Dust and Star-Formation Properties of a Complete Sample of Local Galaxies Drawn from the Planck ERCSC

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The sample

- A truly local sample of 234 star forming galaxies (although D > 4Mpc to exclude objects like M31 and M33)
- 80% complete at 545GHz
- Galactic and AGN sources excluded largely 'by hand' (ERCSC 'EXTENDED' and 'CIRRUS' flags not so great)
- All objects have *redshift independent* distances.

Data

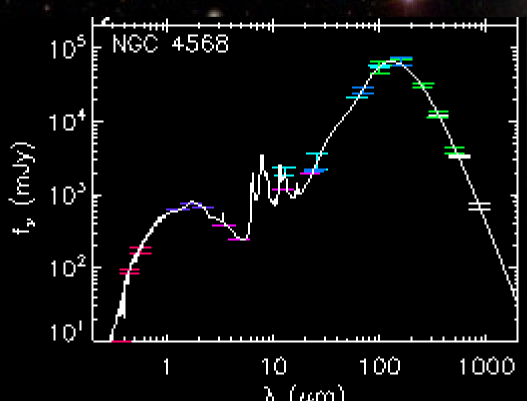
- Planck: 857, 545, 353, 217GHz (*CO corrected*)
  232, 234, 181, 47 objects respectively
- RC3: U, V, B
- 2MASS: 1.25, 1.65, 2.17μm
- WISE: 3.4, 4.6, 12, 22μm
- SPITZER MIPS: 24, 70, 160μm
- IRAS: 12, 25, 60, 100μm
- Herschel: 100, 160, 250, 350, 500μm
  (KINGFISH, HRS, HeViCS, H-ATLAS)
- AKARI: no

Fits to the data

MAGPHYS (da Cunha et al., 2008)

Emission from warm and cold dust components calculated by assuming that stars (young + old) are the only heating source. Energy emitted in IR exactly balances that absorbed in UV/optical.

- Warm dust temperature
- Cold dust temperature
- Dust mass
- Star formation rate



