Maud Galametz
September, the 14th, 2009
The International conference ''Nearby Dwarf Galaxies''

Studying the dust properties of dwarf galaxies at submm wavelengths with LABOCA

Collaborators:
Suzanne Madden
Frédéric Schuller
Marc Sauvage
Frédéric Galliano
Alexandre Beelen
Andreas Lundgren
Sacha Hony
George Bendo
Nicolas Billiot

Contents

1- What do we know of dust properties in dwarfs ?

2- The LABOCA images

3- SED modelling and results

4- Evolution of the D/G mass ratio with submm constraints

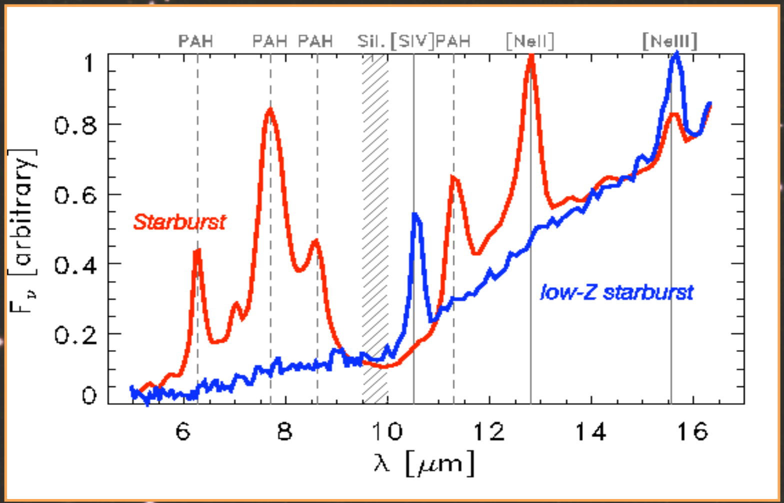
5- Summary

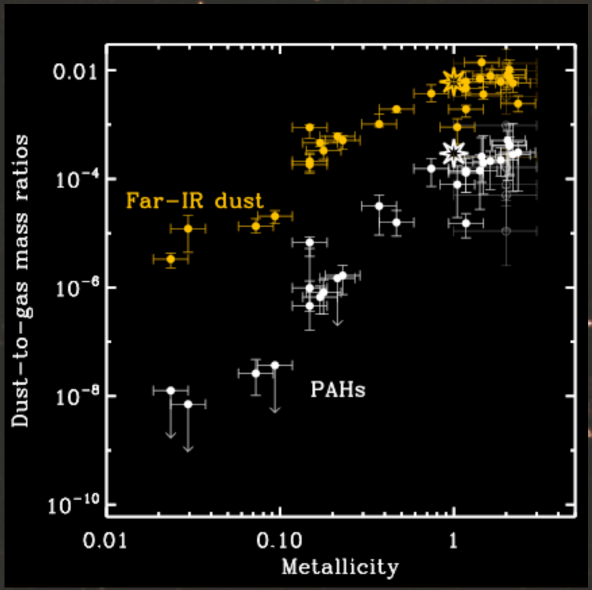
1 Dust properties in dwarf galaxies

✧ Dwarf galaxies

- Building blocks of larger galaxies
- Could present analogies with galaxies of the Early Universe
- Their SED is different from dustier galaxies
  - Less PAH features
  - Usually peaks at shorter wavelengths
  - Lower Dust-to-gas mass ratio

