ALMA / Herschel Archival Workshop
Garching, April 2015

Revealing the structure of the cold dust and submm excess with Herschel and ALMA

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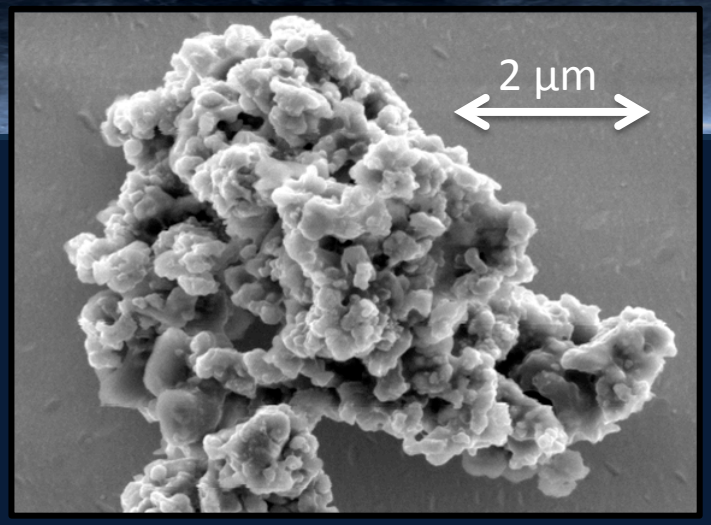
THE DUST EMISSION



$$F_\lambda = \frac{N\pi a^2 Q_\lambda B_\lambda(T)}{D^2}$$

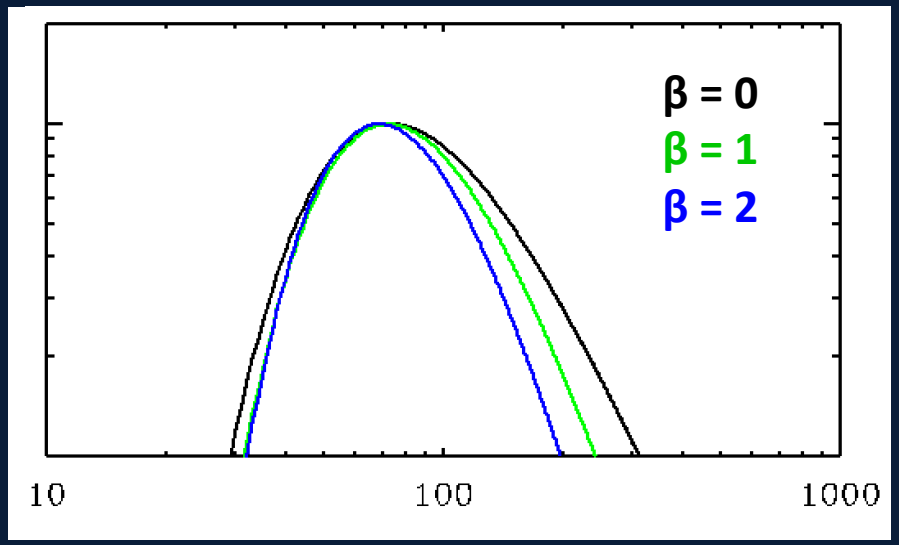
A power-law dependence :

