Galaxy evolution: the role of mid and far-IR spectroscopy
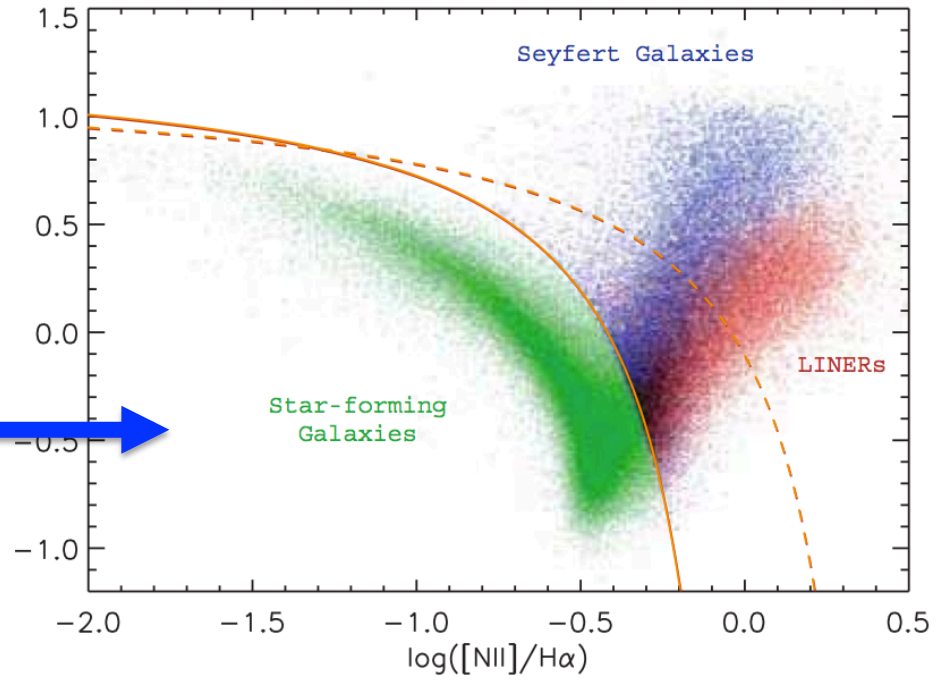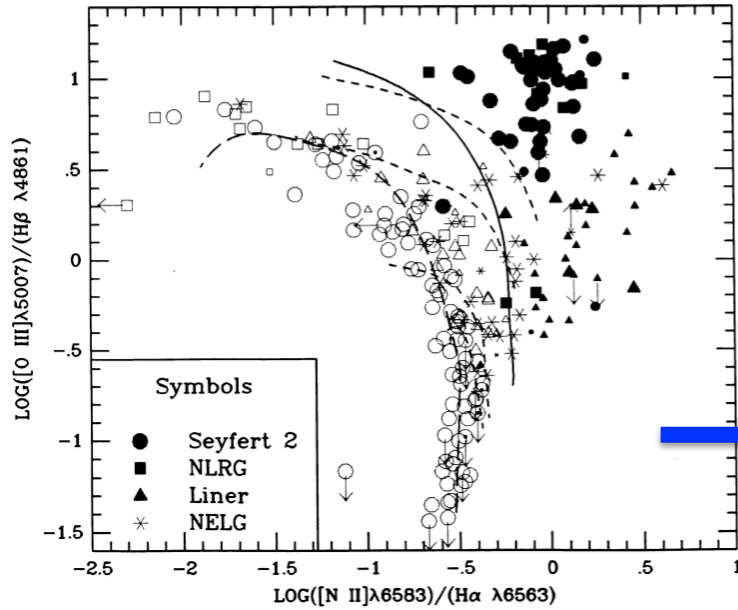
Roberto Maiolino

Why do we need SPICA?

