Far-Infrared and Accretion Luminosities of Present-Day Active Galactic Nuclei

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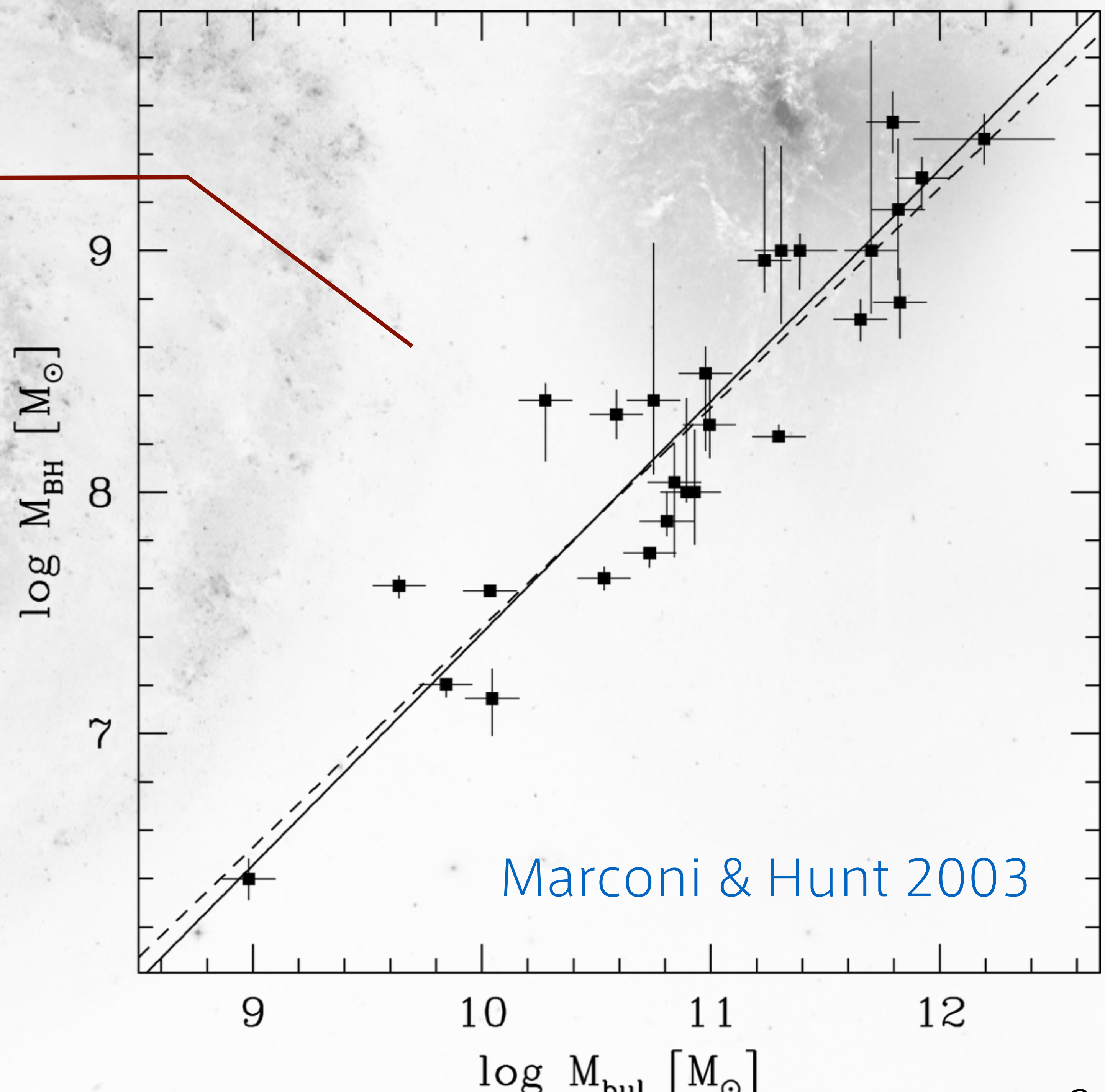
Coevolution of galaxies and SMBHs

Galaxies seem to have co-evolved with supermassive black holes (SMBHs) at their centre.

local universe

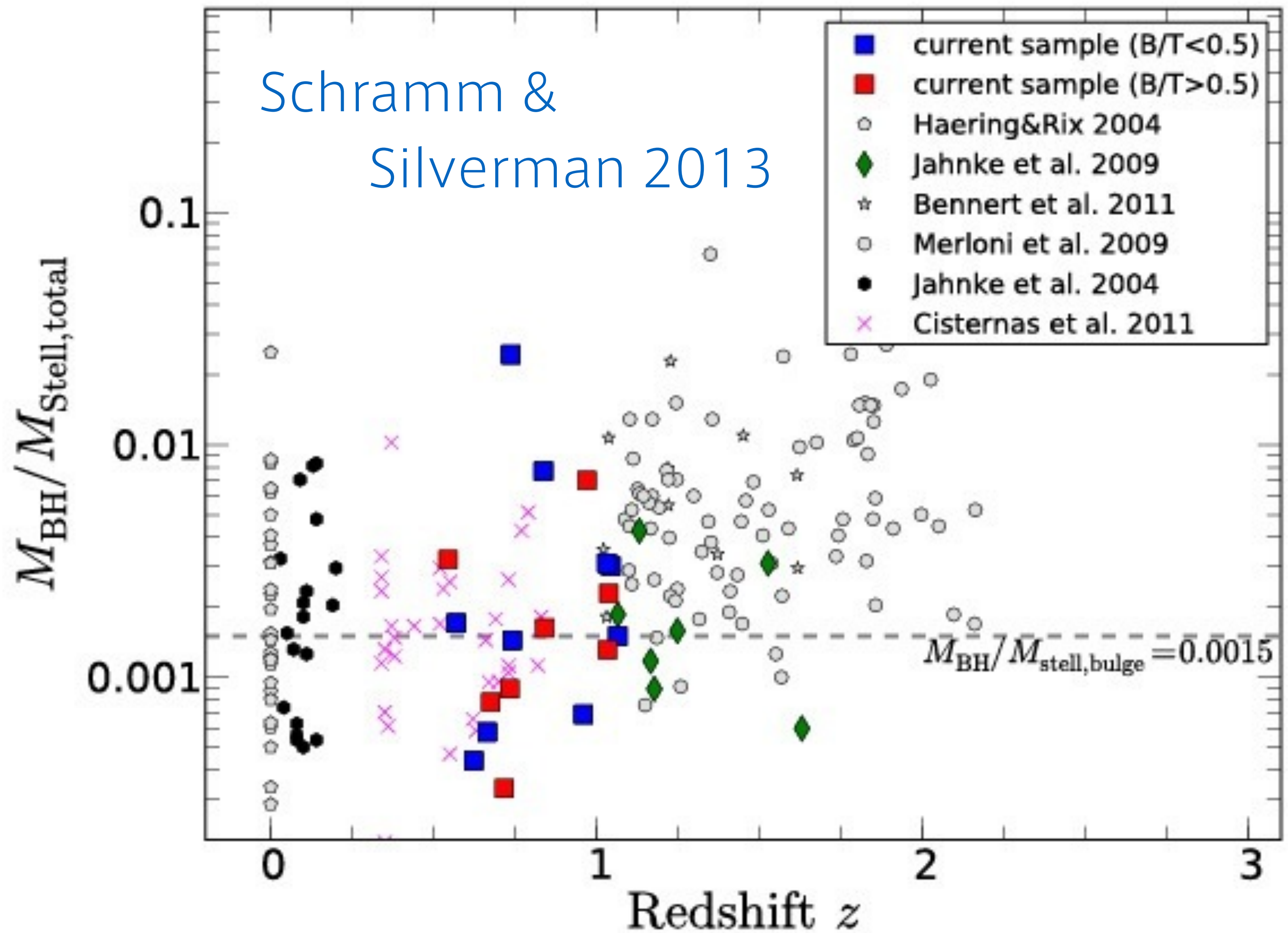


How have they co-evolved in the cosmic history?

Various observational studies have been devoted to investigating the nature of the coevolution.

Redshift evolution of M_{BH}-M_{gal} relation

The redshift evolution of the M_{BH}-M_{gal} relation has been investigated mainly using type-1 active galactic nuclei (AGNs).



We can not reach the evolutional epoch (z > 4) due to observational limits (e.g., flux limit) with current facilities.

AGN-SF connection

The connection between star formation (SF) and AGN is a key phenomenon to understand the coevolution.

SF is a good tracer of the galaxy evolution.

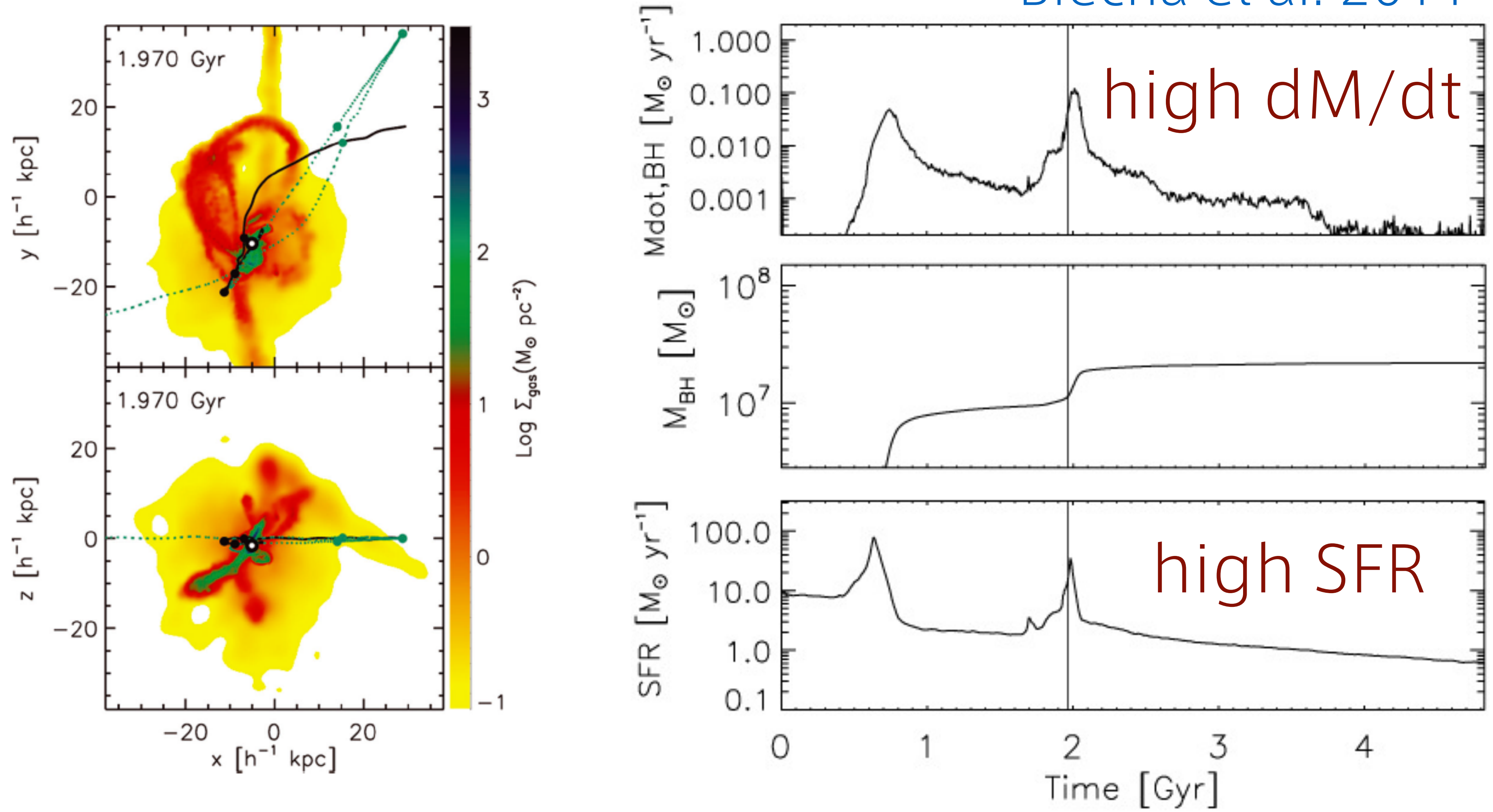
AGN is in a growth phase of SMBH.