$Q_\lambda \sim \lambda^{-\beta}$

- β evolves depending on the
  - particle size
  - species

β = 1 for amorphous material
β = 2 for metals or crystals

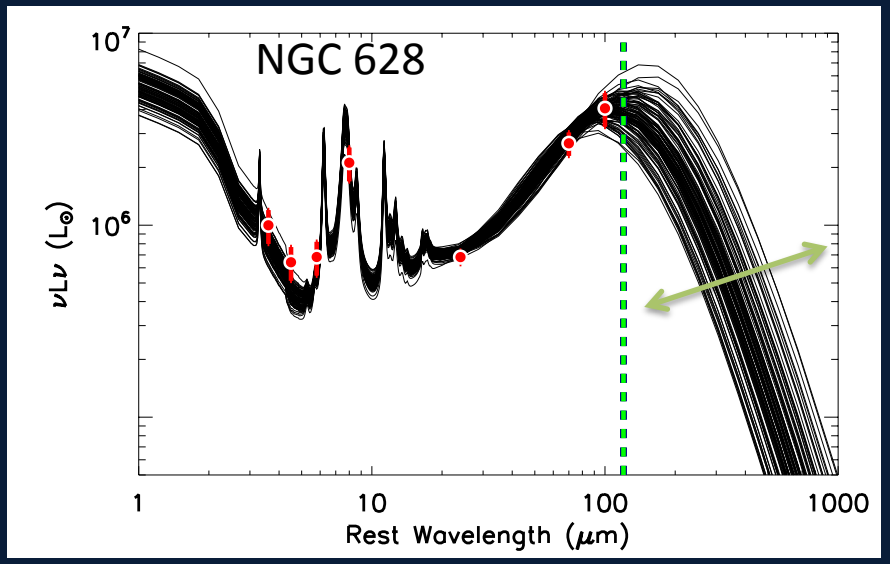
Dependence with the emissivity index

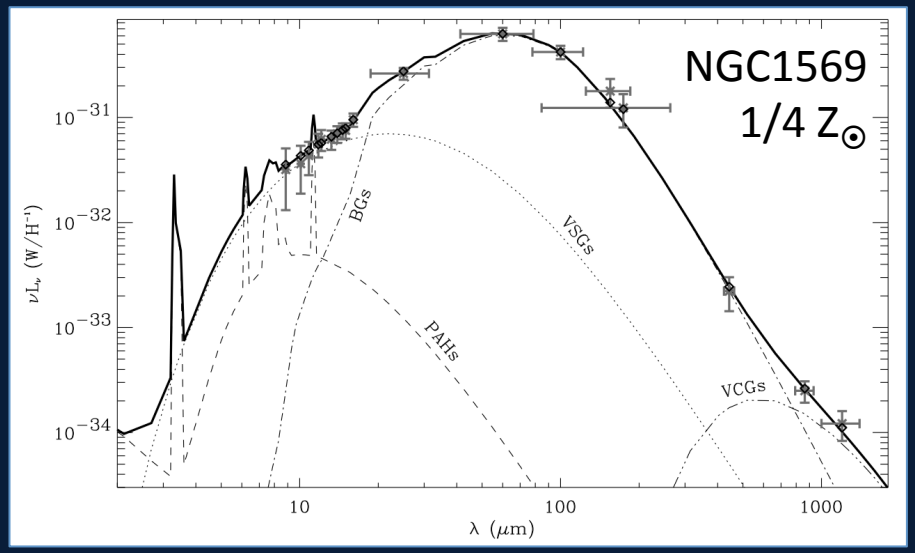


WHAT DID WE KNOW BEFORE HERSCHEL ?

- No constraint on β

→ **Consequences on the dust estimates**





Galliano et al, 2003

- Submm emission in excess detected (esp. in low metallicity objects)

One example … among many others:

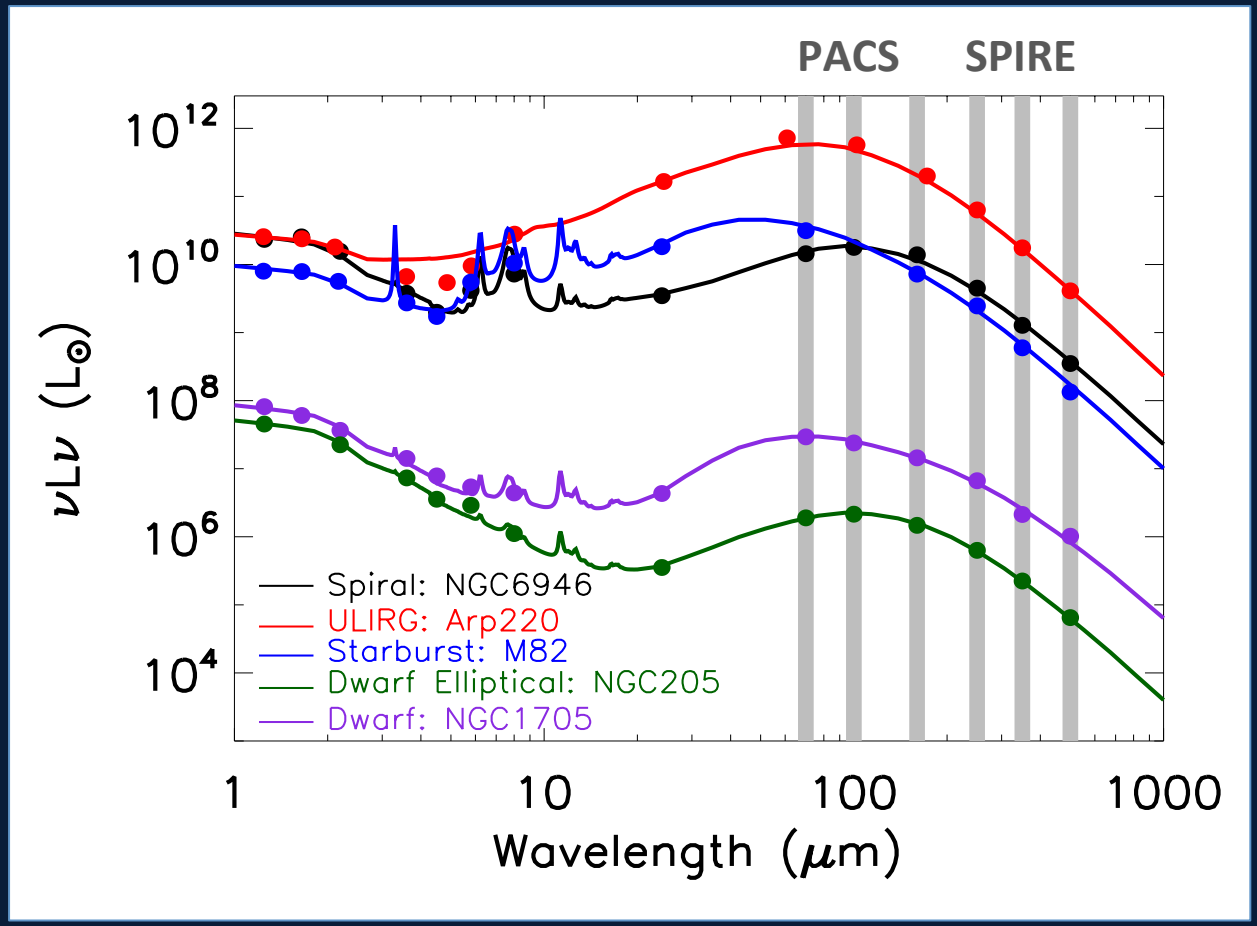
Bendo et al, 2006; *Bot el al, 2010;*
Galametz et al, 2009; *Zhu et al, 2009 …*

→ **Consequences on dust mass estimates**

THE COLD UNIVERSE WITH HERSCHEL

→ Coverage in the submm (70 to 500 μm)

→ Good spatial resolution (2kpc at 10Mpc)

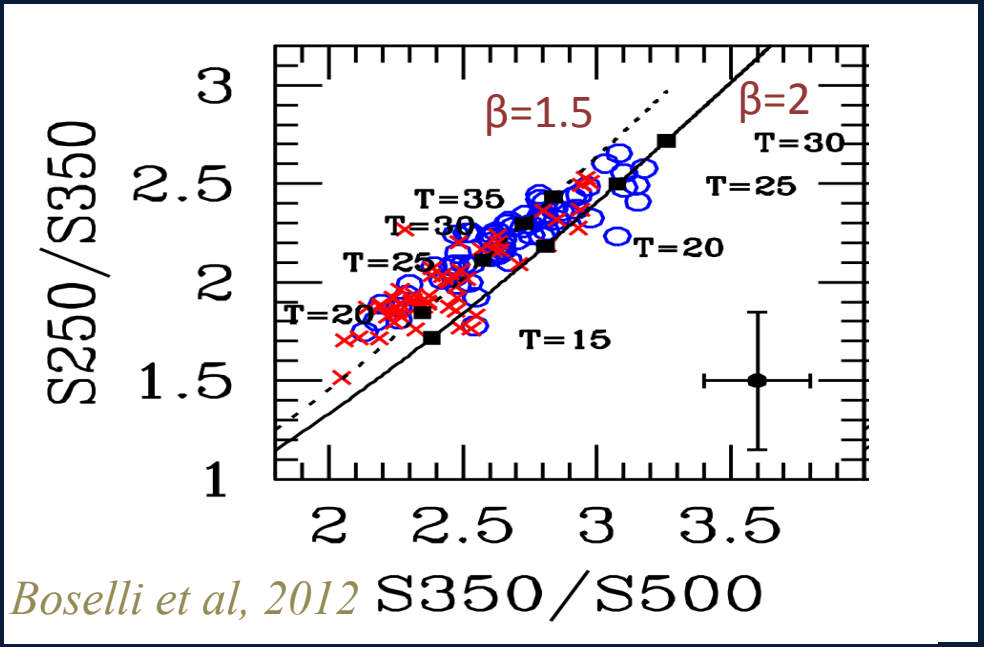


GLOBAL STUDIES

Ratio – ratio diagrams

- First investigations using PACS or SPIRE color ratios

  - $\beta = 2$ only appropriate for the | most-massive objects
    metal-rich



Boselli et al, 2012

Herschel Reference Survey (HRS)

