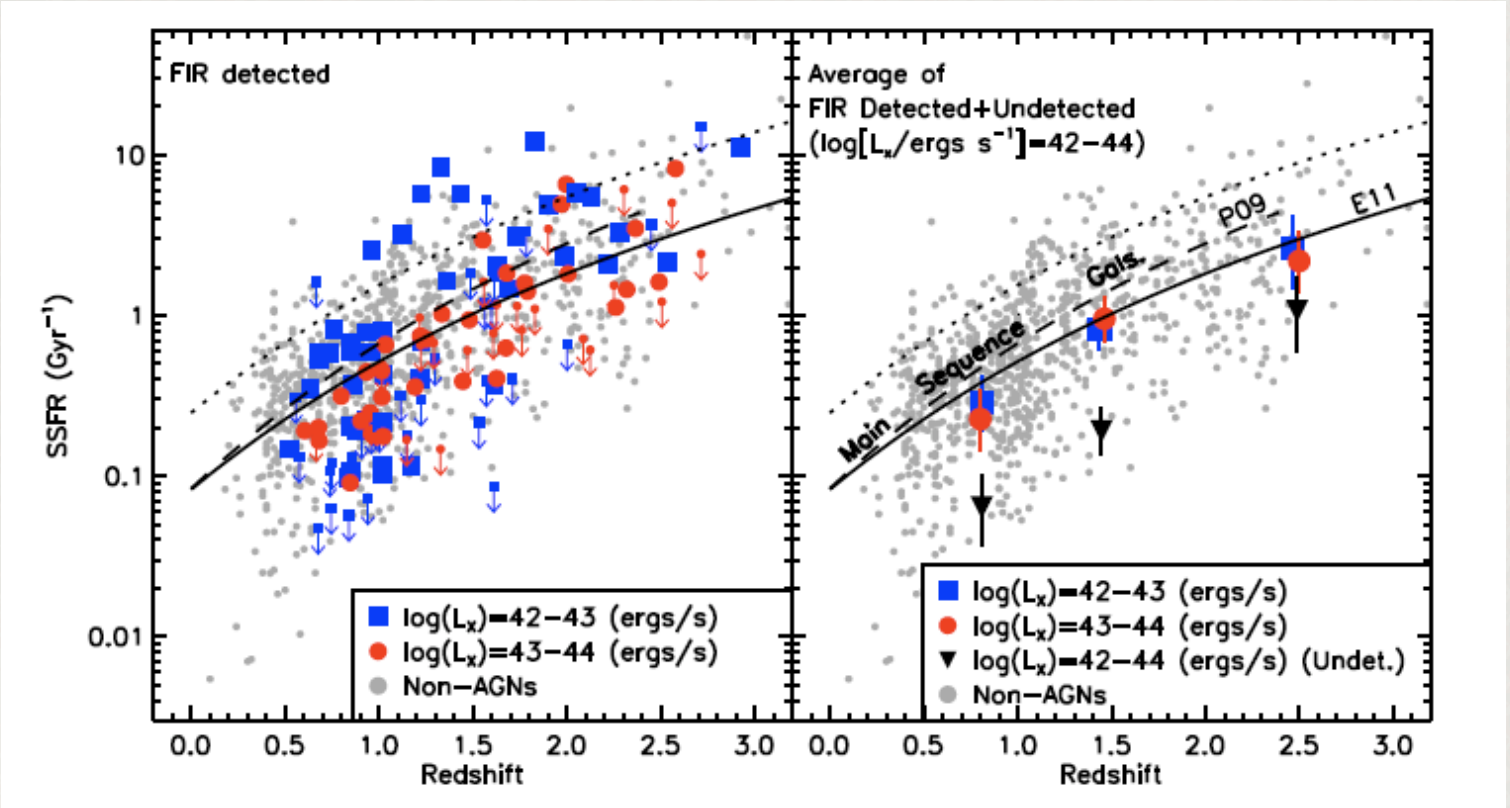
Santini+ 2012

With deep PACS data in GOODS, we explore:

SFR distributions of
FIR-detected galaxies



Most star-forming AGN are on the Main Sequence (!)