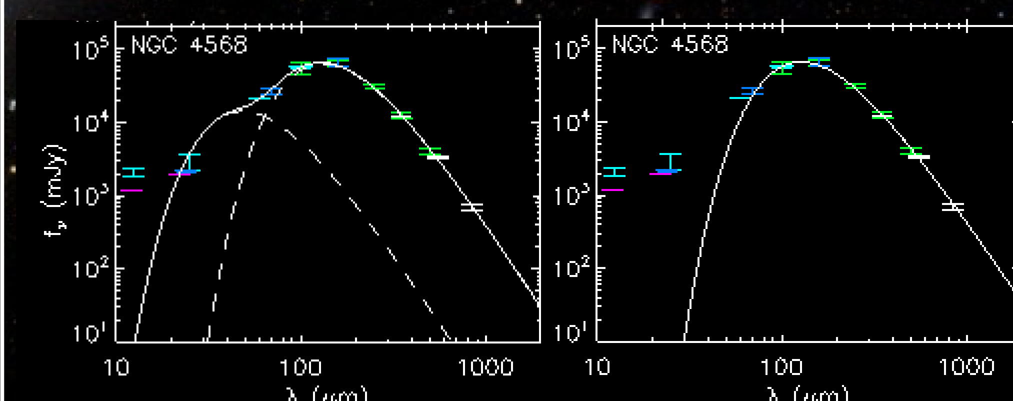
Simple modified black bodies

$\kappa_d(\nu)\, B(\nu, T)$

Single component (T and β free)
- Only fit λ>80μm

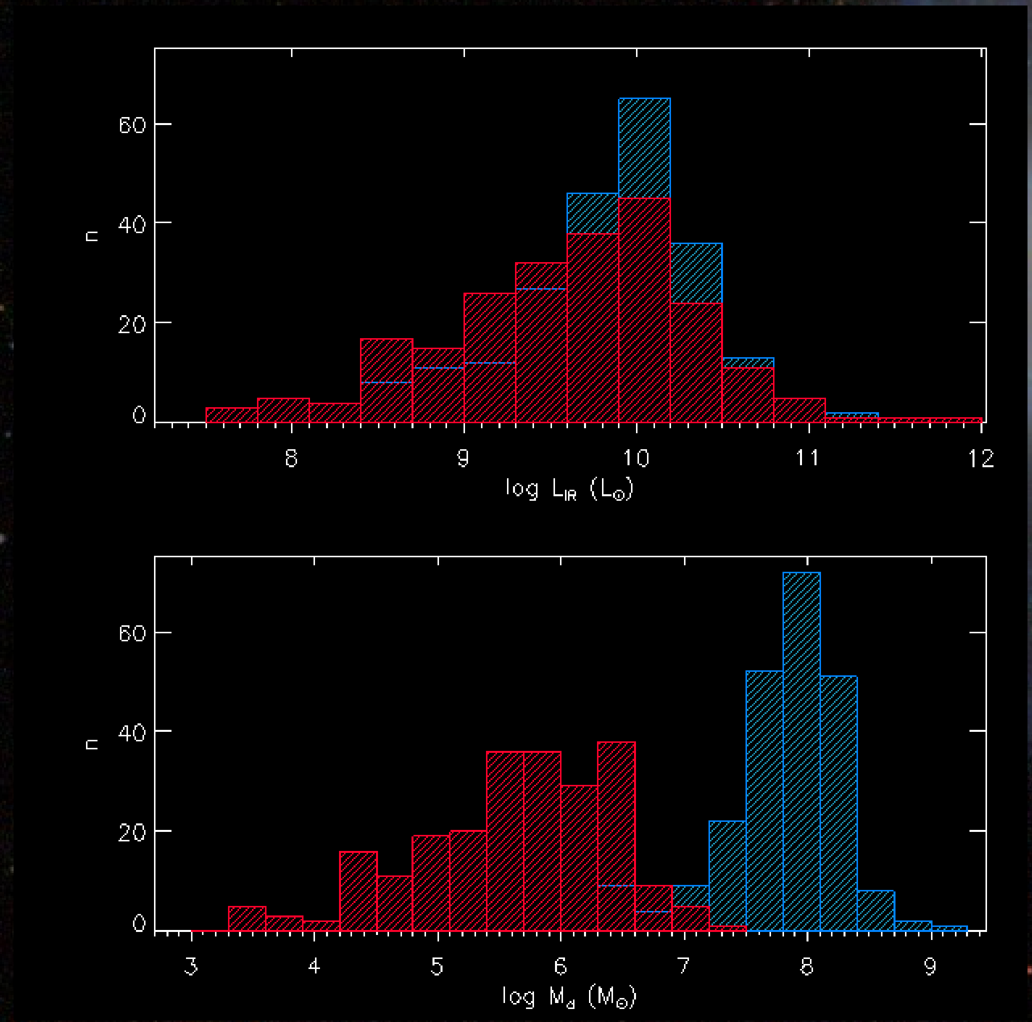
2-component (β=2)
- include 60μm

- (Warm dust temperature)
- Cold dust temperature
- (β)
- Dust mass

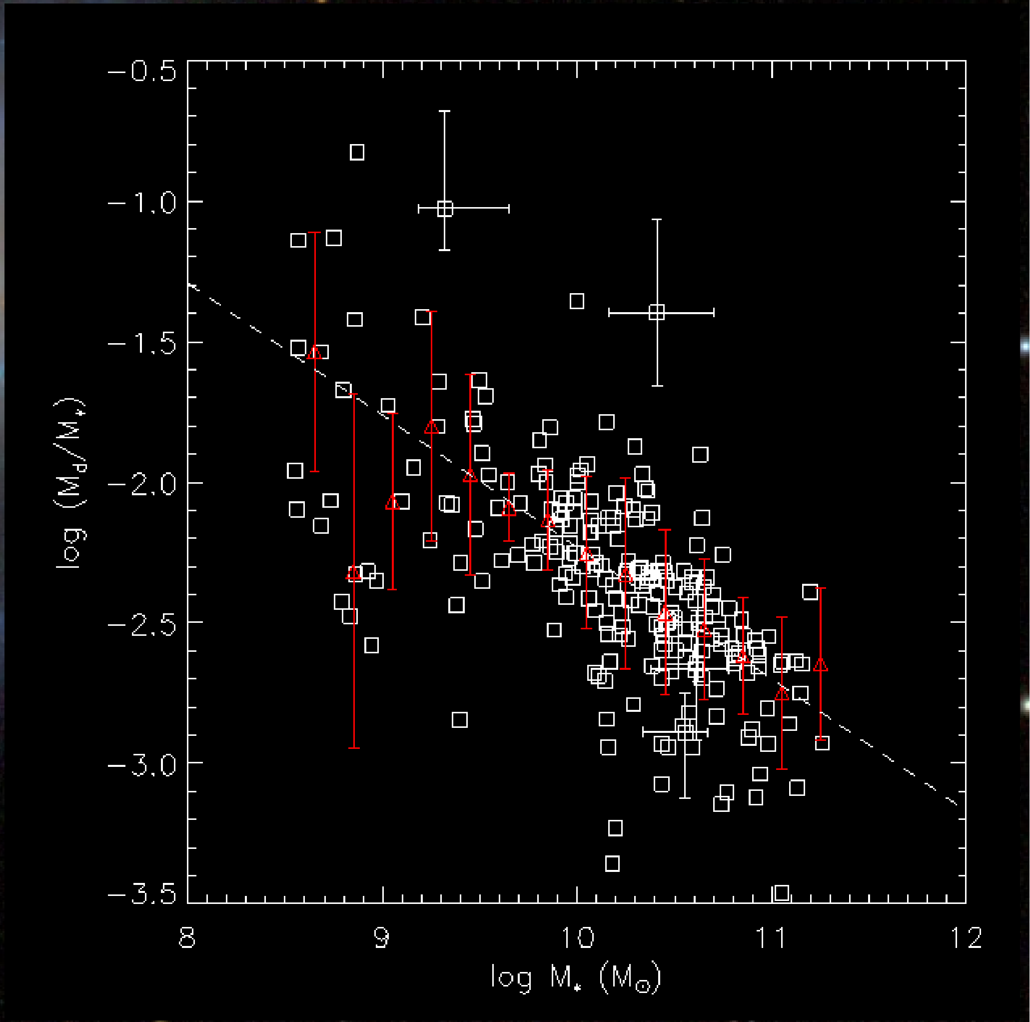


Results (already known)

"Warm dust emits a lot but accounts for negligible mass"



"Smaller galaxies are dustier" (and have more ISM in general)



Results (New)

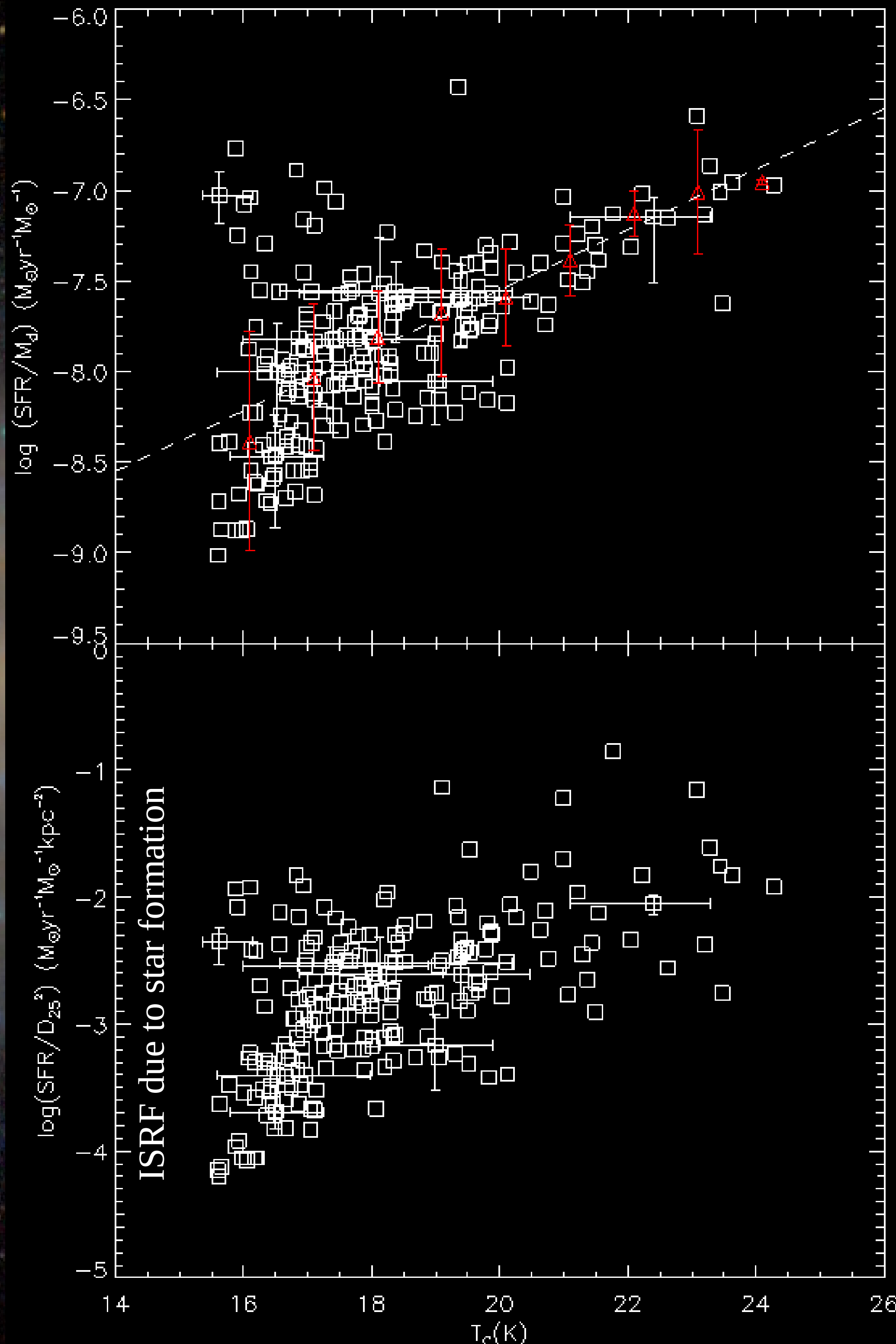
What is heating the *cold* dust?