This AGN-SF connection allows us to investigate an ongoing interaction between galaxy evolution and SMBH growth.

AGN-SF connection (theory)

Some theoretical frameworks can explain the AGN-SF link and also produce the M_{BH}-M_{gal} relation (e.g., Hopkins & Quataert 2010; Blecha et al. 2011).

Blecha et al. 2011

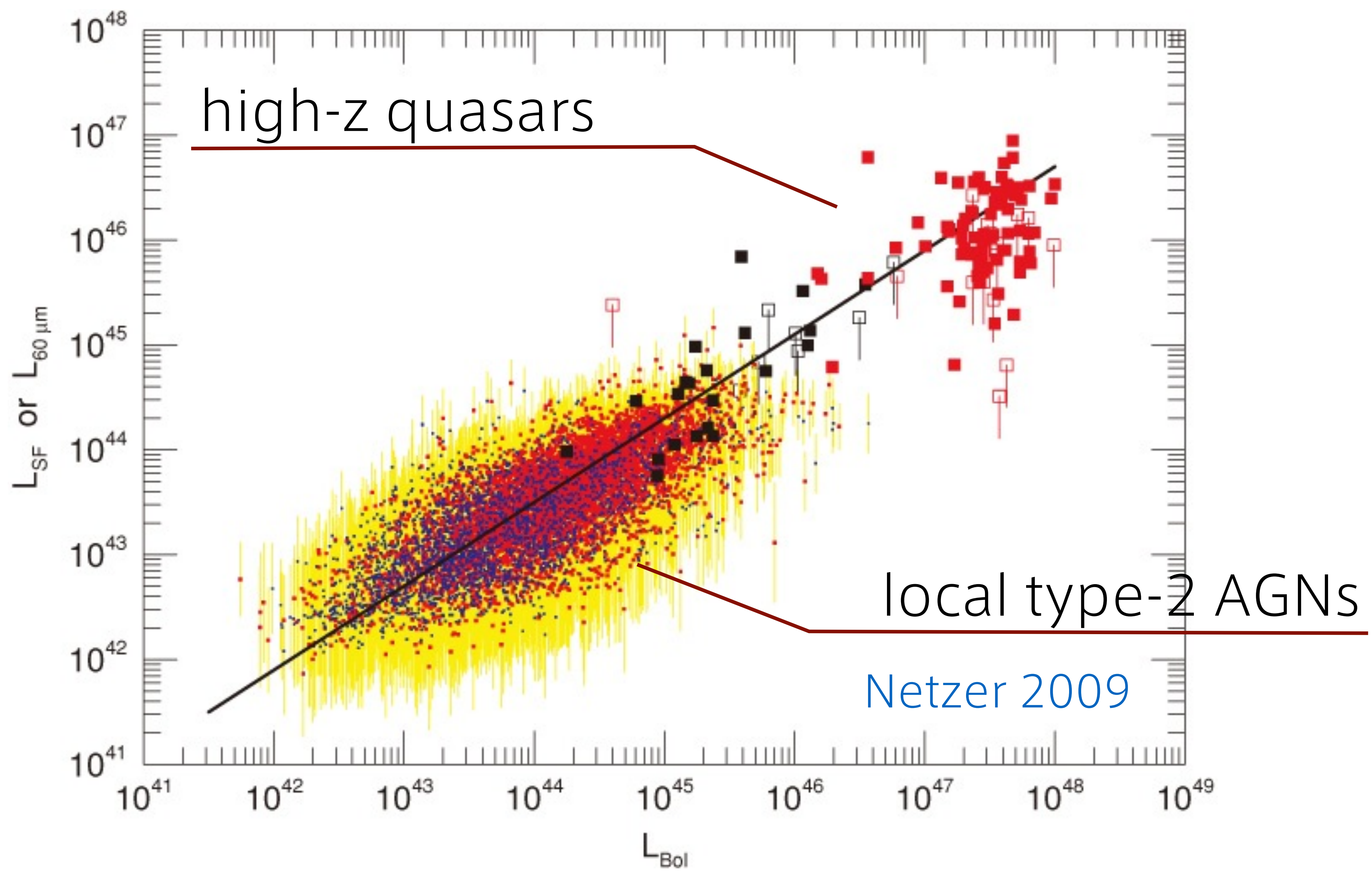


A positive correlation between AGN and SF luminosities is expected from theoretical results.

AGN-SF connection (observation)

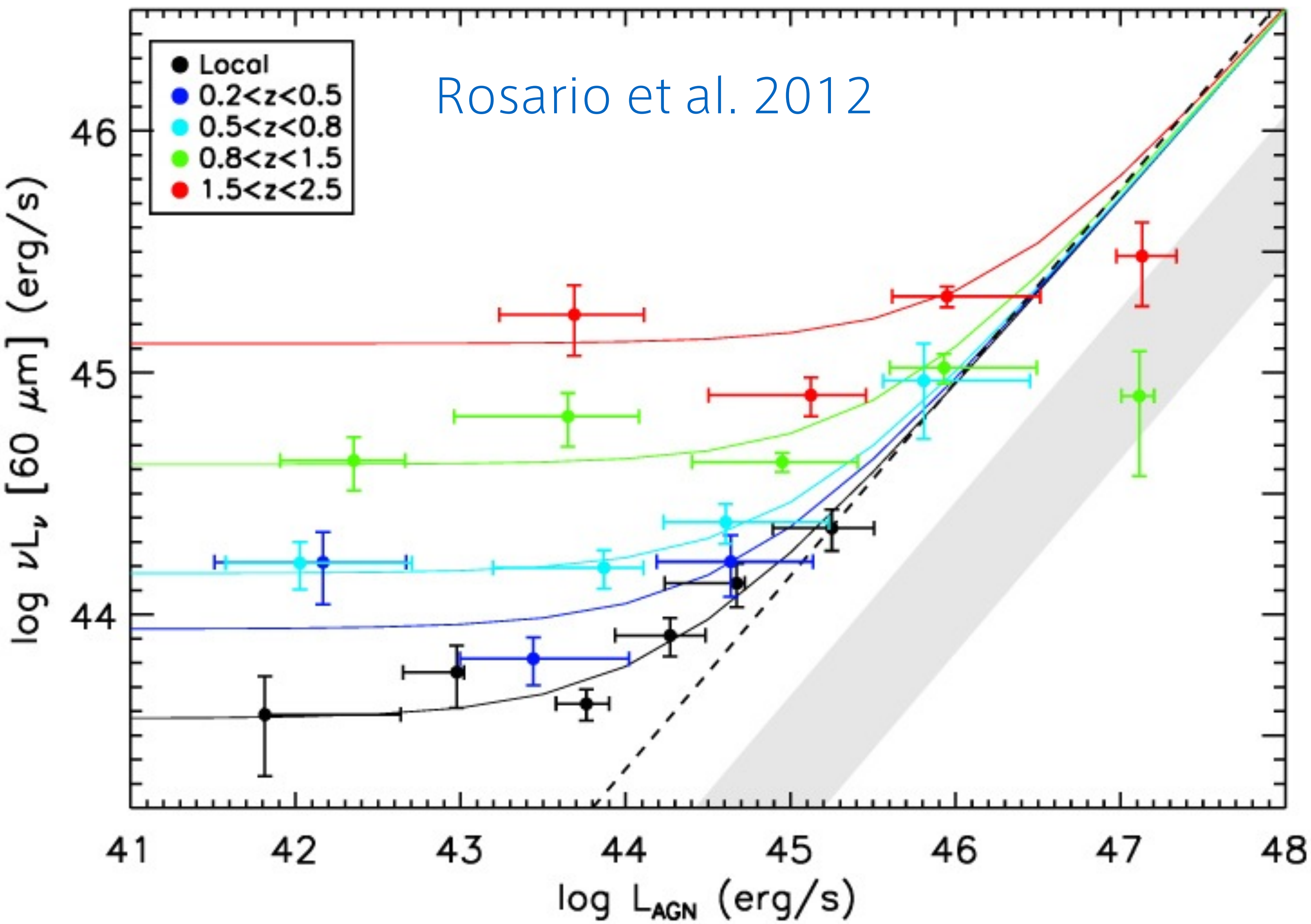
L_{AGN}-L_{SF} relation

The simplest way to understand the AGN-SF connection is investigating the relation between AGN and FIR luminosities.



