ESO Garching – June 29th, 2016

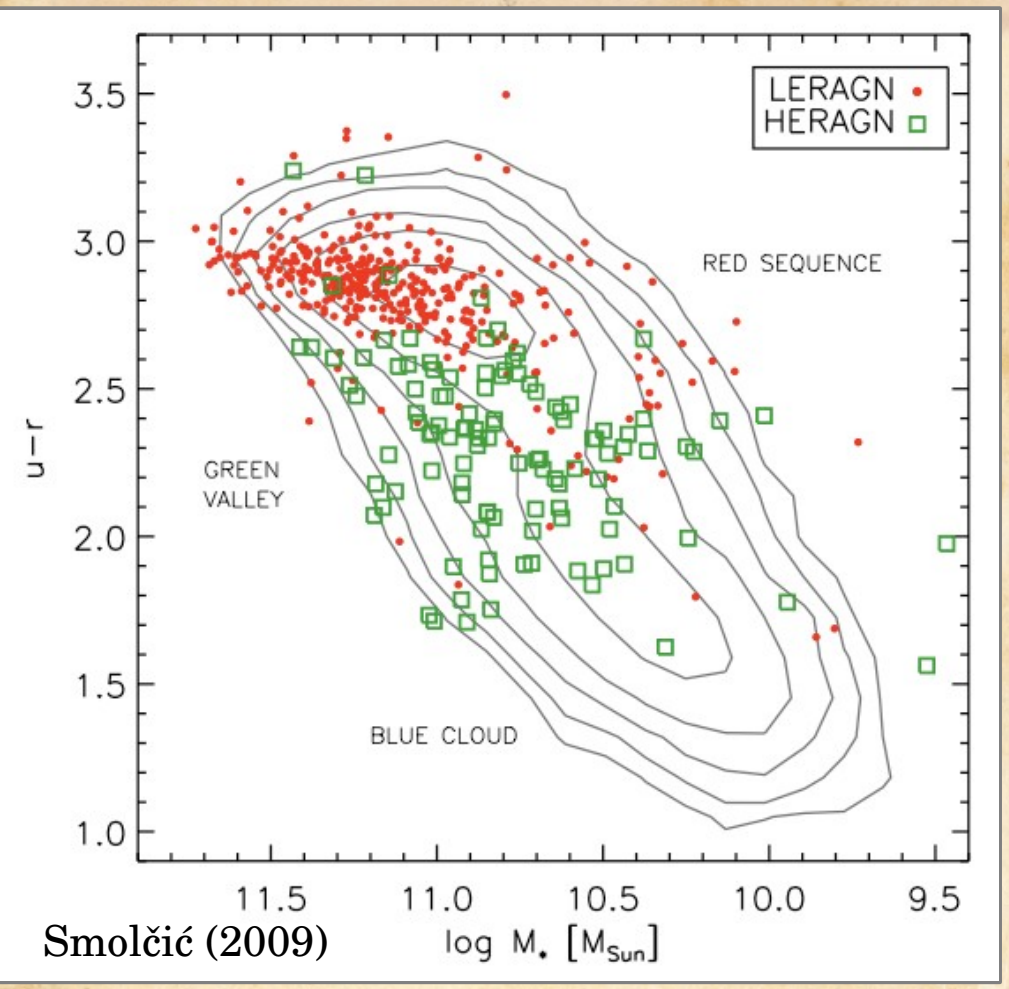
Properties and evolution of radio-AGN hosts since z~4

Ivan Delvecchio
(University of Zagreb)

On behalf of:
V. Smolčić, G. Zamorani, C. Del P. Lagos, S. Berta, J. Delhaize, N. Baran, D. Alexander, D. Rosario, V. Gonzalez-Perez, O. Ilbert, C. Lacey, O. Le Fèvre, O. Miettinen, M. Bondi, C. Carilli, P. Ciliegi, K. Mooley, M. Novak, E. Schinnerer, M. Aravena, P. Capak, F. Civano, N. Fanidakis, N. Herrera-Ruiz, C. Laigle, S. Marchesi, H. McCracken, E. Middleberg, M. Salvato and L. Tasca

.

AGN in the Radio regime (z~0)