Ongoing star formation is contributing significantly to heating even the cold dust. The warmer the dust, the greater the contribution from SF.

SFR/M_d drives T_d more than SFR/M^* (*specific* SFR)

Ongoing star formation contributes to the interstellar radiation field.

So a higher star formation rate does not only imply more warm dust, but warmer cold dust too.



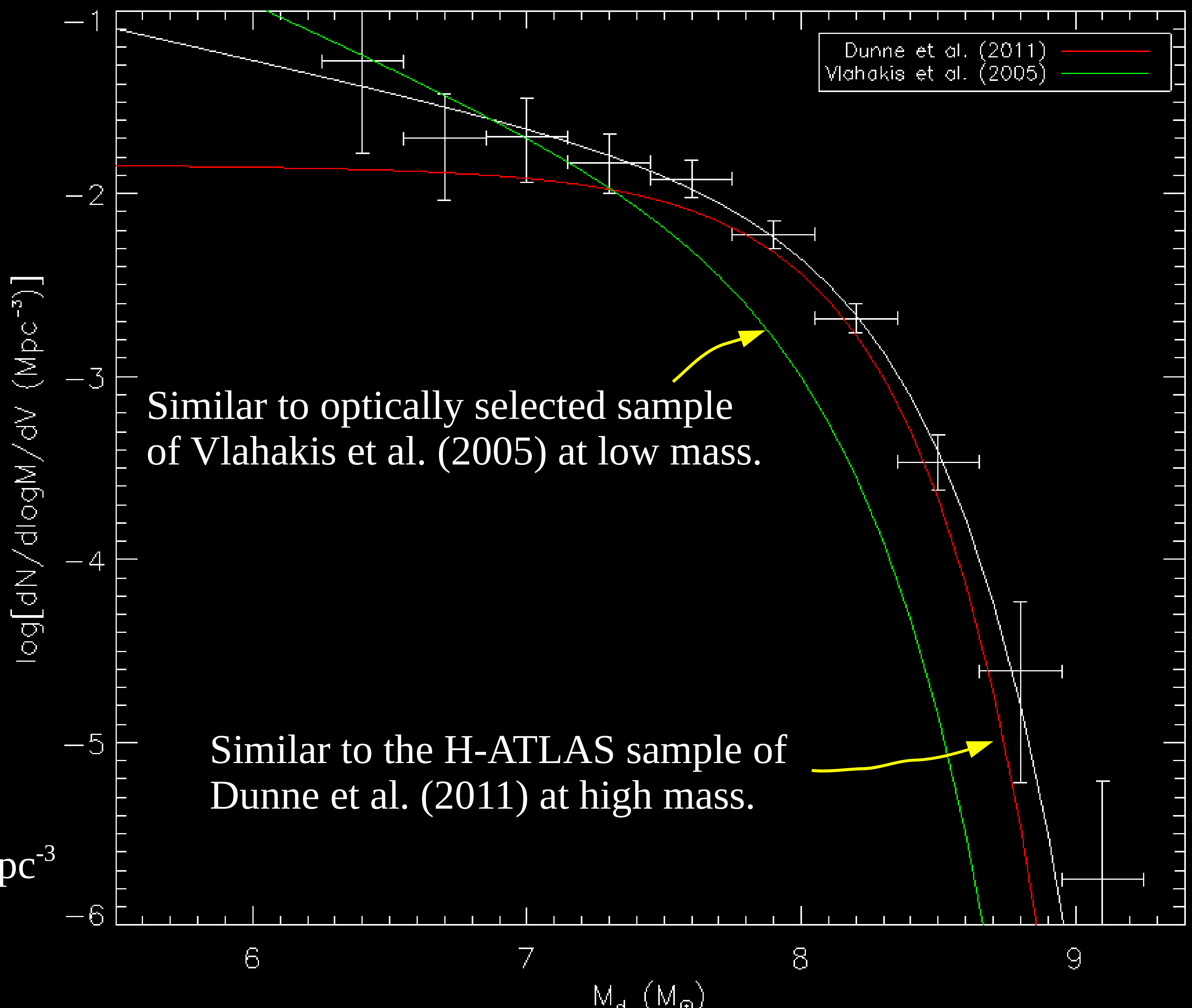
Dust mass function

Local Universe is more dusty.