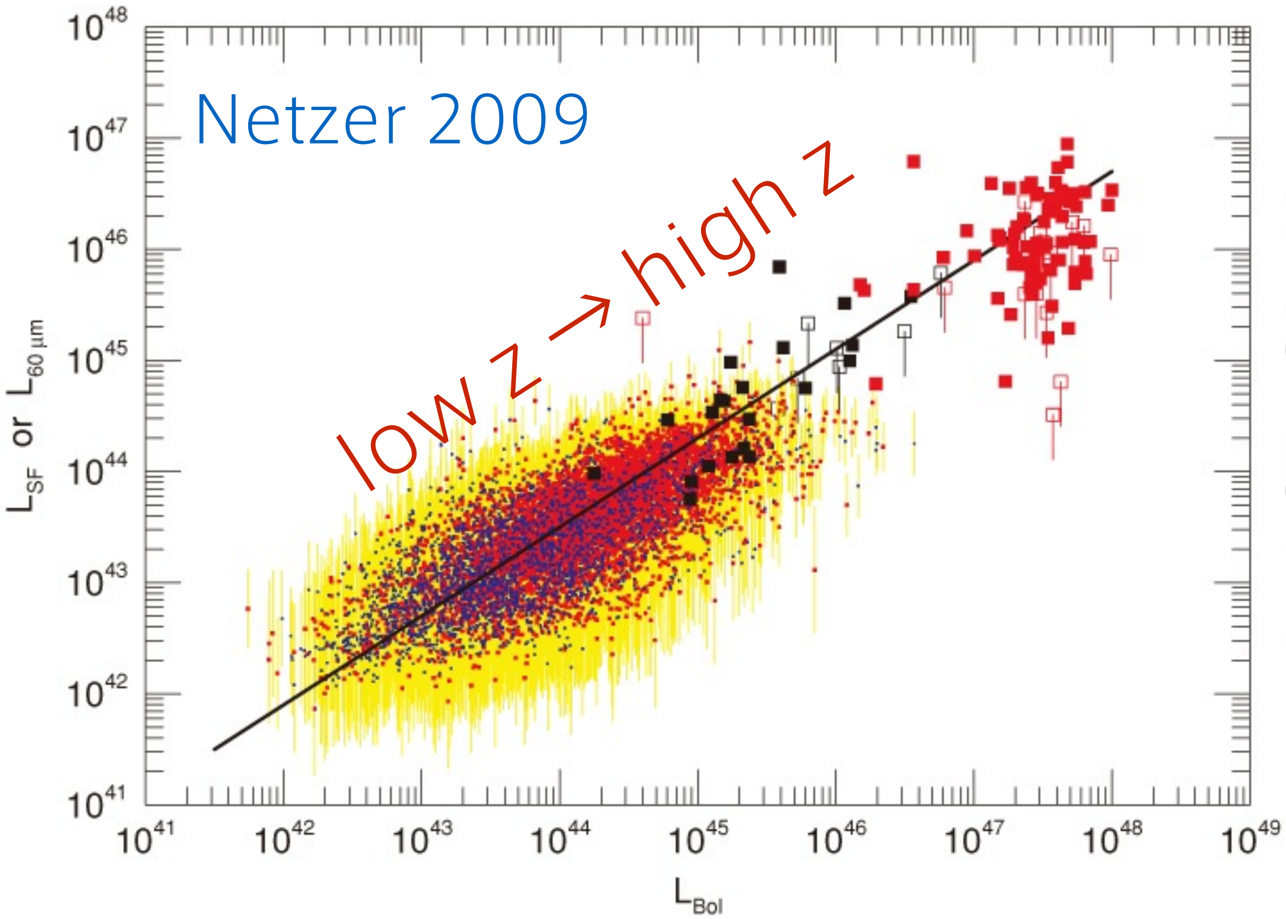
AGN-SF connection (observation)

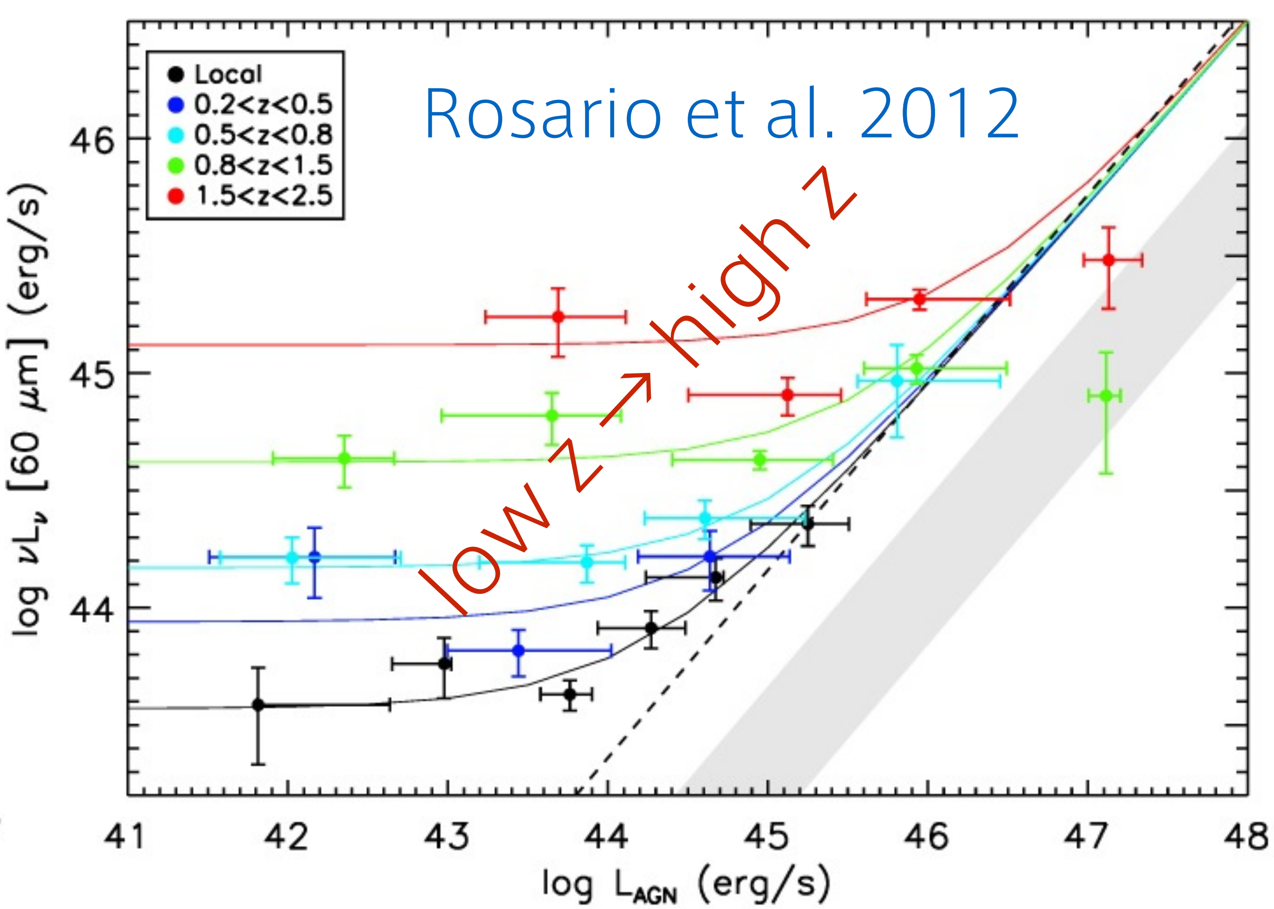
Recently, Rosario et al. (2012) reported characteristic trends.



AGN-SF connection

Are these real correlation?





To avoid artificial effects and understand the L_{AGN}-L_{FIR} relation correctly, we focus on the local universe, and adopt current FIR data.

Sample

SDSS galaxy catalogue

We used the MPA-JHU SDSS DR7 Catalogue.

927,552 galaxies

BPT diagram

We selected type-2 AGNs based on the BPT diagram (Kewley et al. 2006).

$$0.61/[\log([NII]/H\alpha)-0.47]+1.19 < \log([OIII]/H\beta)$$

- $z_{warning} = 0$ (good redshift measurement)
- $0.01 < z < 0.22$
- $S/N > 3.0$ for emission lines, i.e., [OIII], $H\beta$, $H\alpha$, and [NII]

53,282 type-2 AGNs

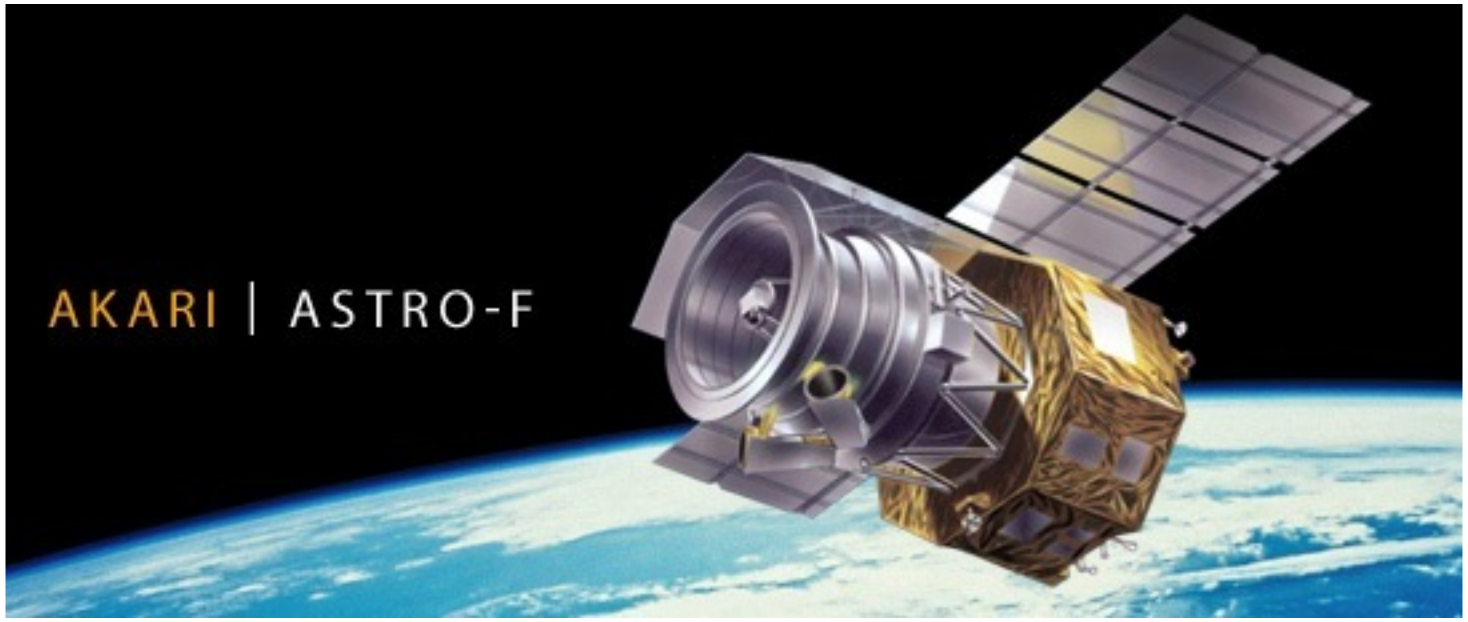
Sample (AKARI)

AKARI/FIS All-Sky Survey Bright Source Catalog (Yamamura et al. 2010): we matched SDSS type-2 AGNs against the AKARI catalogue.

