Scatter between dust and SFR: clues from dust-stars interplay

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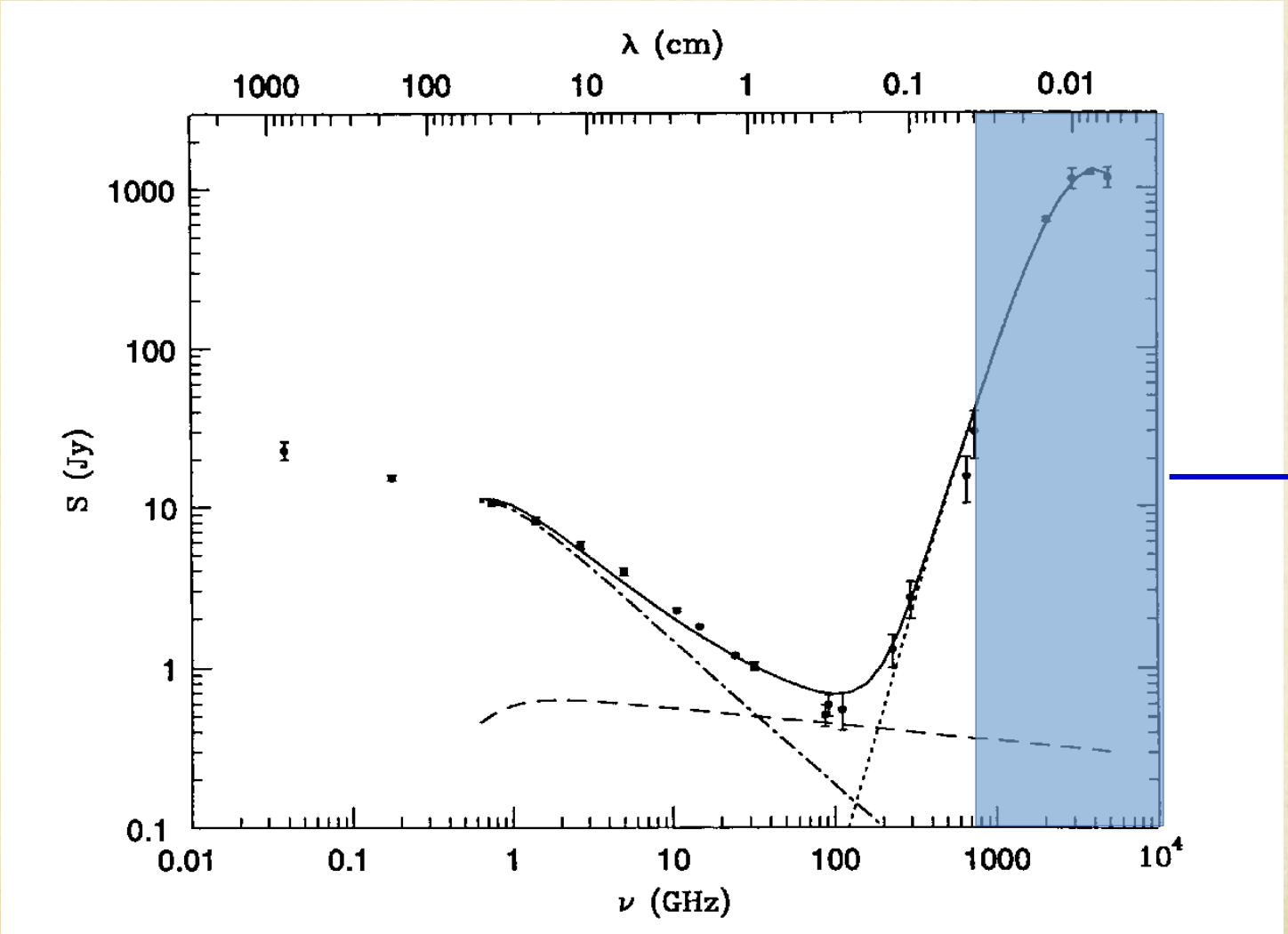
SFRH/BPD/90559/2012
Pest-OE/FIS/UI2751/2014
PTDC/FIS-AST/2194/2012

The plot



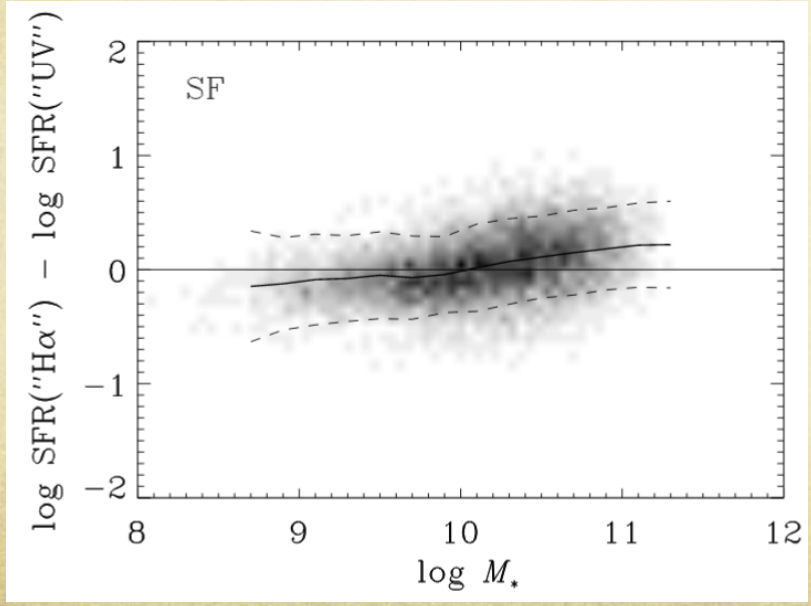
CONDON PLOT COUNT: 11

Introduction: SF Tracers

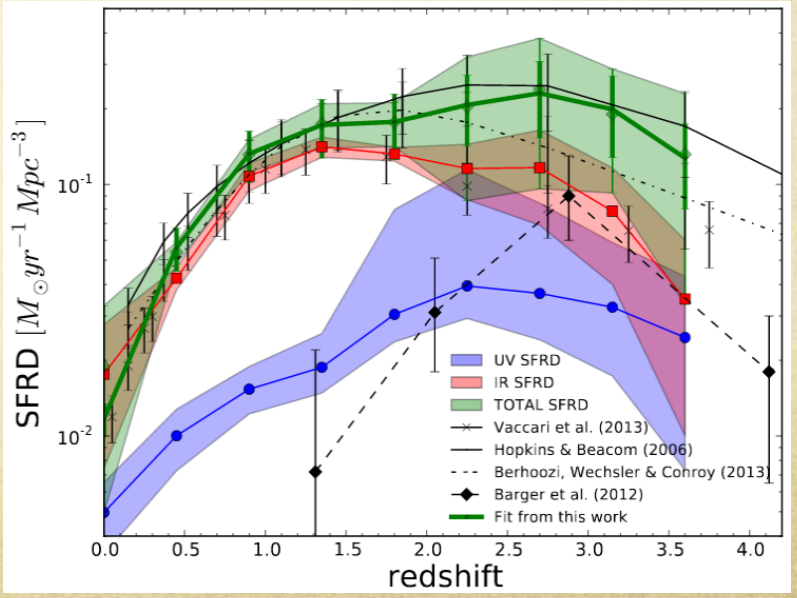
The use of monochromatic indicator is widely used (e.g. Kennicutt 98, or Kennicutt & Evans 2012).
But each indicator comes with its own bias:

- UV = attenuated by dust
- Hα = attenuated by dust
- IR = sensitive to dust heated by old and young stars

