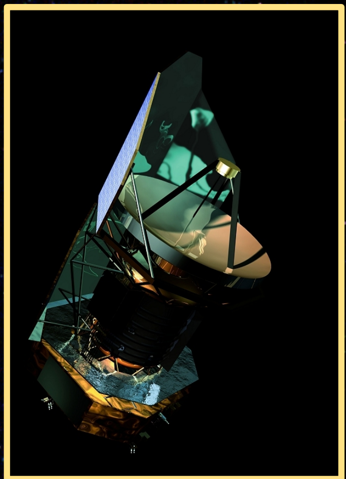
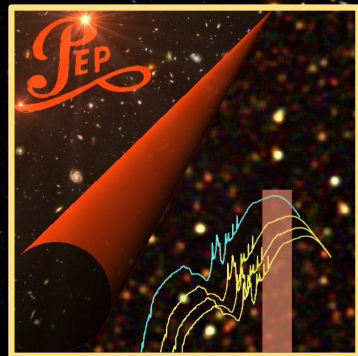
Far-infrared properties of Submm and Optically faint radio galaxies



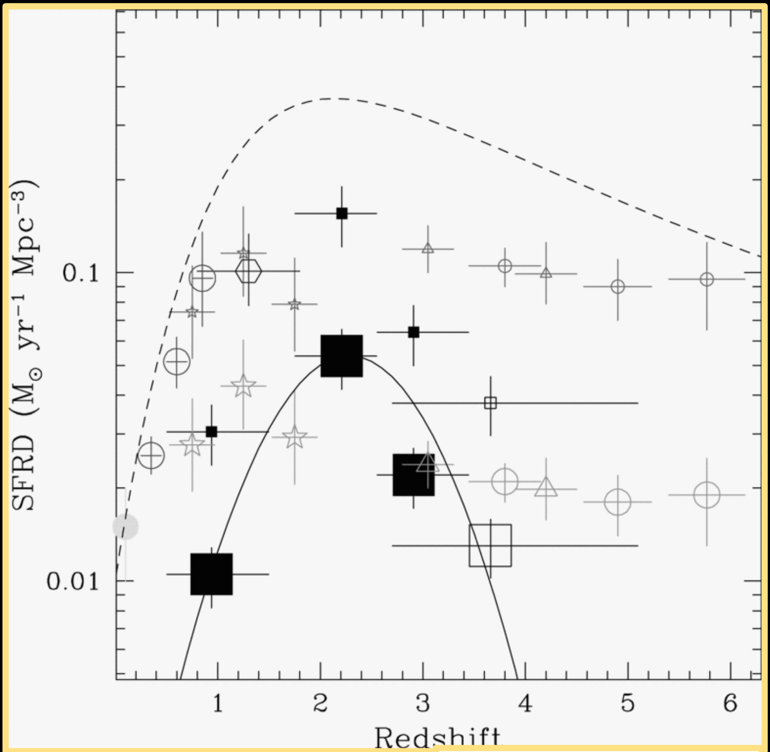
B. Magnelli, P. Santini, D. Lutz,
R. Maiolino, S. Berta and the PACS Evolutionary Probe (PEP) team
MPE-Garching



Noordwijk, Mai 2010

Submm Galaxies (SMGs)

Selection of choice for the most luminous tail of the high-redshift star-forming galaxy population



Chapman et al. (2005)

- Typical redshift of z~2 (Chapman et al. 2005)
- Compact and massive systems (Tacconi et al. 2006, 2008)
- The most luminous SMGs are mostly associated with major mergers (Tacconi et al. 2008)

SMGs play a major role in the stellar mass build up of massive galaxies

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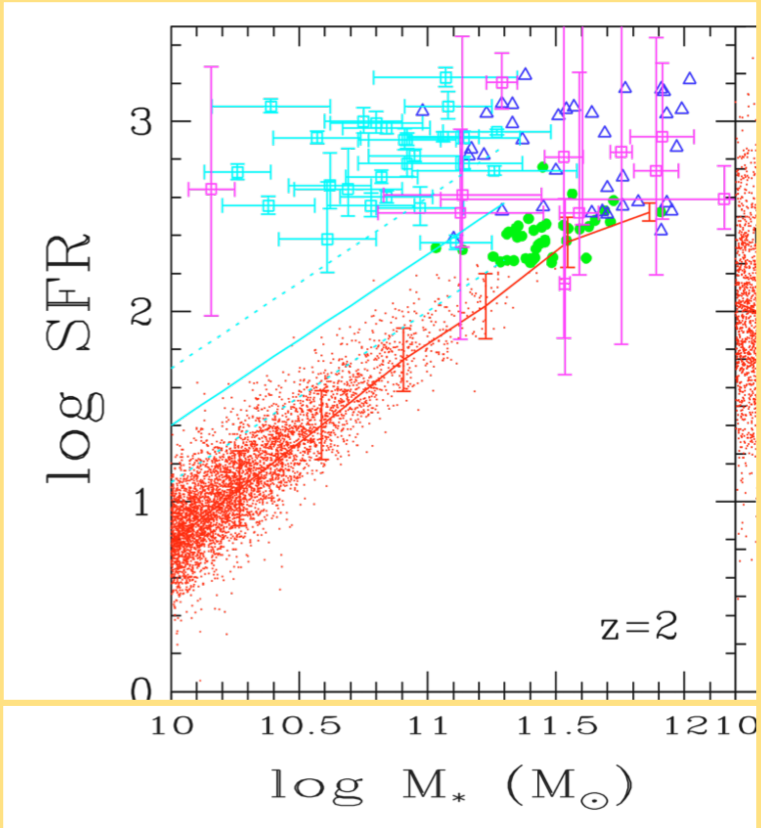