○ 12+log(O/H) > 8.55
× 12+log(O/H) ≤8.55

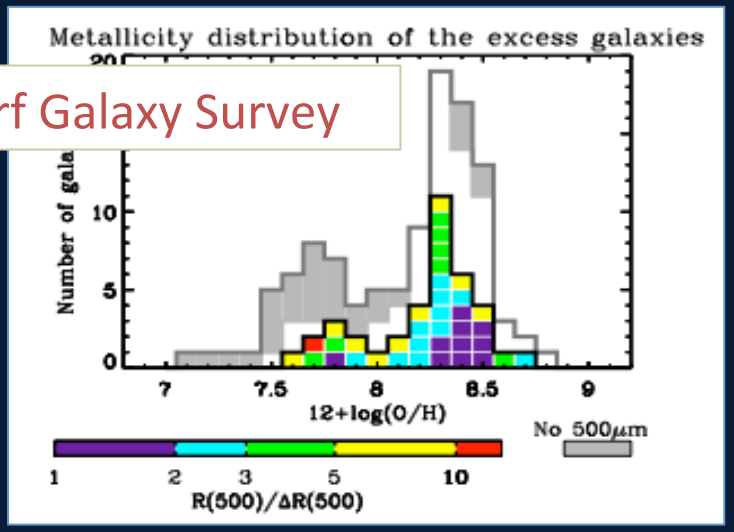
... See also Auld et al, 2012 for the Herschel Virgo Cluster Survey

GLOBAL STUDIES

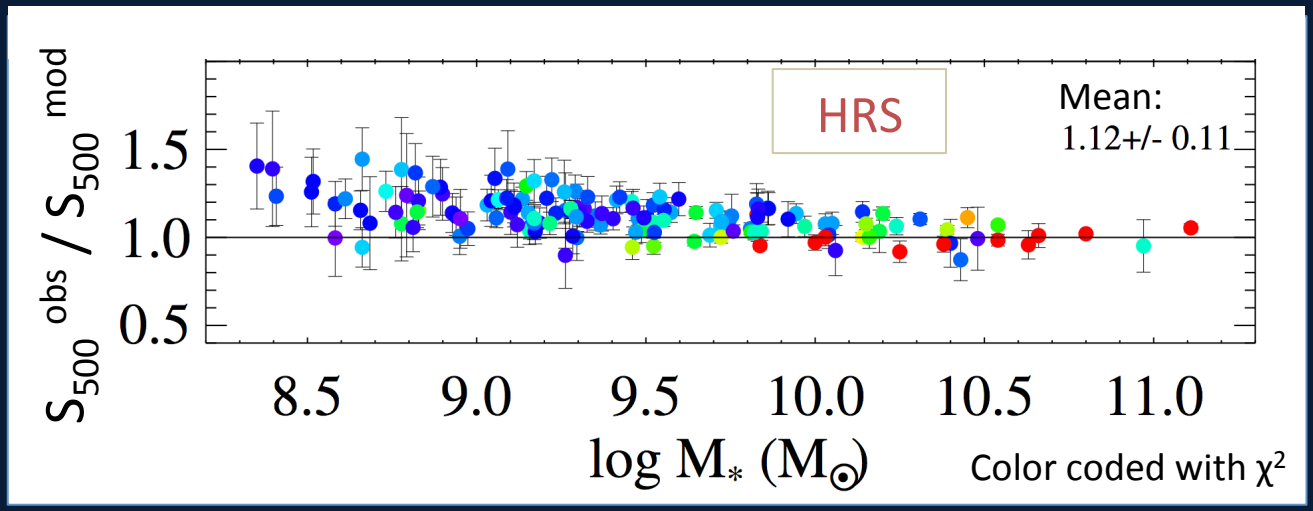
Residuals to SED models

- Variable excesses
- Dependent on the stellar mass
- Not necessarily linked with Z