Wide!

- All sky (limited to SDSS area: 9380 deg^2)
- 5σ detection limit = 0.55 Jy at 90μm

729 AKARI-detected objects



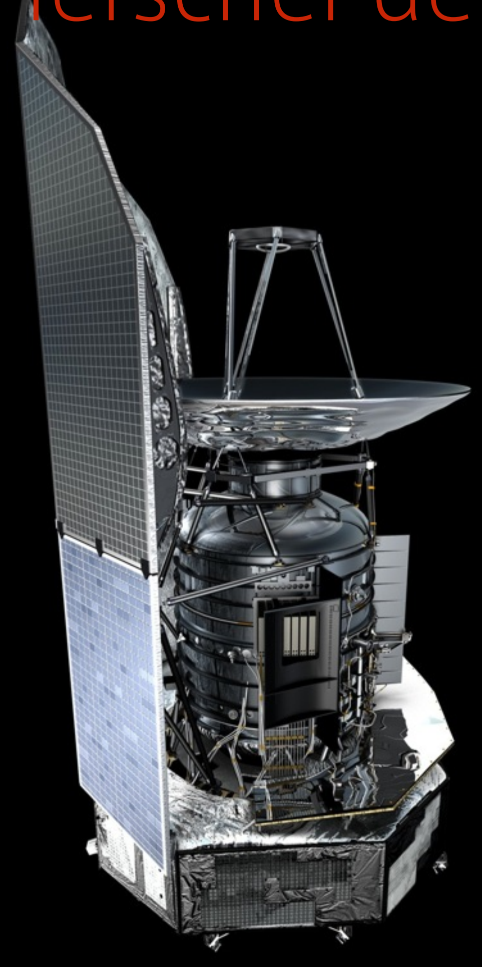
Sample (Herschel)

PEP Survey COSMOS Catalogue (Lutz et al. 2011):
we matched 12 SDSS type-2 AGNs against the PEP catalogue.

- COSMOS field (2 deg^2)
- 5σ detection limit = 0.0075 Jy at 100 μm

Deep!

11 Herschel-detected objects



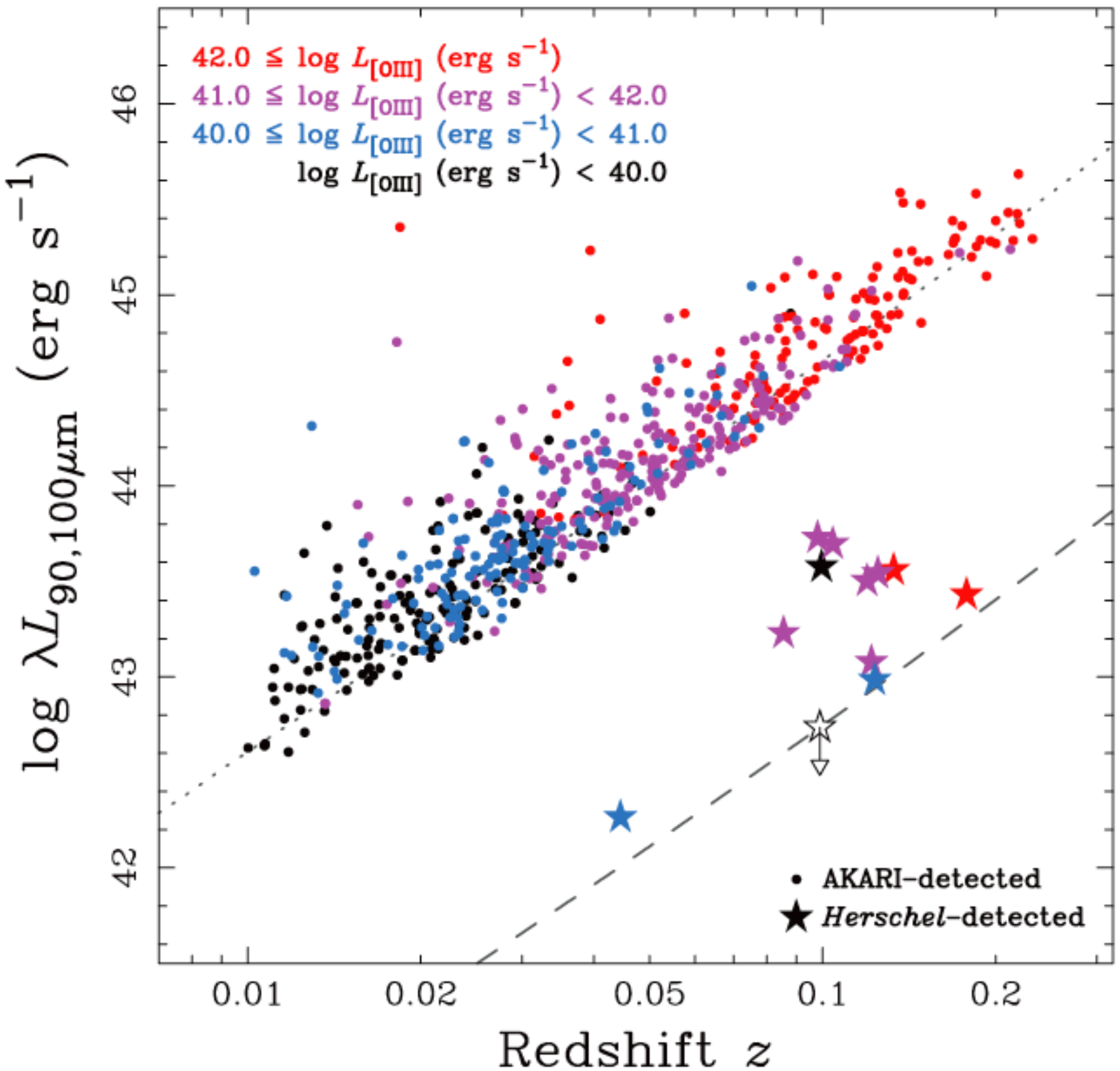
AGN bolometric luminosity

We estimated AGN luminosities from [OIII] and [OI] lines (Netzer 2009).