Galliano et al. 2008

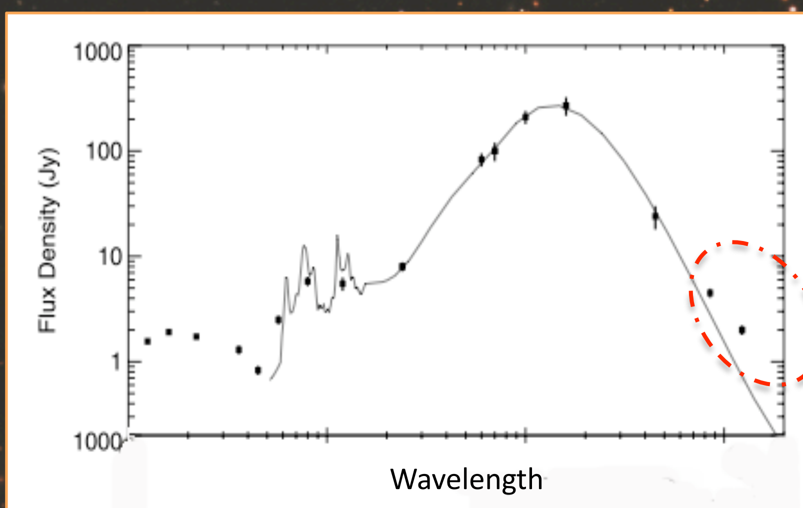




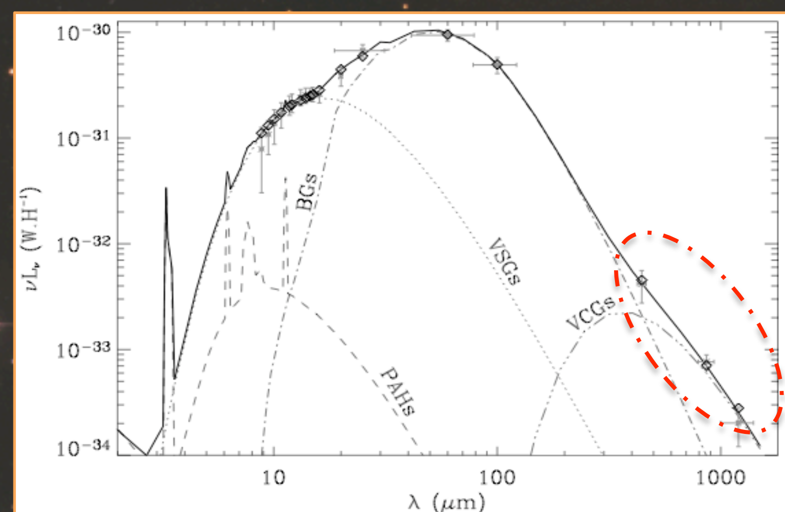
1 Dust properties in dwarf galaxies

✧ SED : Probe the dust grain distribution and temperature

✧Excess in submm: presence of very cold dust ?
→ huge mass of dust missing



Bendo et al. 2006

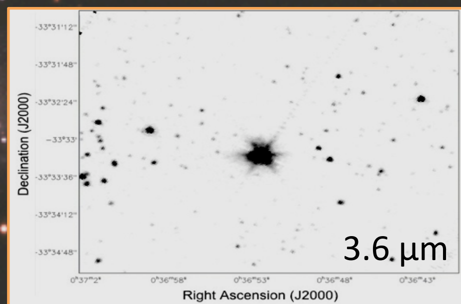


Galliano et al. 2005

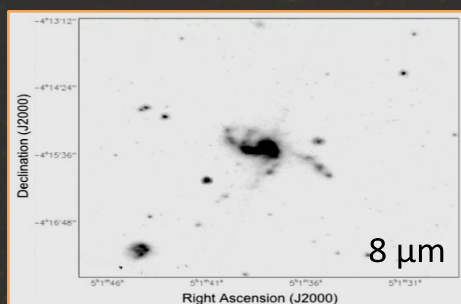
The LABOCA images

✧ The sample, here observed by Spitzer