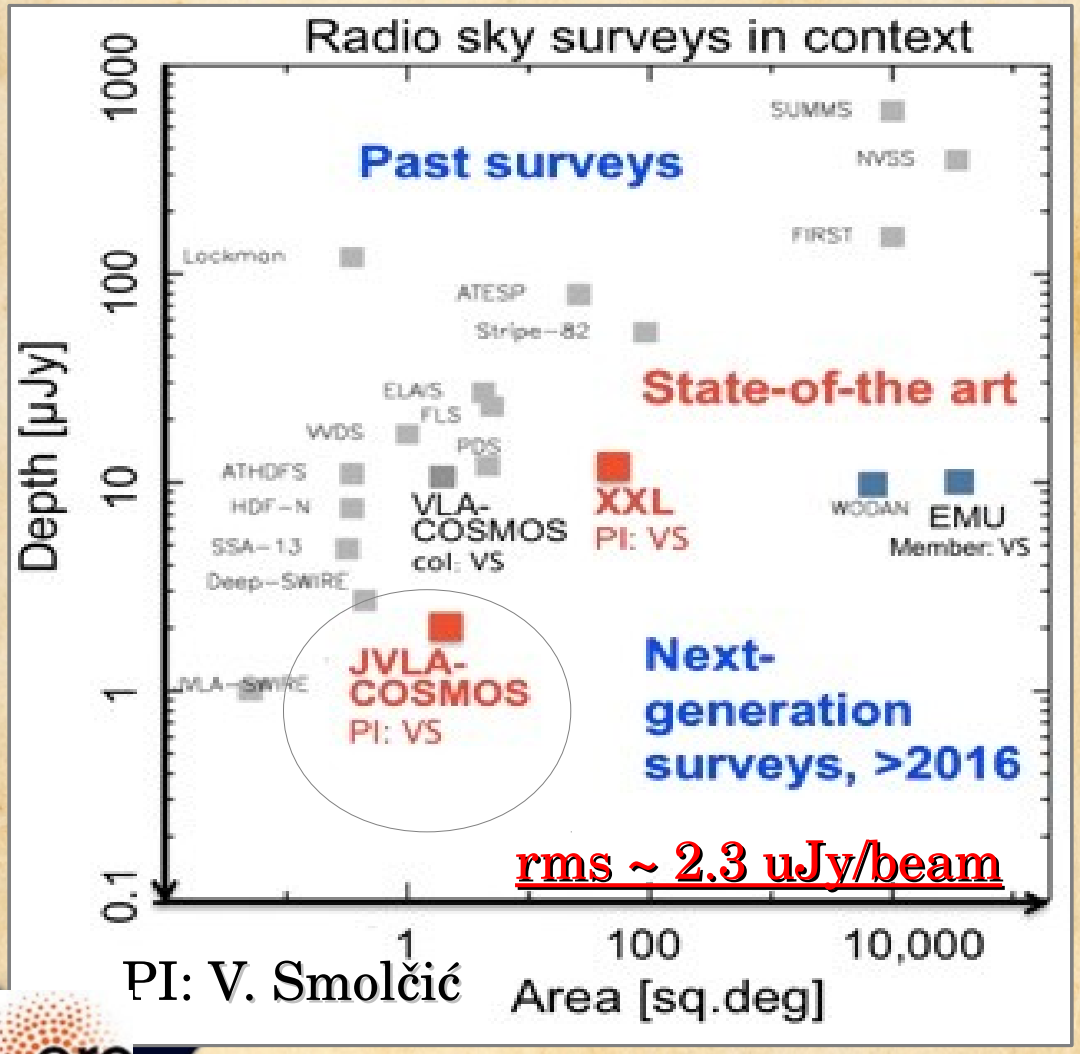
Smolčić (2009)

- SDSS + NVSS local sample
- Optical spectroscopy:
  - High-excitation Radio AGN (HERAGN)
  - Low-excitation Radio AGN (LERAGN)

HERAGN	vs	LERAGN
Green	vs	Red
Low	vs	High M*
High	vs	Low M_{BH} rate
Thin Disc	vs	ADAF

AGN dichotomy in the local Universe is reflected also in their host host-galaxy properties.

Beyond the local Universe: The 3-GHz VLA-COSMOS survey



- 10,830 radio sources selected at 3 GHz in COSMOS over 2.6 deg^2 (Smolčić et al. 2016, accepted)
- ~85% have optical/NIR counterpart (Baran et al., in prep).
- Accurate redshifts and photometry from the COSMOS-2015 catalogue (Laigle et al., 2016)