This led sometimes to systematics due to modeling differences, which in turns bias our conception of galaxy evolution



Salim +07

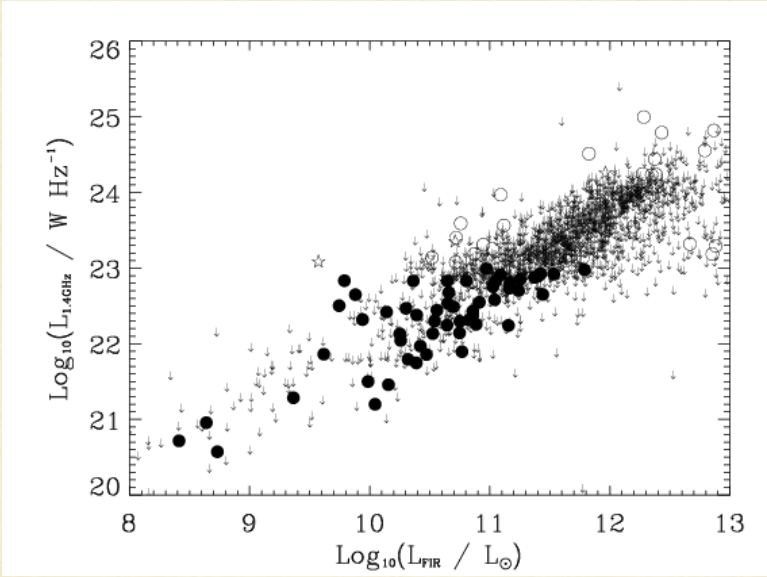


Burgarella +13

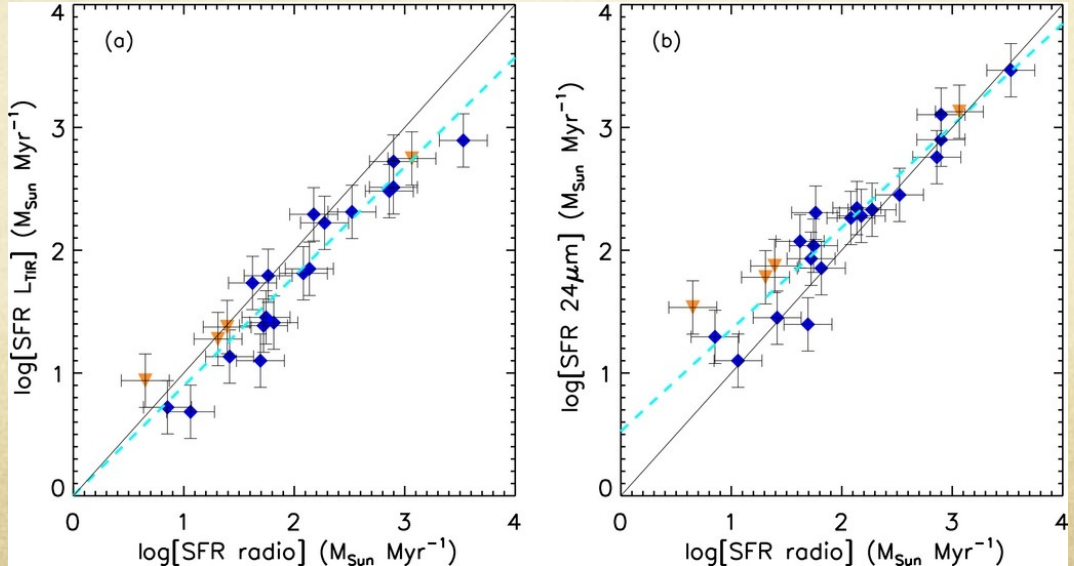
Introduction: SF Correlations

For example: Since radio Continuum and TIR luminosity correlates very well.

The SFR should Correlate with both In the same way… …. that is not the Case in the MW



Jarvis +10



Vutisalchavakul + 13

Motivations

1 – Overcome the bias introduced by the use of IR as a SFR tracer due to the old stellar component heating.
In this way we will understand better what is the origin of the scatter observed.

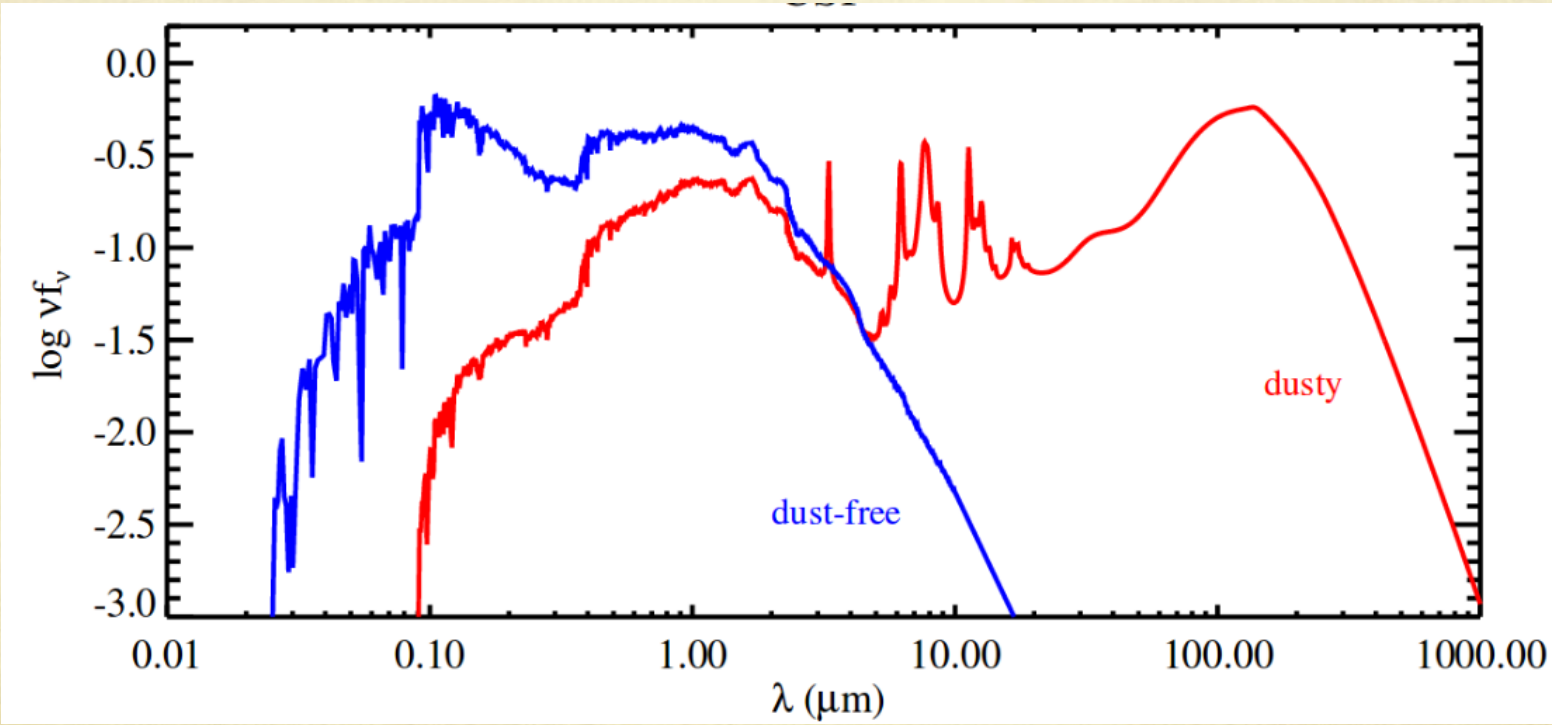
2 – Identify what are data necessary to obtain the point 1.
This is not trivial, becasue for the next 10-15 years there will not be space telescope observing in FIR.