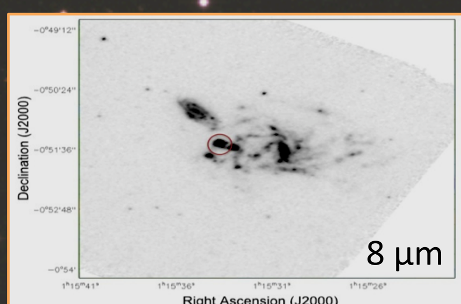
Haro11



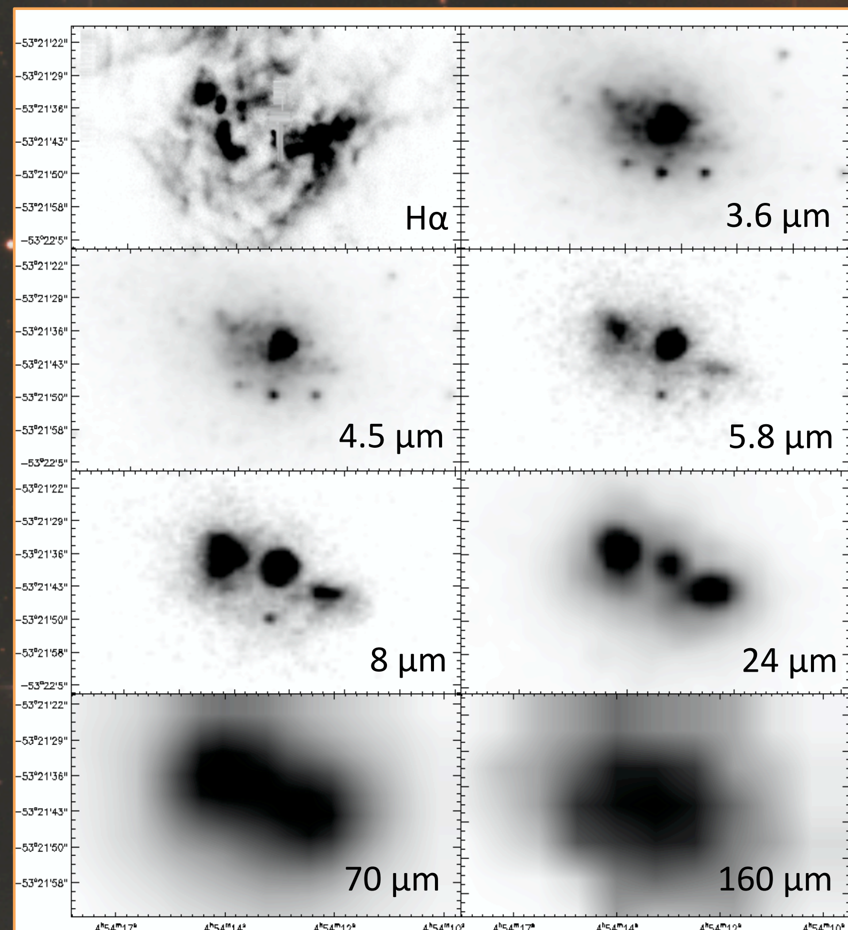
Mrk 1089



UM 311



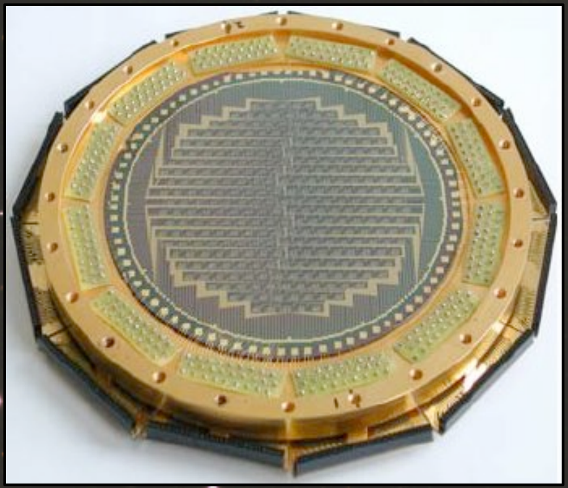
NGC 1705

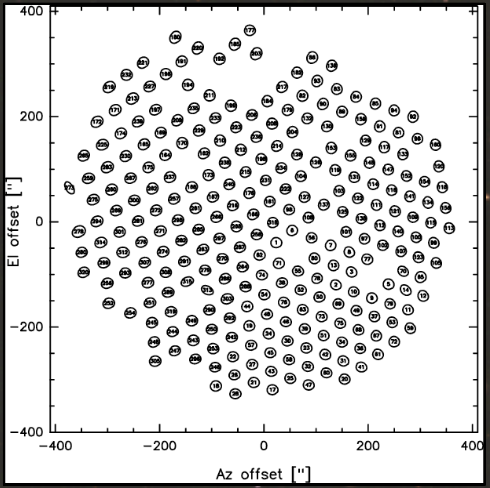


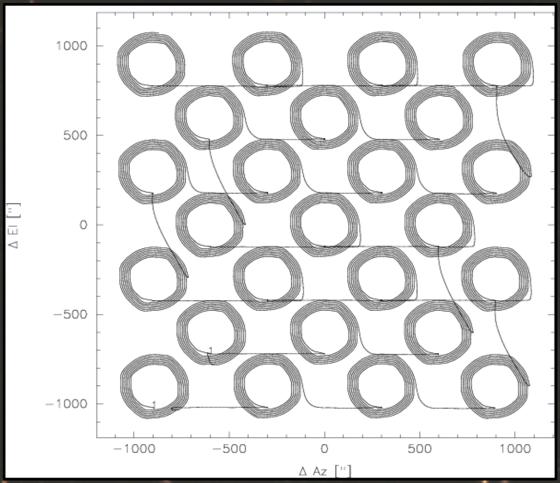
The LABOCA images

✧ LABOCA

- APEX, Atacama desert, Chile
- Observations at 870 µm
- ~300 composite bolometers
- Beam: 18.6''
- Field of view: 11.4 '
- Sample observed in Raster spiral-mode