Dwarf Galaxy Survey



Rémy-Ruyer et al, 2014

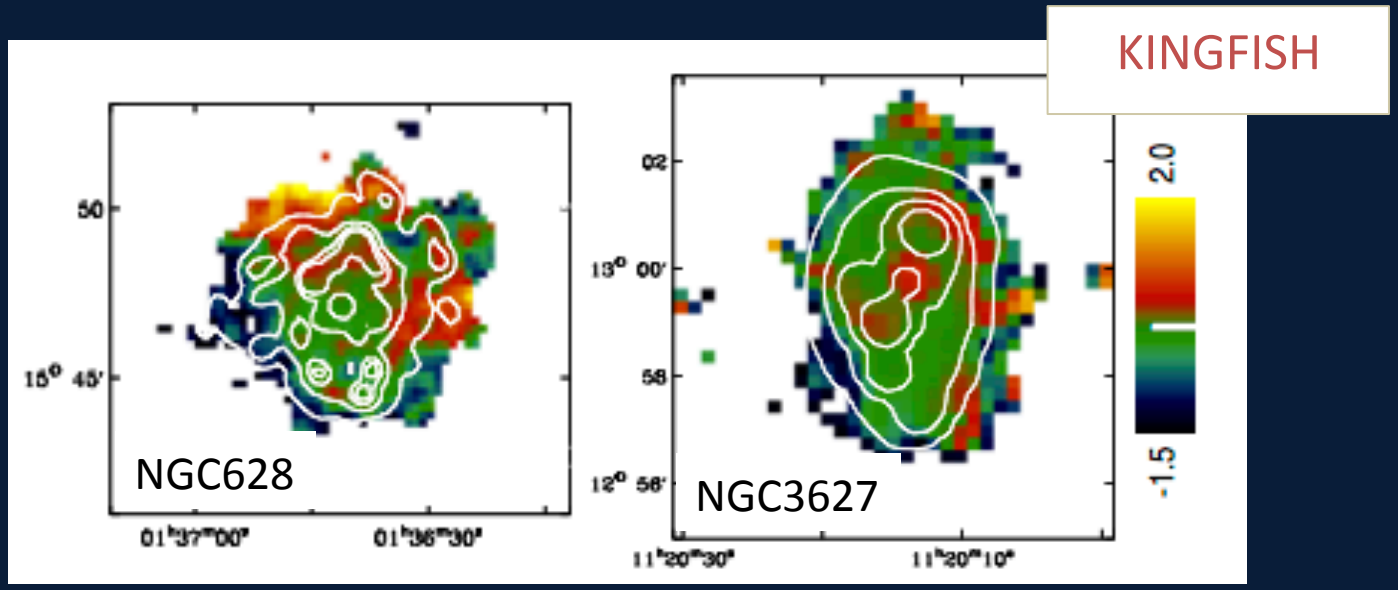


Ciesla et al, 2014

(excess at 500μm above a Draine & Li 07 model)

RESOLVED STUDIES

Probing the excess on local scales



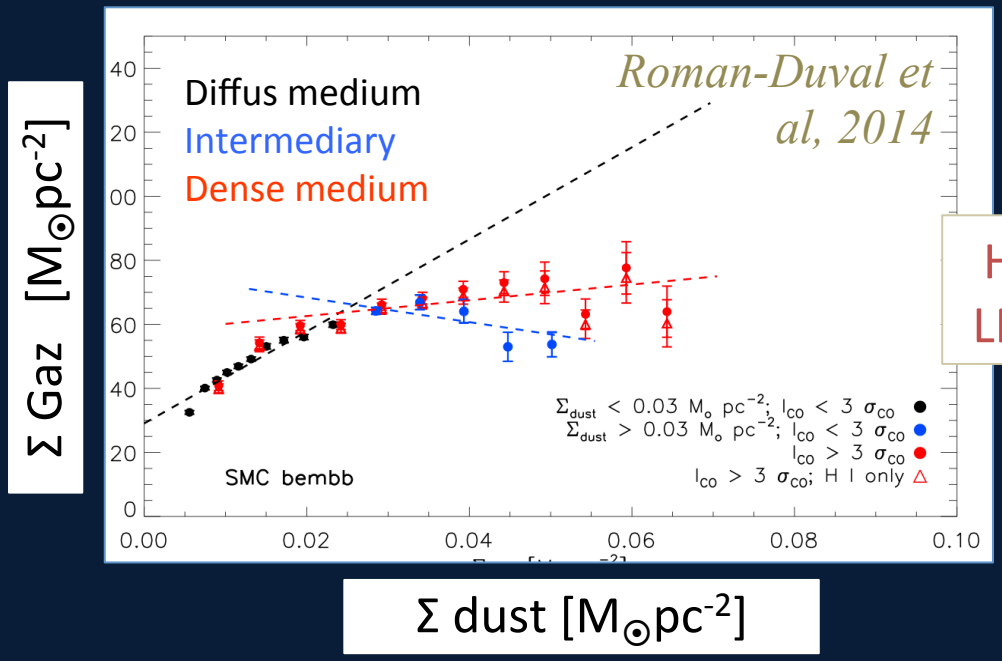
Galametz et al, 2014 (excess at 870μm above a DL07 model)