3 – Yesterday George asked “Is there someone that has problem with dust?”…..and there were.
I feel moved!
GOOD NEWS: TIR is consistent with other SFR tracers (George’s talk)

BAD NEWS:TIR depends on the data available (next slides)

Method

Investigate the relation between dust luminosity, dust mass and SFR in a sample of low redshift ($z<0.5$) normal star forming galaxies. **NO AGN**



Conroy 13

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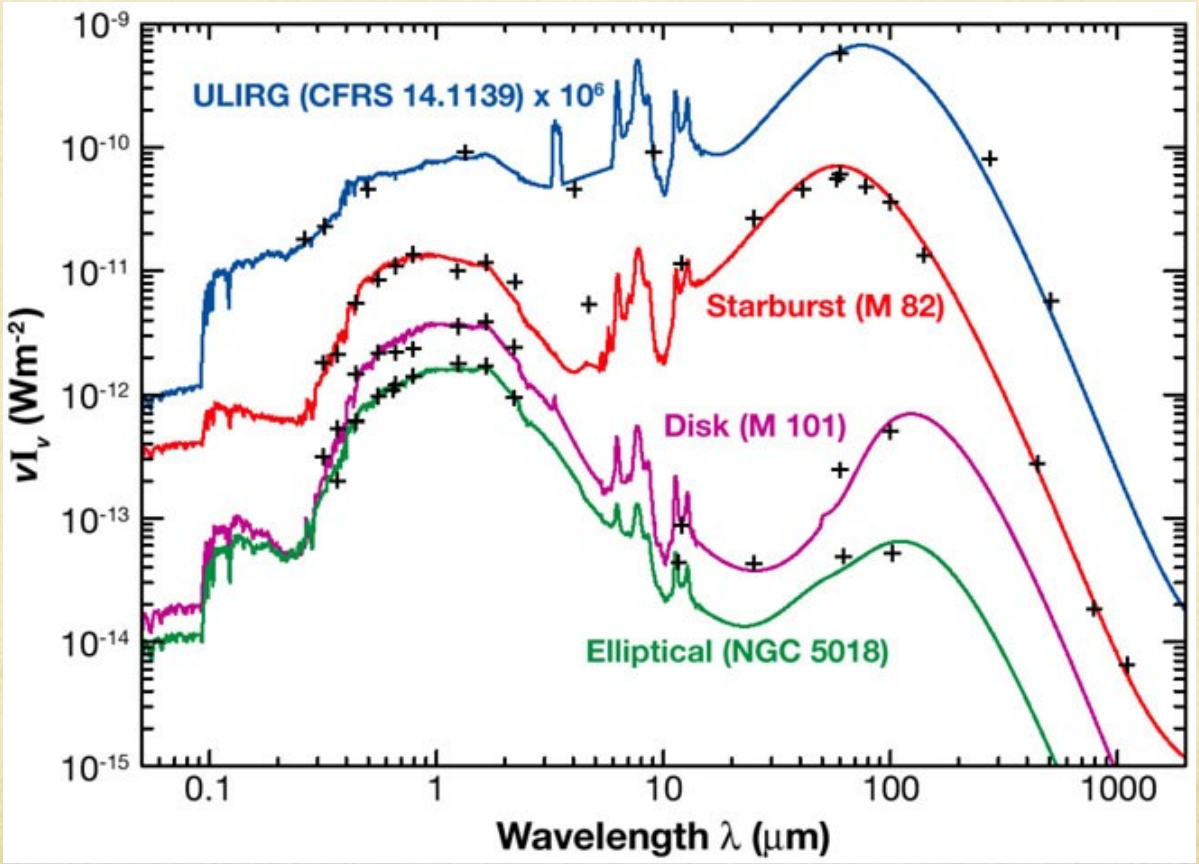

Lagache +05

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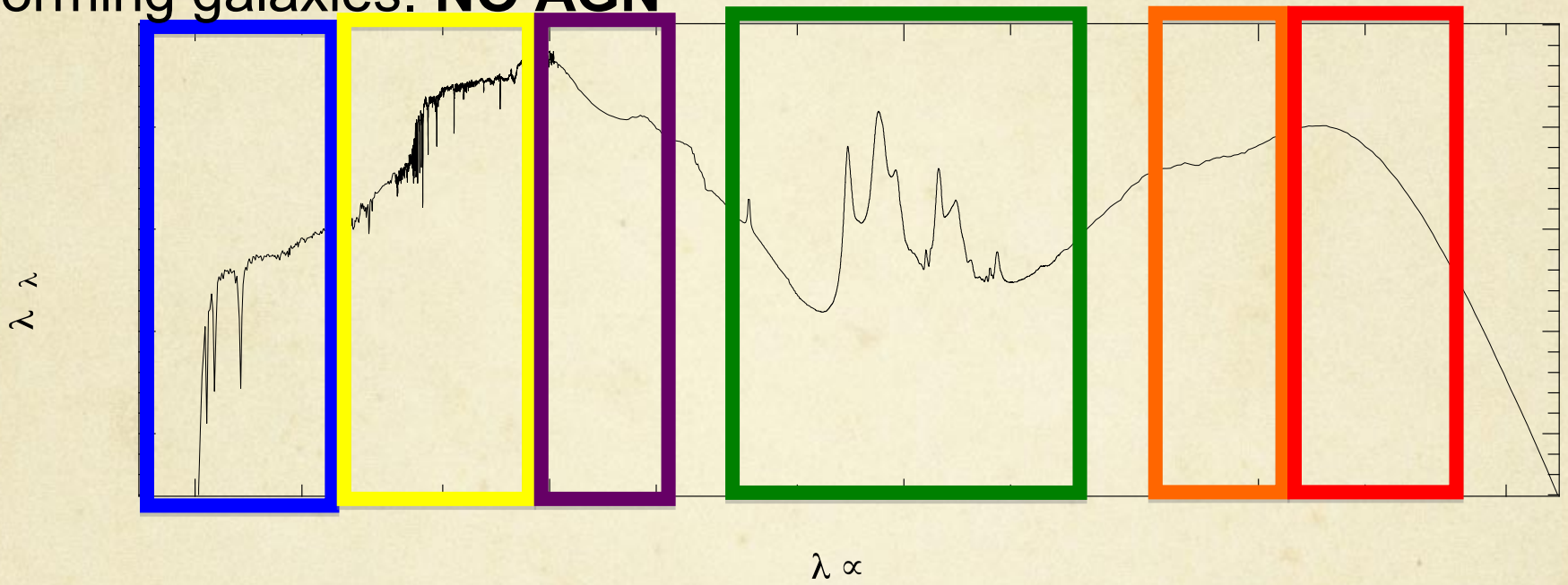