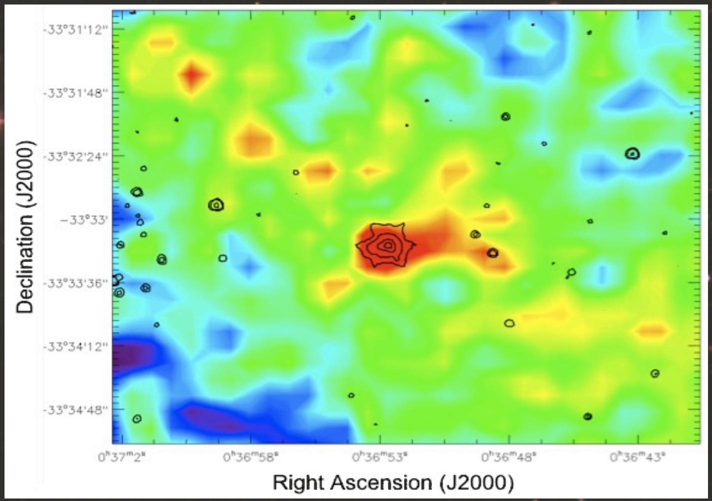




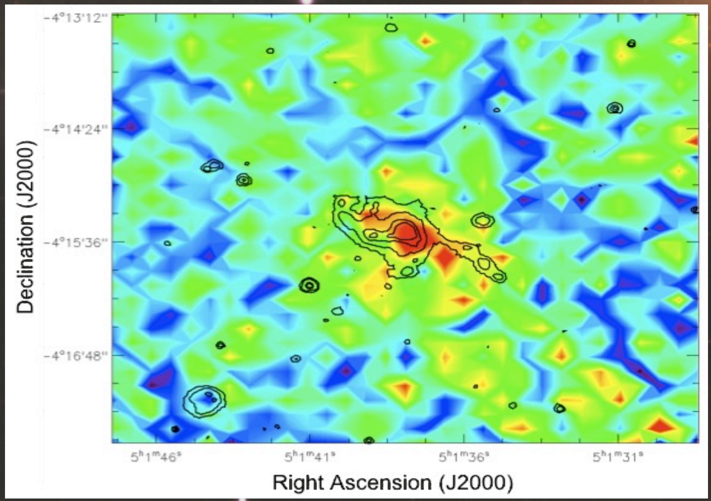


2 The LABOCA images

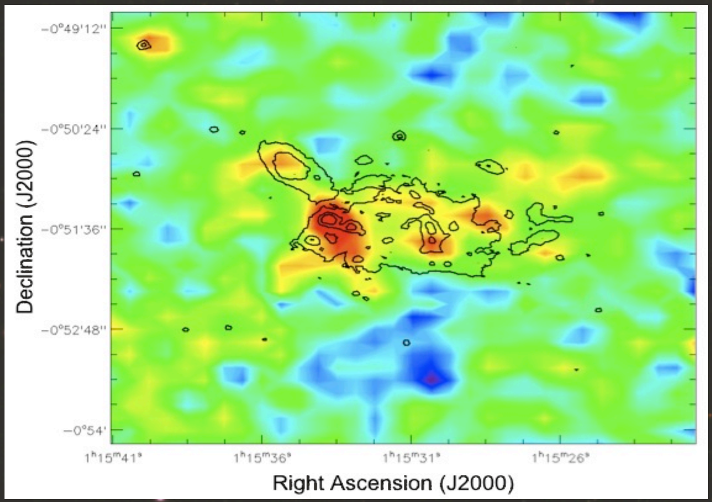
Haro11



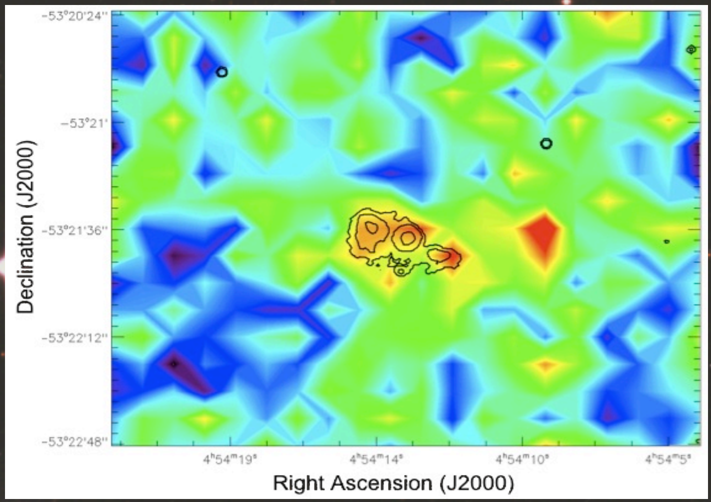
Mrk 1089



UM 311



NGC 1705



Galametz et al. 2009 submitted

SED modelling and results

✧ Fiducial model

- Based on the Galliano et al. 2008 model

- Sources of excitation: ISRF, shape of the Galaxy (Mathis et al., 1983)

