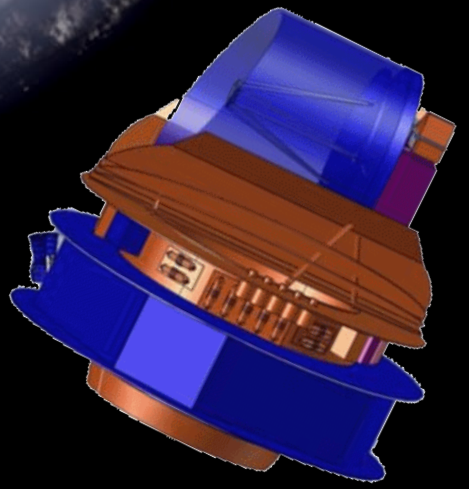
Tracing AGN and SF activity through SED decomposition and IR lines with SPICA

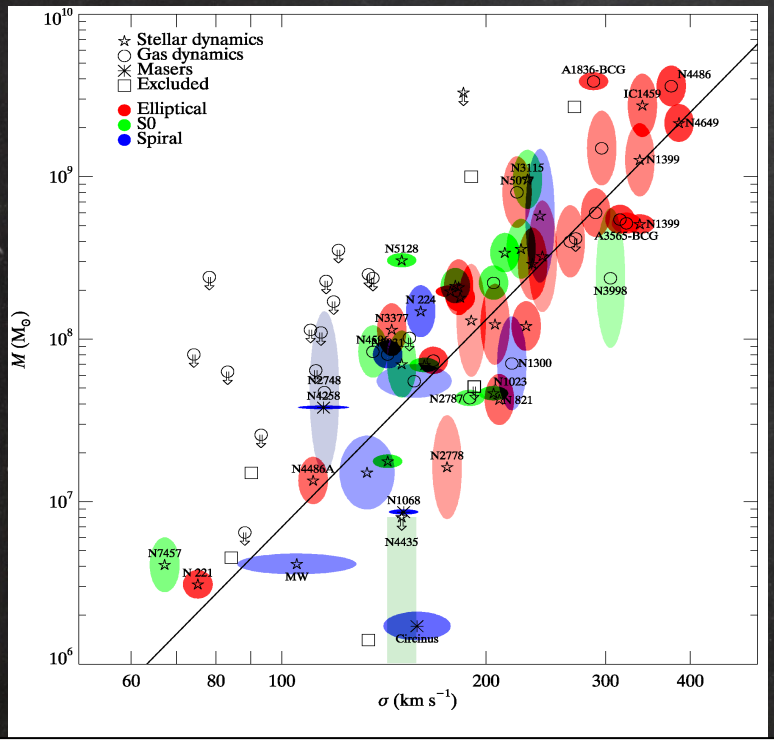


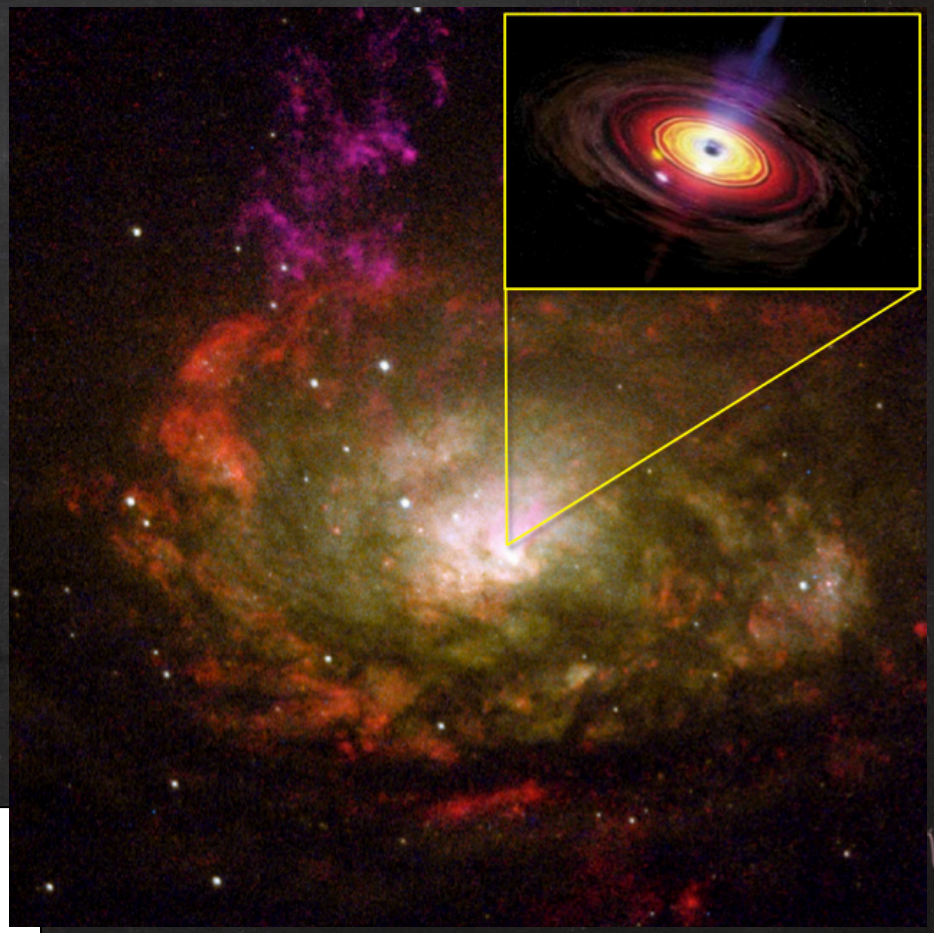
C. Gruppioni (INAF-OABo)

RAS, London - 2016 January 22

The link between AGN and host galaxy properties

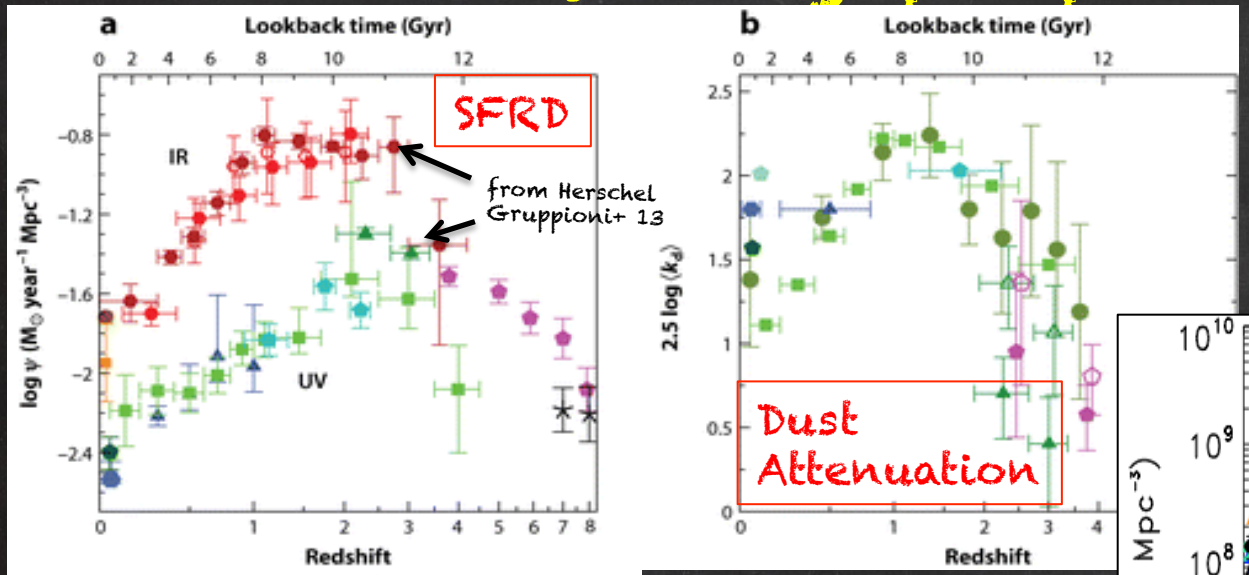
AGN and their host Galaxies are intimately connected

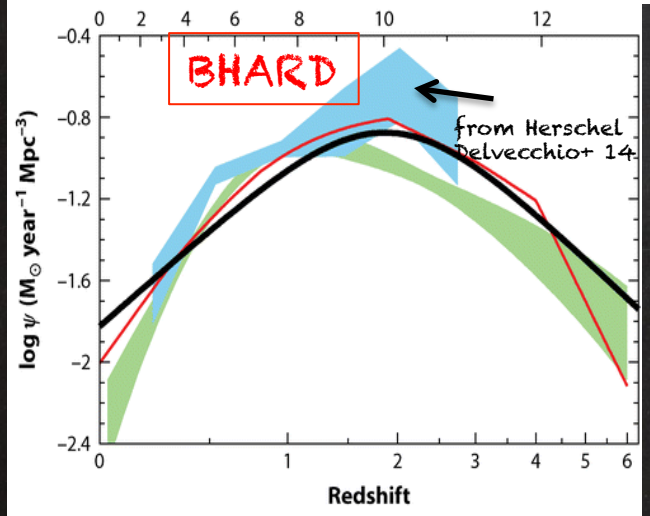




★ M-σ relation (e.g., Magorrian+ 1998; Ferrarese & Merritt 2000; Haring & Rix 2004)