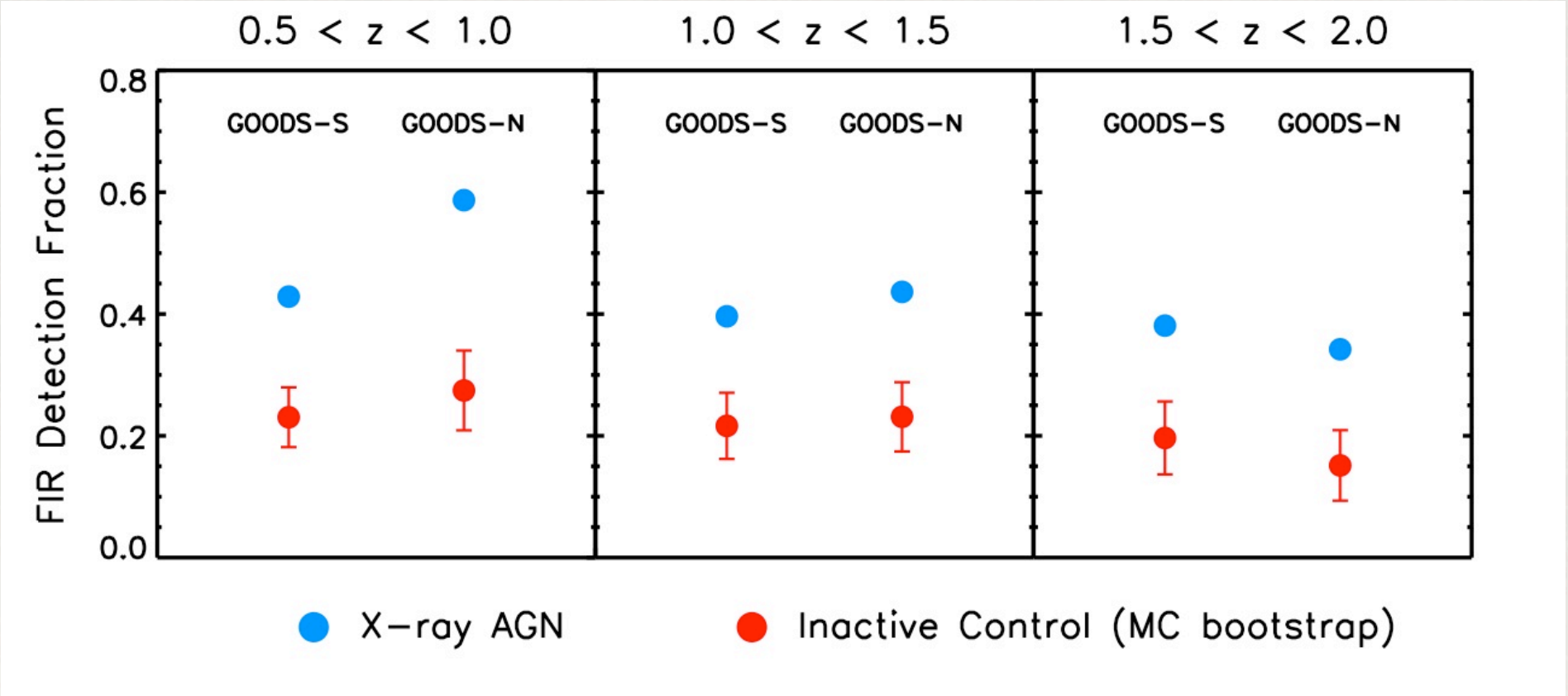


Mullaney+ 2011

Also see Rosario+ 2013a

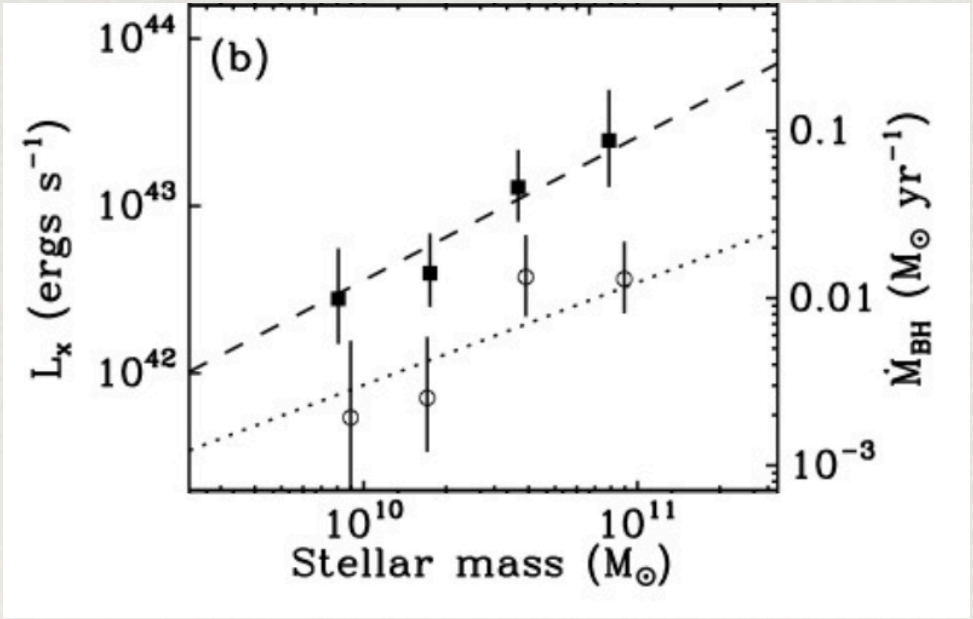
$N_{det}/(N_{det} + N_{undet})$ ▷ fraction of star-forming galaxies