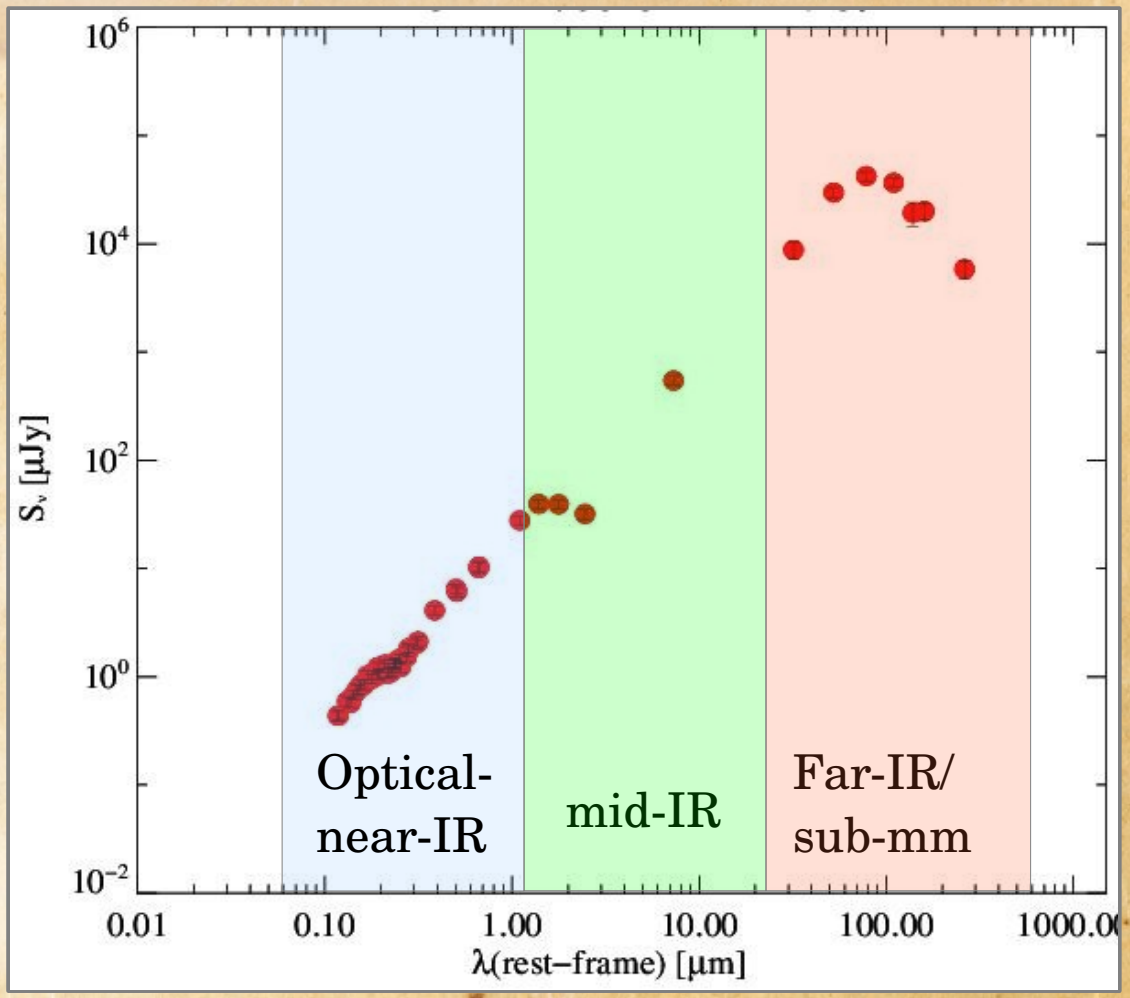
FINAL SAMPLE

7,339

radio sources + multi- λ

Multi-wavelength SEDs

- Optical/NIR: Subaru / UltraVISTA
- Mid-IR: Spitzer IRAC & MIPS
- Far-IR/mm: Herschel & mm data



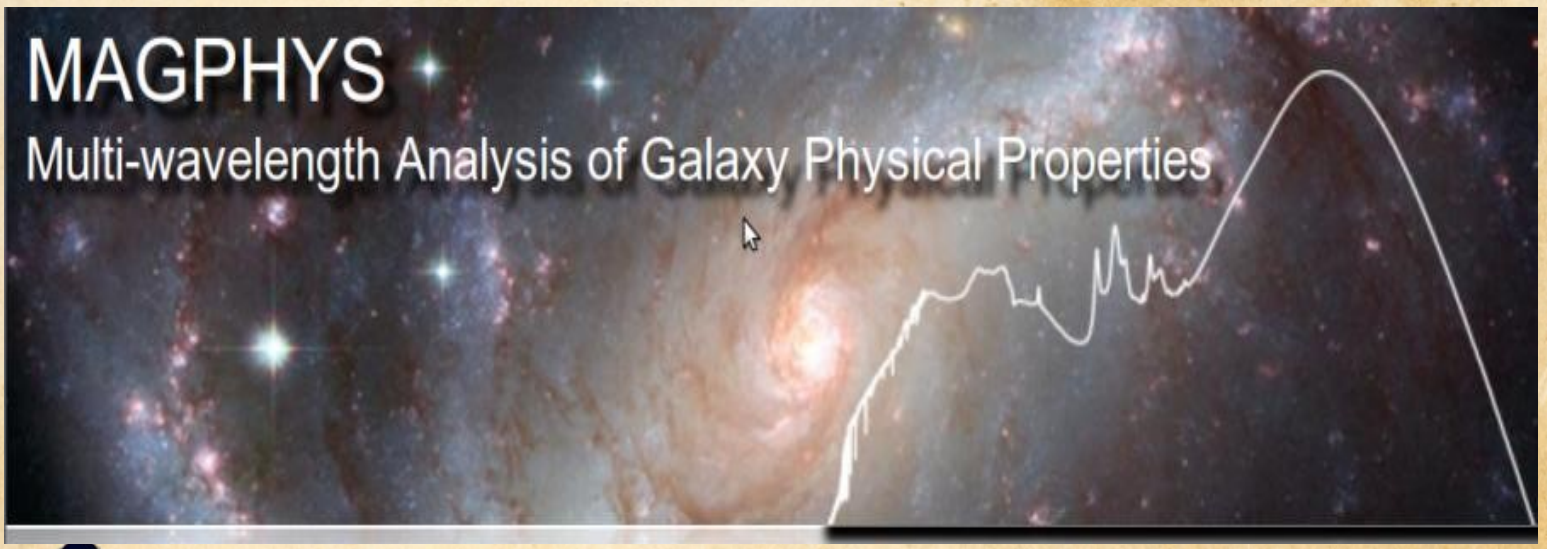
We characterize each individual galaxy from its broad-band spectral energy distribution (SED)

SED-fitting decomposition

SED-fitting code MAGPHYS
(da Cunha et al. 2008)

Galaxy templates

consistency between absorbed stellar light
and IR emission of the galaxy
(= energy balance argument).



SED-fitting decomposition

SED-fitting code MAGPHYS
(da Cunha et al. 2008)