The link between AGN and host galaxy properties

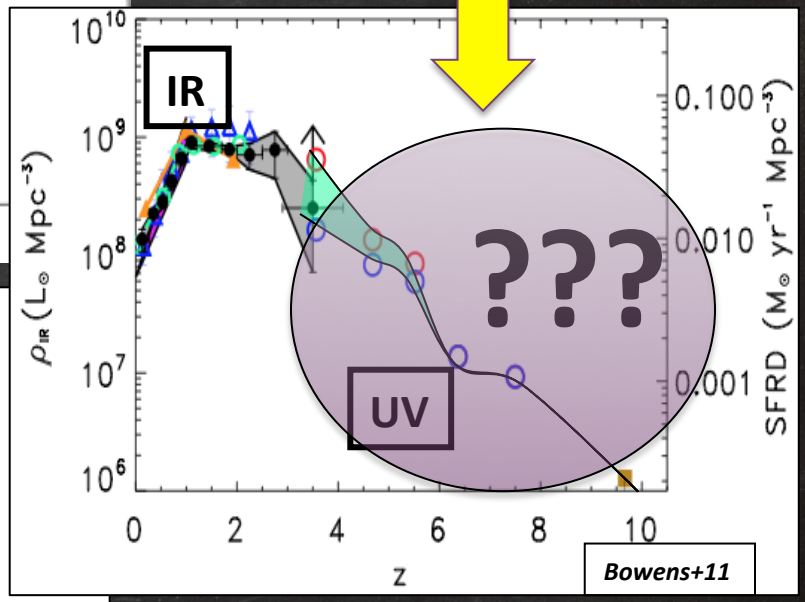




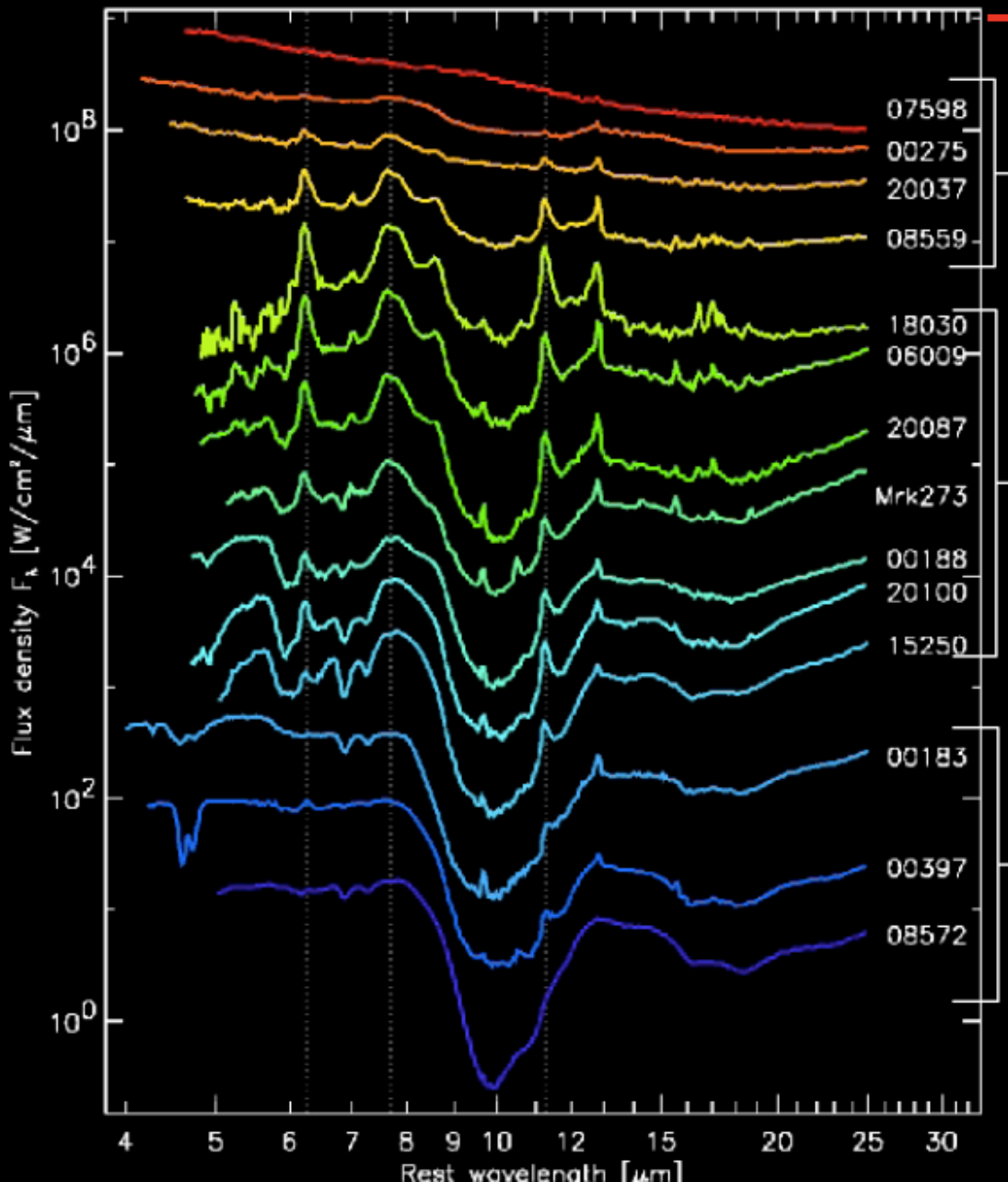
Madau P, Dickinson M. 2014.
Annu. Rev. Astron. Astrophys. 52:415–86

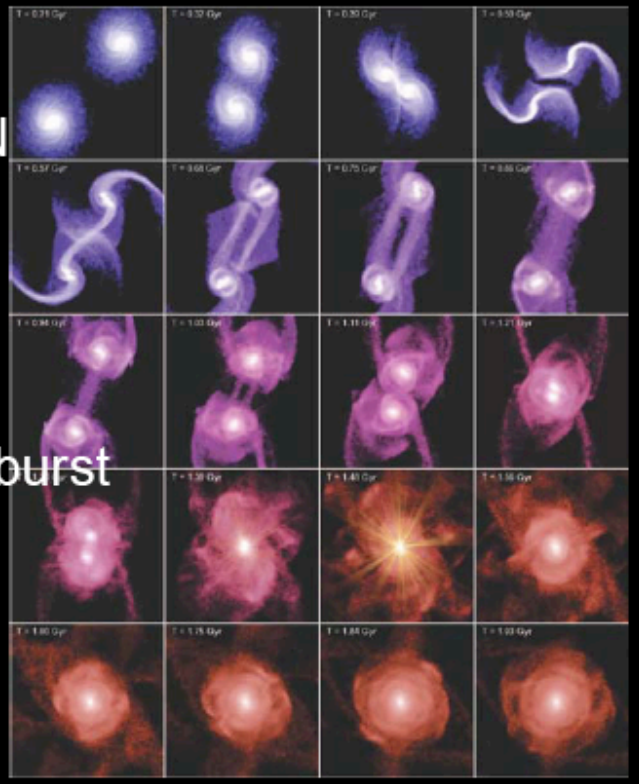
★ Similar cosmic growth history: peak at z~2, decline at later times (e.g., Barger+01, Merloni+04,06, Hopkins+04, Delvecchio+14, Madau&Dickinson 15, ...)

Role of DUST at these early epochs?