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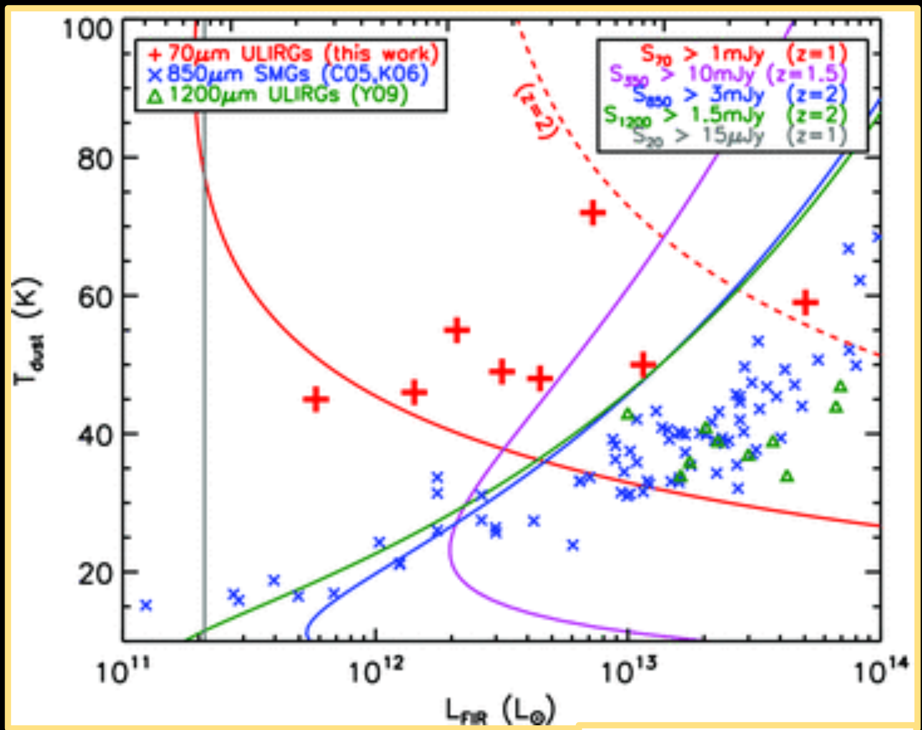
Opticaly Faint Radio Galaxies (OFRGs)

High-redshift star-forming galaxies with hot dust



Casey et al. (2009a)

- Radio-detected but submm-faint galaxies with UV spectra consistent with high-redshift starburst (Chapman et al. 2004)
- OFRGs have a comoving density, stellar masses and sizes comparable to SMGs
- Pre-Herschel dust temperature estimates have found Tdust~52K (Casey et al. 2009a,b)

Problematics

SMGs

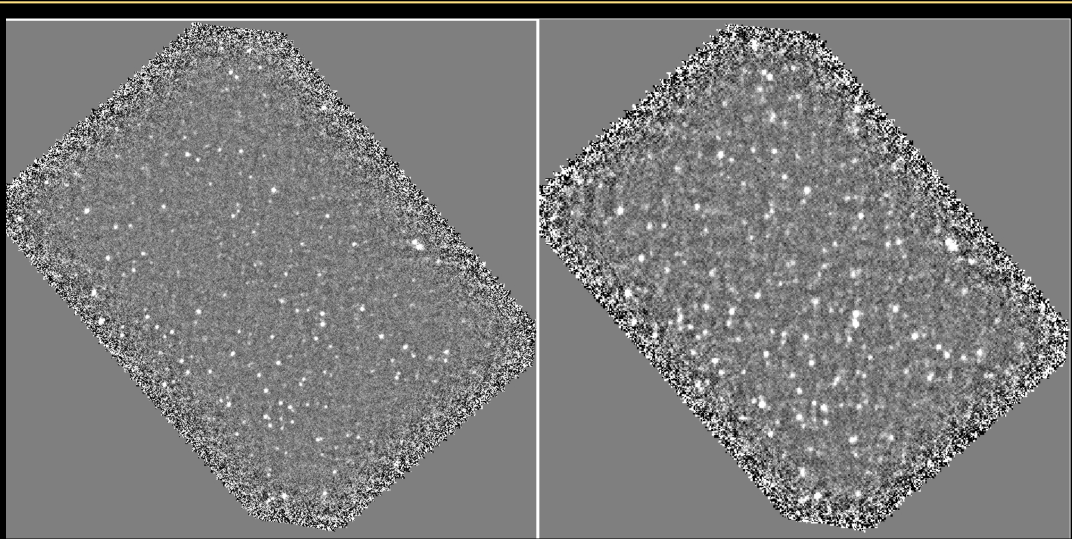
- Estimate the dust temperature and infrared luminosity of SMGs using measurements encompassing the peak of the dust emission in the Far-Infrared
- Compare our results with previous estimates (e.g. Chapman et al. 2005)
- Study the FIR/radio correlation
- Study their dust mass contents with respect to their stellar masses, their gas masses and their metallicities