**Mid-IR and Far-IR extragalactic spectroscopy
is currently at the same stage
as optical spectroscopy 30 years ago**

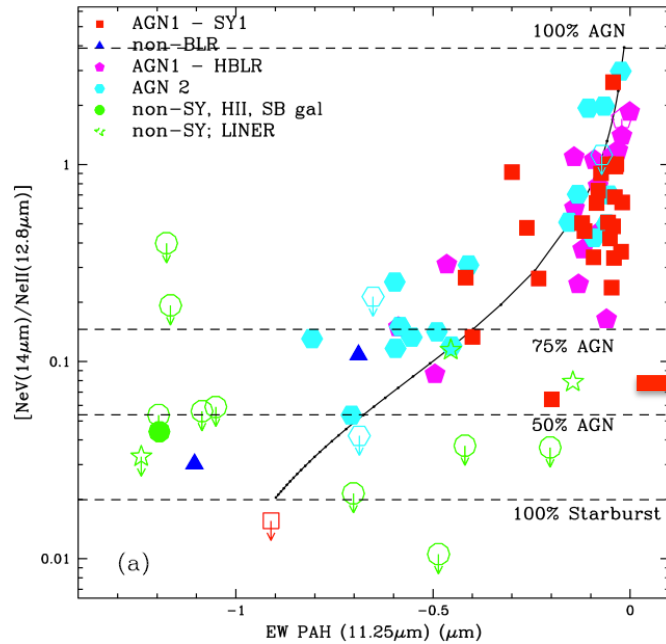Veilleux & Osterbrock **1987** (~100 galaxies)

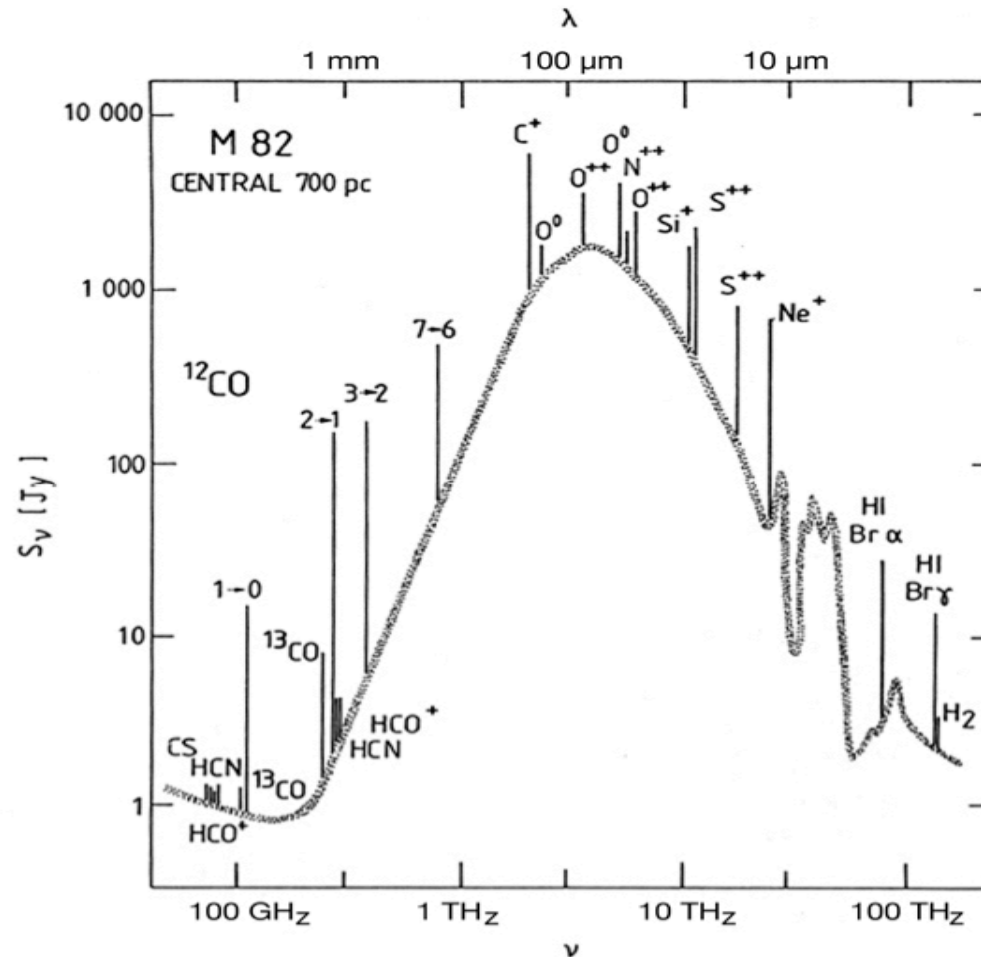Groves+ **2006** (>10^5 galaxies)