Mid-IR Spectroscopy: AGN versus Starburst



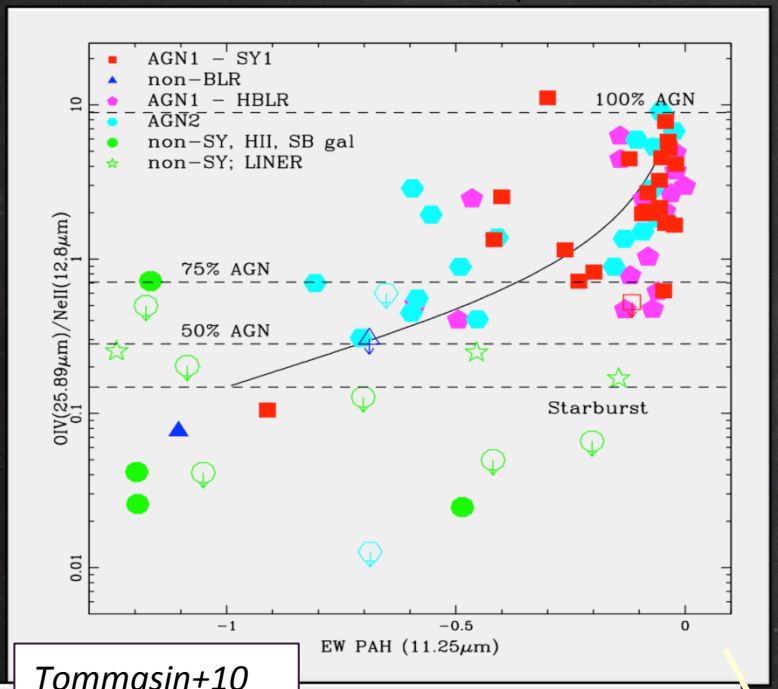


Hopkins et al. 2006

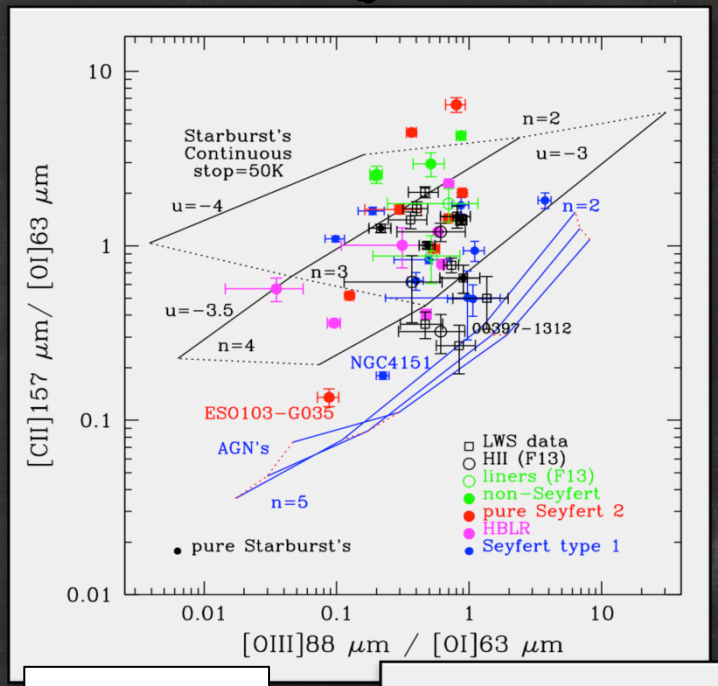
Armus et al. (2006, IRS GTO ULIRG program)

Veilleux et al. (2006, 2009 QUEST)

Mid- and Far-IR Diagnostics



Tommasin+10

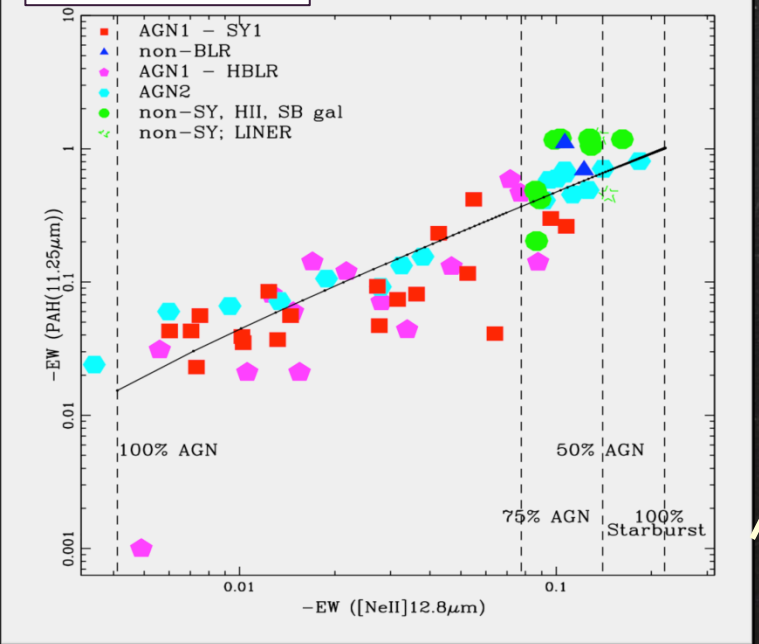


Spinoglio+15

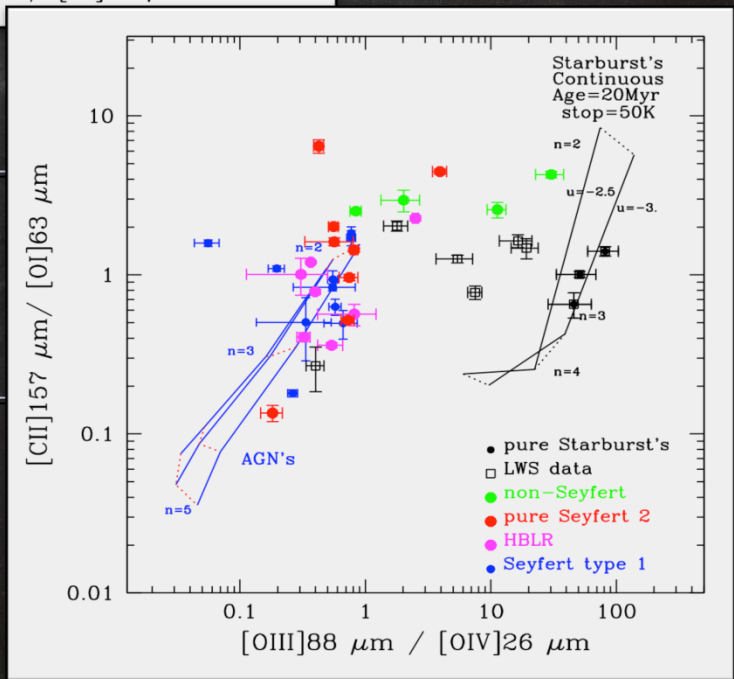
Plenty of strong mid- and far-IR features to detect high-z galaxies and measure redshifs

↓

Disentangle AGN from starburst



at z>2 PAH lines redshifted in the SAFARI range

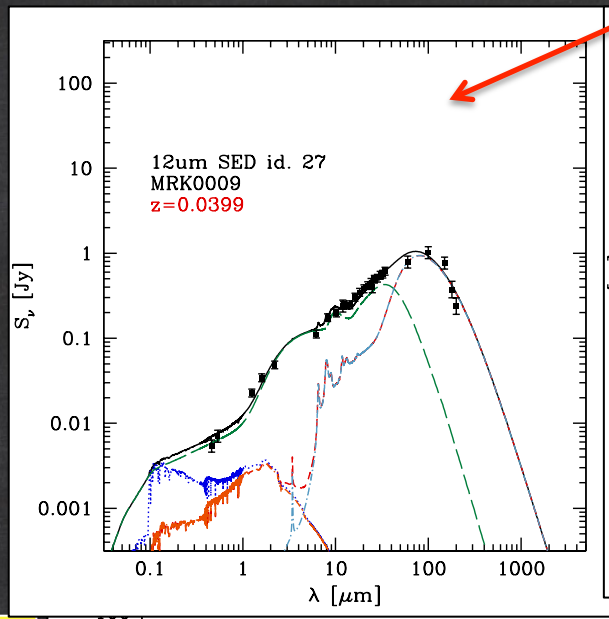


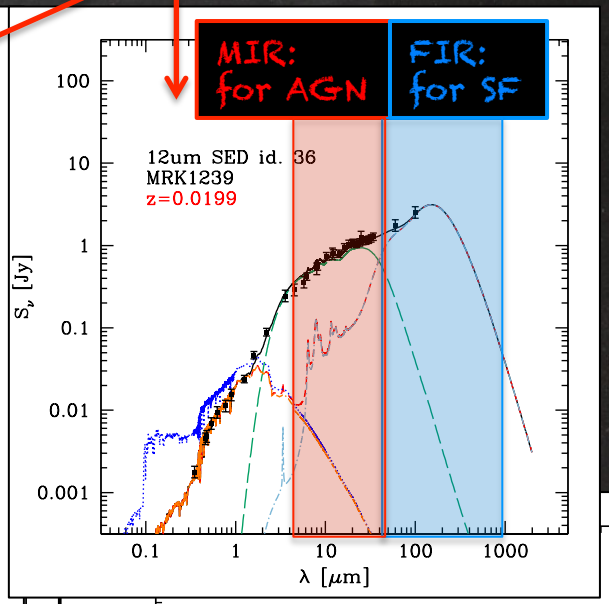
Broad-band SED-fitting Decomposition

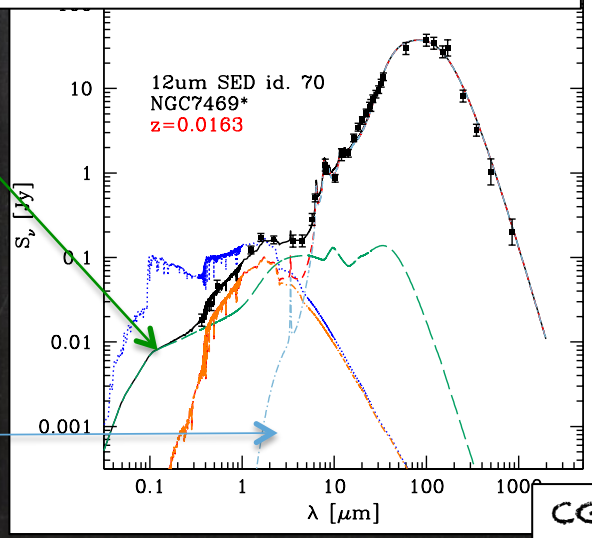
Modified MAGPHYS + AGN
(daCunha+08 + Feltre+12 => Berta+13)