OFRGs

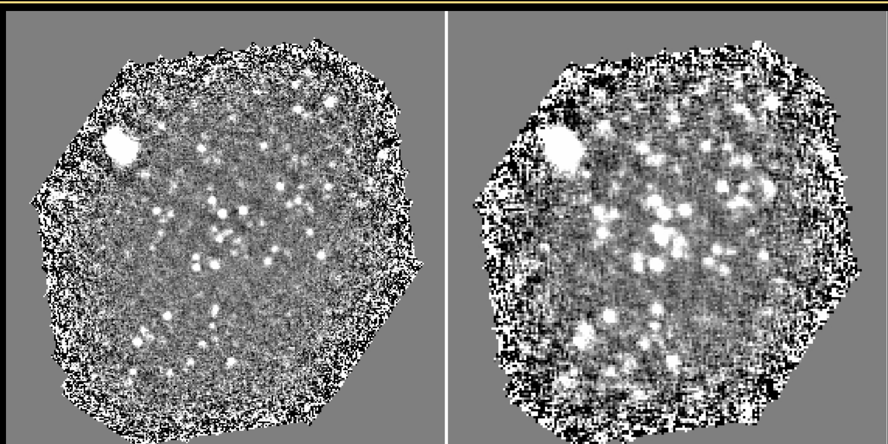
- Confirm whether or not OFRGs are high-redshift ULIRGs with hot dust temperature

Data

GOODS-N 100um (~3mJy-3σ) & 160um (~6mJy-3σ)



A2218 100um (~2.5mJy-3σ) & 160um (~5mJy-3σ)



Samples

To obtain accurate dust temperature estimates we restrict our study to a sample of SMGs and OFRGS with robust redshift estimates derived from secured radio/mid-infrared identifications

GOODS-N SMGs

Ref: Pope et al 2006 (SCUBA)+Chapin et al. 2009 (AzTEC)

✓ **27 SCUBA sources (21 zspec + 6 zphot)**
✓ **2 AzTEC sources (all zspec)**

(SMGs with multiple optical counterparts are treated as one system since they are thought to be merging galaxies)

GOODS-N OFRGs

Ref: Casey et al. (2009a,b)

✓ **9 sources (all zspec)**

A2218 SMGs

Ref: Kneib et al. (2004), Knudsen et al. (2006, 2008)