OPTICAL SPECTROSCOPY

MIR-FIR SPECTROSCOPY

Tommasin+ **2010** (~60 galaxies)

SPICA … ~2020

~100 galaxies observed so far, despite mid-IR/far-IR bands hosting the **strongest lines** in nearly any galaxy…
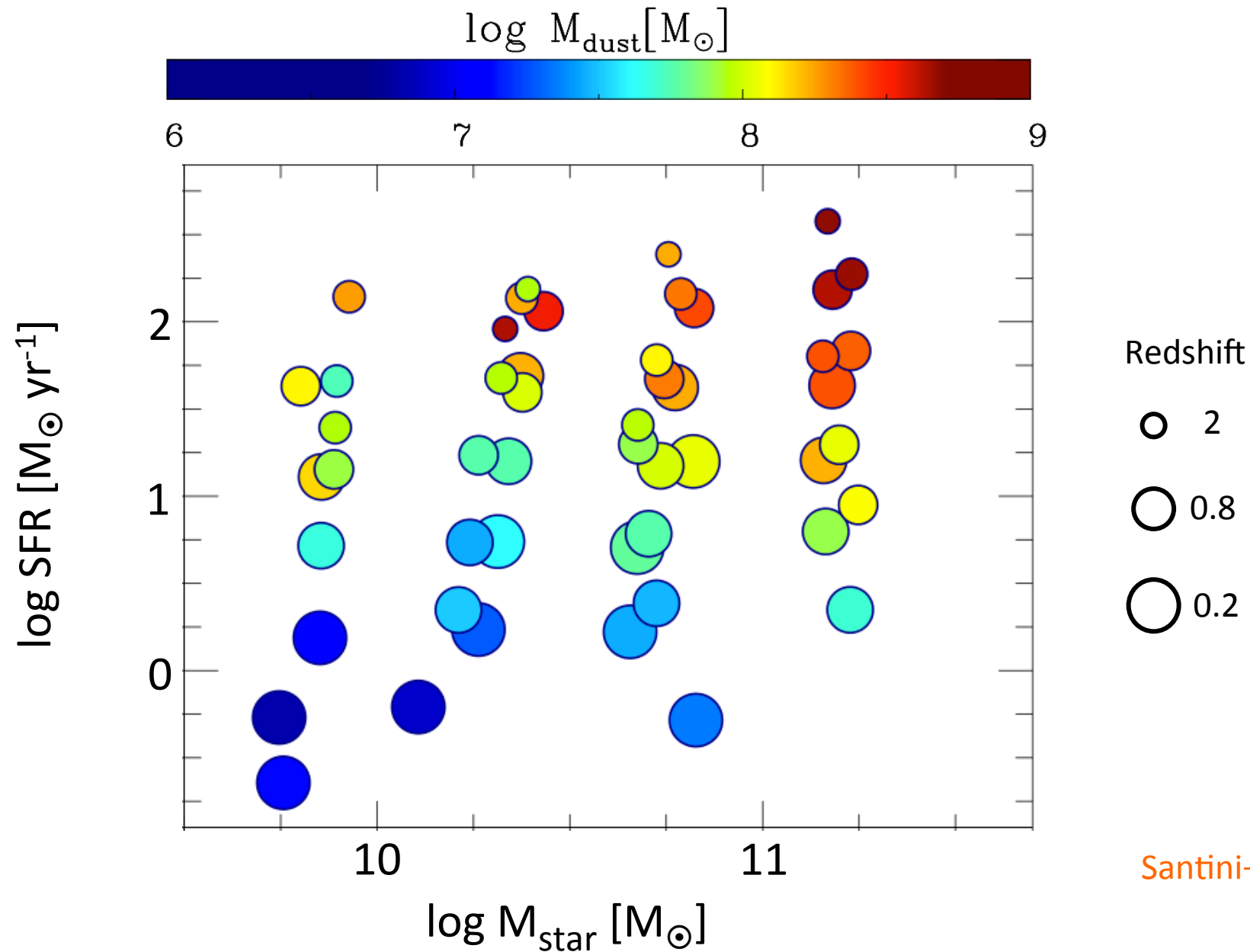huge potential if we could access them with "good" sensitivity…