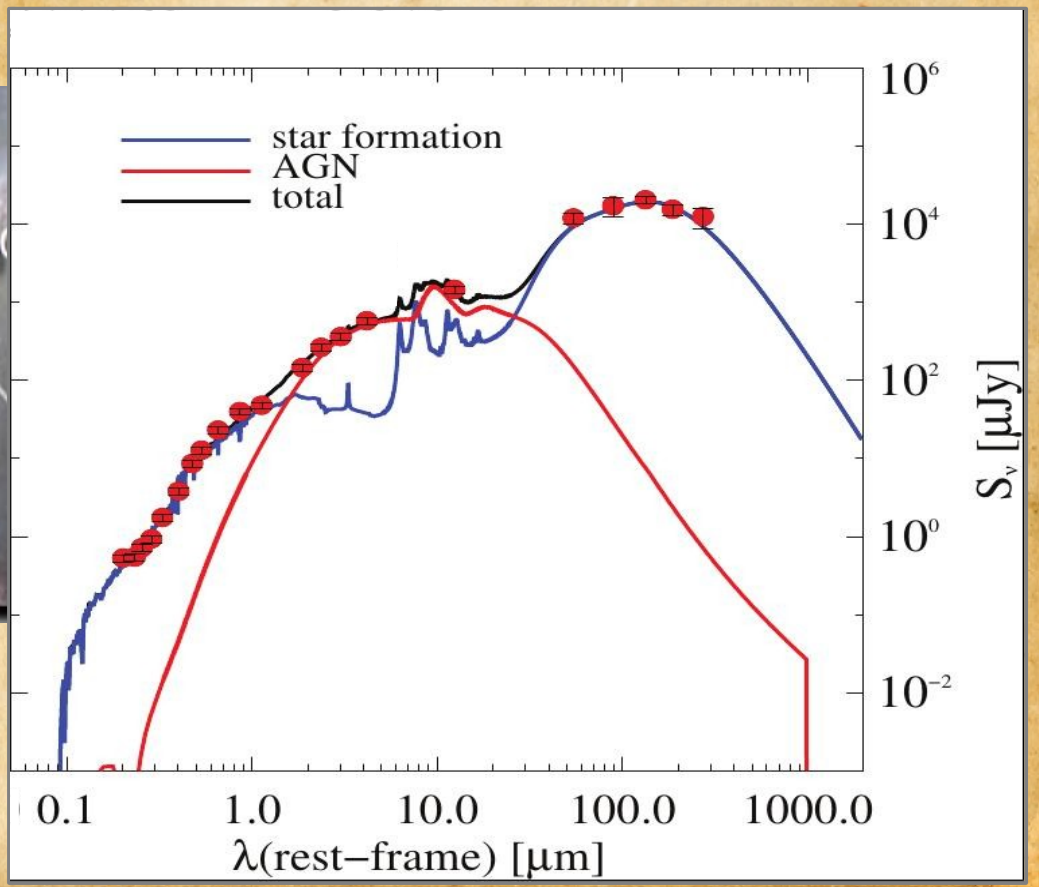
Galaxy templates

consistency between absorbed stellar light and IR emission of the galaxy
(= energy balance argument).

3-component SED fitting code
(Berta et al. 2013)

AGN library of templates

physically-motivated models of accretion disc and dusty torus emission
(Fritz et al. 2006; Feltre et al. 2012)



SED-fitting decomposition

SED-fitting code MAGPHYS
(da Cunha et al. 2008)

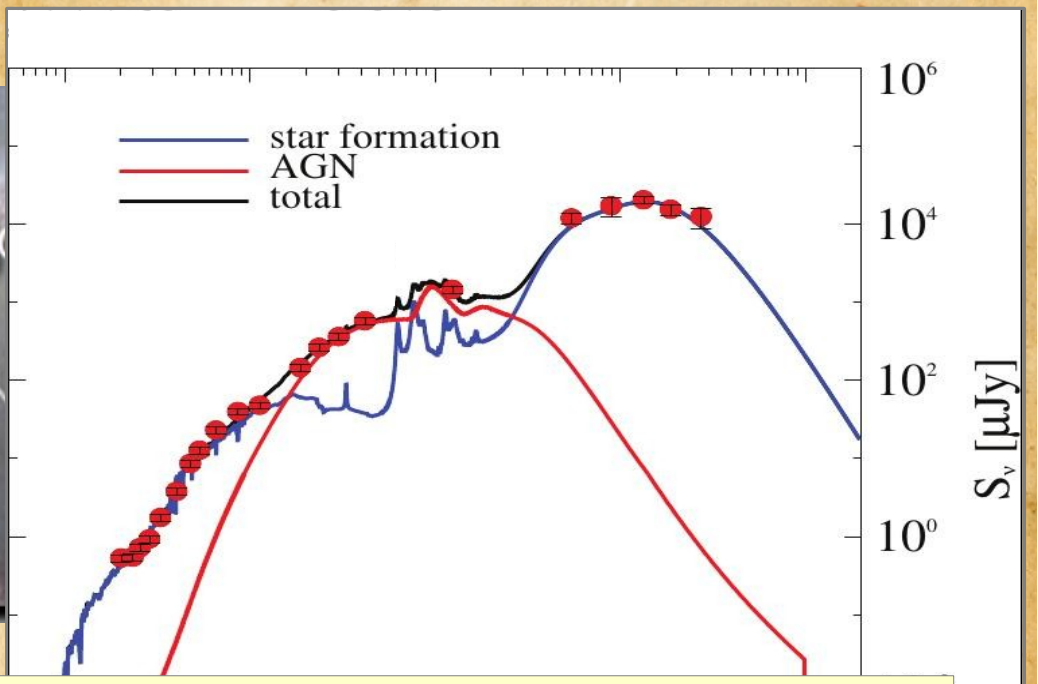
Galaxy templates

consistency between absorbed stellar light and IR emission of the galaxy
(= energy balance argument).