✓ **6 sources but 3 of them correspond to the same lensed galaxy (all zspec)**

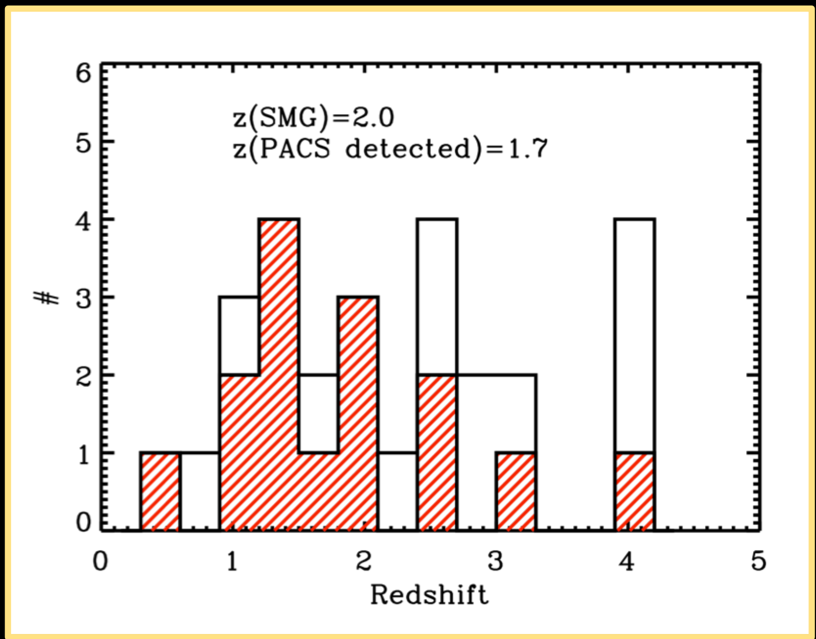
Samples

PACS detection rate

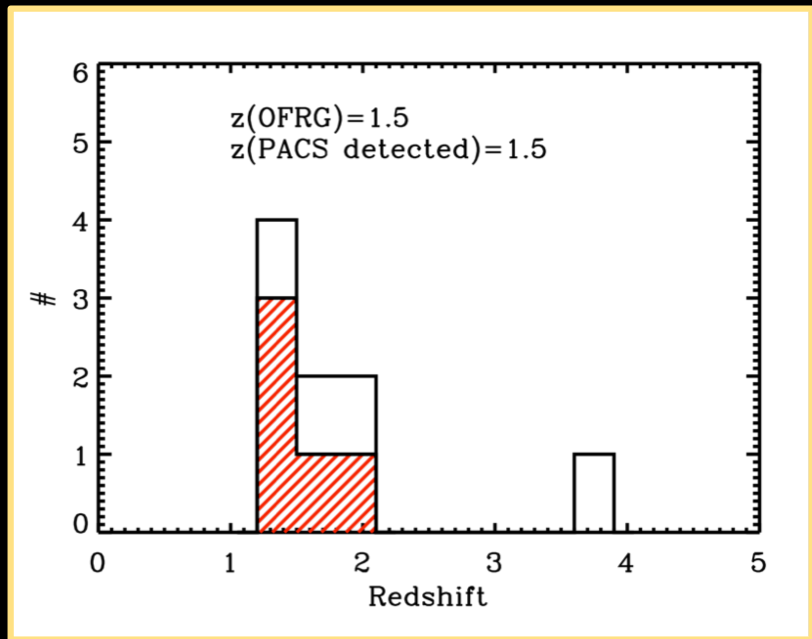
19 out of 35 SMGs are detected in the PACS 100um and 160 um bandpasses