Most AGN hosts are normal SF galaxies

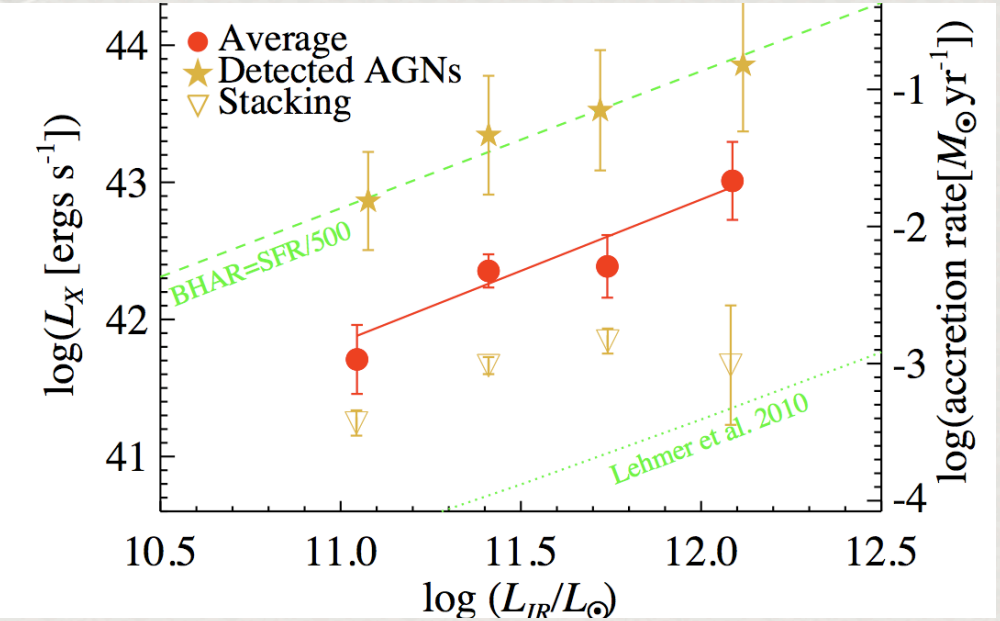


Rosario+ 2013a

This explains trends of AGN incidence with M_* and SFR among star-forming galaxies