- In some objects: Contamination by:
  - Free-free/synchrotron
  - CO(3-2) line
- Flattening of the effective β
  - with radius in 3/11 objects
  - in late-type non-barred spirals

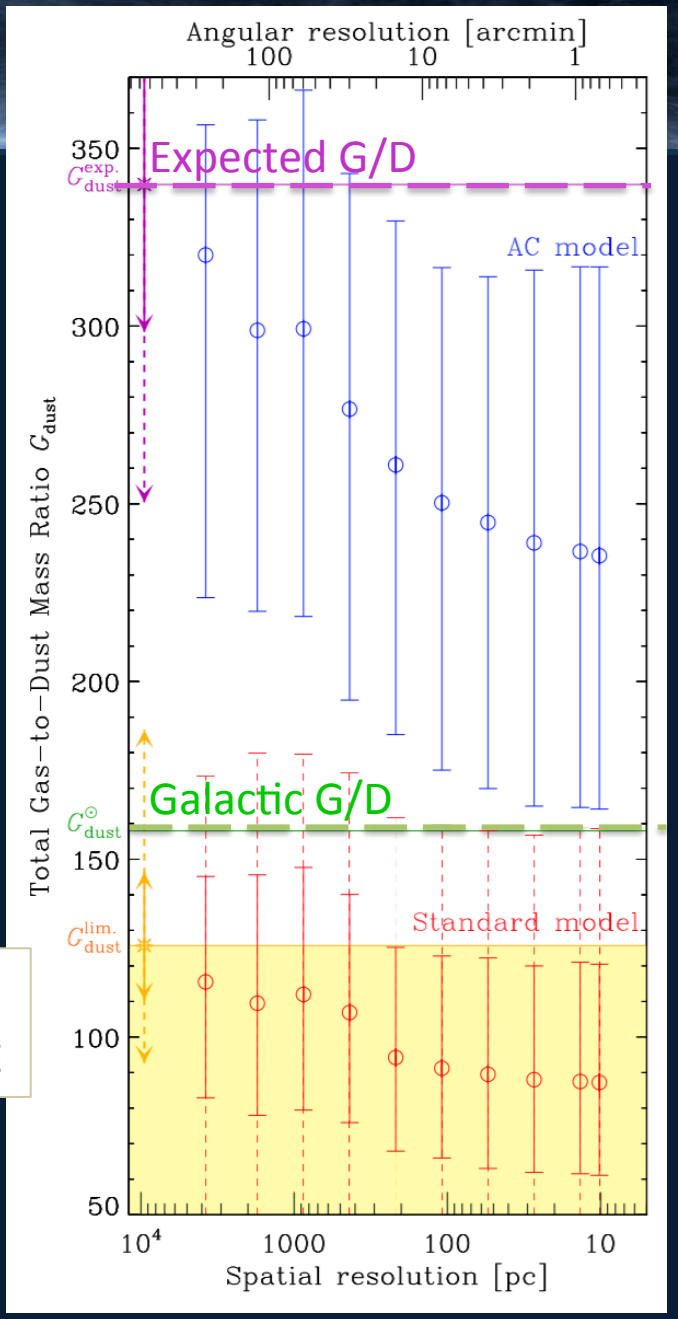
RESOLVED STUDIES

In the Magellanic Clouds

- Use of amorphous carbon dust grains
  → Better agreement of the G / D
- Emissivity increases in dense regions
  → Dust aggregates / coagulation