5 out of 9 OFRGs are detected in the PACS 100 um and 160 um bandpasses

SMGs



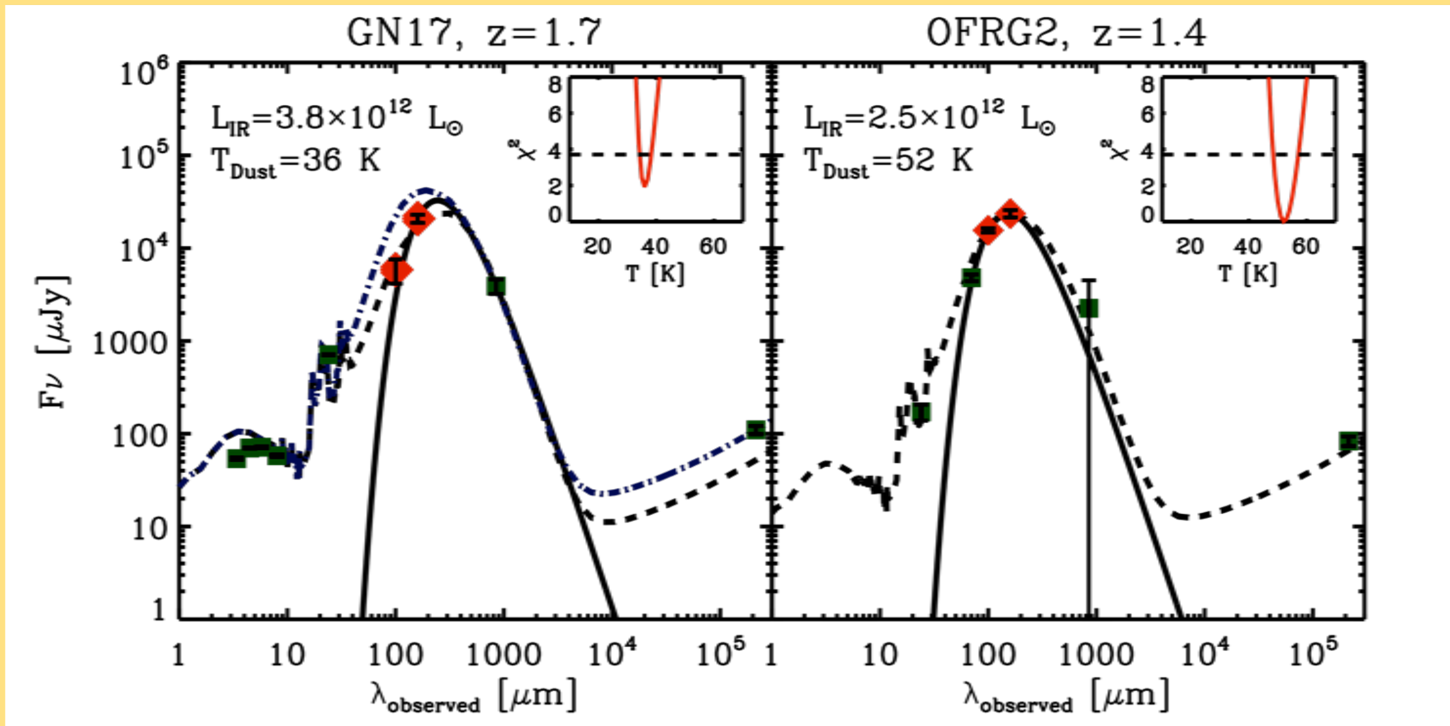
OFRGs



Data Analysis

Estimating the infrared luminosity and the dust temperature

SMGs | OFRGs

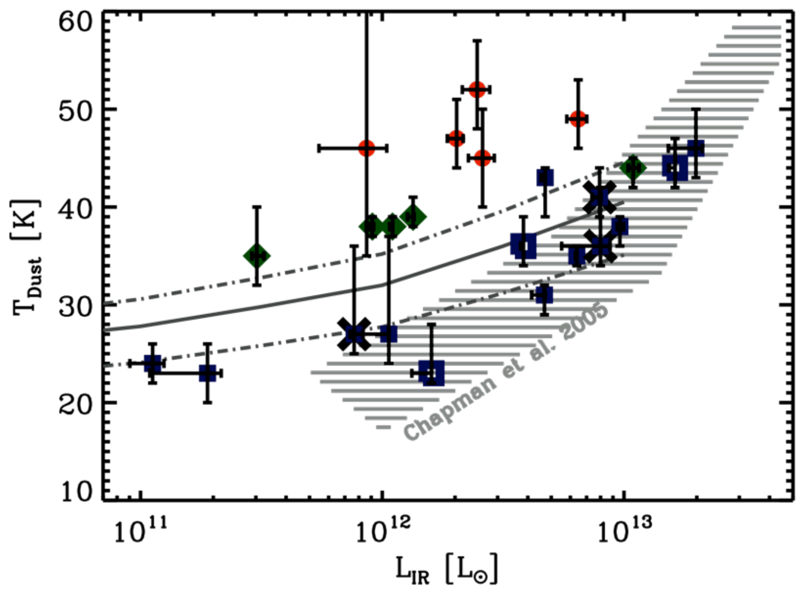


Magnelli et al. (2010)

We fit a greybody (β=1.5) function to their PACS and SCUBA photometries

Results

T vs LIR

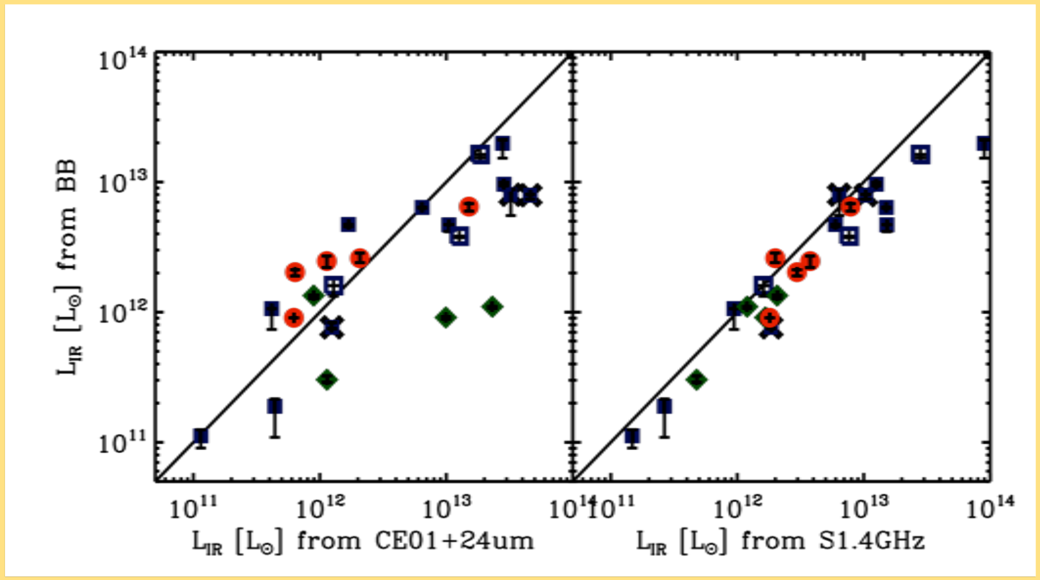


Magnelli et al. (2010)