3-component SED fitting code
(Berta et al. 2013)

AGN library of templates

physically-motivated models of accretion disc and dusty torus emission
(Fritz et al. 2006; Feltre et al. 2012)



(1) Decomposing AGN emission from host-galaxy light
(2) Classification: *AGN* or *galaxy* (statistical and incomplete method)

AGN populations in Radio

Rad. Eff. AGN

(Radiative AGN activity)

X-ray + mid-IR + SED fitting (#1516)

~ 21% *radiatively Efficient* AGN

1) Lx > 10^{42} erg/s (e.g. Szokoly et al. 2004)

2) Mid-IR colour-colour diagram (Donley et al. 2012)

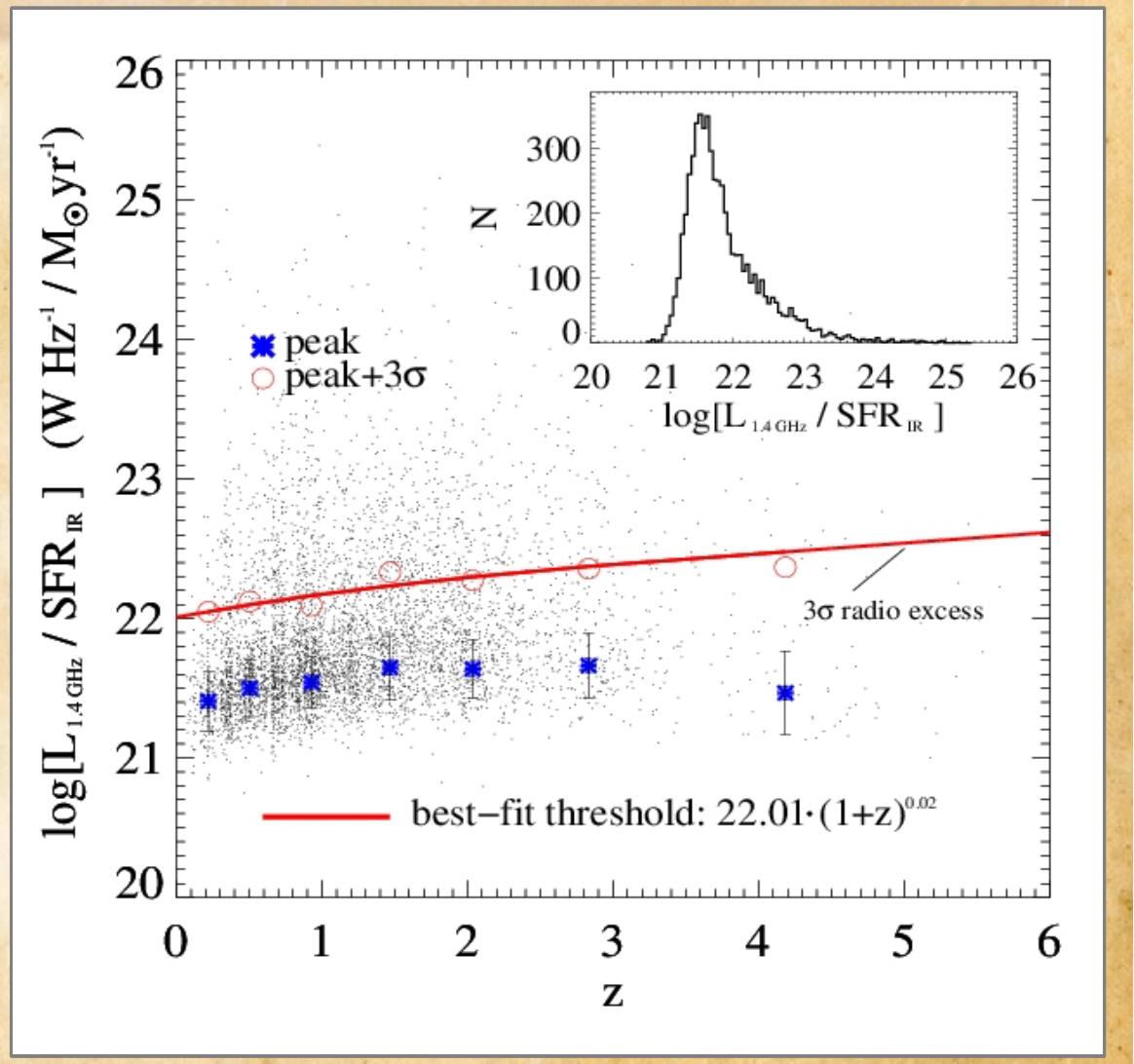
3) SED-fitting identified AGN

Radio-excess AGN

(Delvecchio et al. 2016, in prep)

- Considering 79% of *non* Rad. Eff. AGN
- Radio 1.4 GHz luminosity
- SFR_IR from galaxy's SF luminosity (Kennicutt 1998)

Distribution of $\log(L_{RADIO} / SFR_{IR})$



Radiatively Inefficient AGN detected via radio excess show up only in Radio

AGN populations in Radio

Rad. Eff. AGN

(Radiative AGN activity)

X-ray + mid-IR + SED fitting (#1516)

~ 21% *radiatively Efficient* AGN
(7% shows >3σ radio-excess)