$$\log L_{AGN} = 3.53 + 0.25 \log L_{[OIII]} + 0.75 \log L_{[OI]}$$

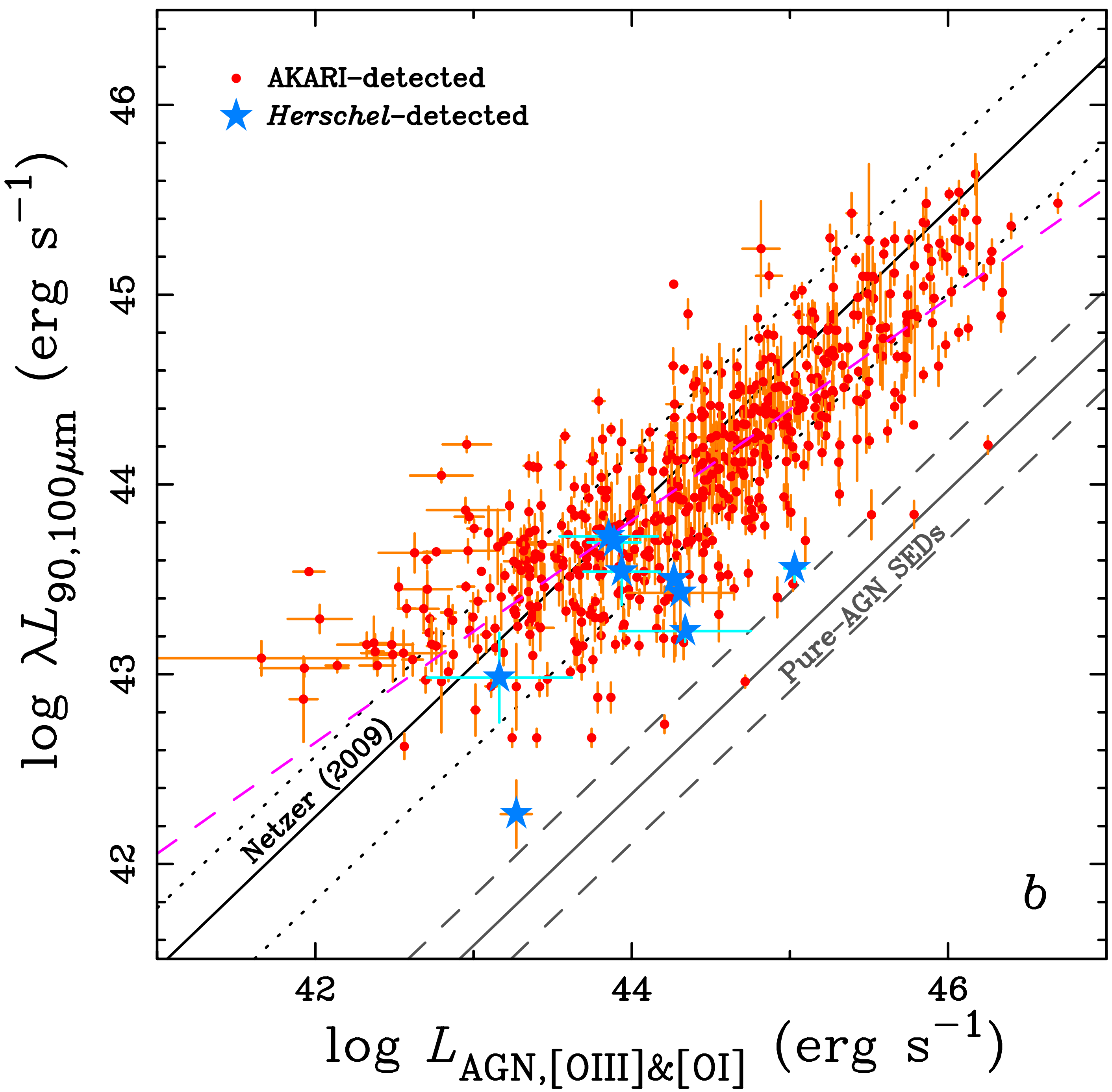
- S/N > 3 for [OI] line

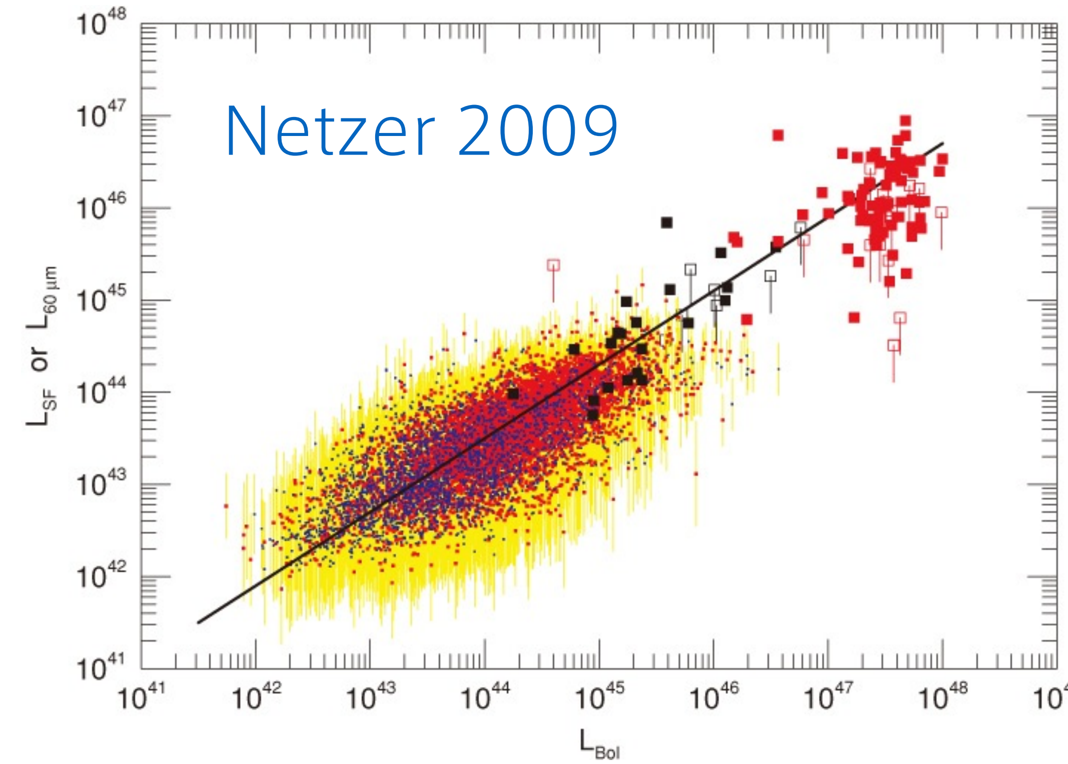
Finally, we obtained 627 AKARI-detected and 11 Herschel-detected objects.

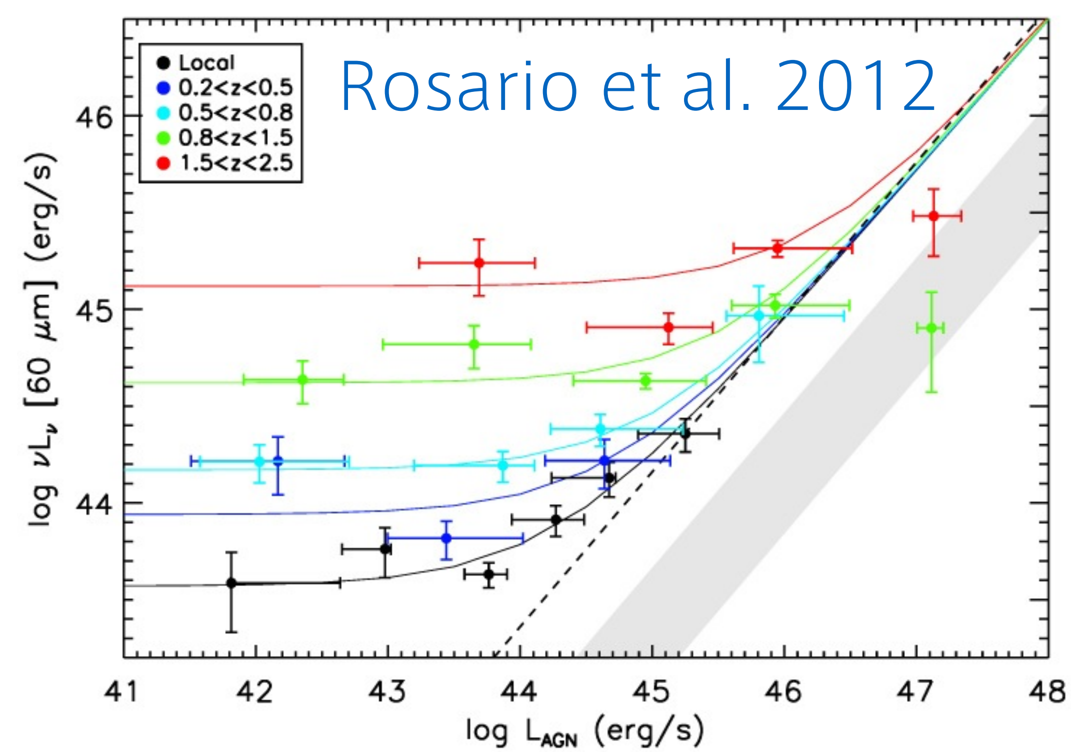


Results

We confirmed a positive linear correlation.