Paradoxically, the most massive and most star forming galaxies are
the most difficult to study in the optical because the most obscured by dust

log $M_{dust}[M_\odot]$

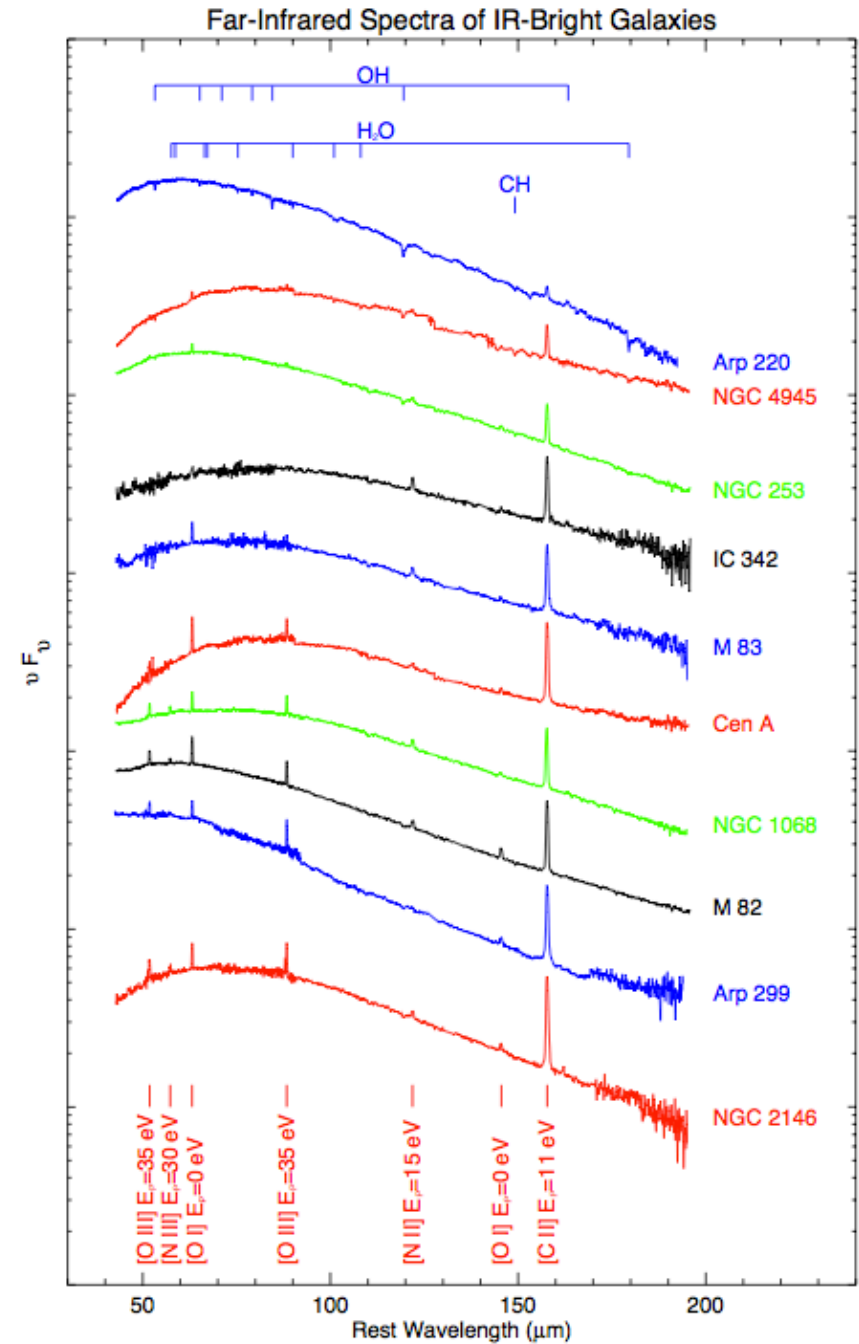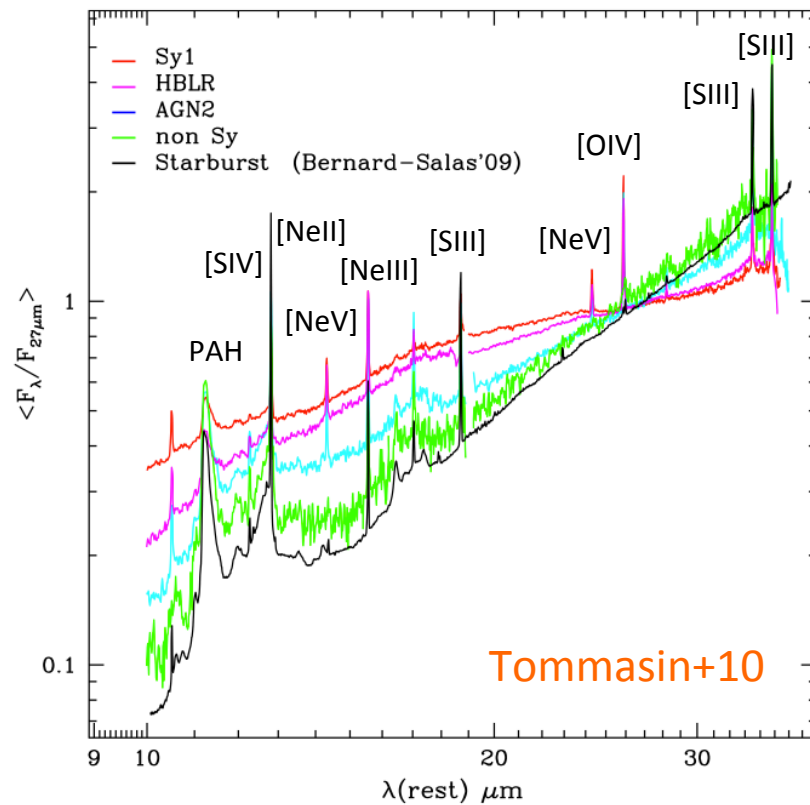log SFR [$M_\odot$ yr^{-1}]
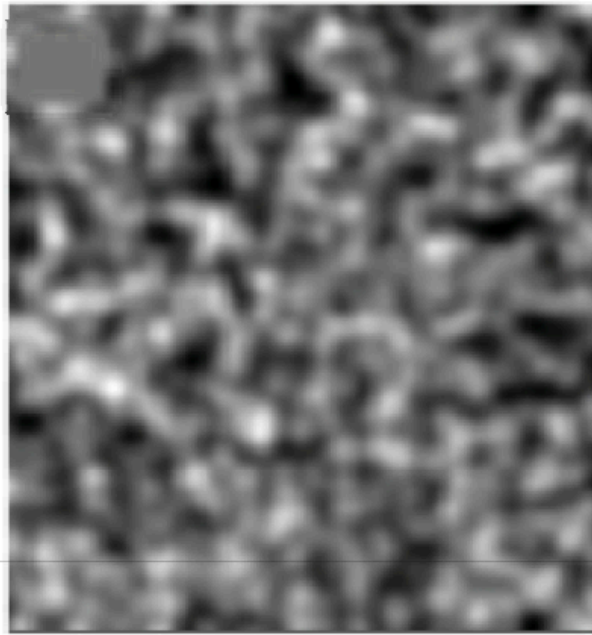
log M_{star} [$M_\odot$]