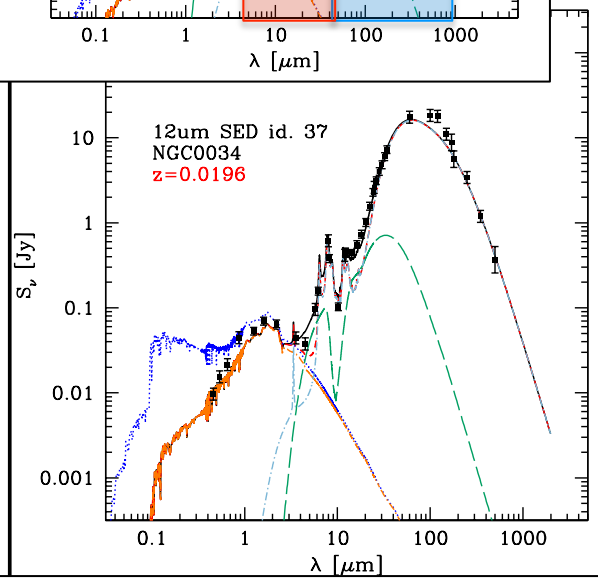
Self-consistent link of the energy absorbed by dust in the UV-**optical** and dust emission in the MIR/FIR + torus emission

Some Examples of SED-decomposition





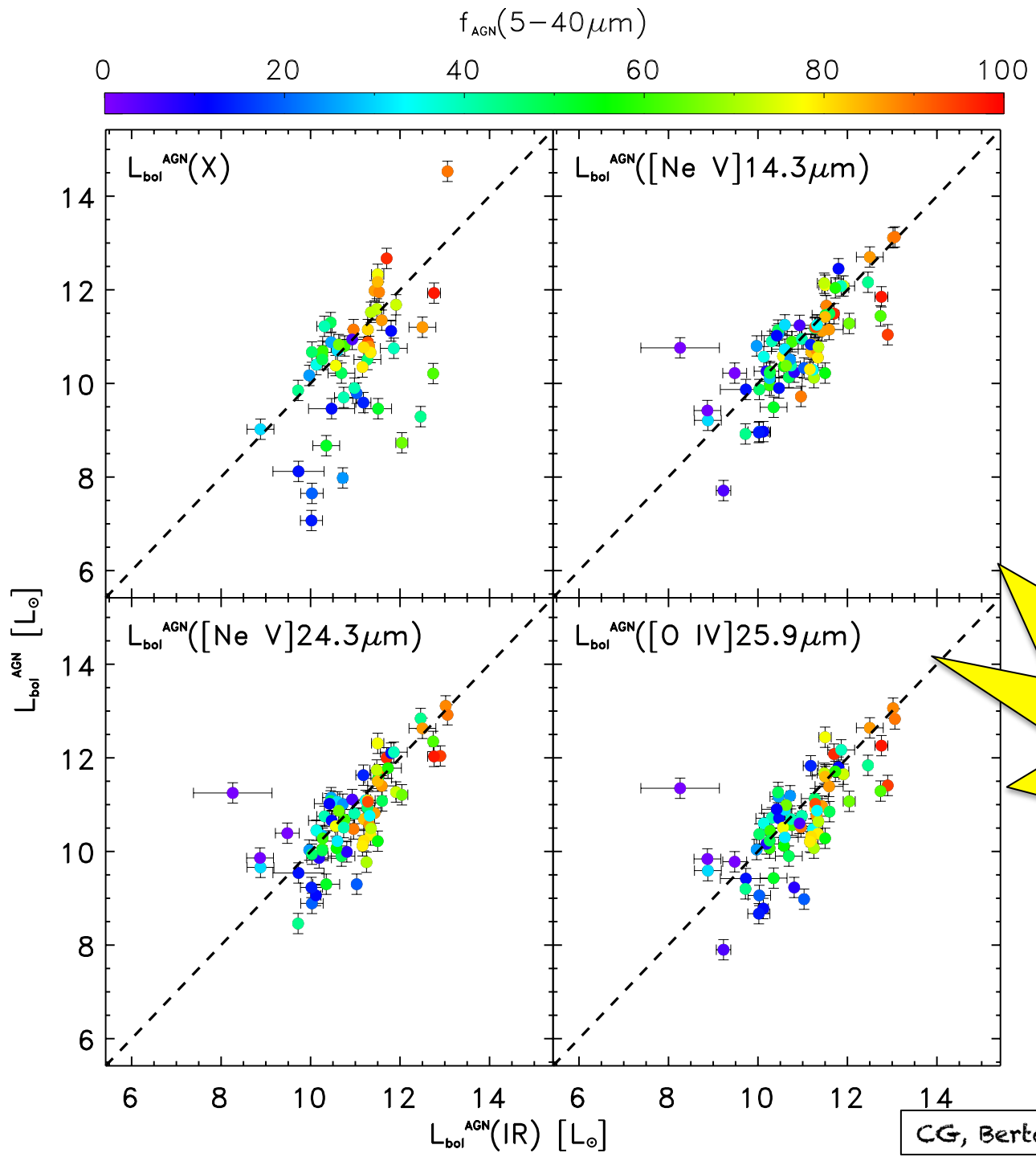




L_{ACC} from AGN torus model

L^{SF} from re-emitted stellar light (L_{IR}[8-1000μm] is a proxy)

CG, Berta, Spinoglio+2016, MNRAS subm.