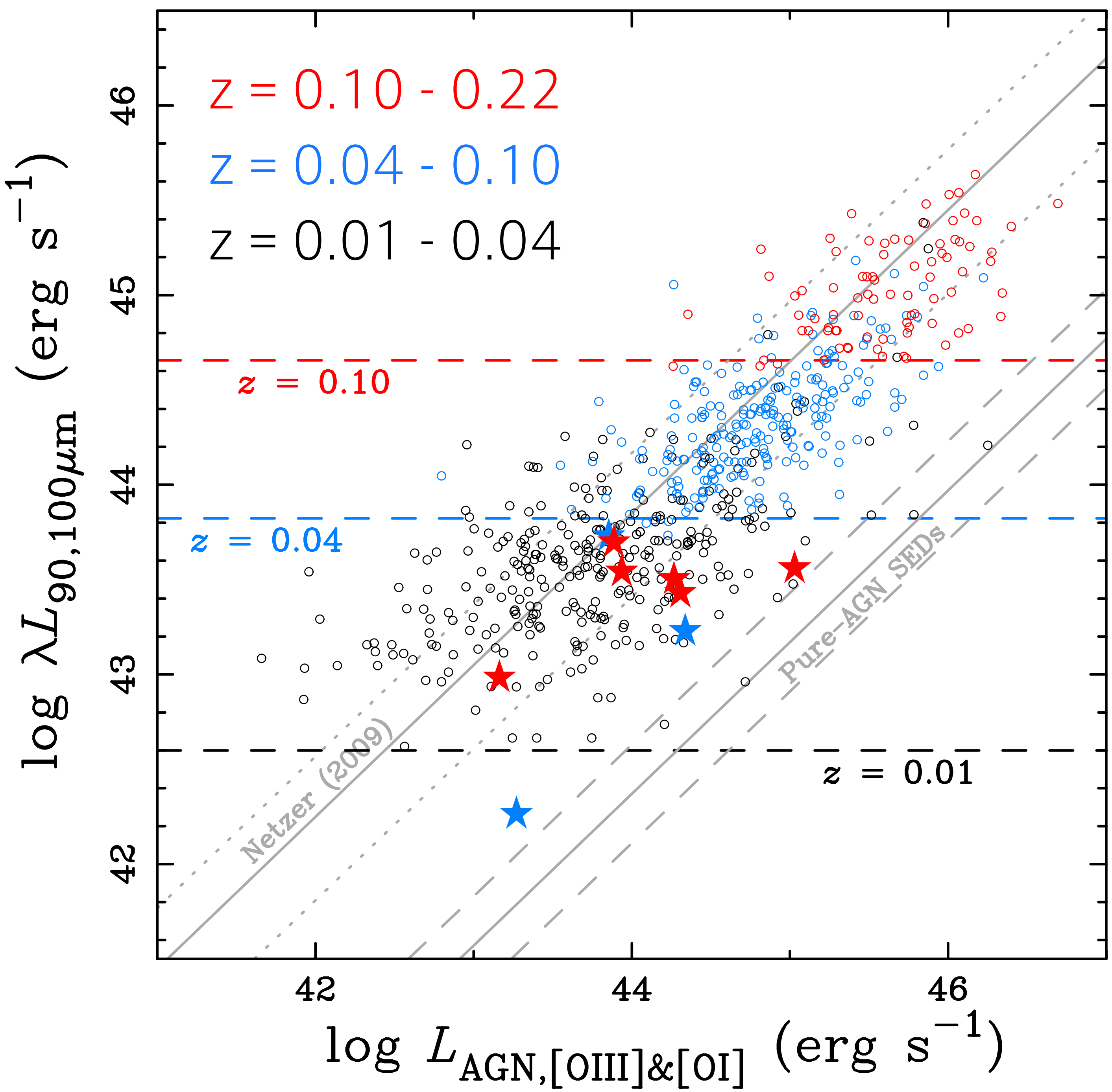


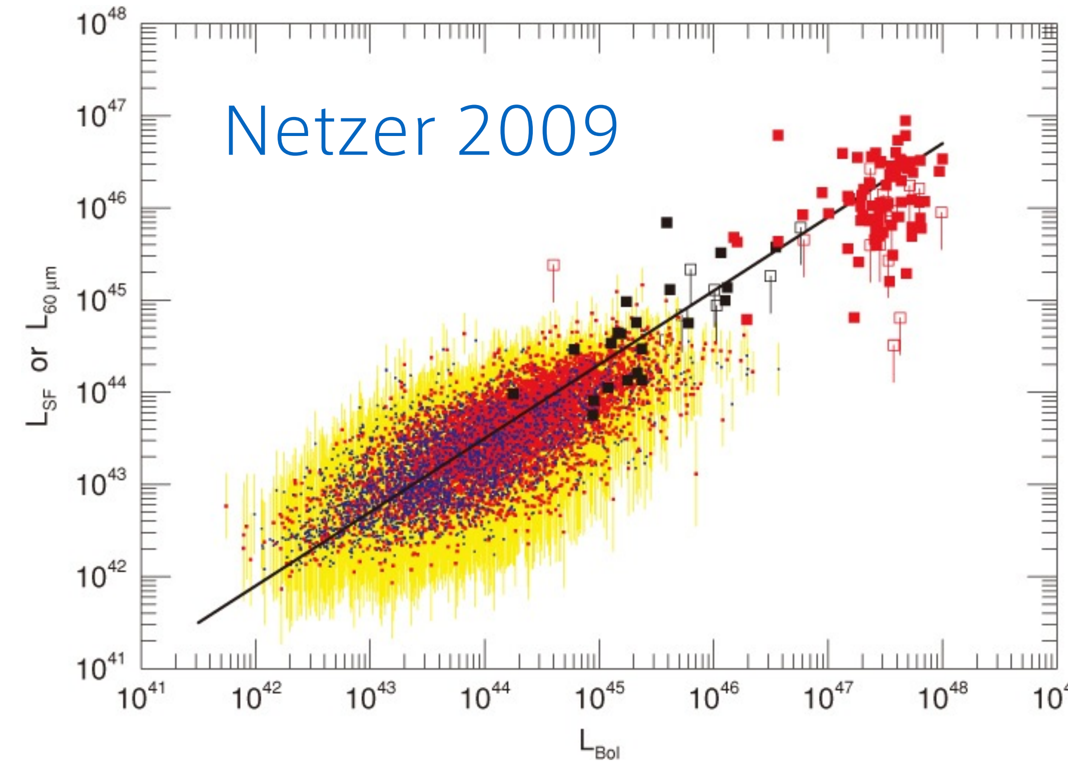


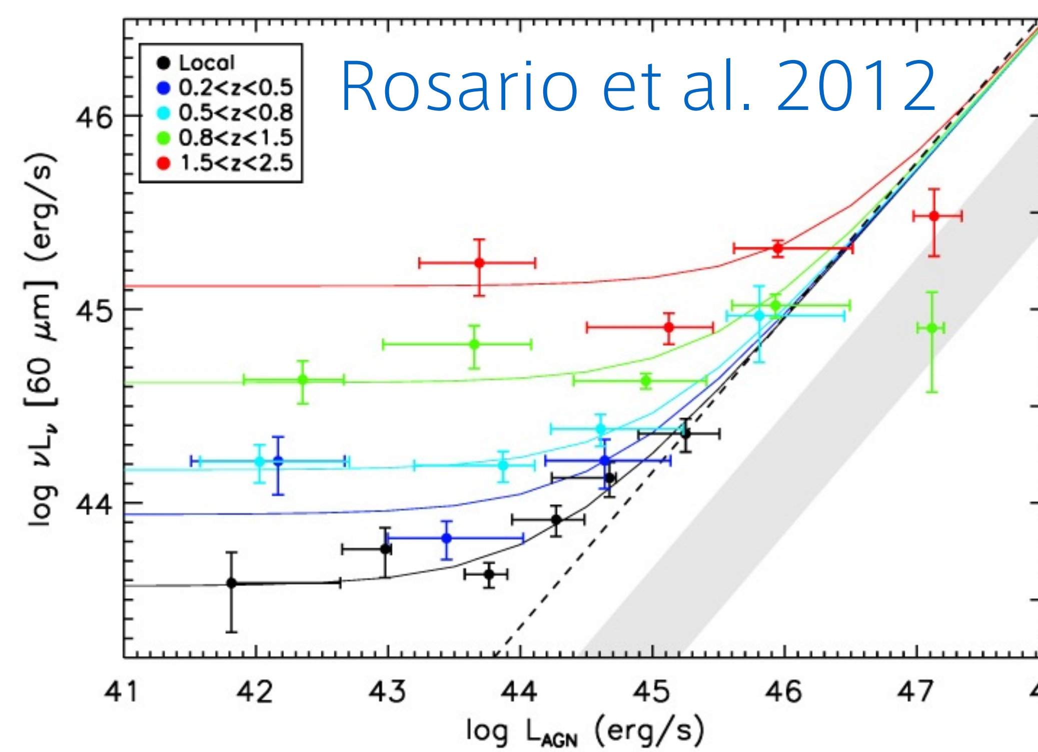


Malmquist bias

Redshift distribution

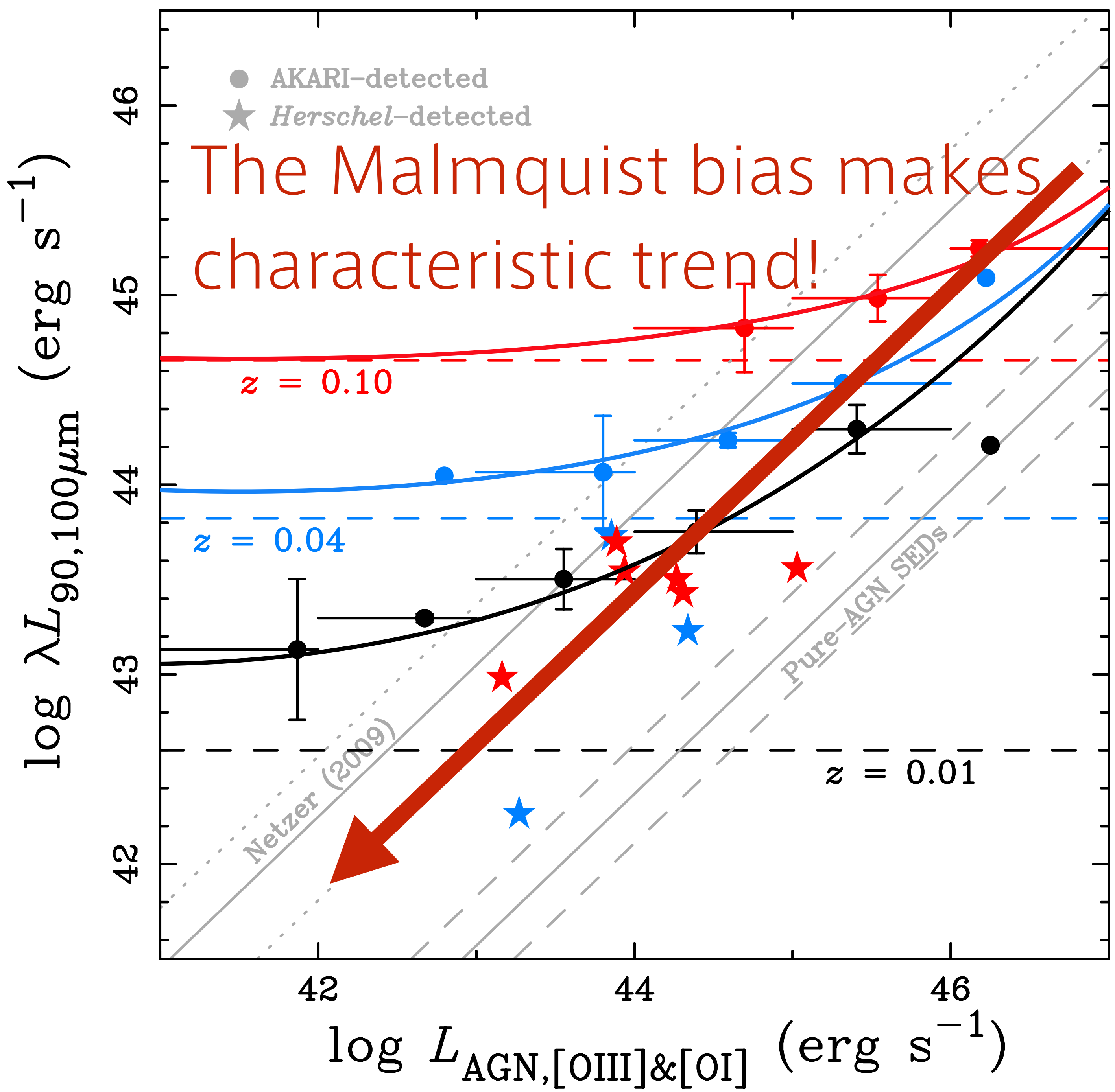




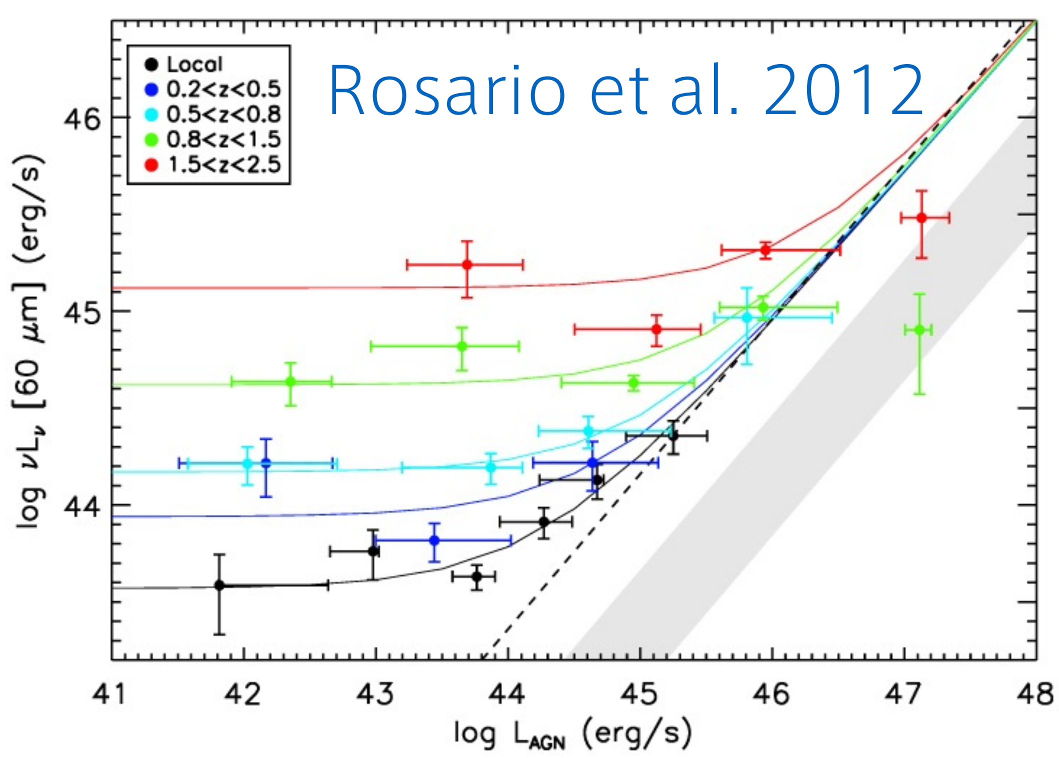


Malmquist bias

Averaged FIR luminosities of AKARI sample

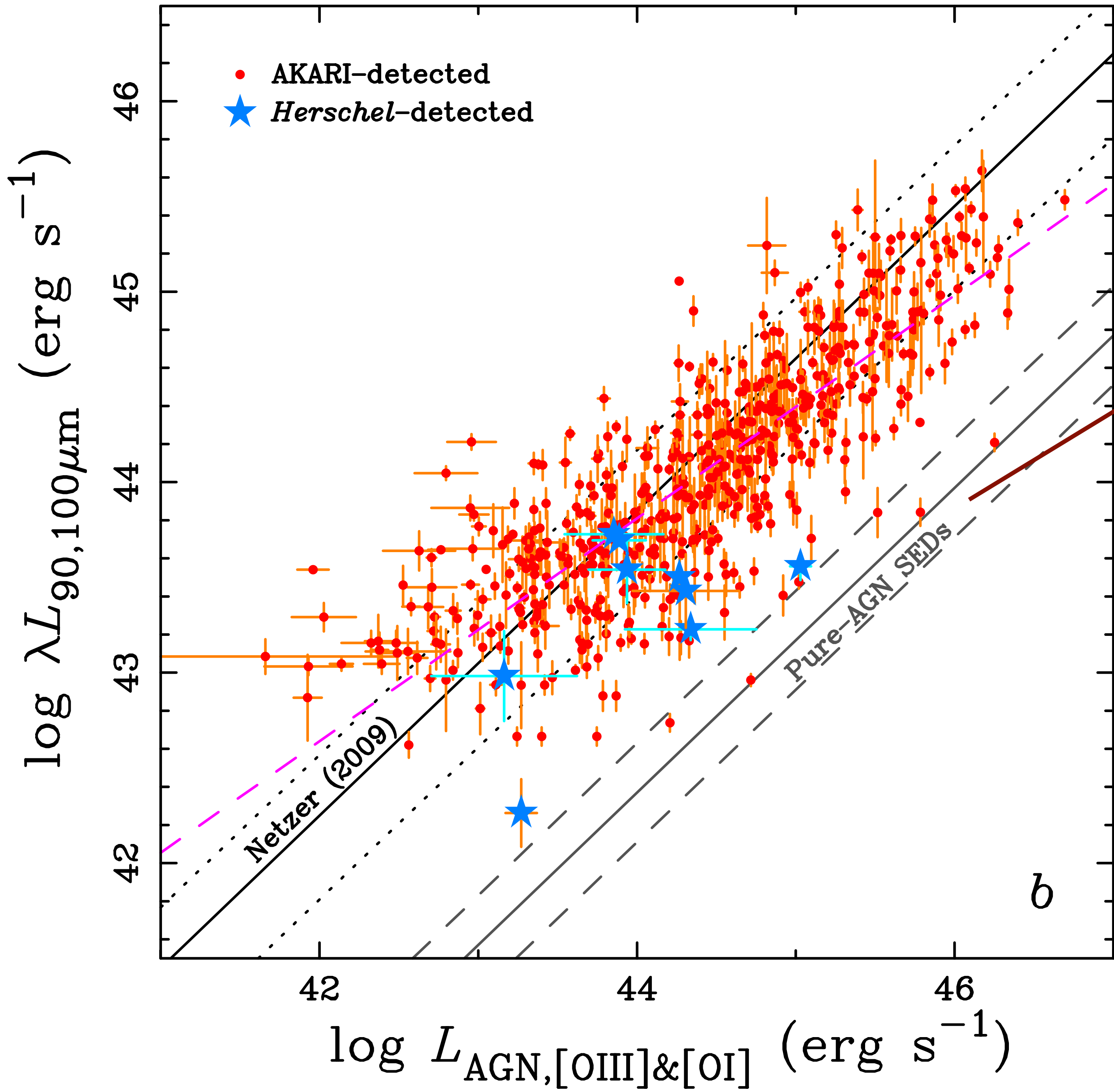


z = 0.10 - 0.22
z = 0.04 - 0.10