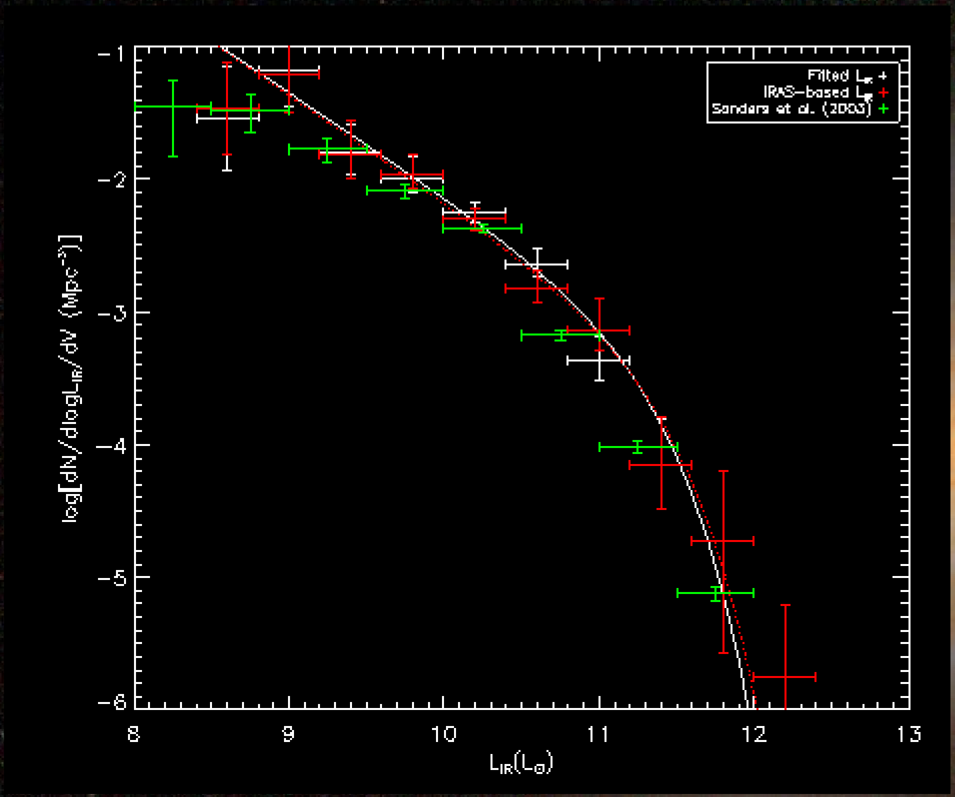
α_d = -1.3

Dust mass density of local Universe:

7.0 ± 1.4 x 10^5 $M_\odot$ Mpc^{-3}

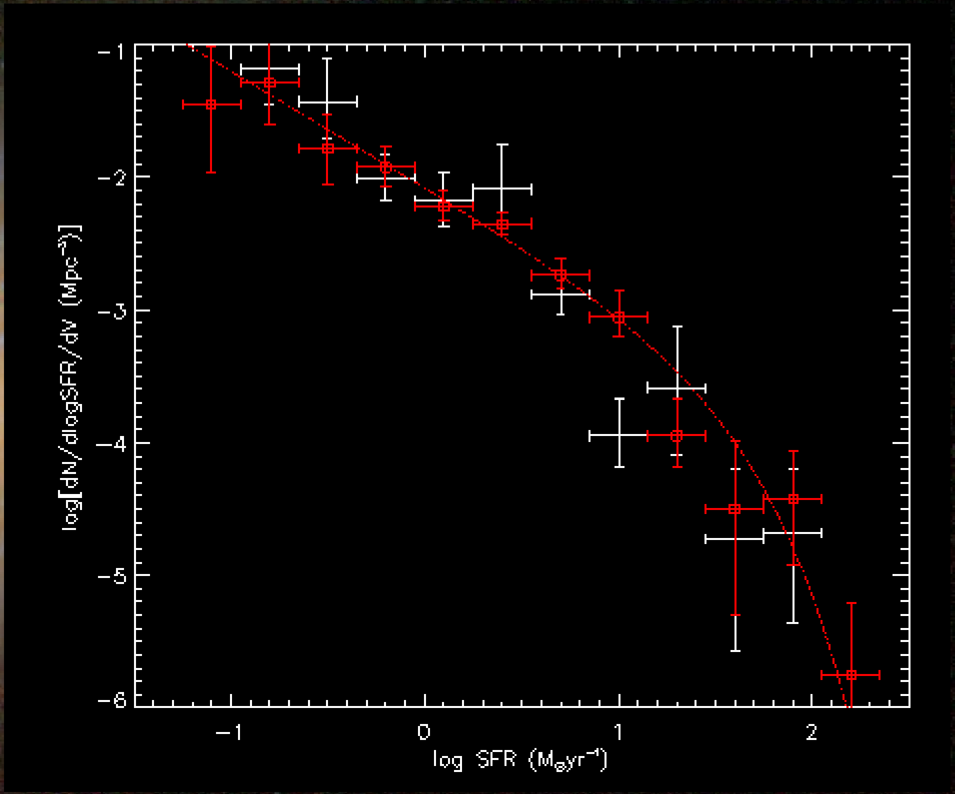


Total infrared luminosity function



α_{IR} = -1.8

Star formation rate function

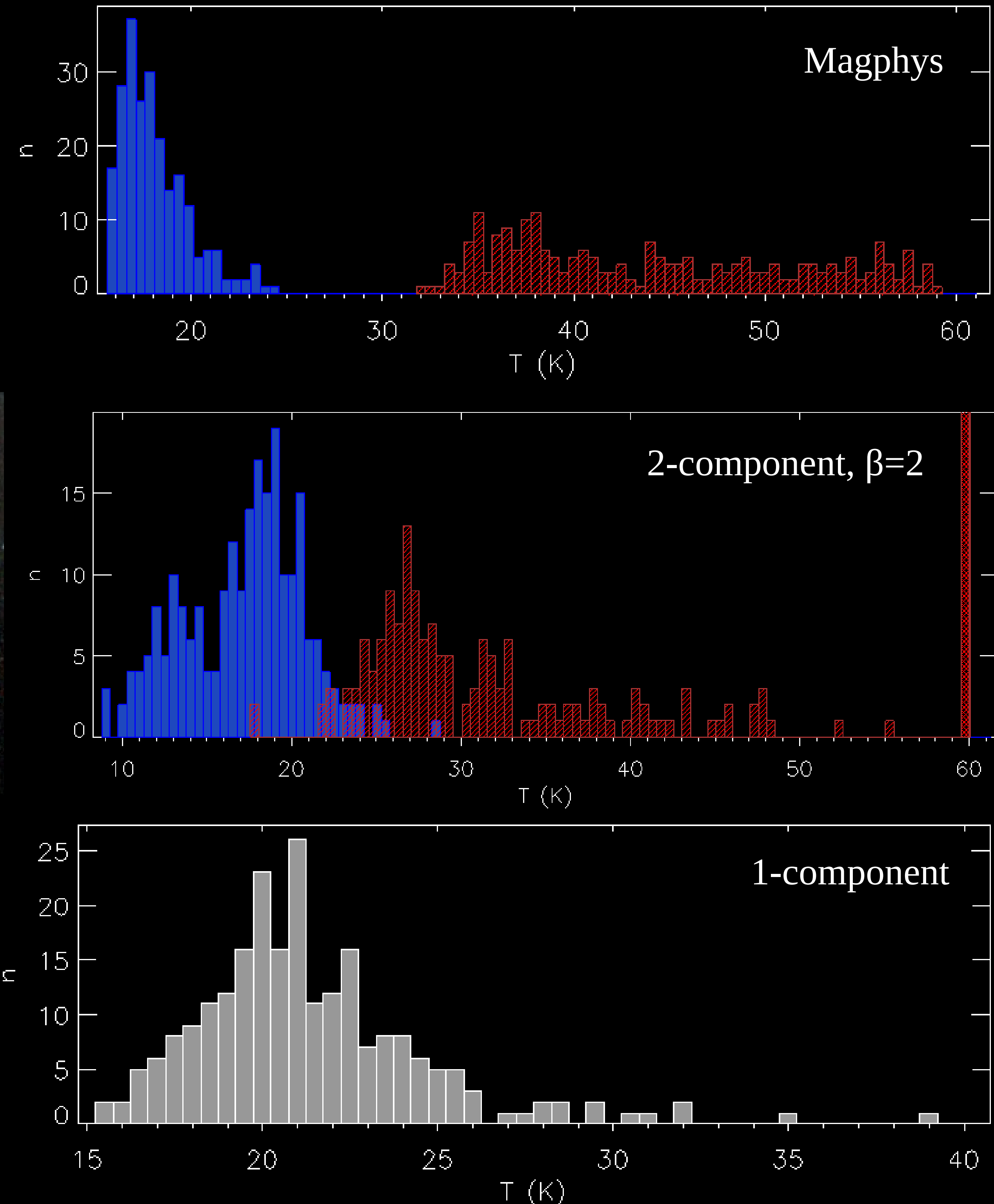


α_{SFR} = -2.3

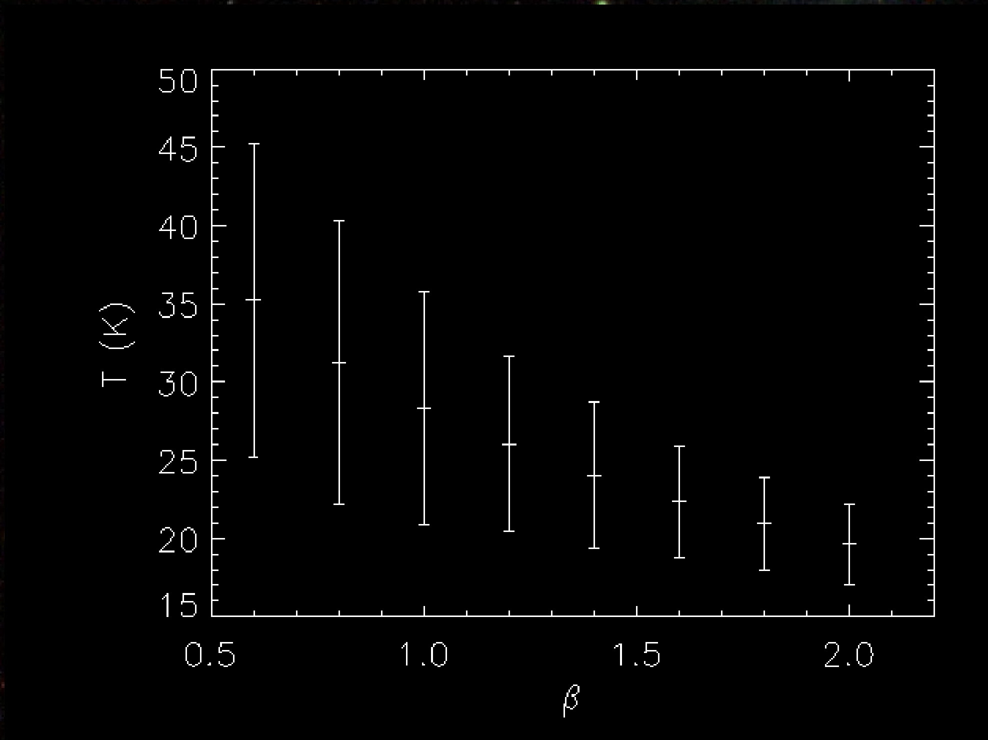
Dust temperature

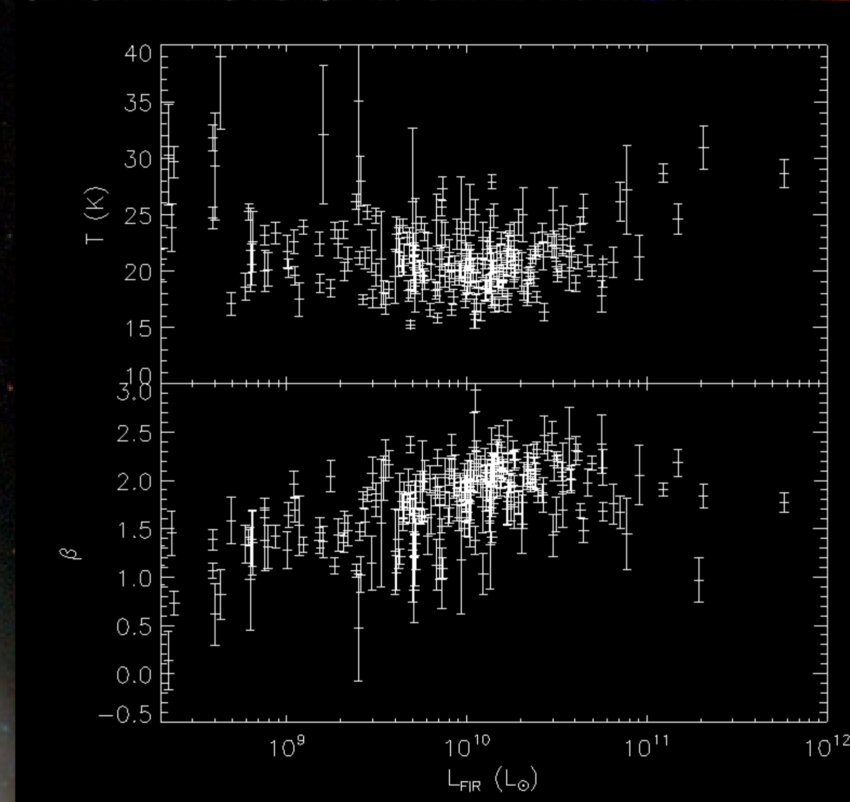
Median T(cold) = 18.8 K

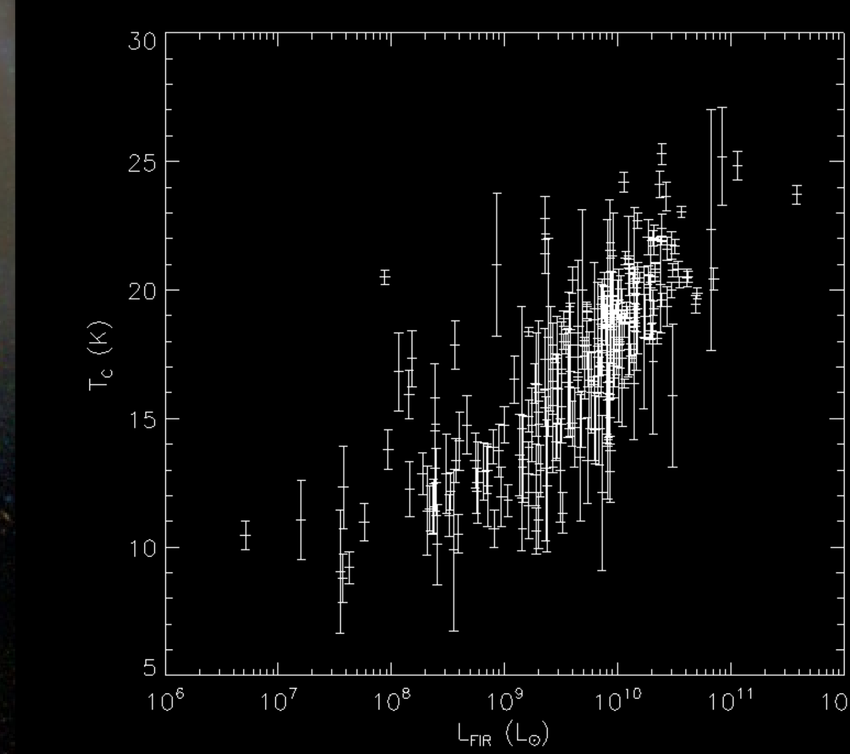
Cold component as low as 10 K (12 K using only objects with >5 data points at λ ≥ 80μm).