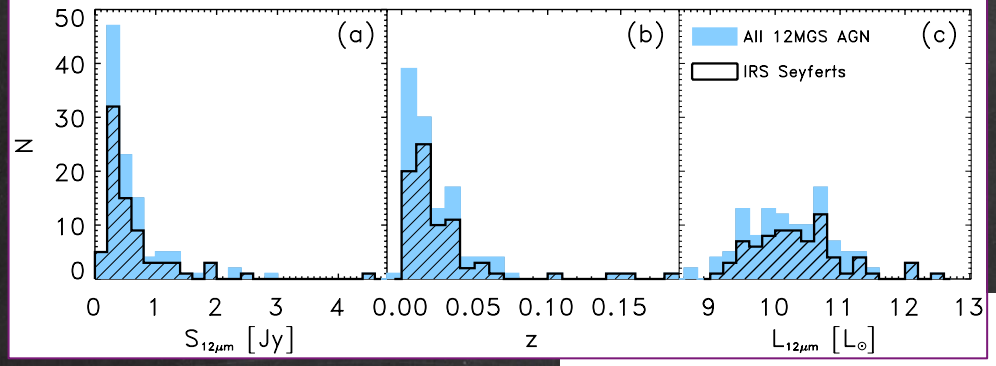


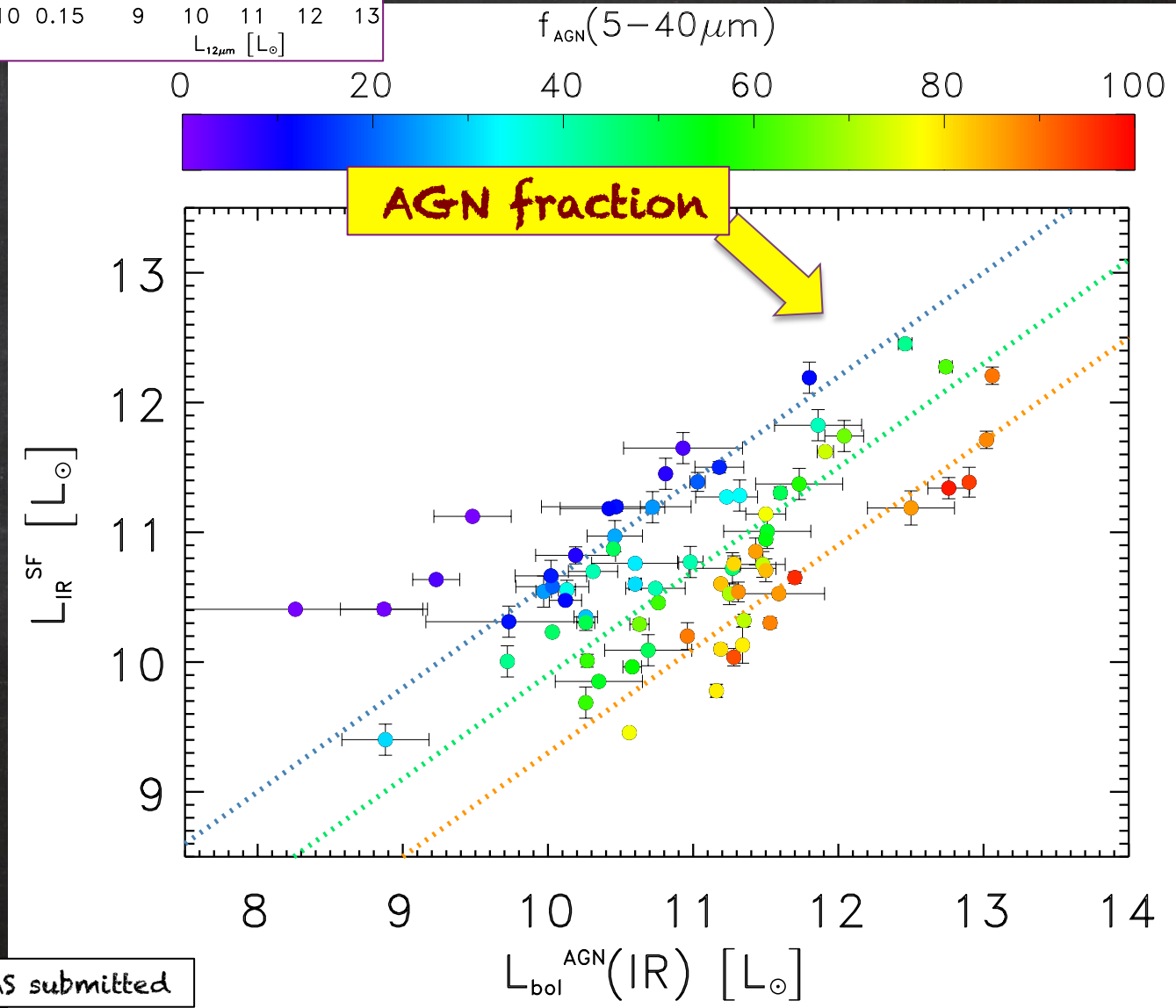
$L_{acc}(IR)$ derived from SED-fitting (= $L_{bol}^{AGN}(IR)$) compared to L_{bol}^{AGN} from other estimators (i.e. X-ray, [NeV], [OIV])

Good Agreement!

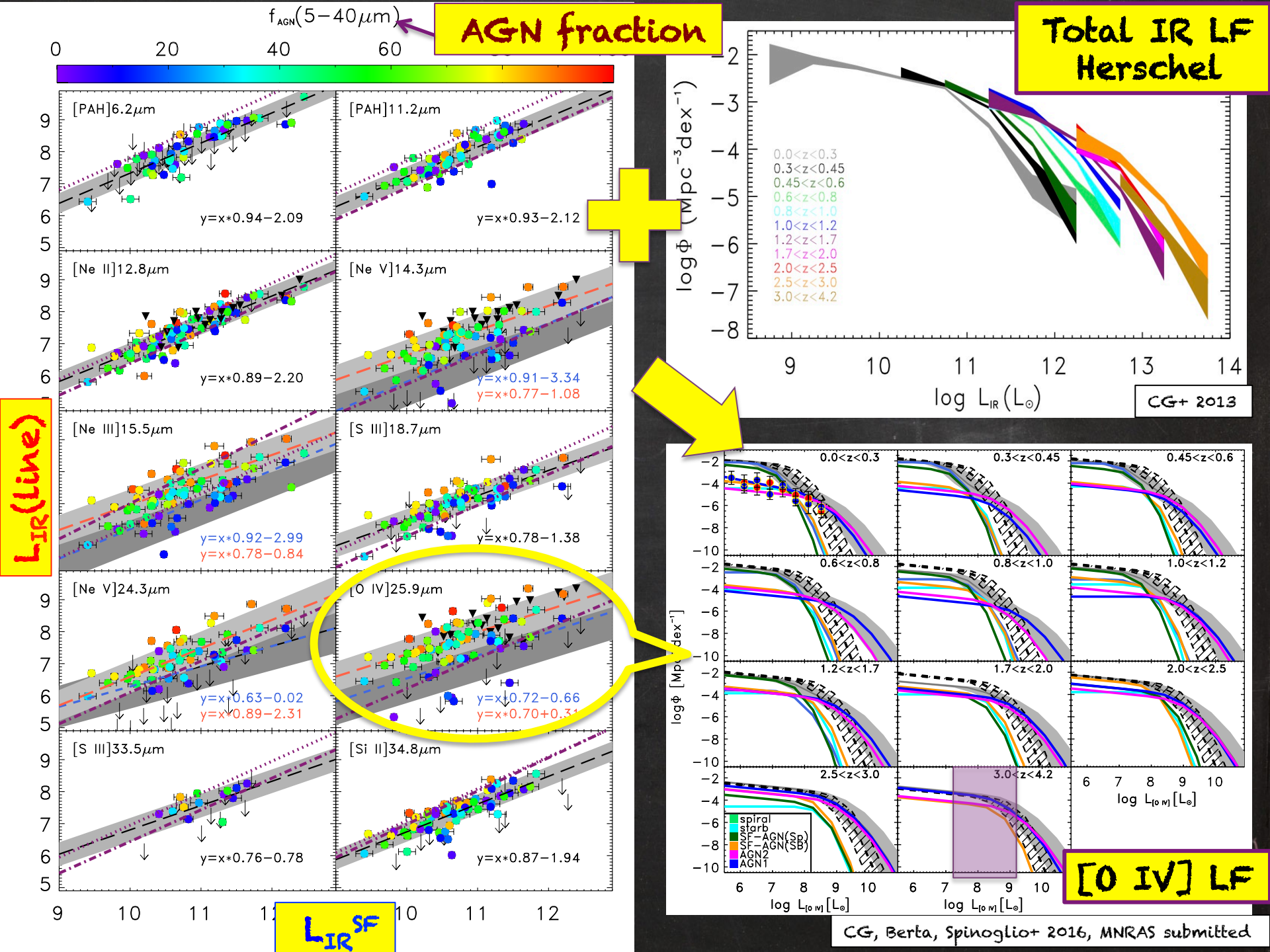
CG, Berta, Spinoglio+ 2016, MNRAS submitted