z = 0.01 - 0.04



Luminous AGN hosted by low SFR

Luminous AGNs hosted by low- or no- SF galaxies are rare in our sample (< 1%).

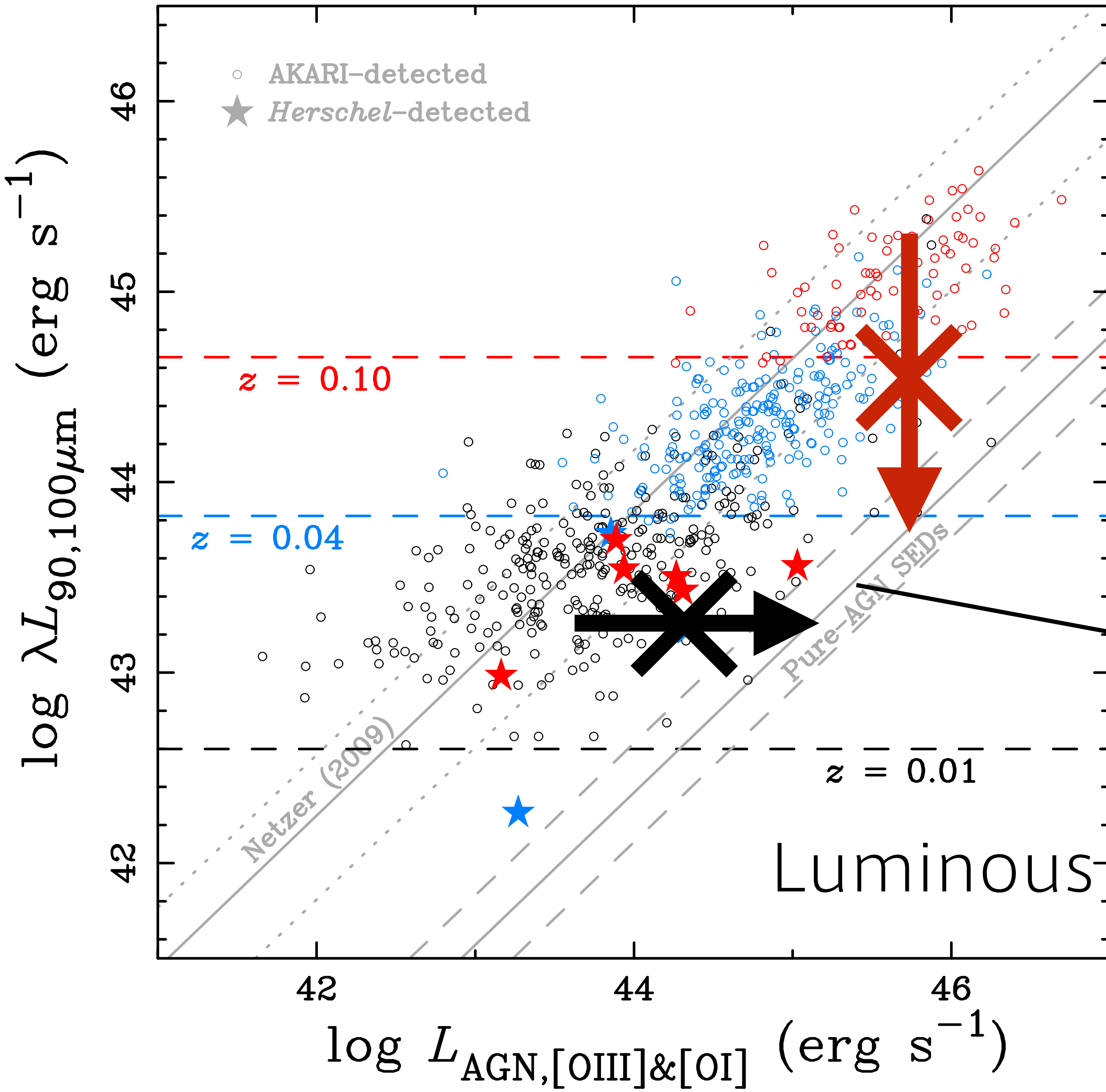


Pure-AGN candidates

Is luminous AGN hosted by no-SF galaxy really rare population?

Artificial effect?

Are Pure AGNs really rare objects?



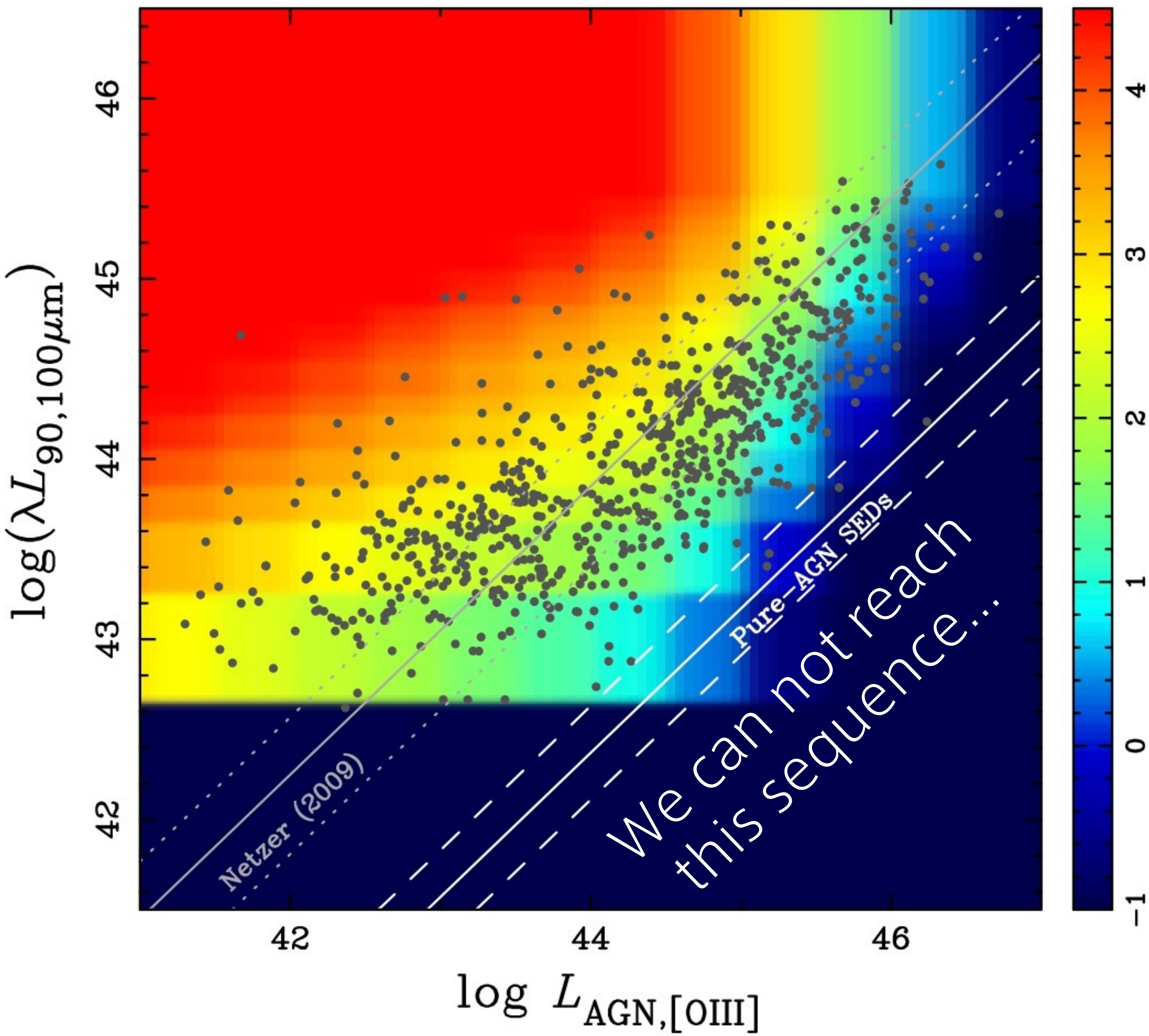
Low-LFIR objects can not be detected at high z!