Radio-excess
Rad. Ineff. AGN

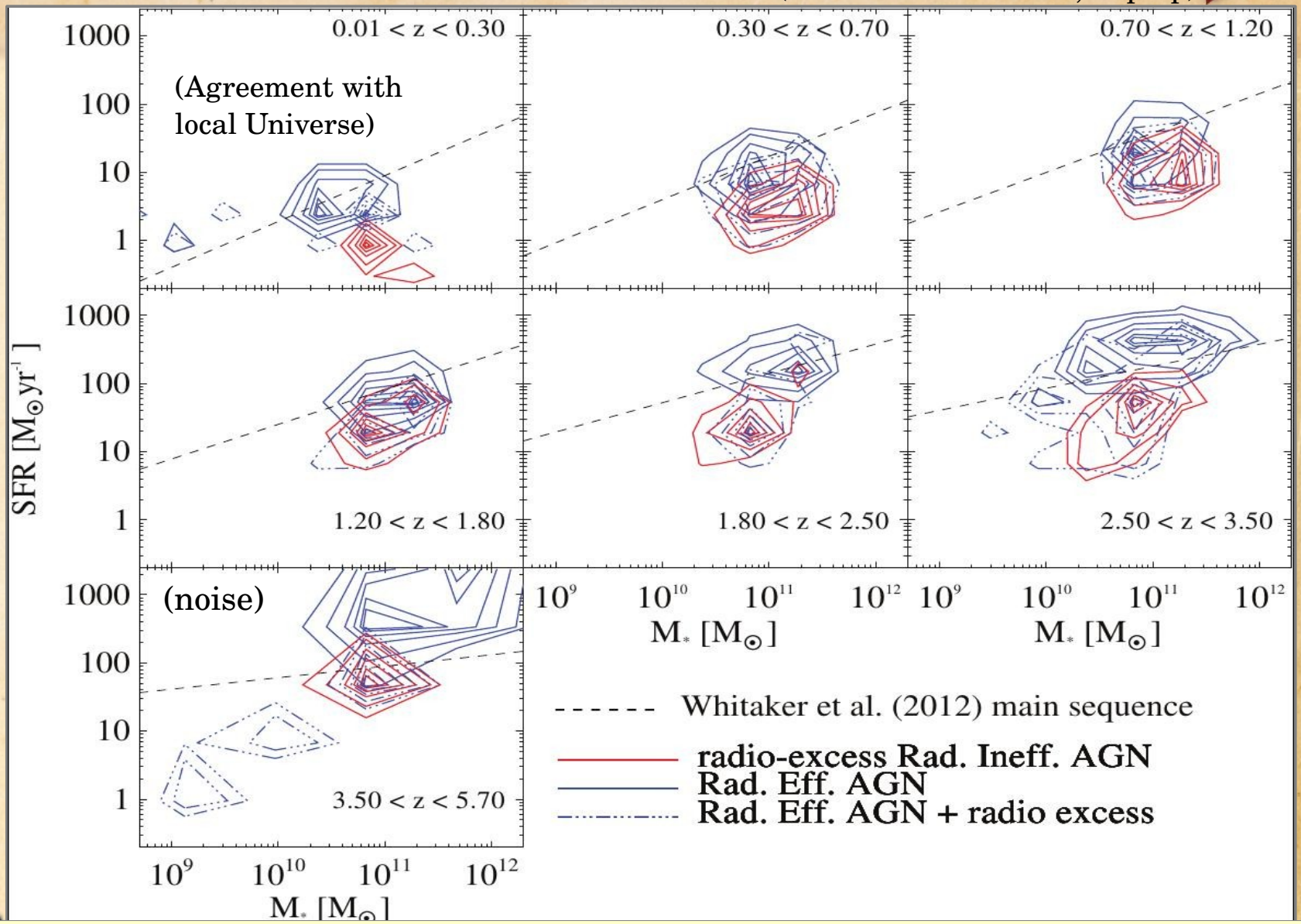
(Mechanical AGN activity)

Radio-excess (#1247)

~ 17% *radiatively Inefficient* AGN
with radio excess

SFR-M* plane

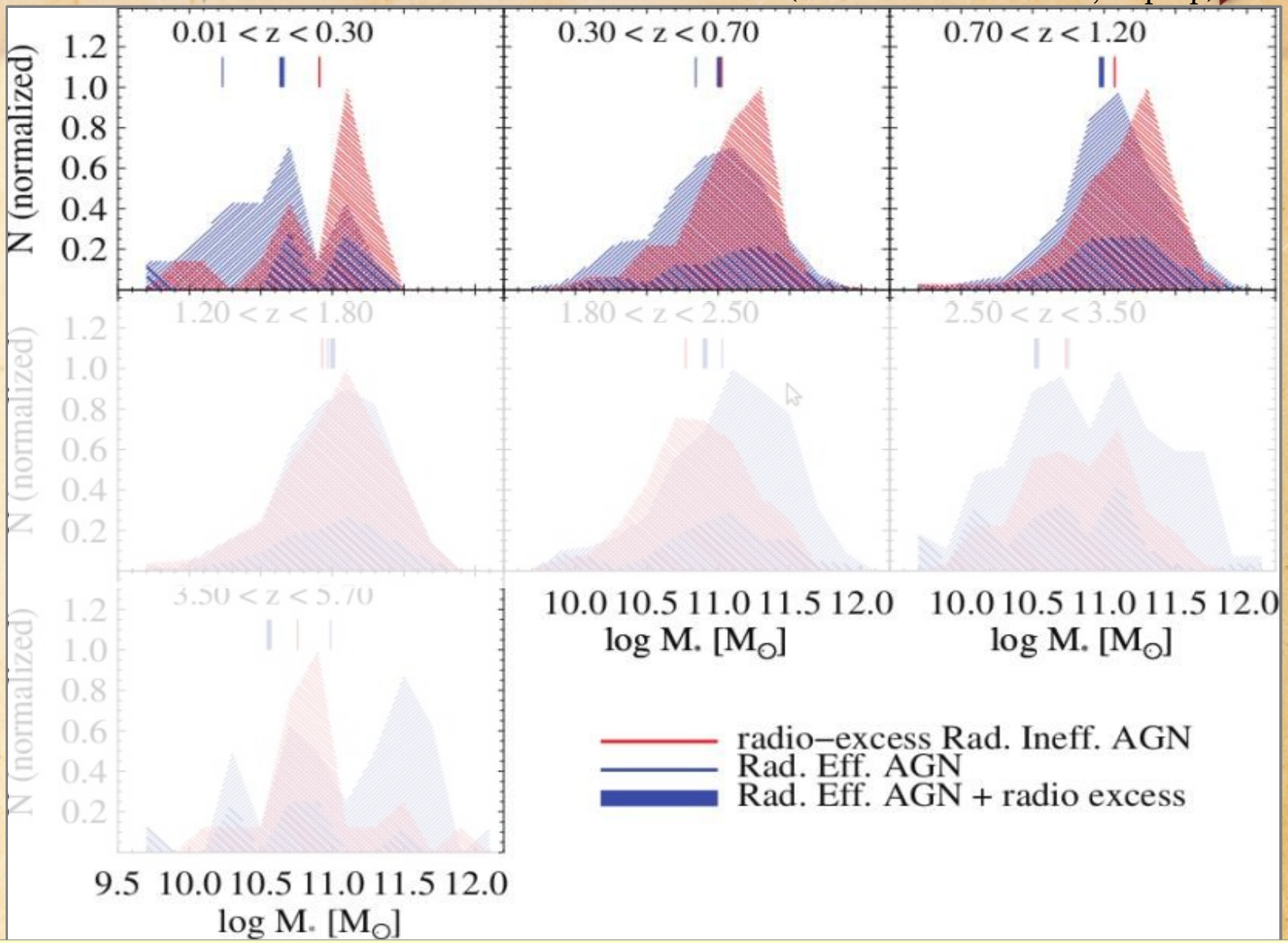
(Delvecchio et al. 2016, in prep)