UV SDSS 2MASS WISE PACS SPIRE

Removing WISE

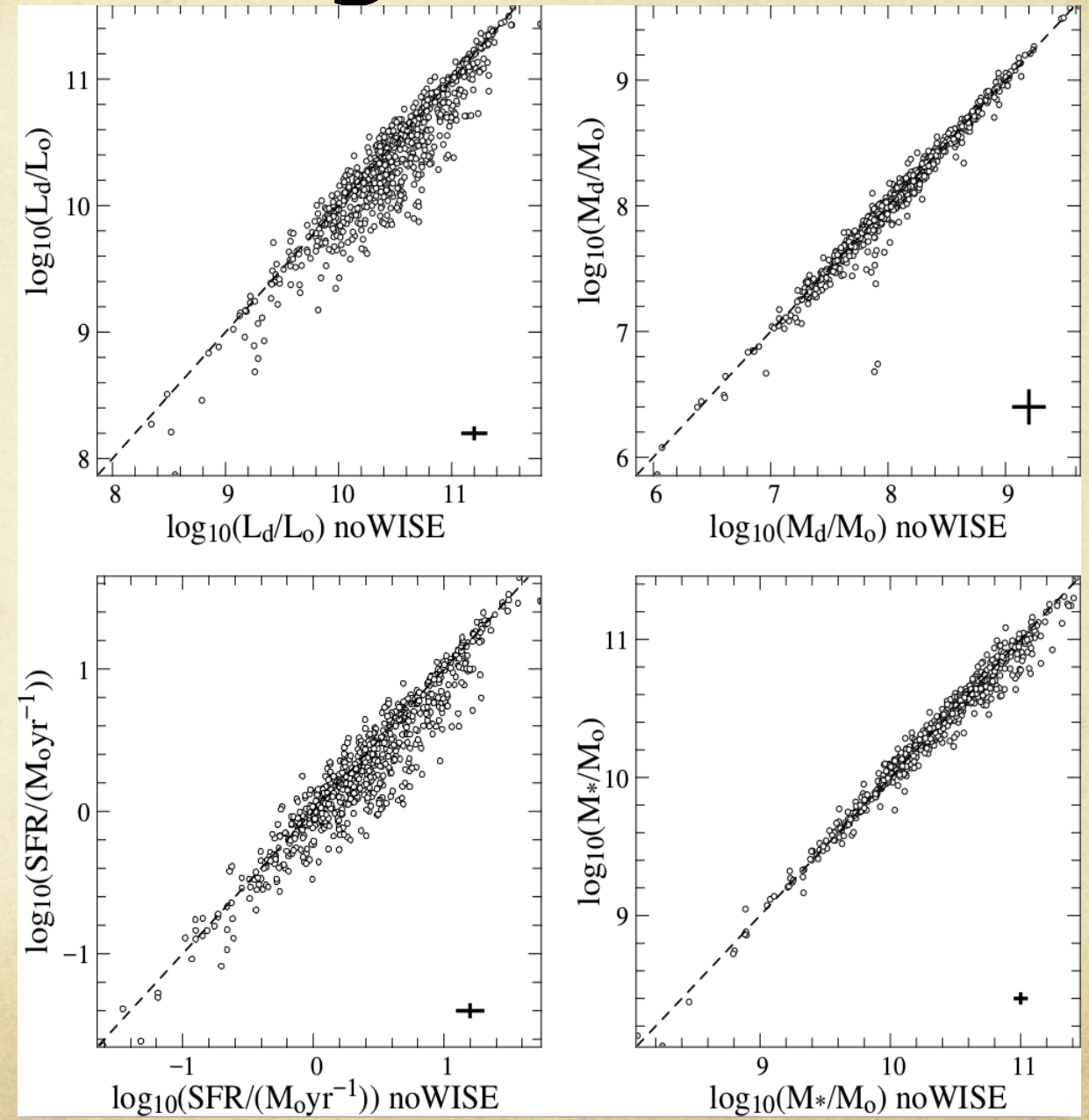
Negligible differences in stellar and dust mass.

Dust luminosities overestimated by 28%

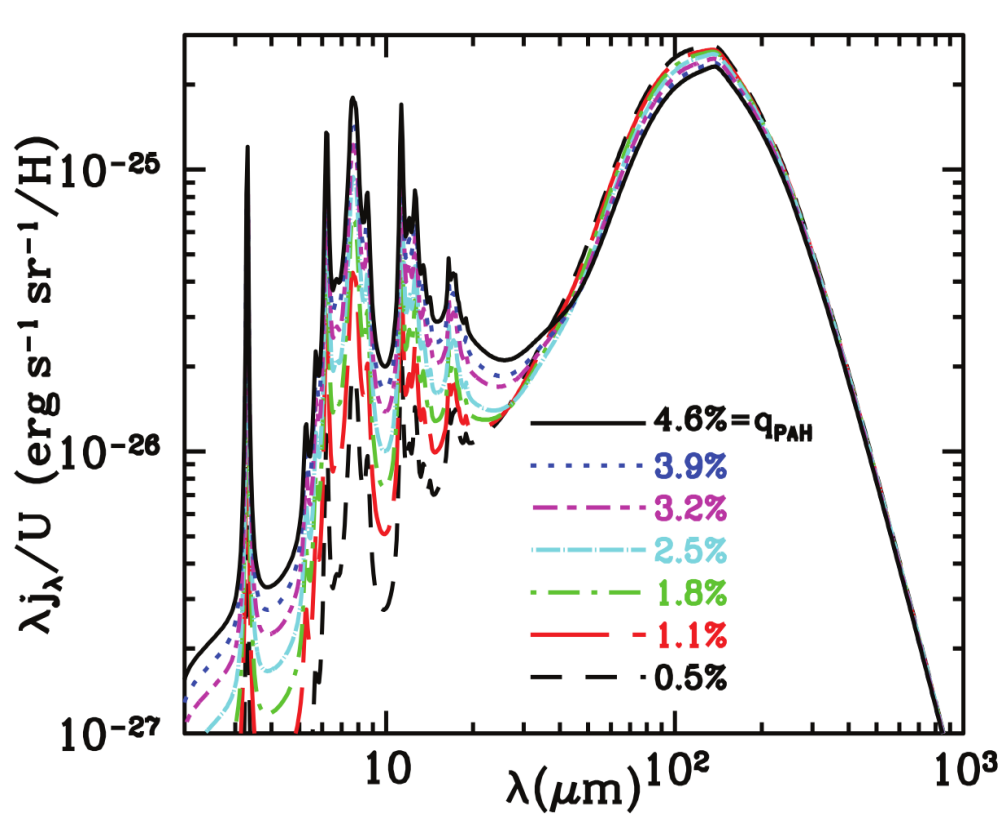
SFR overestimated by 20%

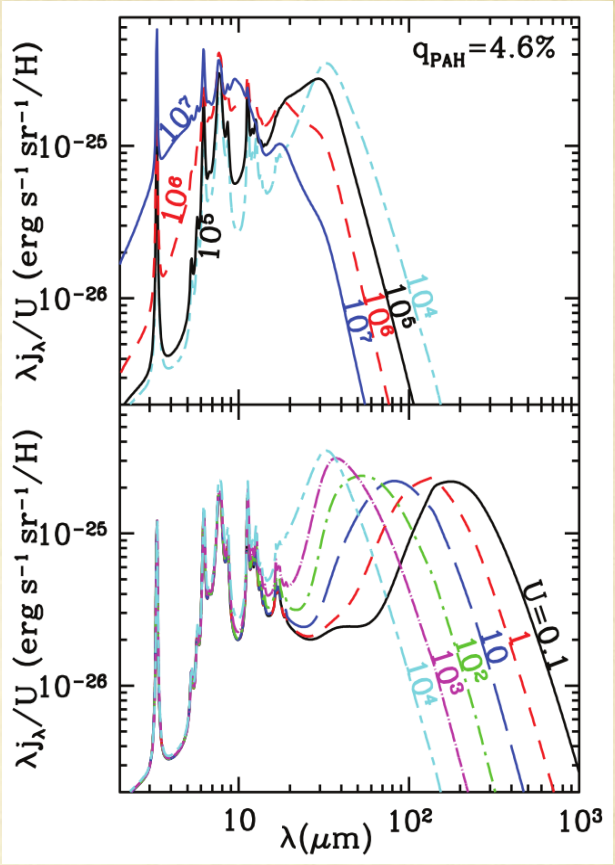
WHY?????????