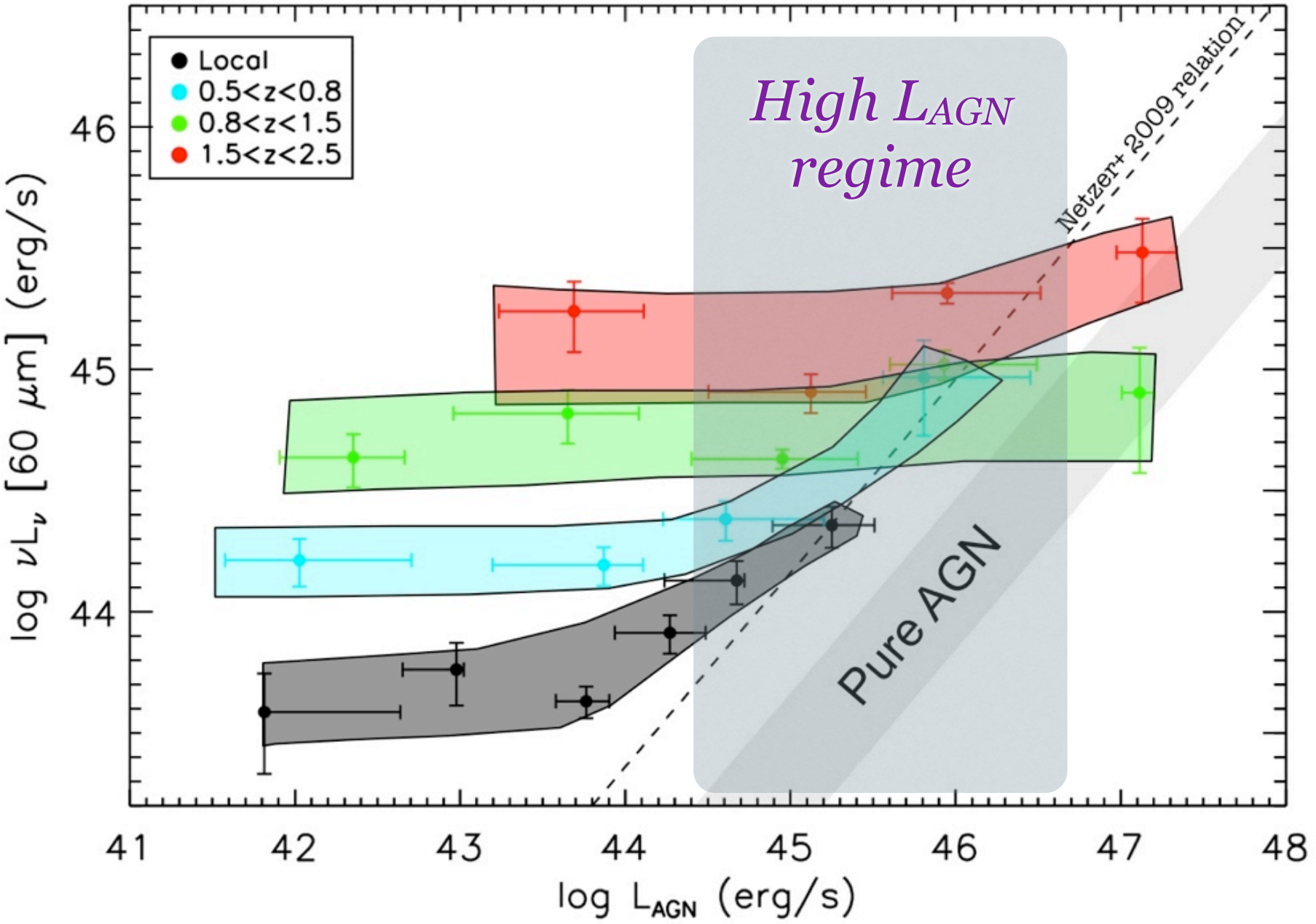


Mullaney+ 2012



Chen+ 2013

*There are a larger fraction of **AGN of all luminosities** at higher masses or higher SFRs.*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High L_{AGN} regime