T/β degeneracy



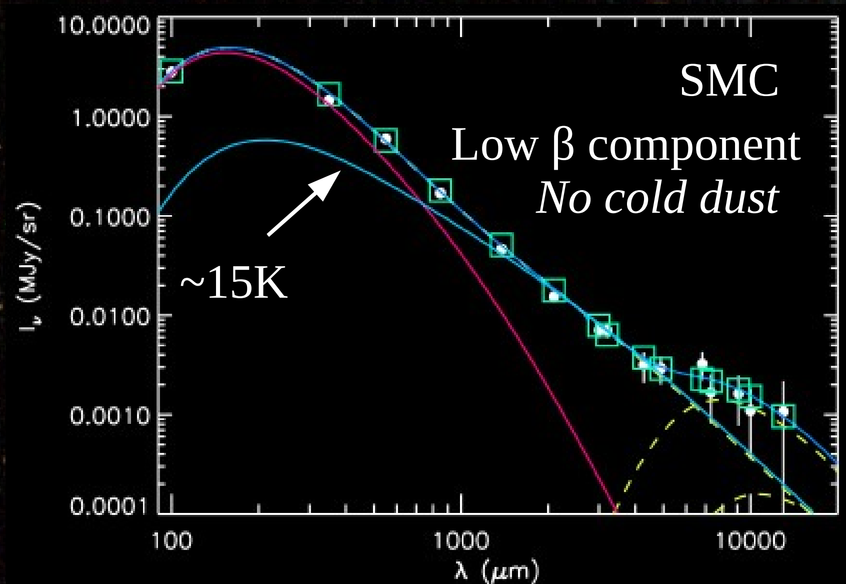




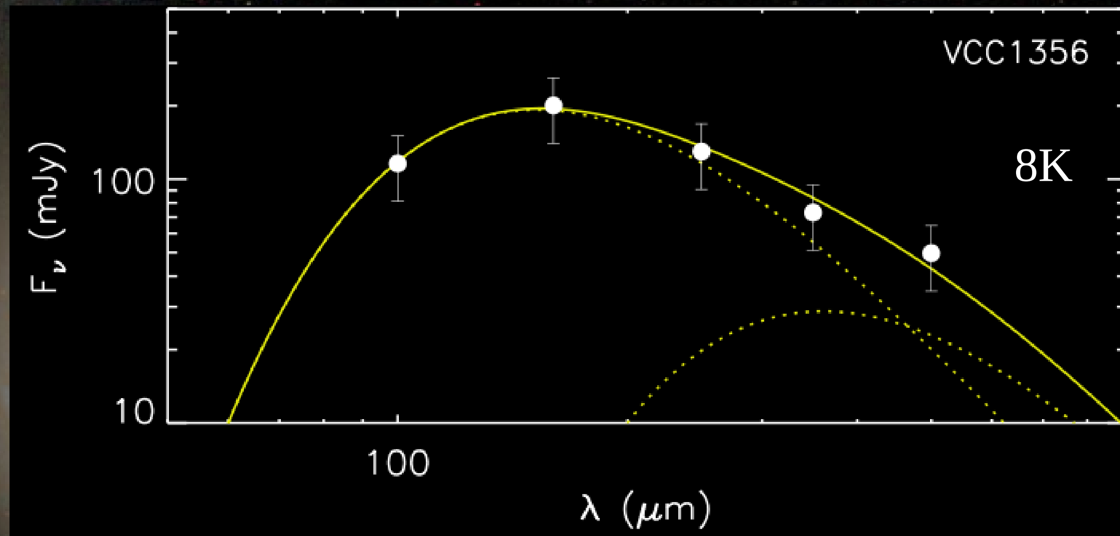
What about very cold dust?

See also: O'Halloran et al. (2010), A&A, **518**, L58

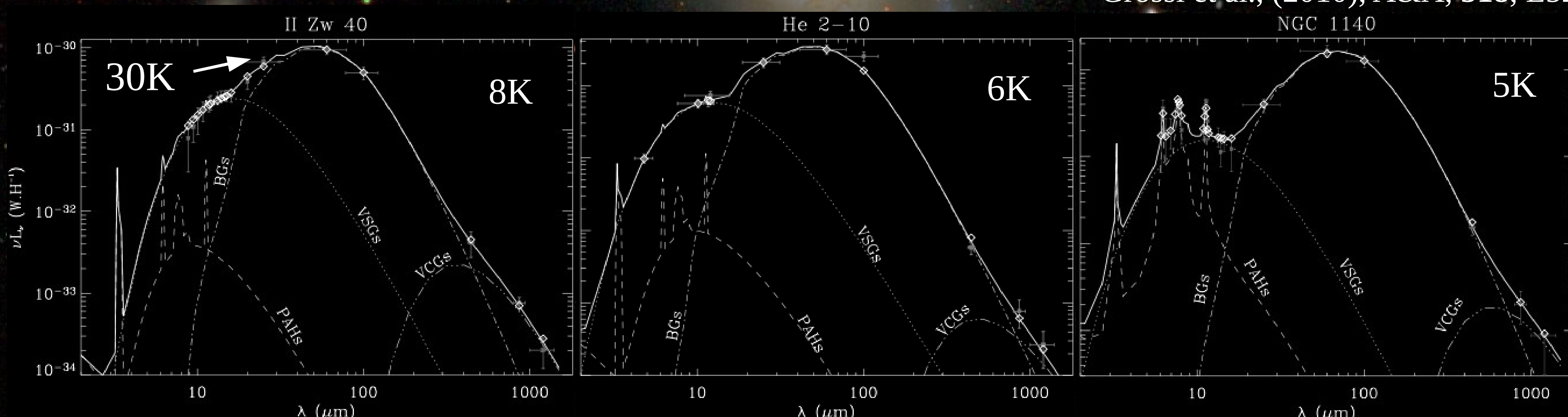
Planck early results XVI, A&A, **536**, A16