Pappalardo in prep



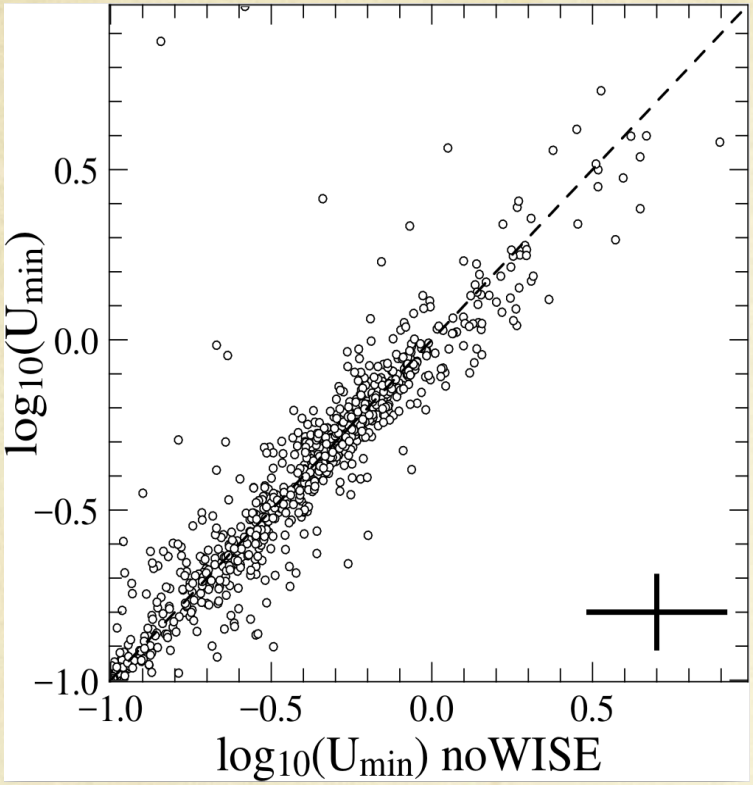
Removing WISE

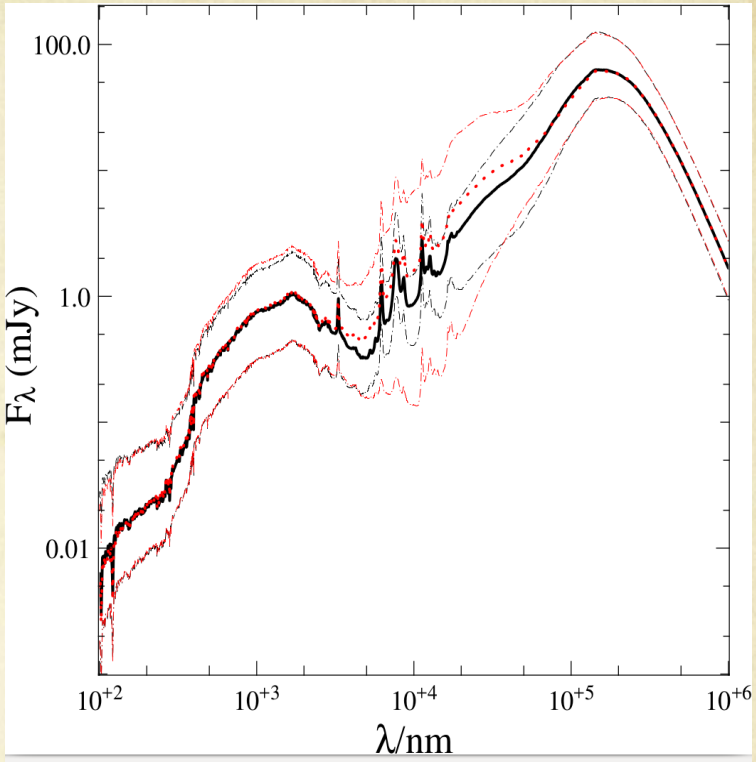




Draine & Li 2007 consider in their physically motivated model both the dust emission due to the star forming region and the PAH (qpah parameter) and the dust heated by the interstellar radiation field (Umin parameter).

Removing WISE





The variations of Umin are in the order 2.5%, negligible. The median SED shows huge variations in the region dominated by warm dust component. In that regions there is also strong emission of PAH. This implies relevant variations of the qpah parameter.

Removing PACS

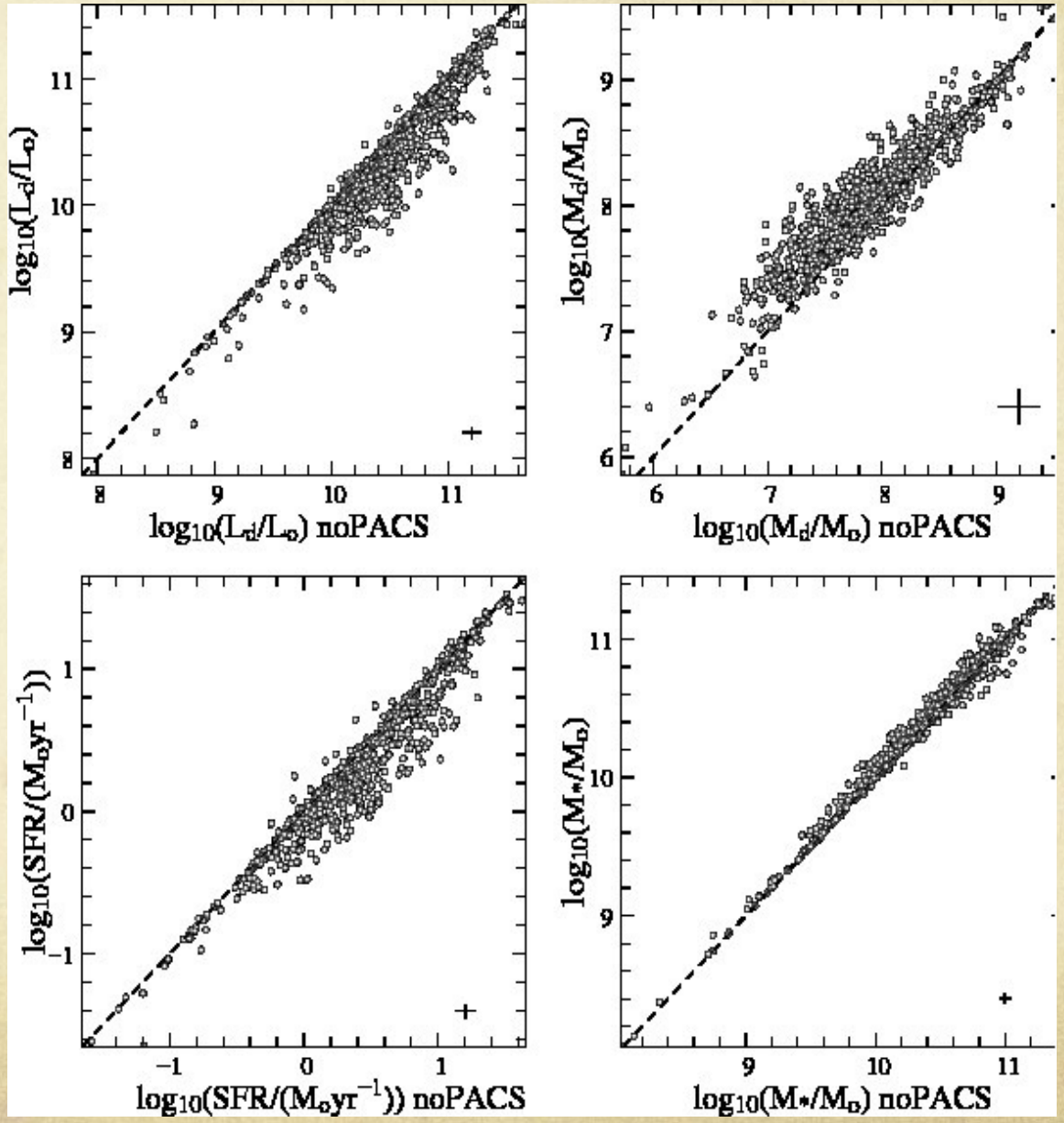
Negligible differences in stellar dust mass.