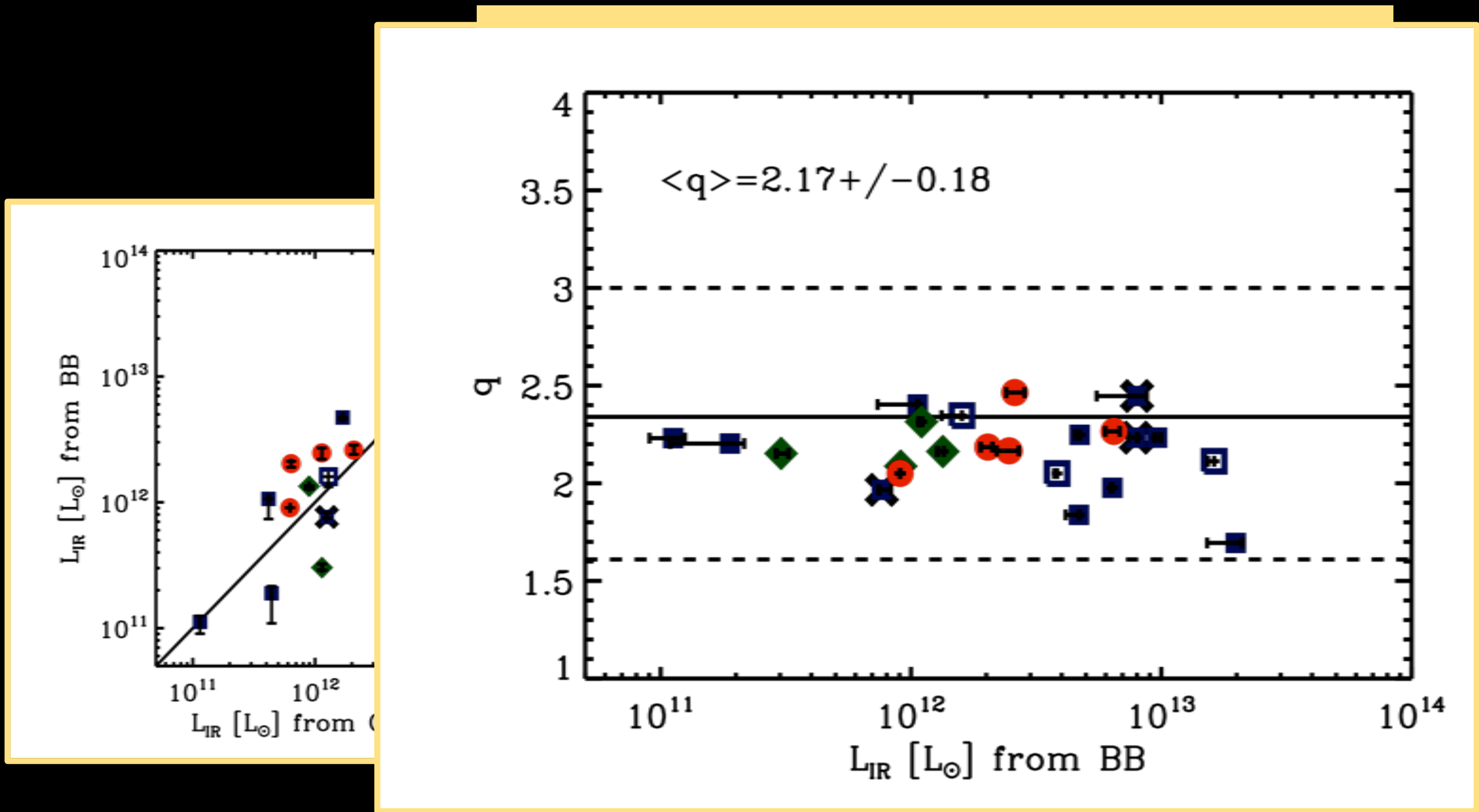
- SMGs are biased towards cold dust temperature
- We confirm the extremely large infrared luminosities of SMGs. Such high luminosities are difficult to reconcile with secular evolution (Davé et al. 2010)
- OFRGs are biased toward hot dust temperature
- Lensed-SMGs exhibit intermediate dust properties

Results

Mid-infrared /radio to LIR conversion



- The infrared luminosities inferred using mid-infrared observations (24um) are significantly more uncertain than those inferred using the FIR/radio correlation
- The FIR/radio correlation holds at high redshift, even if we find a value of <q> slightly lower than in local systems (2.17 instead of 2.35)
- Previous dust temperature estimates (e.g. Chapman et al 2005), which were based on the FIR/radio correlation, are hence consistent with our results



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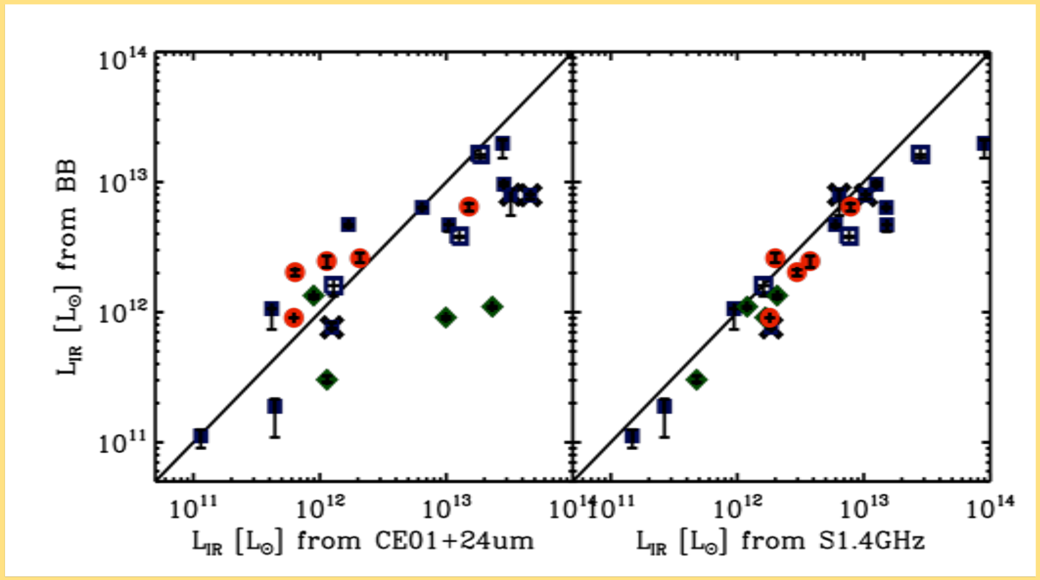