Pure AGN seauence

Luminous AGNs are rare at low z!

AKARI's case

AKARI's case (0.55 Jy, 9380 deg^2) at 0.01 < z < 0.22

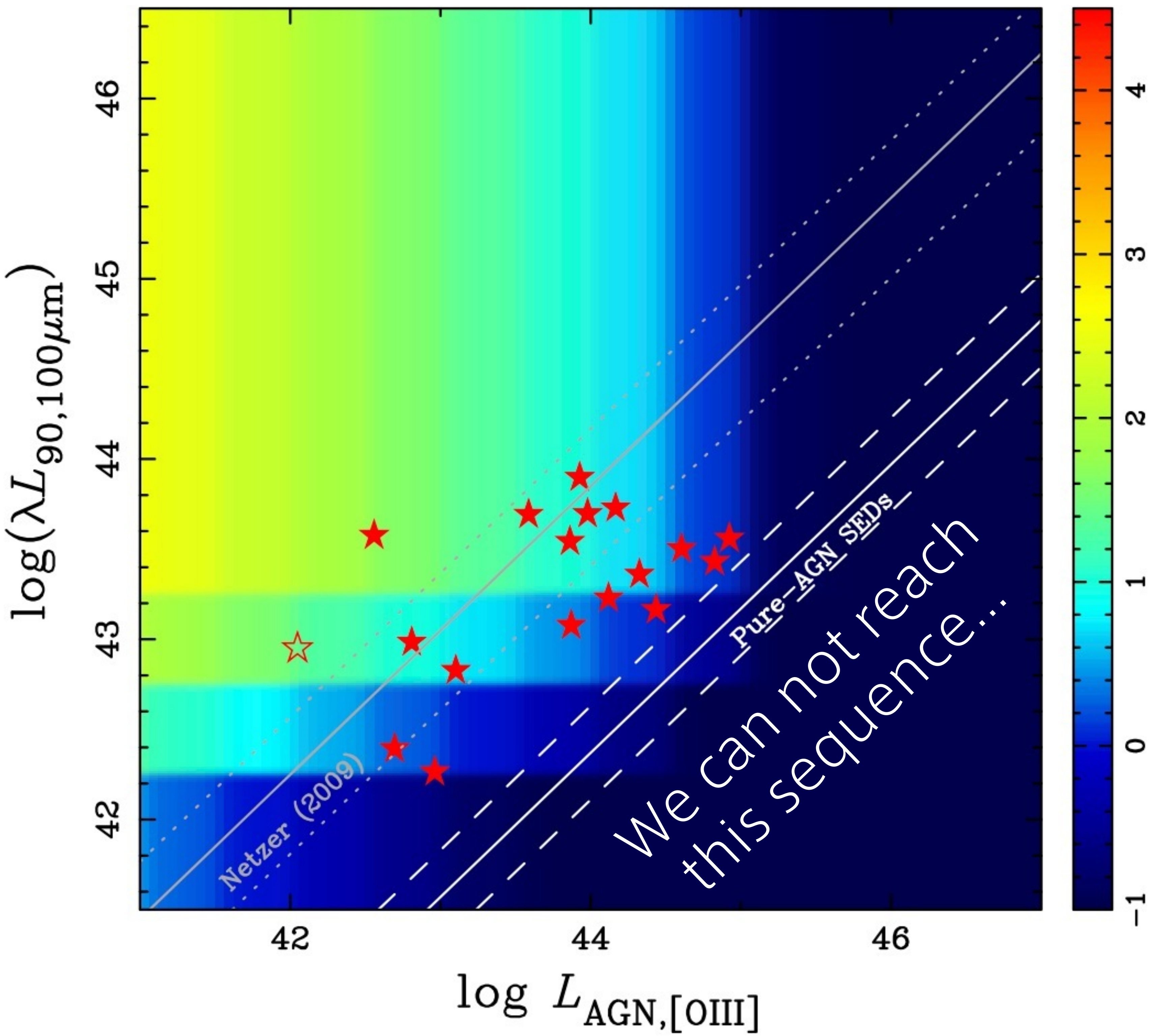


AGN luminosity function (Bongiorno+2010)

Due to shallow data

Herschel's case

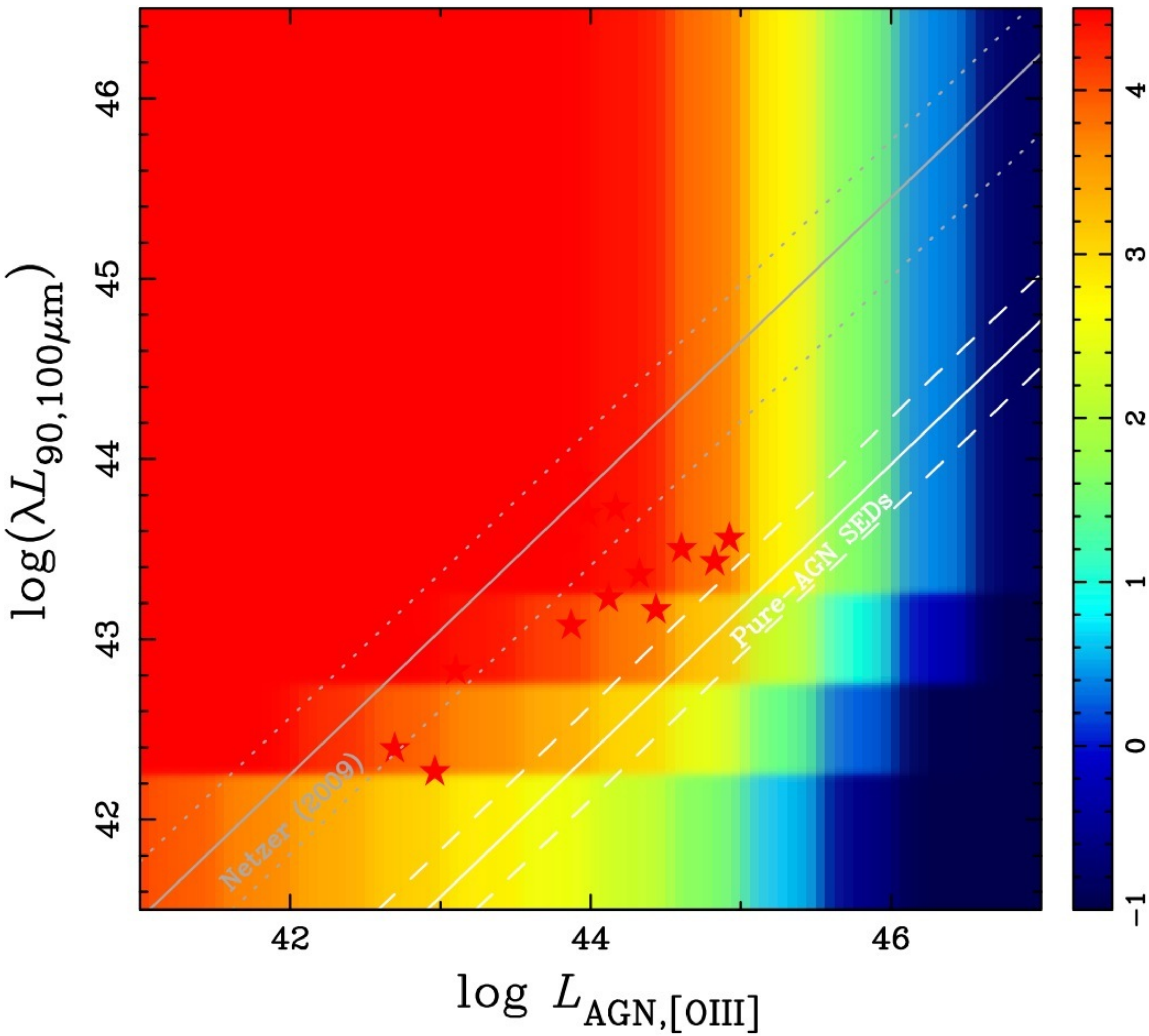
Herschel's case (0.0075 Jy, 2.0 deg^2) at $0.01 < z < 0.22$



Due to narrow area

Wide and deep FIR survey

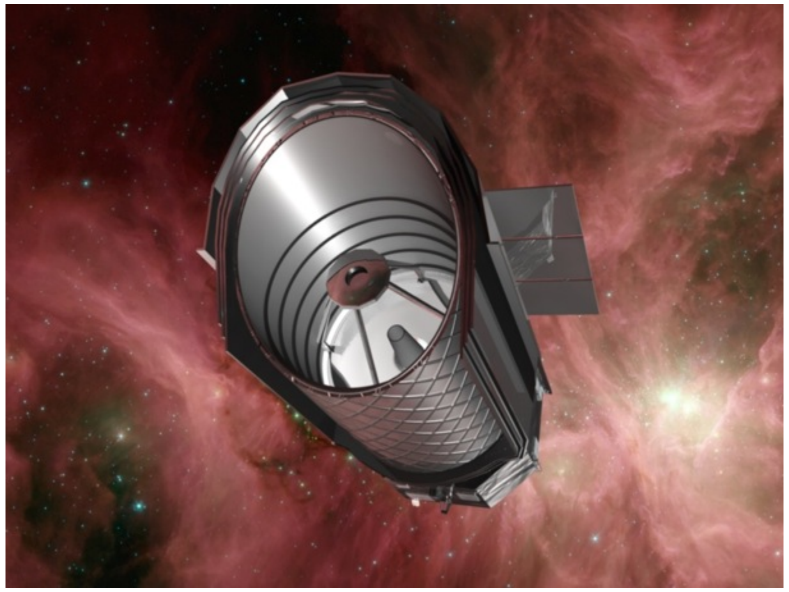
To understand the real AGN-SF connection…



Wide (9380deg^2)

Deep (0.0075 Jy)

SPICA



Summary

The AGN-SF connection is a key phenomenon to understand the coevolution of galaxies and SMBHs (ongoing interaction).

Does the L_{AGN}-L_{SF} relation show linear trend? or characteristic?

The Malmquist bias seems to make characteristic trends. By using deep FIR data, we confirmed the linear trend.

Is there no luminous AGNs with no- or low-SF galaxies?

We can not answer this question with current FIR facilities.

A wide and deep FIR survey is required to examine whether low- or no- SF AGNs exist or not (e.g., SPICA).