Dust luminosities overestimated by 25%

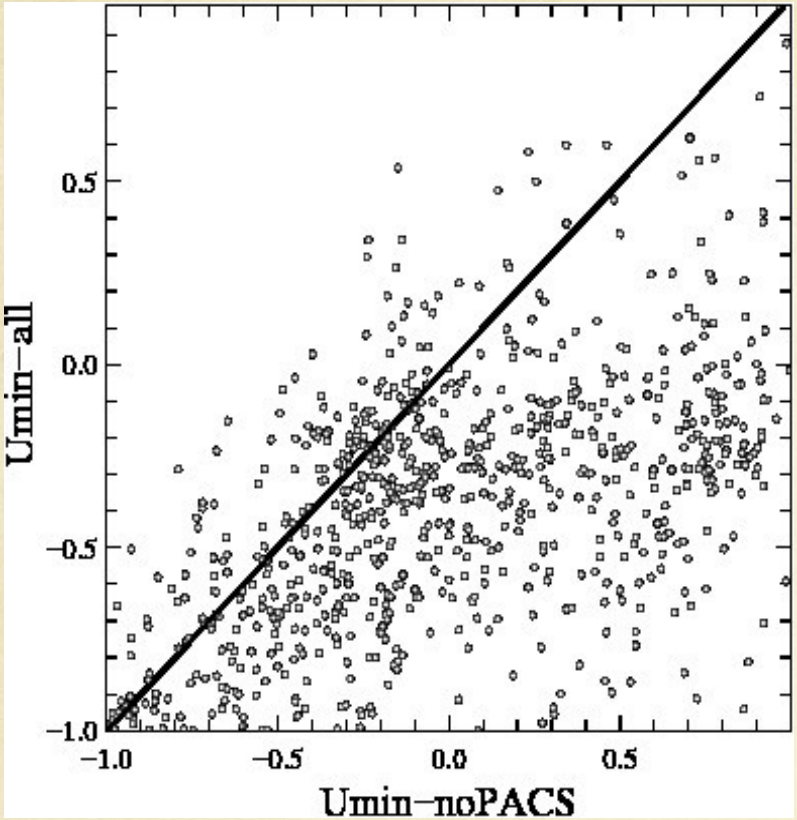
SFR overestimated by 30%

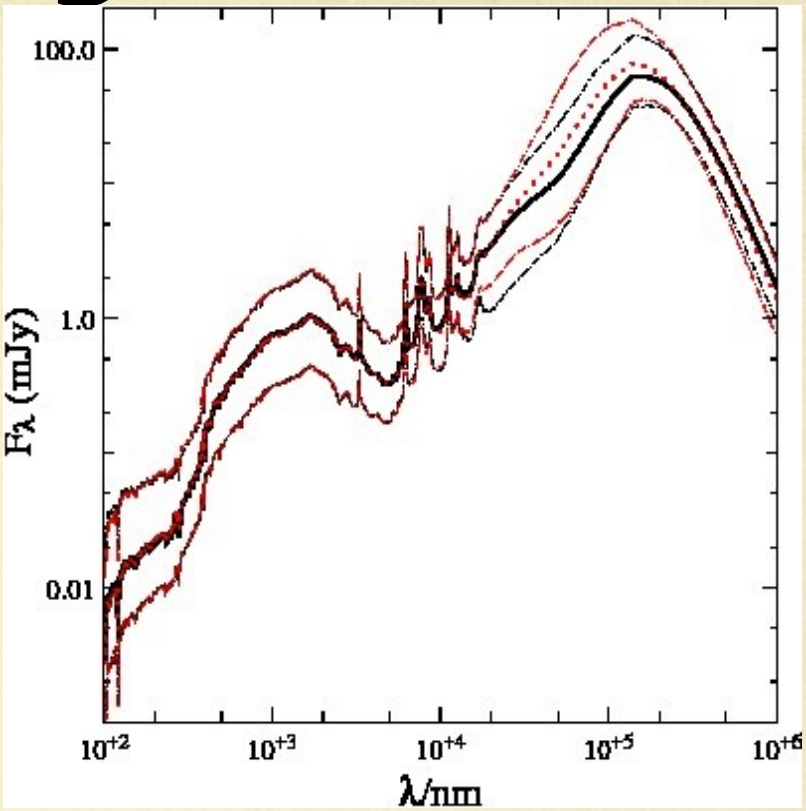
Dust Mass underestimated by 38%

WHY?????????