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Pure AGN
log νL_ν [60 μm] (erg/s)
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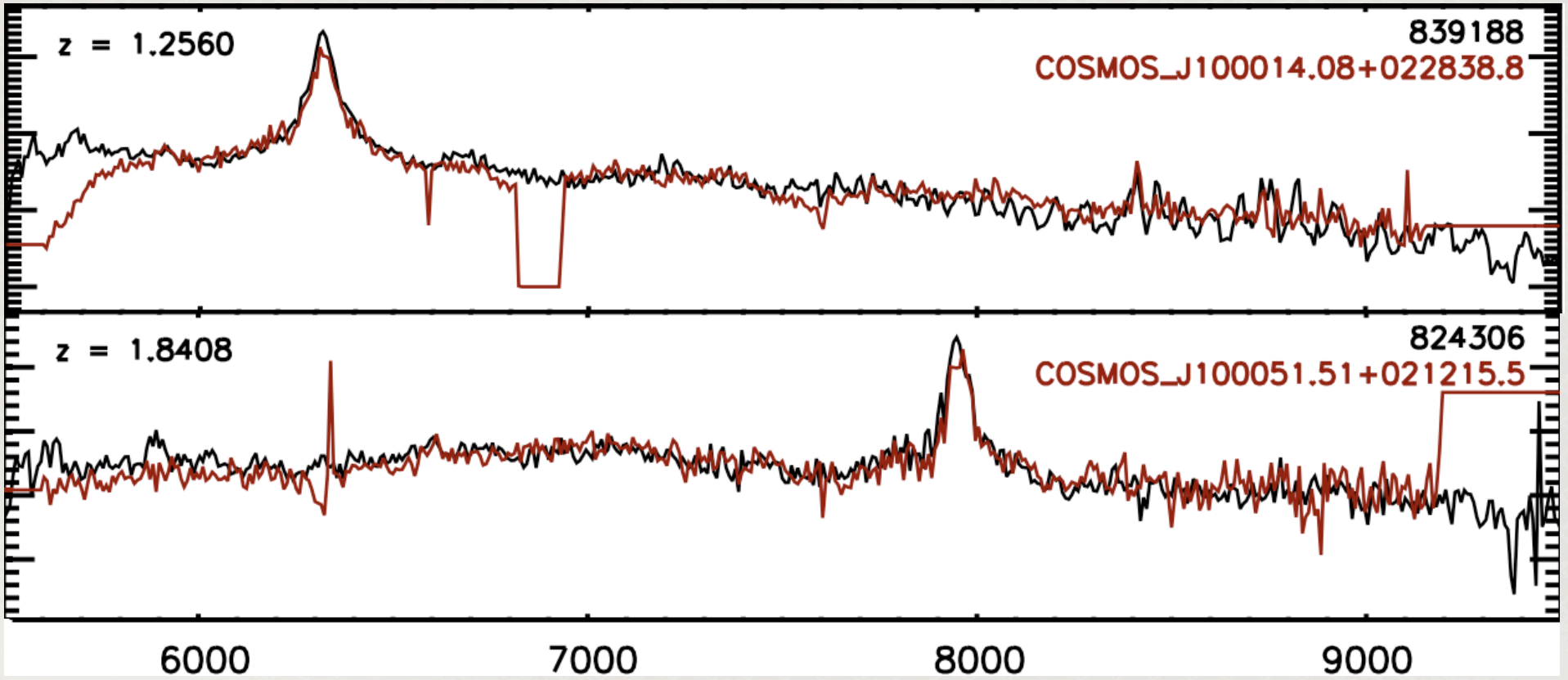
46