Rad. Eff. AGN lie around the MS, while Rad. Ineff. AGN are 2-3 times below

M* distributions

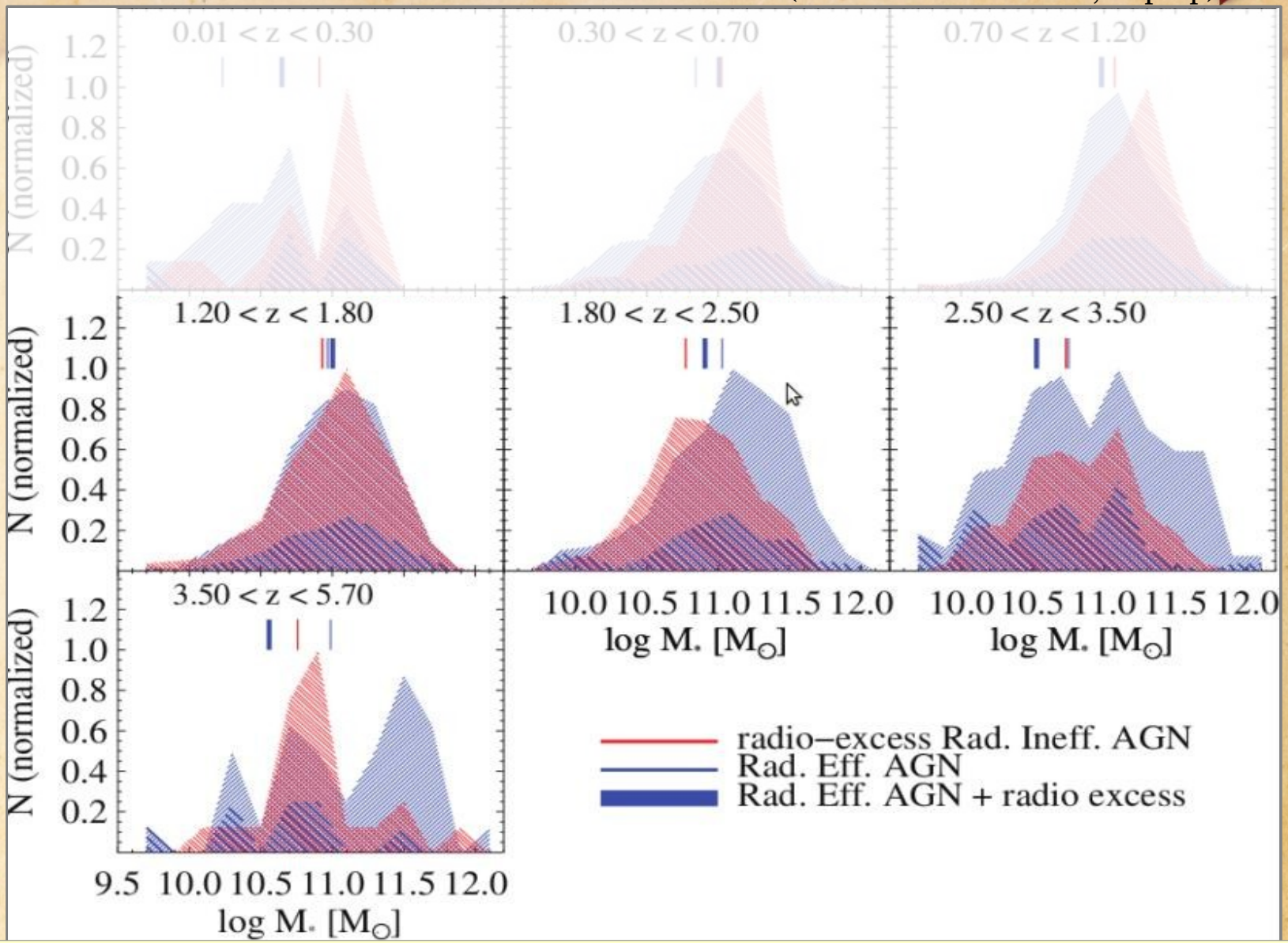
(Delvecchio et al. 2016, in prep)