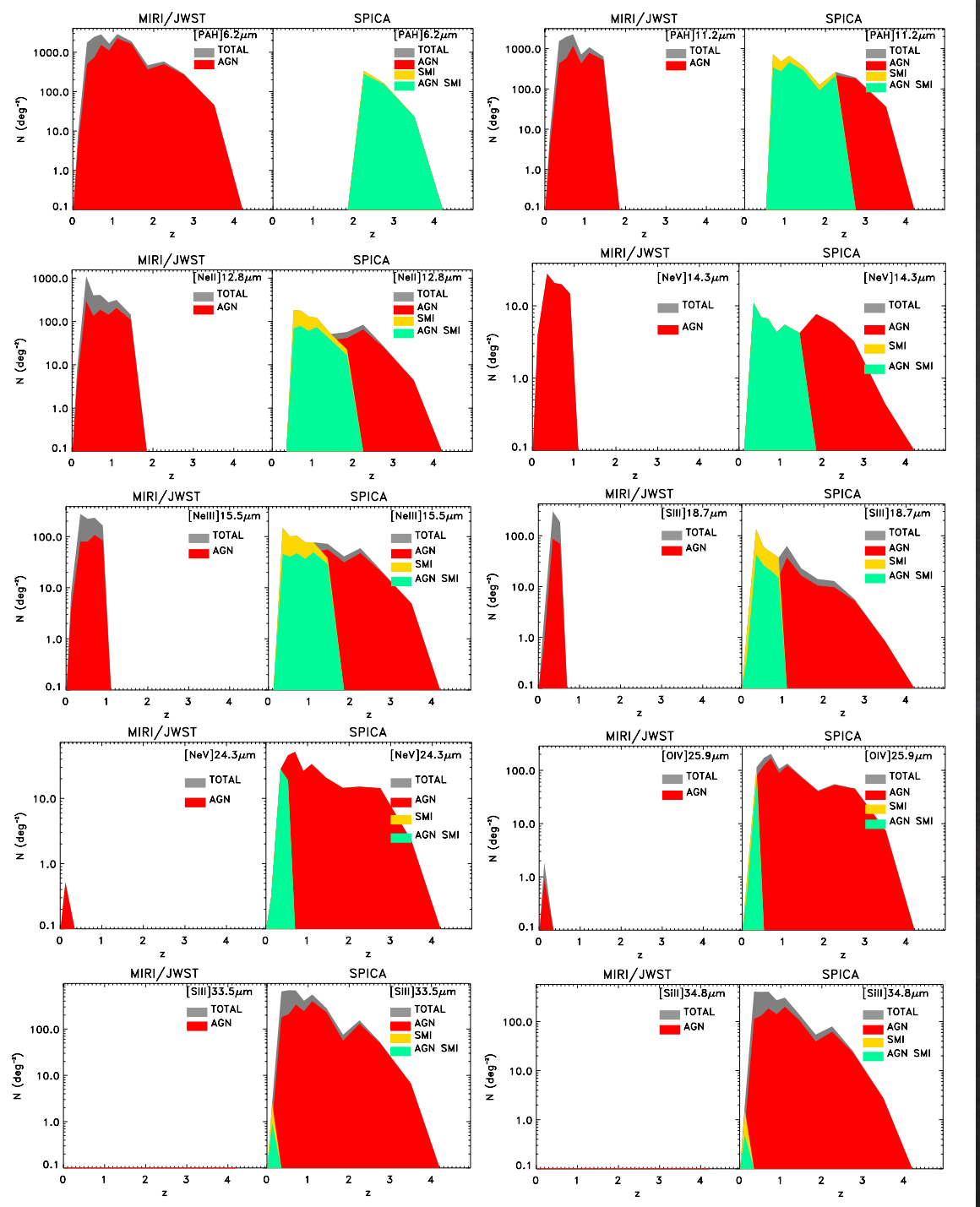
AGN vs. SF





CG, Berta, Spinoglio+ 2016, MNRAS submitted

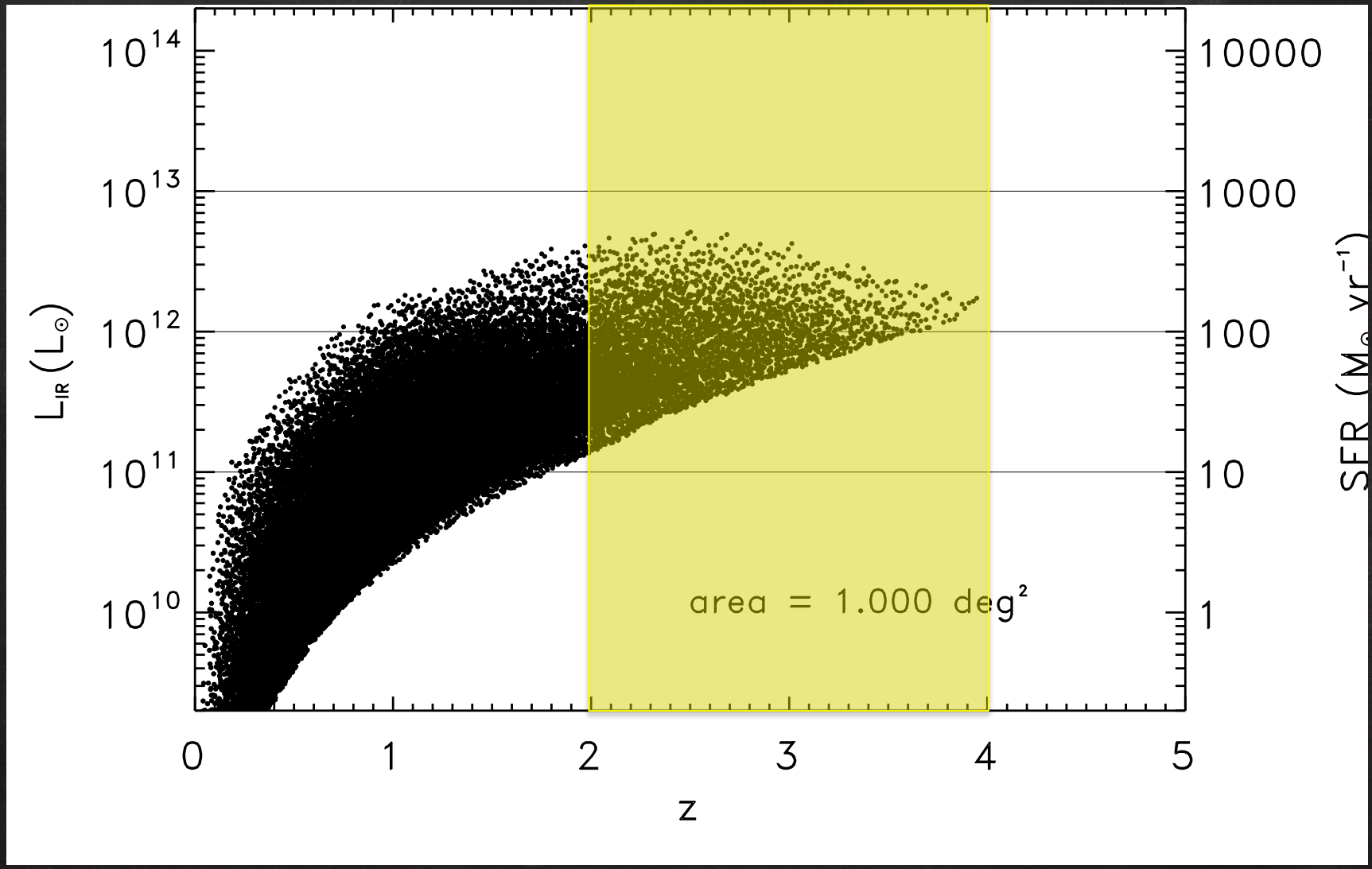

AGN fraction
$f_{AGN}(5-40\mu m)$
0
20
40
60
[PAH]6.2μm
y=x*0.94−2.09
[PAH]11.2μm
y=x*0.93−2.12
[Ne II]12.8μm
y=x*0.89−2.20
[Ne V]14.3μm
y=x*0.91−3.34
y=x*0.77−1.08
[Ne III]15.5μm
y=x*0.92−2.99
y=x*0.78−0.84
[S III]18.7μm
y=x*0.78−1.38
[Ne V]24.3μm
y=x*0.63−0.02
y=x*0.89−2.31
[O IV]25.9μm
y=x*0.72−0.66
y=x*0.70+0.31
[S III]33.5μm
y=x*0.76−0.78
[Si II]34.8μm
y=x*0.87−1.94
$L_{IR}(line)$
L_{IR}^{SF}
Total IR LF
Herschel
$\log\Phi$ (Mpc^{-3}dex^{-1})
0.0<z<0.3
0.3<z<0.45
0.45<z<0.6
0.6<z<0.8
0.8<z<1.0
1.0<z<1.2
1.2<z<1.7
1.7<z<2.0
2.0<z<2.5
2.5<z<3.0
3.0<z<4.2
log L_{IR} ($L_\odot$)
CG+ 2013
spiral
starb
SF−AGN(Sp)
SF−AGN(SB)
AGN2
AGN1
log $L_{[O\,IV]}$ [$L_\odot$]
[O IV] LF
CG, Berta, Spinoglio+ 2016, MNRAS submitted