HERITAGE
LMC / SMC



Galliano et al, 2013

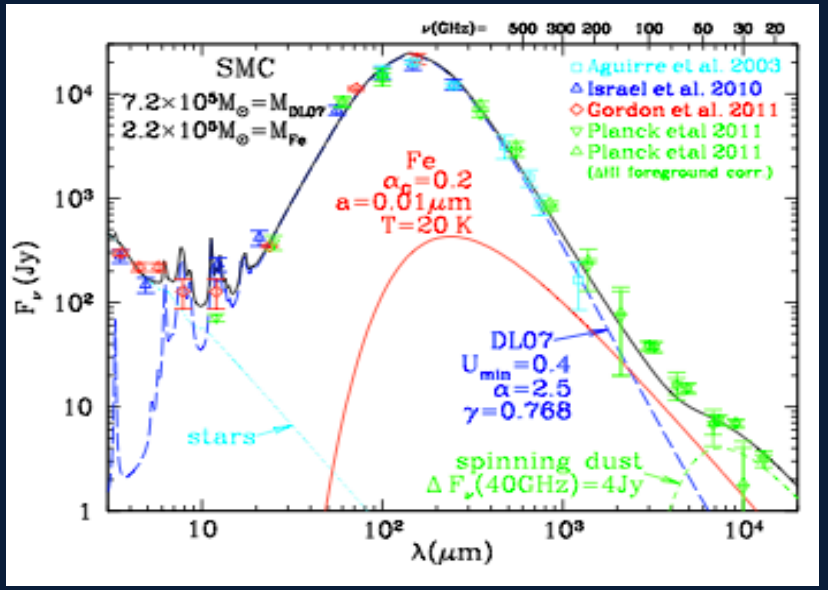
REMAINING QUESTIONS

... on the dust populations

- Very cold dust ?
- Another component ?

(< 10nm Fe Magnetic Nanoparticles

Draine & Hensley, 2012)



Draine & Hensley, 2012

... on the dust properties

- Are the variations of β with temperature real ?
- Should we definitively move to amorphous carbons in dust models ?

(Jones et al, 2013; 2014)

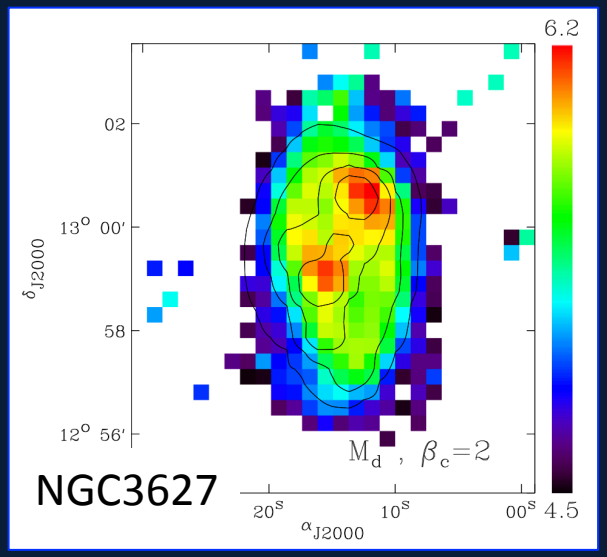
- How does the coagulation of grains in dense clouds affect the dust masses ?

THE CONTRIBUTION OF ALMA

Currently

- Limited by the resolution of - Herschel / SPIRE maps
  - ground-based submm facilities (e.g. LABOCA)

→ No details below kpc scales



Dust mass map of NGC3627 (36")
MIPS 24 μm contours

THE CONTRIBUTION OF ALMA

The spatial resolution

- Will enable us to physically connect [the local dust properties / the sites
- For instance

  - Extra dust component or emissivity variations with wavelength

    → Shape of the submm slope (flat slope? break?)

  - Very cold dust, grain coagulation in cold clumps :

    → Spatial correlation between submm/mm emission and CO clumps

  - Spinning dust linked with PAHs :

    → Spatial correlation between PAH and the mm emission

ALMA / HERSCHEL are complementary

Proposal preparation

Herschel observations provide predictions for ALMA

(expected continuum level, expected gas masses)

Large scales

Herschel provide maps of the extended emission that can be combined with ALMA observations

Small field of view of ALMA

Herschel observations enable us to build a catalogue of regions of interests

(regions with submm excess, dense star forming clumps)