Rad. Eff. AGN typically hosted in less massive galaxies than Rad. Ineff. AGN

M* distributions

(Delvecchio et al. 2016, in prep)



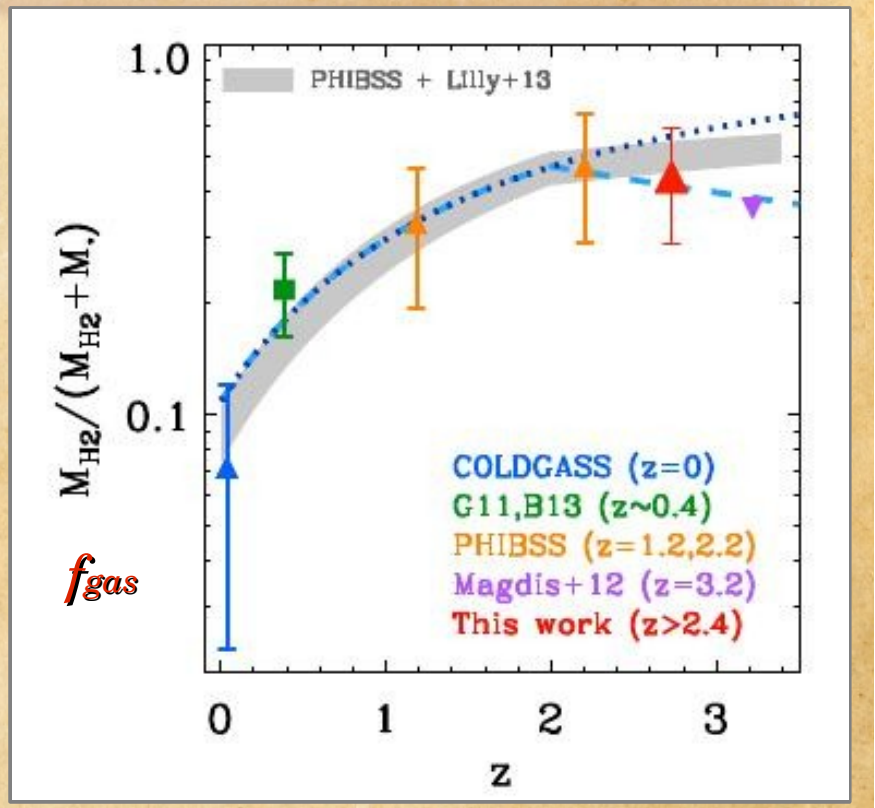
z=1.5: similar M* distributions

z=2: possible reversal (6.4 σ) of the M* behaviour (galaxy "downsizing"?)

Hint of "downsizing"?

- Rad. Eff. AGN live preferentially in MS galaxies
- Molecular gas fraction increases with redshift $f_{gas} \sim (1+z)^2$ in MS galaxies (Saintonge et al. 2013)
- AGN accretion occurs more likely in gas-rich galaxies (e.g. Vito et al. 2014)

Saintonge et al. (2013)



- Massive galaxies at high redshift host Rad. Eff. AGN activity more commonly than less massive galaxies

- Galaxies below the MS have less cold gas, meaning less efficient SMBH accretion

Summary:
Radio-AGN dichotomy at high-z?

Rad. Eff. AGN

Radio-excess
Rad. Ineff. AGN

Rad. Ineff. AGN typically live in less star-forming and more massive galaxies than Rad. Eff. AGN (high-z analogs of Low/High Excitation AGN?)

Summary:

Radio-AGN dichotomy at high-z?

Rad. Eff. AGN

Radio-excess
Rad. Ineff. AGN

Rad. Eff. AGN with radio-excess show intermediate properties between the two main AGN classes: transitional phase?

(e.g. Farrah et al. 2012; Cicone et al. 2014; Perna et al. 2015; Brusa et al. 2015, 2016)

Summary:

Radio-AGN dichotomy at high-z?

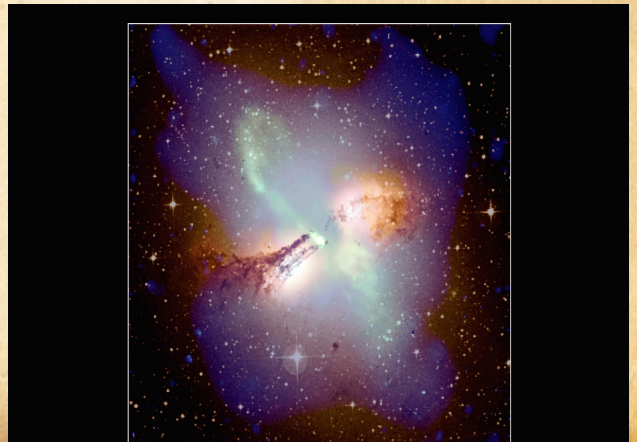
1) **Rad. Eff. AGN**

3) **Radio-excess**
Rad. Ineff. AGN

Rad. Eff. AGN + radio-excess

(A transitional phase?)

2)



Take-away messages

Multi-wavelength diagnostics essential to identify
two-fold AGN population:
Rad. Eff. AGN (21%) and radio-excess, Rad. Ineff. AGN (17%)

At z<1, Rad. Ineff. AGN live in less star-forming
and more massive galaxies than Rad. Eff. AGN.

At z~2, we observed a reversal of the M* distribution:
cold gas might be the key driver of this trend

Rad. Eff. AGN with radio-excess show intermediate properties
between the rest of Rad. Eff. AGN and Rad. Ineff. AGN:
transitional phase?