The Mean SFR of QSO host galaxies

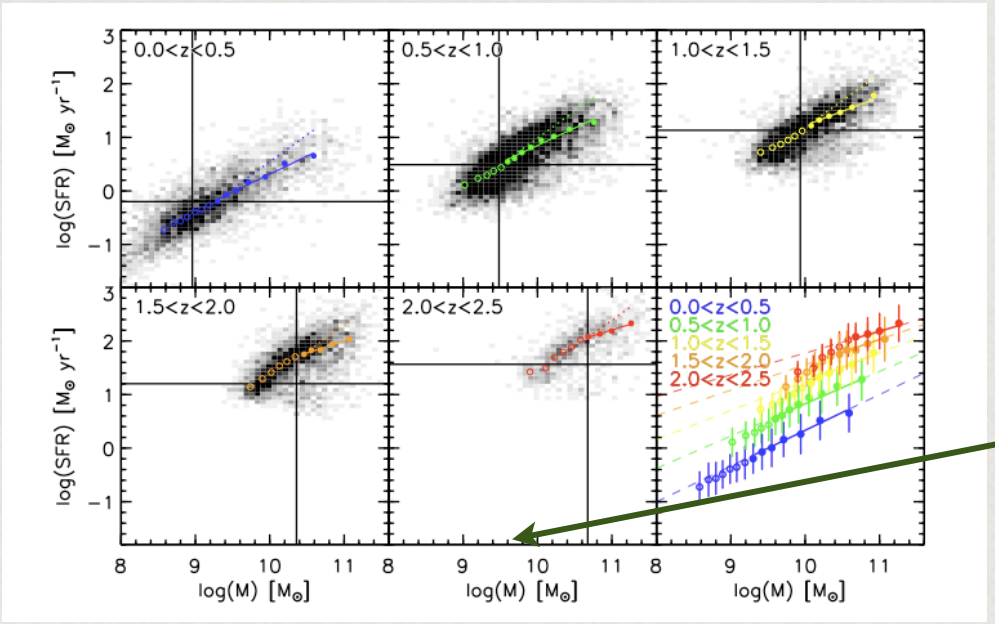


260 QSOs in COSMOS with deep FIR data.

Two order of mag in AGN luminosity, mass and accretion rate.

Rosario+ 2013b

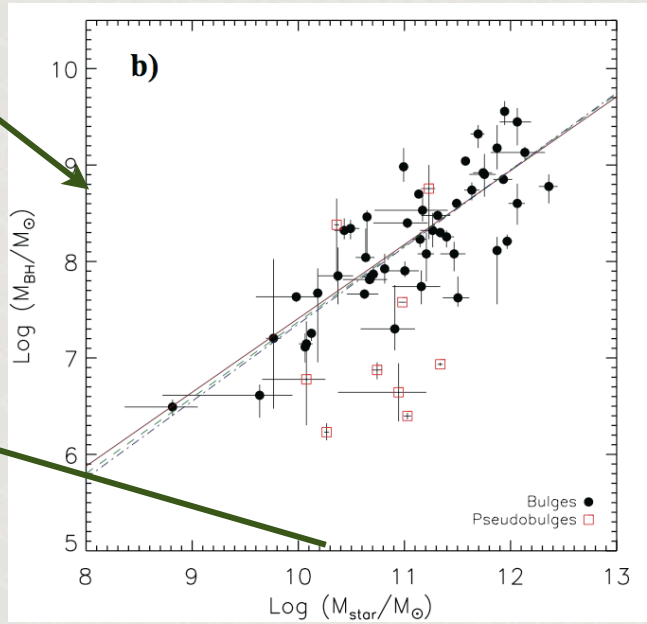
A Baseline Model for QSO Host galaxies



SFR - M* relation calibrated from SF galaxies (Whitaker+ 2012)