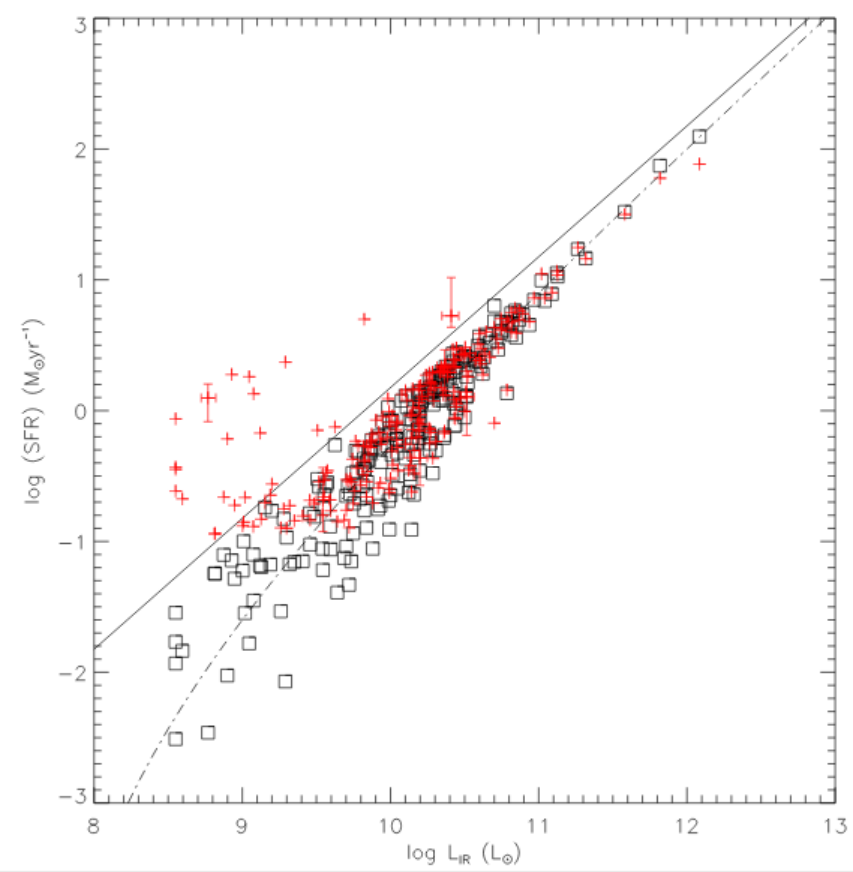
Removing PACS

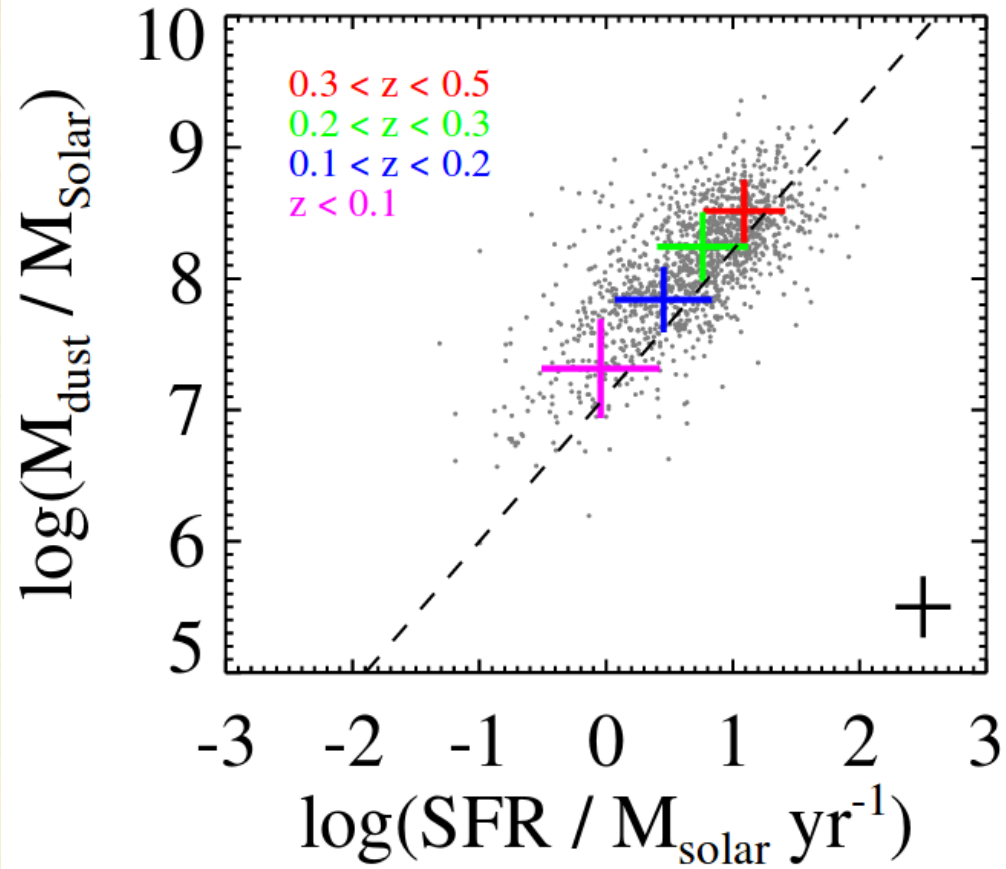




In average Umin is overestimated by 50%
What change in the median SED are the region where there is the bulk of the dust emission, the region where the dust is heated by the interstellar radiation field. Overestimating this lead to an overestimation of the dust mass.

Correlations



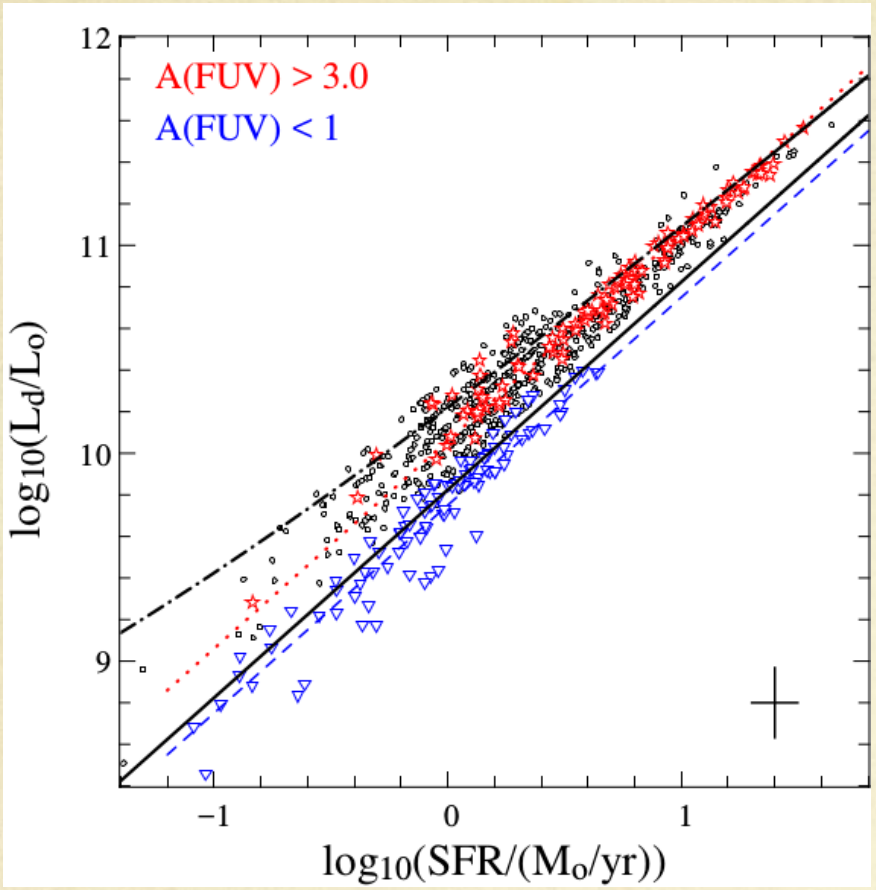


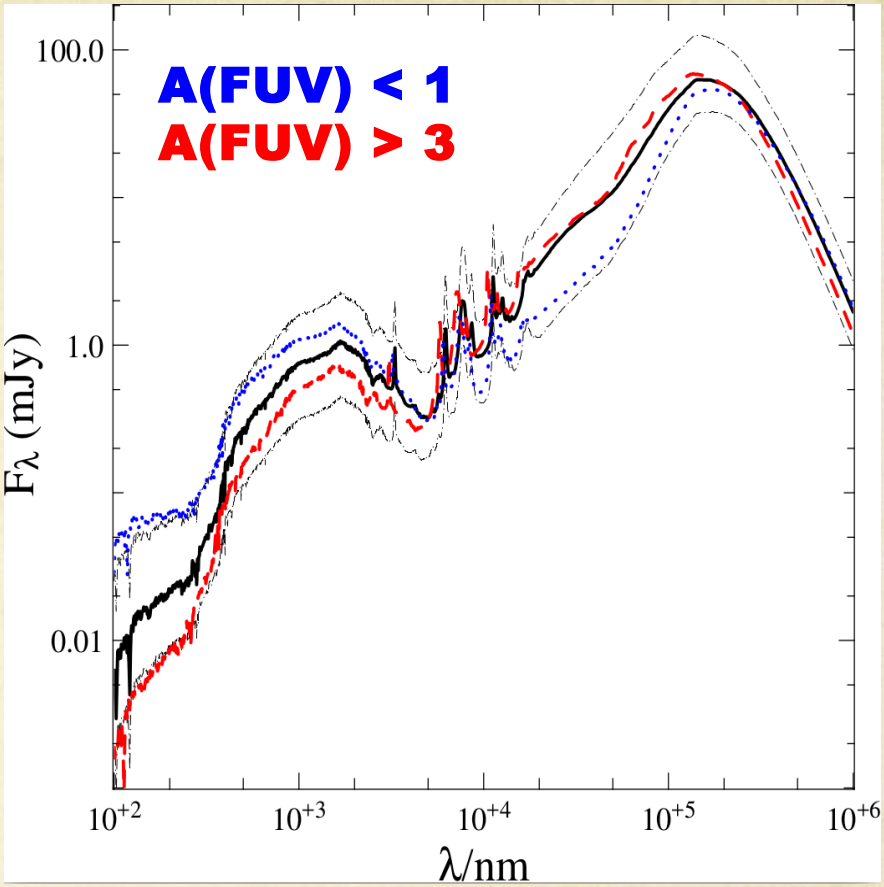
Clemens +13

Smith +12

However, the problem persist, and both the dust luminosity and the dust mass show a not negligible scatter, considering that the SED is well sampled.