Planck collaboration XVII, A&A, **536**, A17

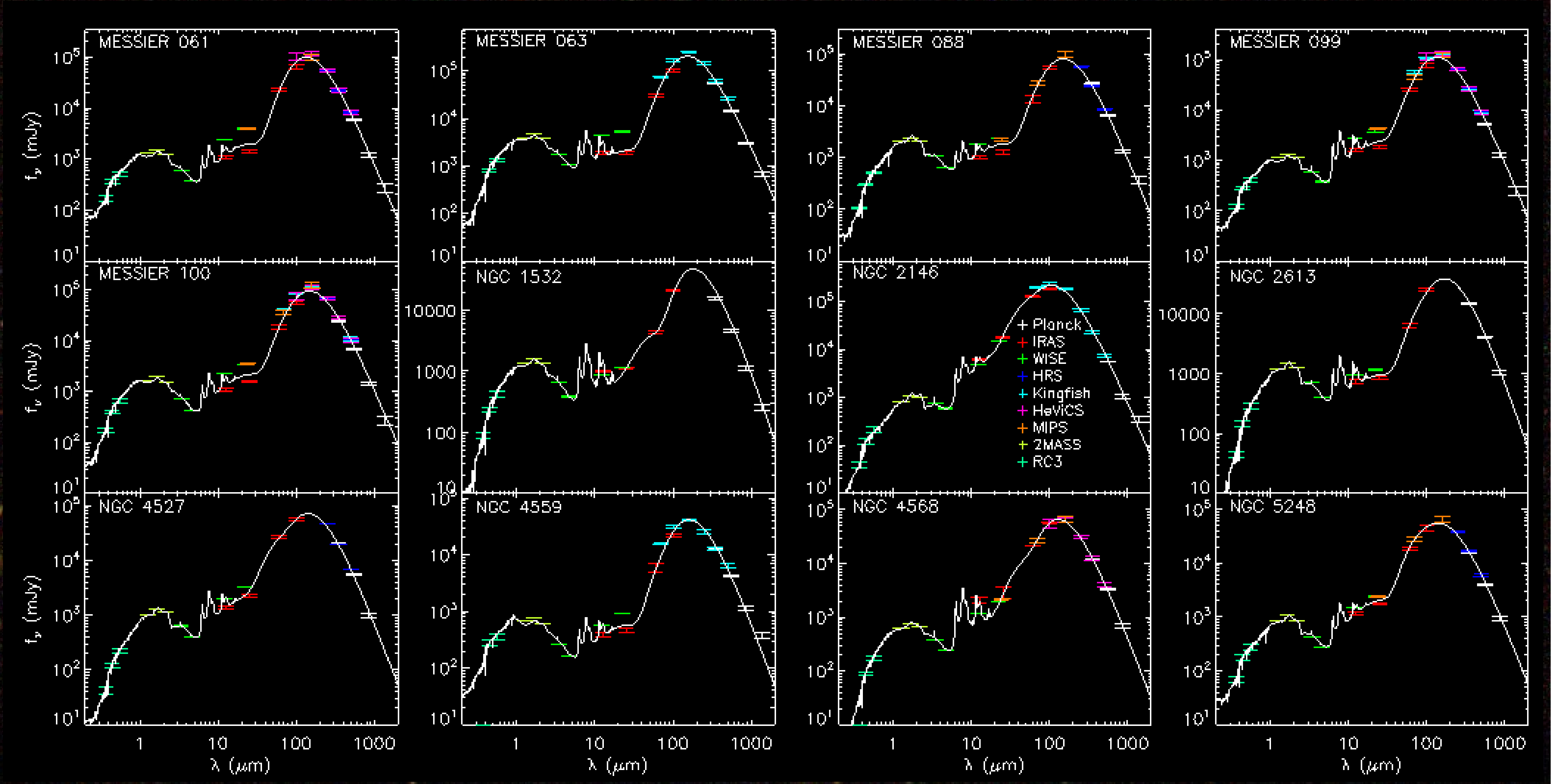


Grossi et al., (2010), A&A, **518**, L52



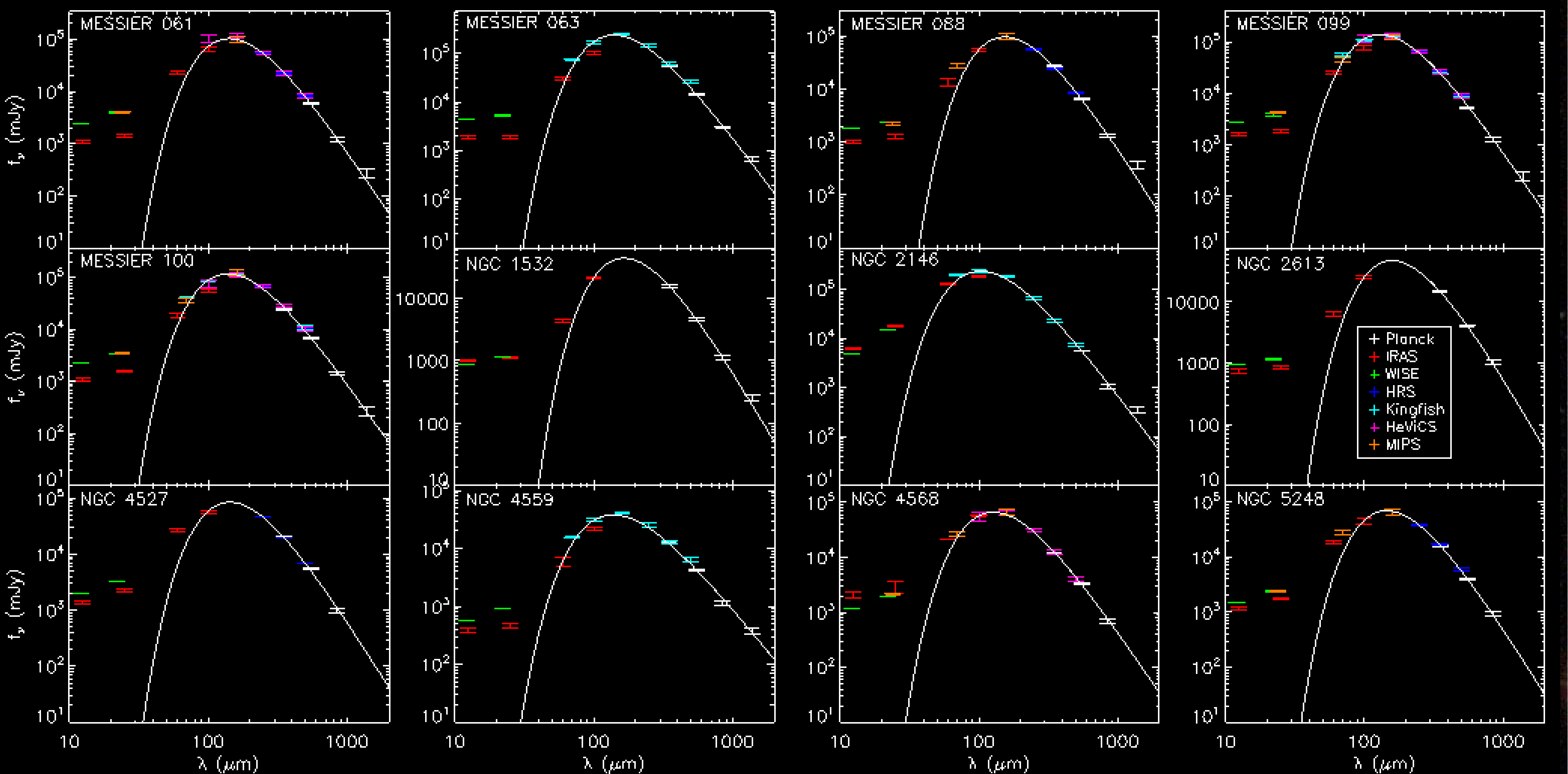
Galliano et al. (2005), A&A, **434**, 867