M_{BH}

M_*



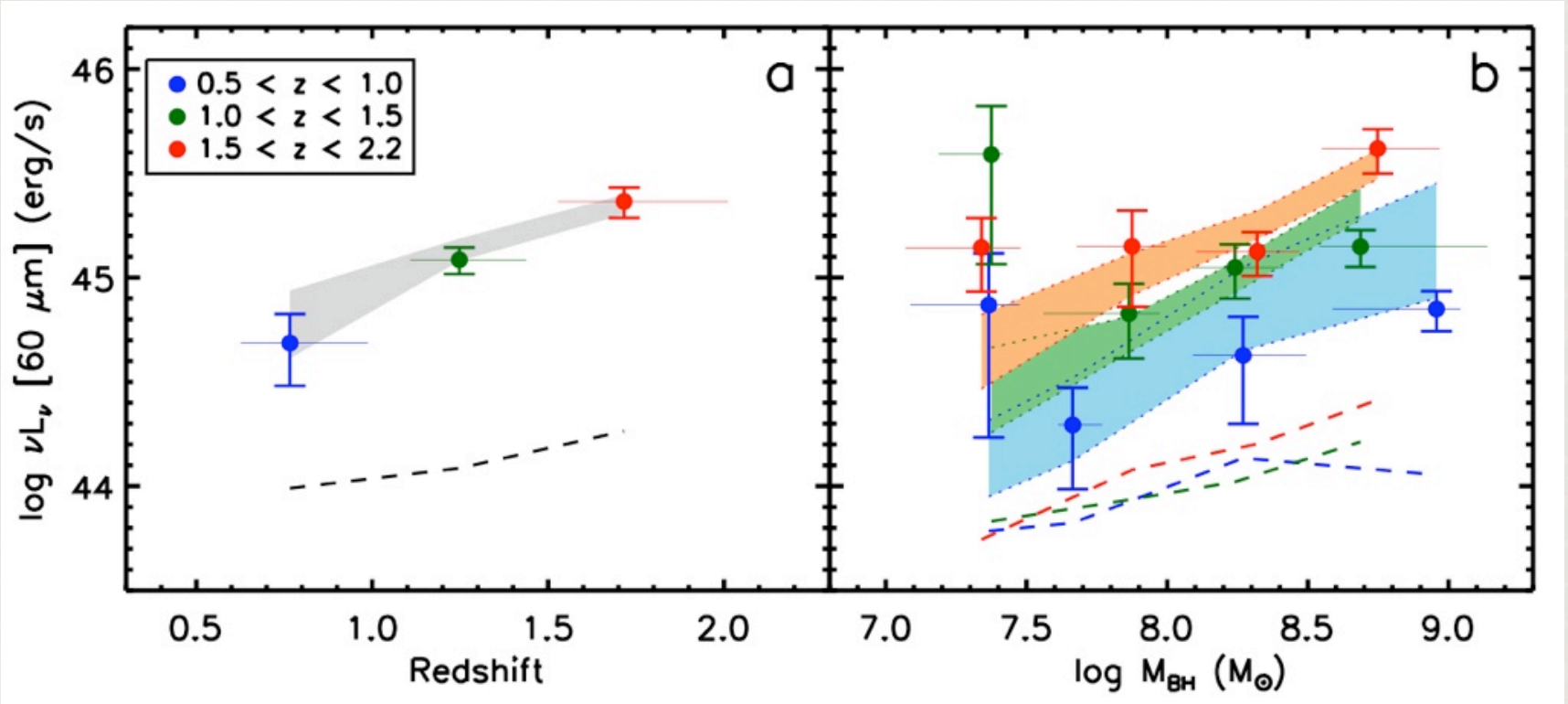
Local M_{BH} - M* relation (Sani+ 2011)

No evolution in M_{BH} - M*

Scatter in all relations accounted for using Monte-Carlo bootstrapping

Small correction for AGN emission in the FIR (unimportant at high z)

QSO hosts are also *very likely* on the Main Sequence



Also see Bonfield+ 2011, Dai+ 2012

Rosario+ 2013b

Luminosity correlations can arise from selection effects + physical accretion rate limits

Synthesis and Future Direction

- Moderately luminous AGN are in normal galaxies. Mergers are not critical and starbursts are not primary.
- Luminous AGN? Correlation suggests co-evolution (mergers?), but QSOs could also be in mostly normal galaxies.
- Evidence exists for a dominant "stochastic evolution" channel governed by gas supply. Merger channel will runs in parallel, but is less important at high redshift.