- Sources of IR emission: dust, PAHs, stars.

  - Dust and PAHs: Grain properties of Zubko et al., 2004

    Optical properties of PAHs of Draine & Li, 2007

  - Power law relation: $dM_{dust}(U) \propto U^{-\alpha}$ (Dale et al., 2001)

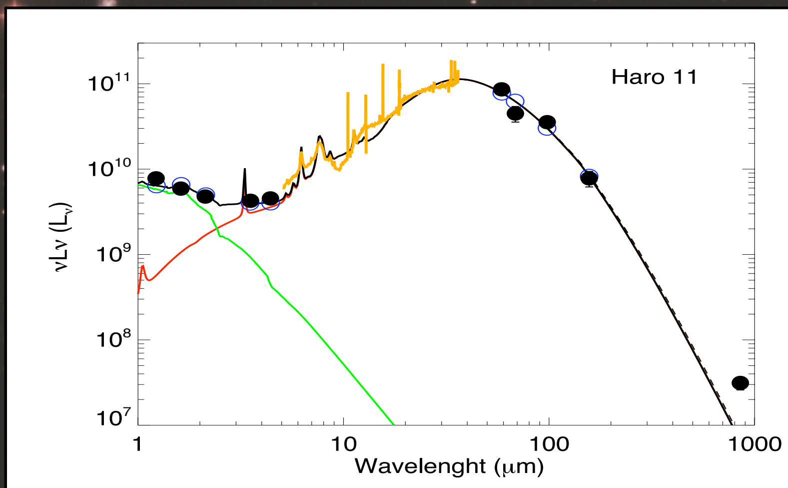
  - Substract the stellar component, synthesised from the NIR points using PEGASE.