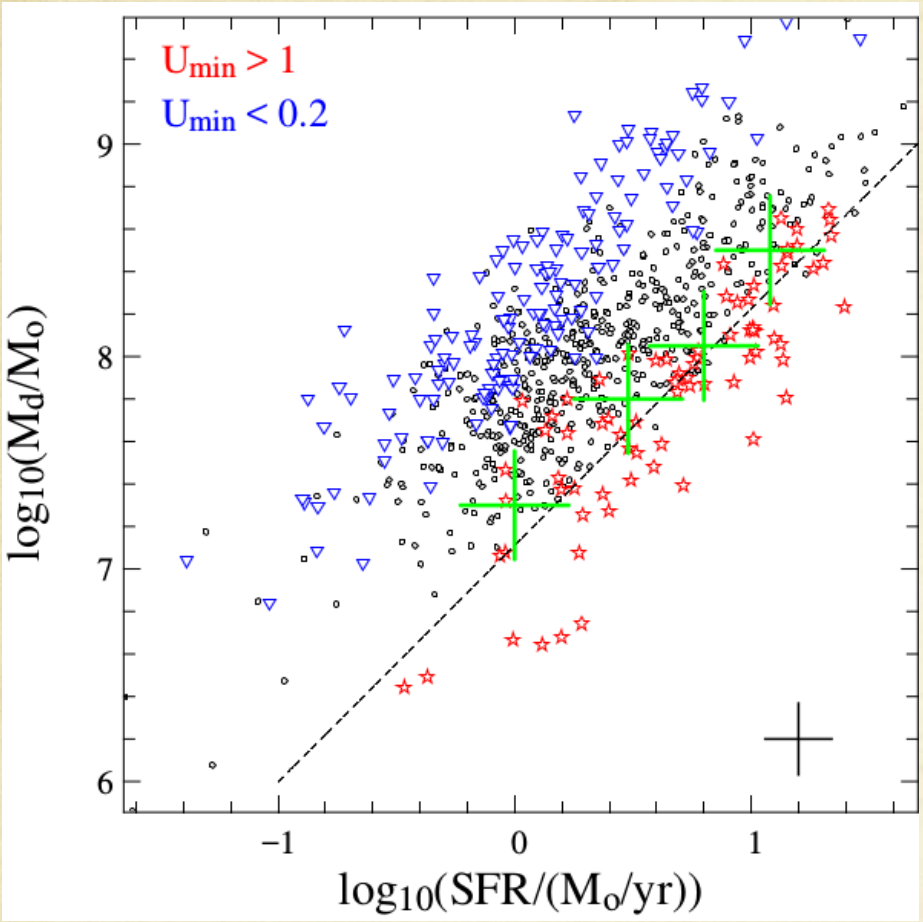
Correlations

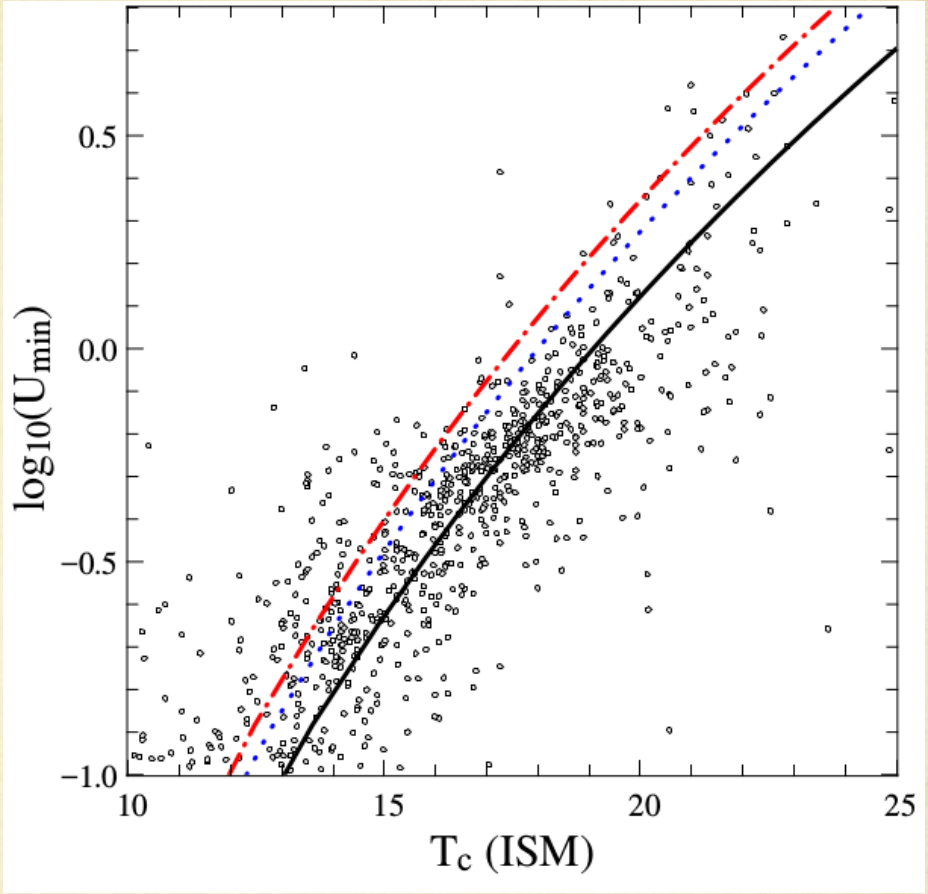




The dust luminosity and the SFR correlates very well, above all at higher SFR. However this relation is linked to the attenuation due to the dust suppressing the FUV. For higher attenuation the correlation becomes more scattered

Correlations





Galaxies with lower Umin have higher dust mass, but this dust component is not heated by the star formation.

$T_d = A * U^{1/(4+\beta)}$; $\beta = 2$;

T_d=17.5 K (MW), T_d=18 K (SINGS), T_d=19.5 K (LRS)

Conclusions

- Removing WISE data dust luminosities is overestimated by 28%, and SFR overestimated by 20%.

The fits without MIR constraints increase artificially the efficiency of the radiation field in heating the dust, leading to misleading dust luminosity and then SFR!!!!!

- Removing PACS data dust luminosities are overestimated by 25%, SFR overestimated by 30%, and **dust Mass underestimated by 38%.** This is because **Umin is overestimated by 50%**

- The dust luminosity and the SFR correlates very well, if we consider the attenuation due to the dust suppressing the FUV.

- Galaxies with lower Umin have higher dust mass, but this dust component is not heated by the star formation. The temperature of the cold ISM is higher in galaxies with higher U implying the possibility of a selection criteria based on this parameter