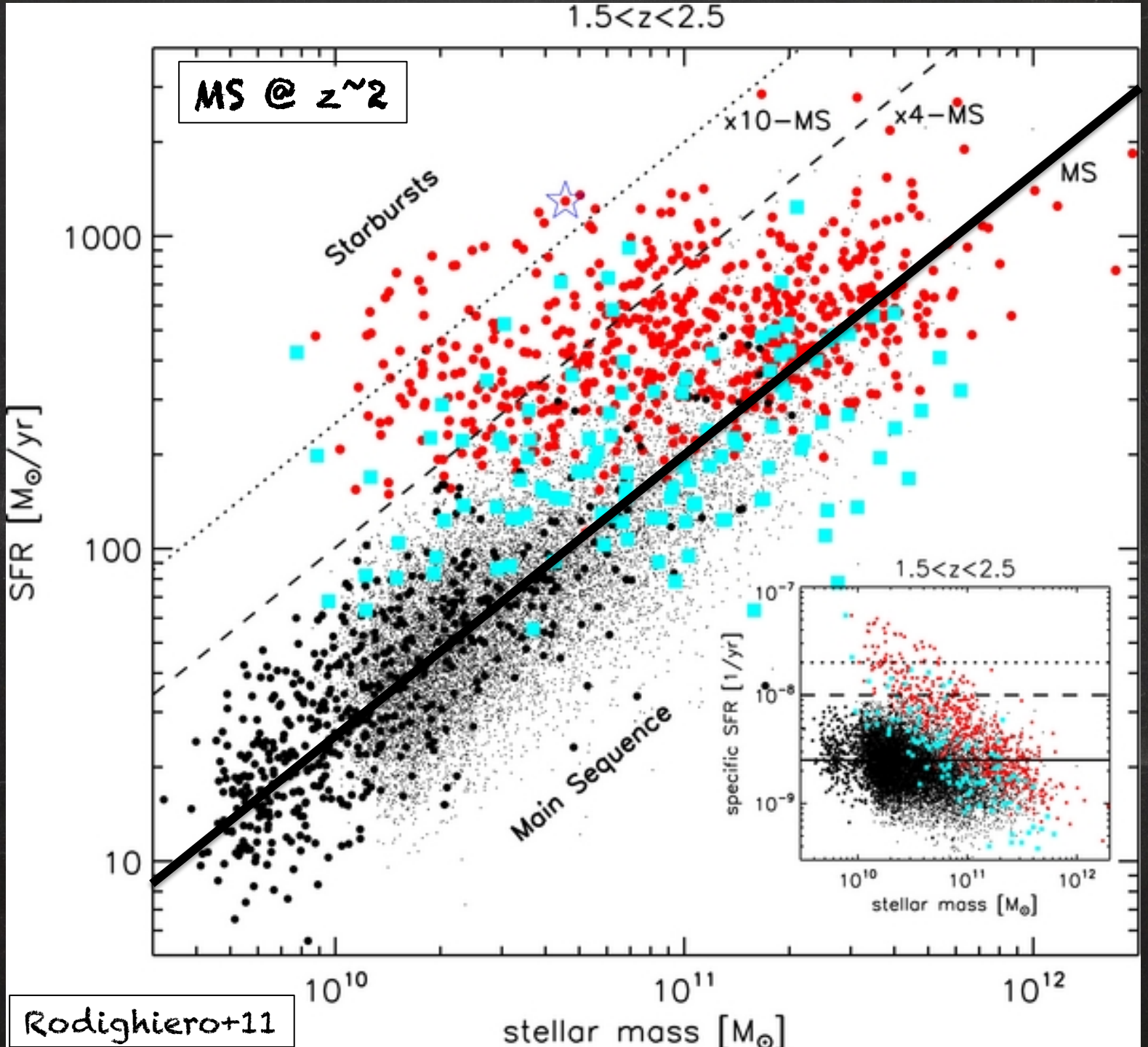


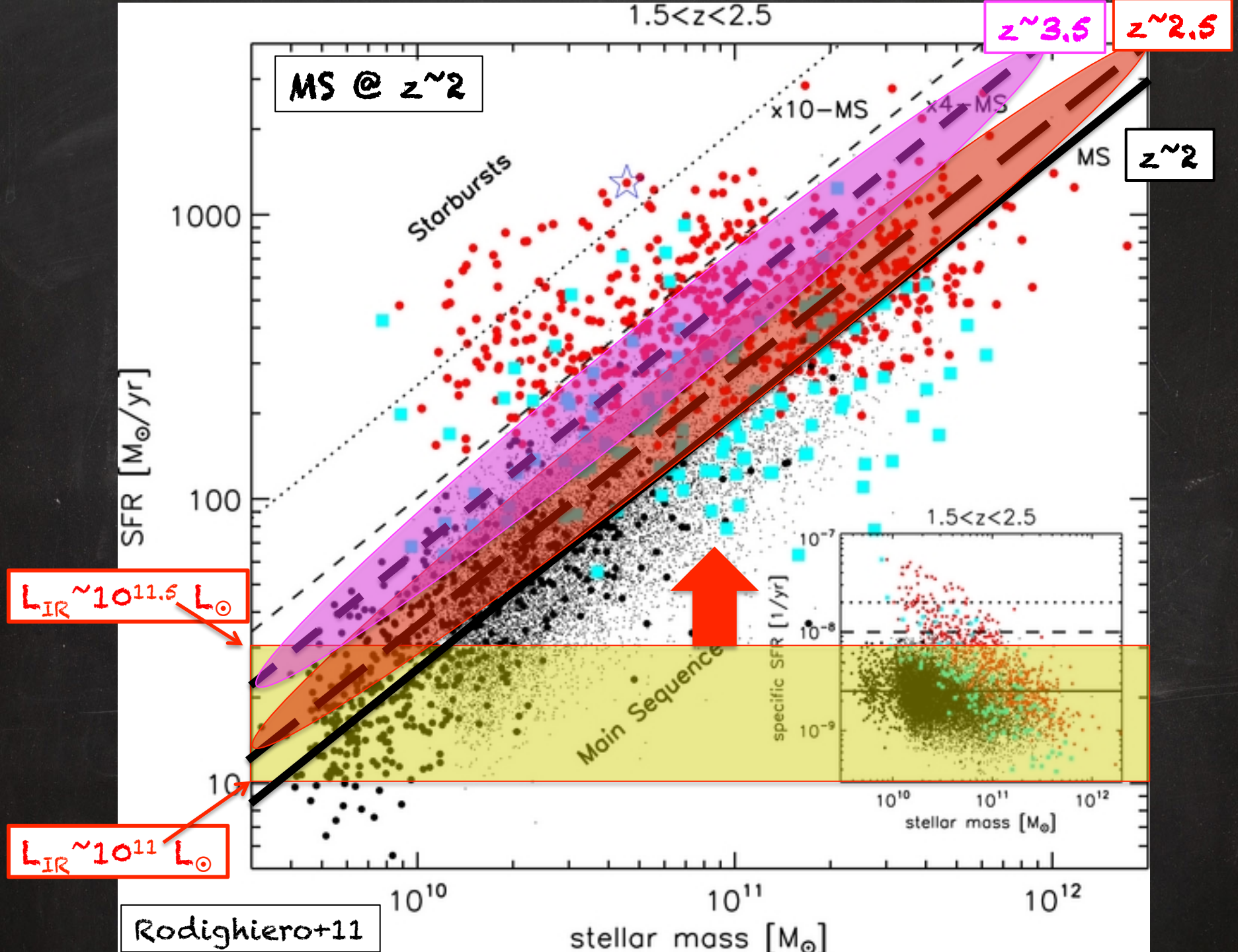
Redshift distributions of objects detectable in the different IR lines with MIRI/JWST and SMI+SAFARI/SPICA

Able to observe 100s of sources in the strongest lines (e.g. [OIV]) to z~3-4

How deep? How far?



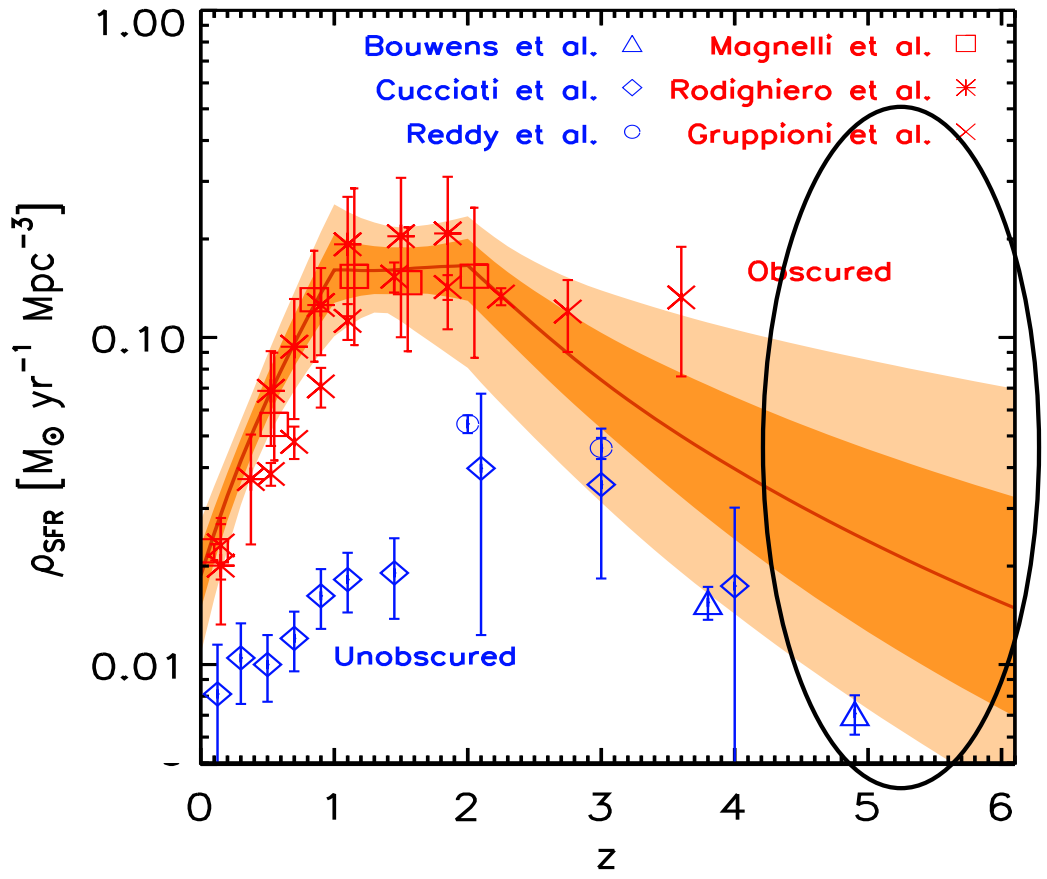

MS @ z~2
1.5<z<2.5
x10−MS
x4−MS
MS
Starbursts
Main Sequence
SFR [M⊙/yr]
1000
100
10
10^10
10^11
10^12
stellar mass [M⊙]
1.5<z<2.5
specific SFR [1/yr]
10^-7
10^-8
10^-9
10^10
10^11
10^12
stellar mass [M⊙]
Rodighiero+11


MS @ z~2
1.5<z<2.5
z~3.5
z~2.5
z~2
x10−MS
x4−MS
MS
Starbursts
Main Sequence
SFR [M⊙/yr]
1000
100
10
L_IR ~10^11.5 L⊙
L_IR ~10^11 L⊙
1.5<z<2.5
specific SFR [1/yr]
10^-7
10^-8
10^-9
10^10
10^11
10^12
stellar mass [M⊙]
Rodighiero+11

What if we want to reach higher redshifts?