Redshift

Santini+13

The role of SENSITIVE mid/far-IR spectroscopy

- Redshifts
- Environment
- SFR
- Metallicity
- Density and excitation
- AGN diagnostics
- Feedback
- Environment

Plenty of strong mid- and far-IR features to detect high-z galaxies and measure redshifts
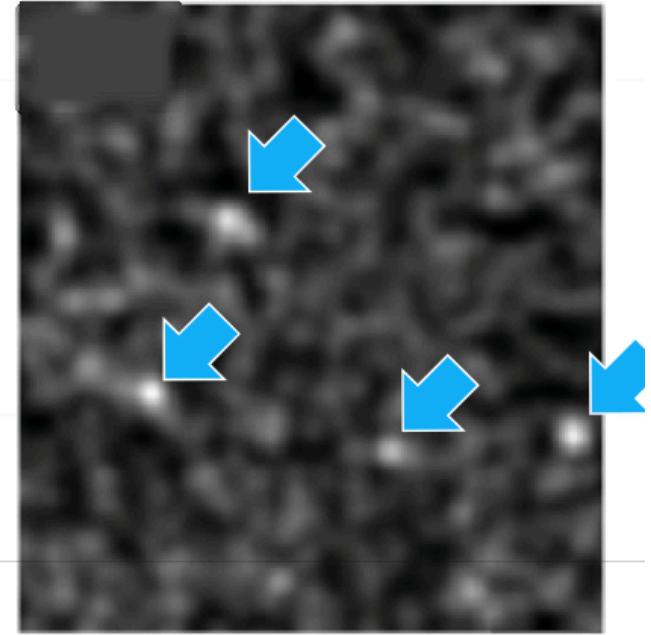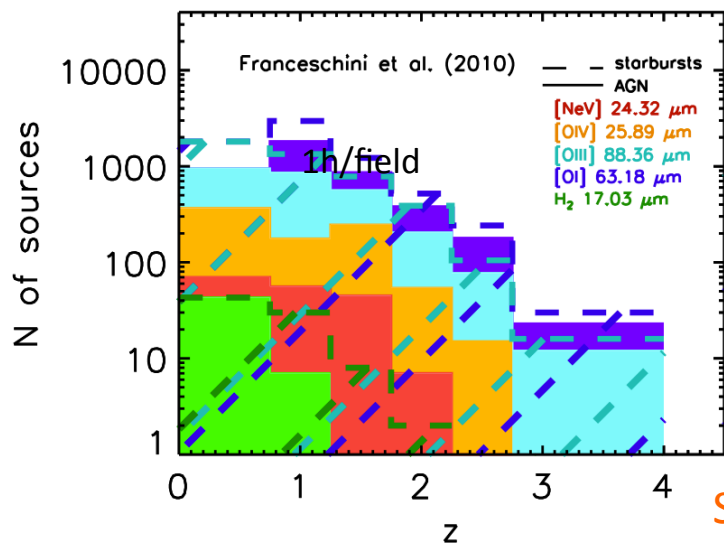

Tommasin+10

Far-Infrared Spectra of IR-Bright Galaxies

Overcoming confusion with spectroscopy

Photometry @ 120μm   Slice @ 63.2μm   Slice @ 58.3 μm

Franceschini et al. (2010)

starbursts
AGN
[NeV] 24.32 μm
[OIV] 25.89 μm
[OIII] 88.36 μm
[OI] 63.18 μm
H₂ 17.03 μm

1h/field

N of sources

z

Spinoglio+12

>10^4 (10^5) redshifts from a typical SAFARI-SPICA large survey…
why do we need so many?

125 Mpc/h

The role of environment

- Spectroscopic redshifts are needed to assign galaxies to large scale structures

- $>10^4$ galaxies are needed to identify large scale structures ($>10^5$ can give 3D clustering)

- $>10^4$ needed to disentangle degeneracies between overdensity and galaxy properties

Peng+ 10: dissecting the role of environment from galaxy properties with 10^5 galaxies