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Dust Content

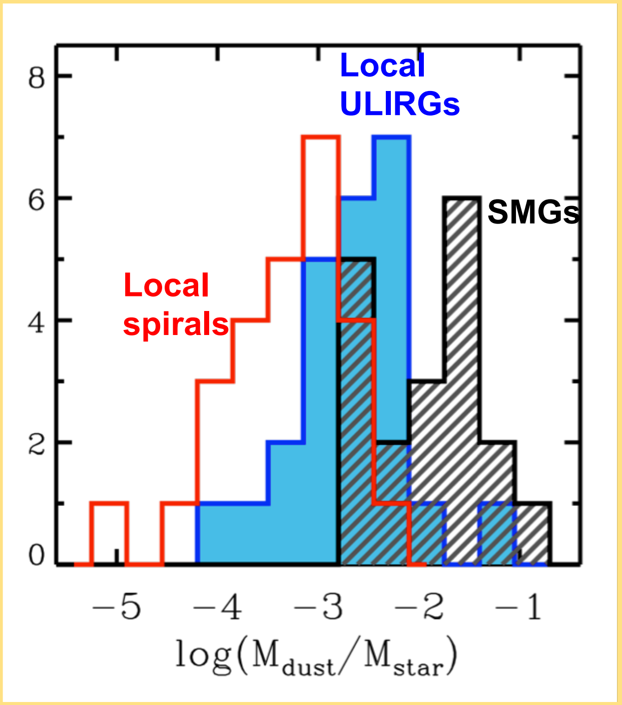
Santini P., Maiolino R., Magnelli B. and the PEP team

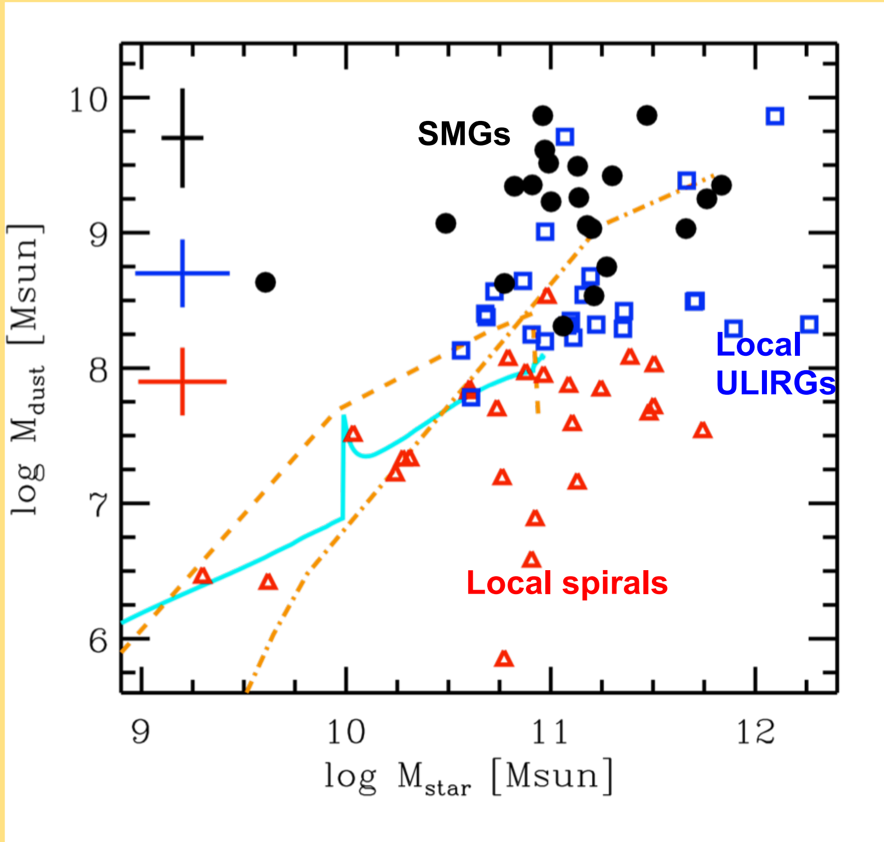
Aim: Investigate the dust content in SMGs and compare with local SF galaxies (spiral and ULIRGs) + compare with stellar and gas content

Method:

- Mdust : fit PACS + submm fluxes to GRASIL
- Mstar : opt-to-nearIR SED fitting at known redshift
- Mgas : from CO observations (when available)
- Z : from optical nebular lines (when available)