SPICA SMI Photometric Survey at 30-37 μm

Growth of Cosmic Star-Formation



SF history: Planck Paper 30

We would like to chart the onset and early growth of star formation in the epoch prior to z=4 (the first 1.5 Billion years) ?

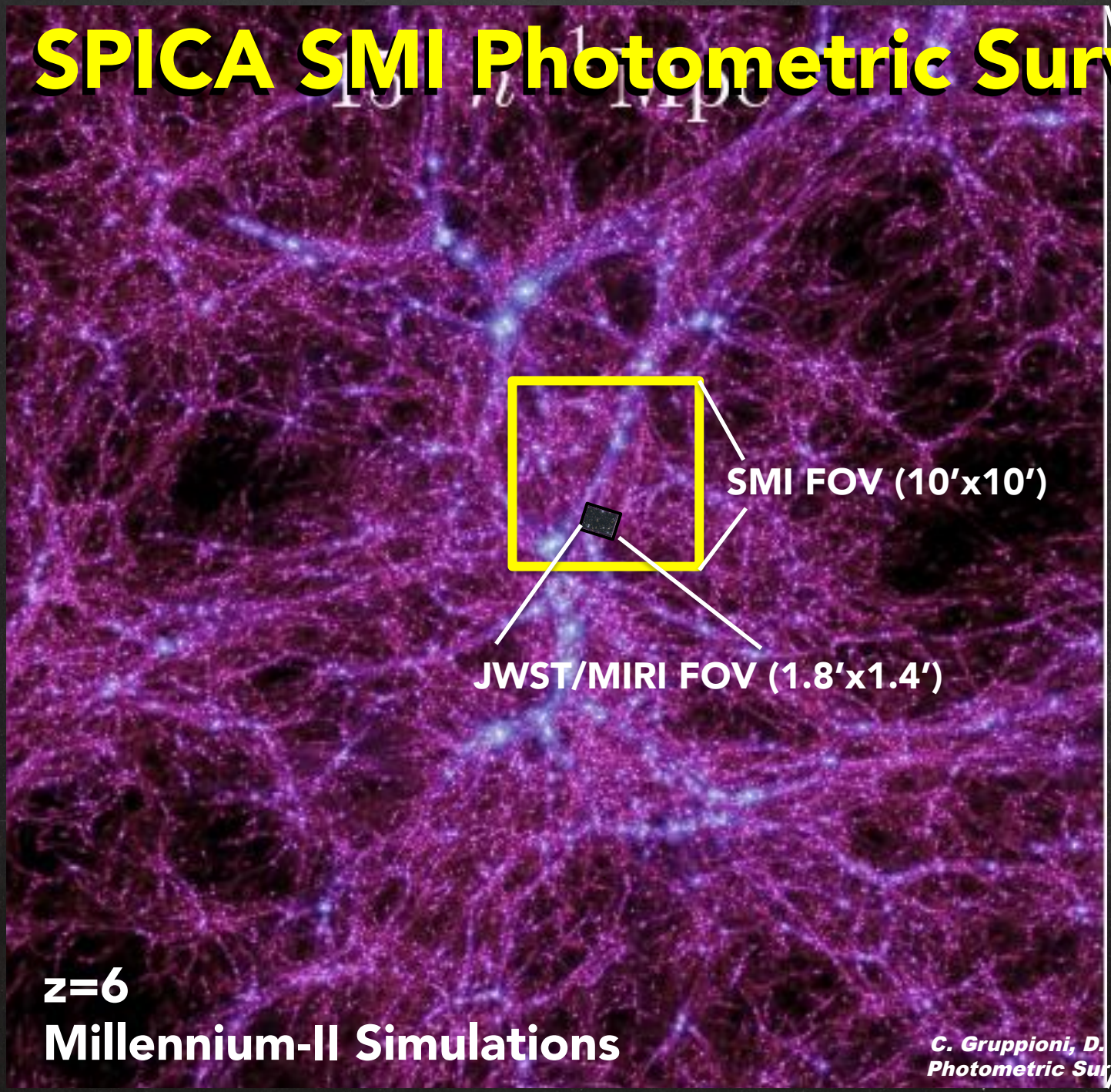
e.g. was this dominated by massive galaxies or small ones? How much does dusty SF contribute?

z>4 has large uncertainties and all data on this epoch comes from rest-frame UV / optical surveys (Lyman break sources) (GRB measurements and reionizaton constraints suggest flatter SFR at e.g. z~7.)

Require redshift-resolved far-IR / submm luminosity functions to complement UV-based studies.

(M. Bradford)

SPICA SMI Photometric Survey



1 deg² observable with SMI in ~64 h to confusion limit (9μJy)

C. Gruppioni, D. Clements, L. Ciesla: Photometric Survey: SPICA use case

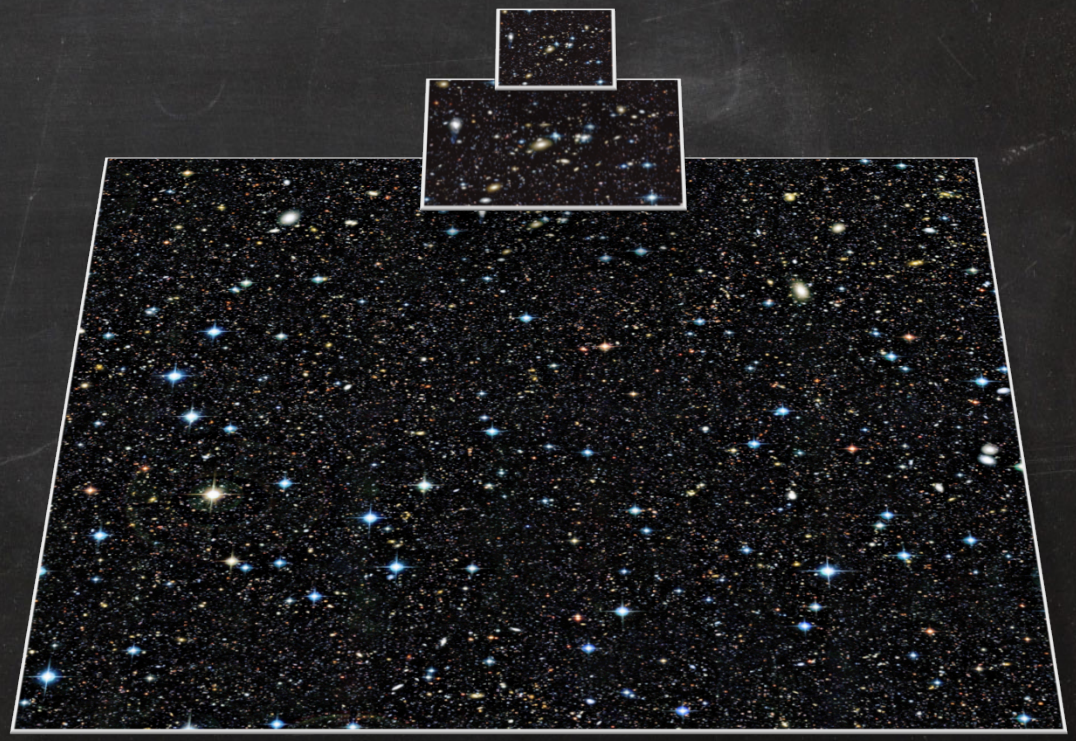
SPICA SMI Photometric Survey

- Survey Strategy (total amount of time ~210 hours):

- Ultradeep (sub-confusion):
  to ~3 μJy in two 10′x10′ fields (32 hours)
  + six lensing fields for greater effective depth, >10x fainter fluxes (100 hours)

- Deep (confusion):
  to ~9 μJy in 1 deg^2
  (64 hours)

- Shallow:
  to ~0.2 mJy in 100 deg^2 (13 hours)



C. Gruppioni, D. Clements, L. Ciesla:
Photometric Survey: SPICA use case


Thank You !