None here...



MESSIER 061
MESSIER 063
MESSIER 088
MESSIER 099
MESSIER 100
NGC 1532
NGC 2146
NGC 2613
NGC 4527
NGC 4559
NGC 4568
NGC 5248
Planck
IRAS
WISE
HRS
Kingfish
HeViCS
MIPS
2MASS
RC3
f_ν (mJy)
λ (μm)

None here...



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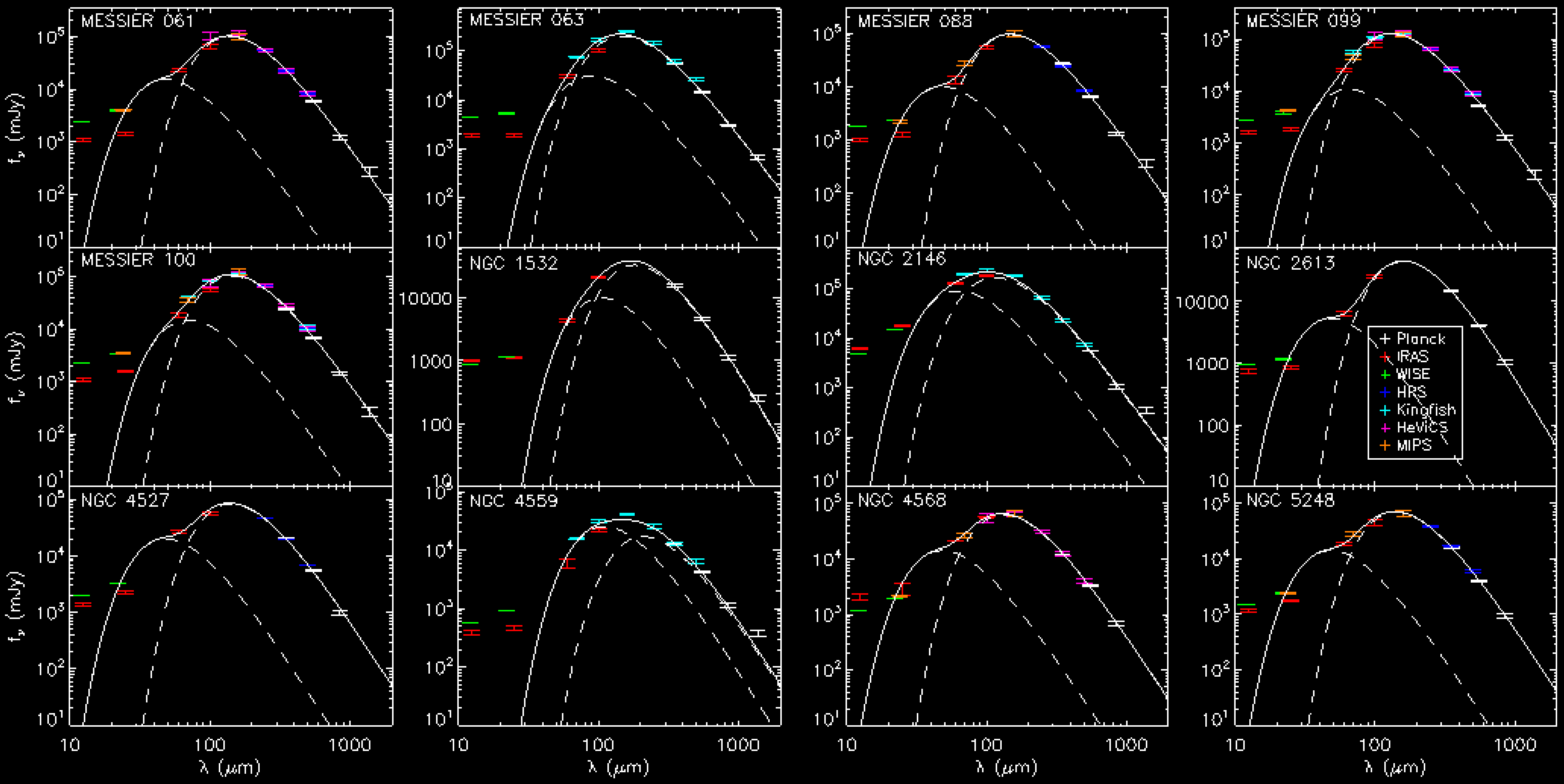

No evidence for dust at < 10K.
The SEDs just never look like those of dwarfs in which a clear sub-mm excess is seen.

Conclusions ...for a cold dust emission selected local sample

- A normal local star forming galaxy has:

T(cold) ≈ 17.8 K	T(warm) ≈ 38 K (but less certain)
M(dust) ≈ 7.8 x 10^7 $M_\odot$	M(dust)/M* ≈ 0.0046
M(dust)/M(HI) ≈ 0.022	

- Always beware of the T/β degeneracy
- Ongoing star formation has an important role in heating even the cold dust
- No evidence for an *extra* very cold (5-10 K) dust component

- The local Universe has:

Dust mass density ≈ 7.0 ± 1.4 x 10^5 $M_\odot Mpc^{-3}$ (Greater than recent Herschel estimate)

Total infrared luminosity densiy ≈ 1.74 ± 0.33 x 10^8 $L_\odot Mpc^{-3}$

Star formation rate density ≈ 0.0216 ± 0.0093 $M_\odot yr^{-1} Mpc^{-3}$