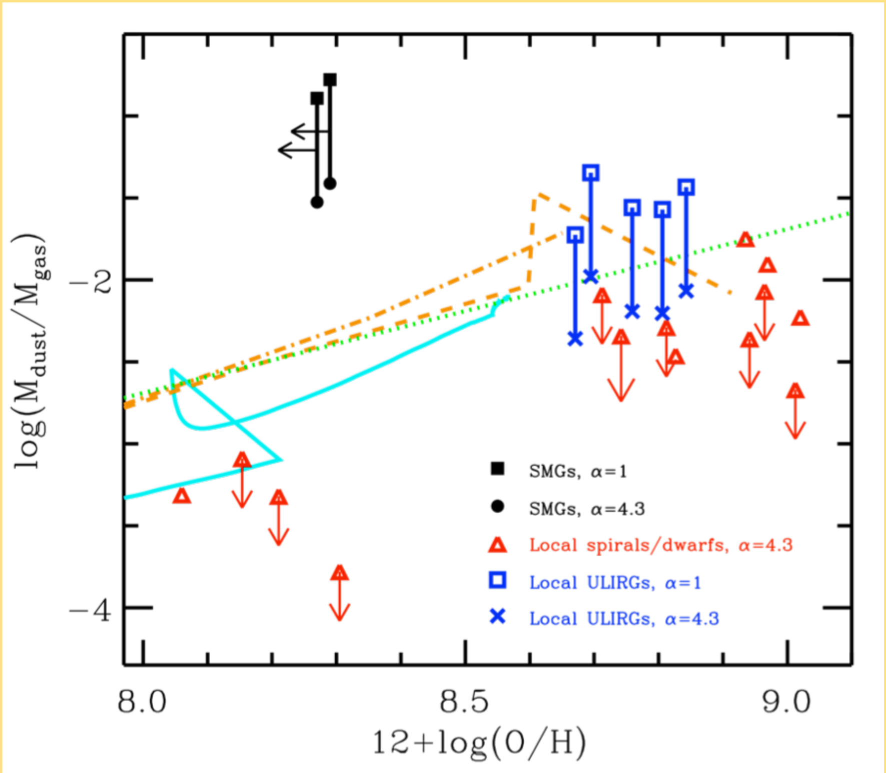
Dust Content : Mdust vs Mstar





Mdust/Mstar in SMGs is a factor ~30 higher than in spirals and a factor ~6 higher than in ULIRGs

Dust Content



Independently of the CO-to-H2 mass conversion, the mass of metals inferred from the dust content is much larger (>factor 10) than the mass of metals inferred from the gas phase

Possible interpretation :

- Dust masses incorrectly estimated because dust properties in SMGs are very different from those assumed in the models and in local galaxies (unlikely)
- « Skin effect » : the large amount of dust makes the dense, metal rich regions undetected at optical wavelength, optical nebular lines used to trace metallicity only probe the outer, metal poor regions

Conclusions

- We obtain for the first time robust estimates of the dust temperature and the infrared luminosity of SMGs and OFRGs

- SMGs are biased towards cold dust temperature while OFRGs are biased towards hot dust temperature

- We confirm the extremely large infrared luminosities of SMGs. Such high luminosities are difficult to reconcile with secular evolution (Davé et al. 2010)

- Mdust/Mstar in SMGs is a factor ~30 higher than in spirals and a factor ~6 higher than in ULIRGs

- In SMGs, the mass of metals inferred from the dust content is much larger (>factor 10) than the mass of metals inferred from the gas

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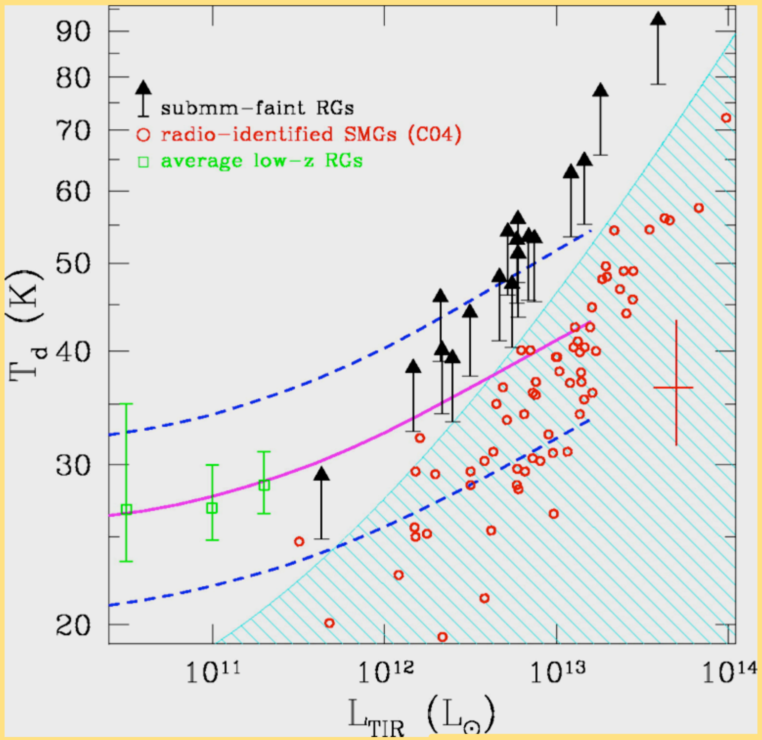

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