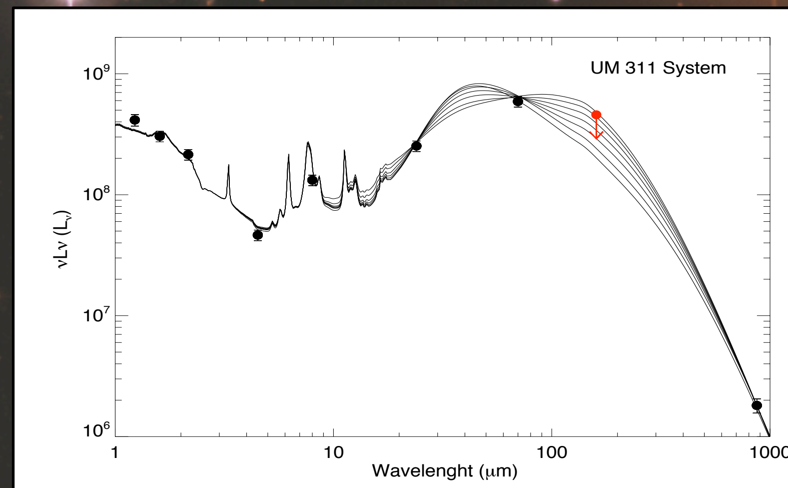
Galametz et al. 2009 submitted

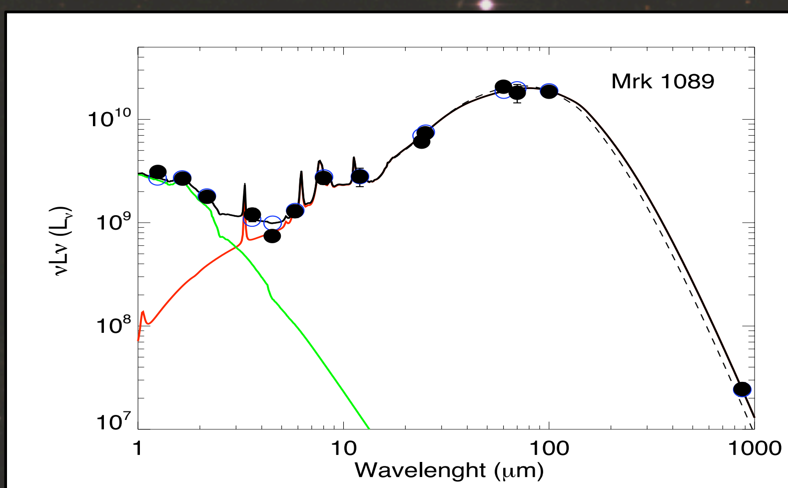
SED modelling and results

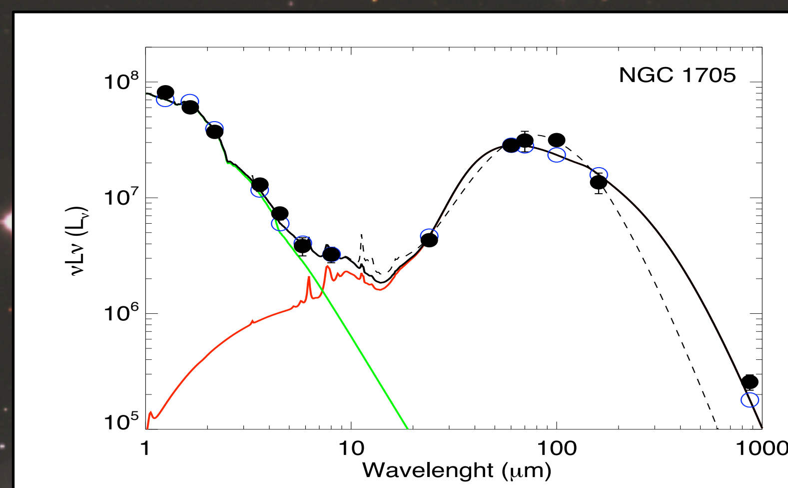
✧ Fiducial model

Data: 2MASS, IRAS, IRAC, MIPS, LABOCA









3

SED modelling and results

✧ Possible hypothesis to explain the excess

→ Hot (100K) dust with a lower emissivity index (β=1)
Lisenfeld et al. 2001

→ Extra ISM component heated at $U=U_{min}$
Draine et al. 2007

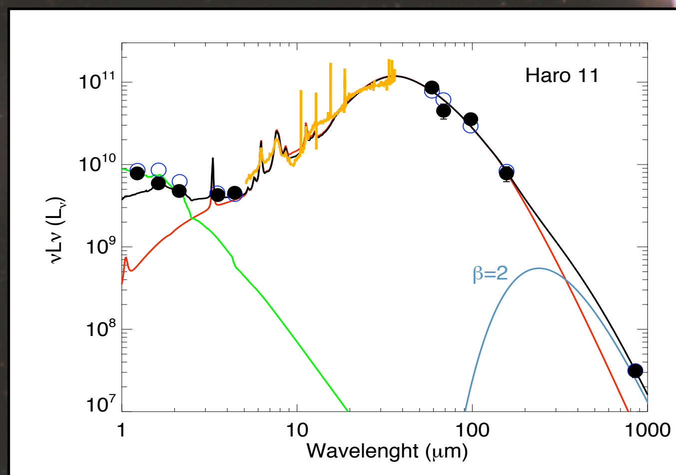
→ Change in dust emissivity as a function of wavelength
Dupac et al. 2003, Meny et al. 2007

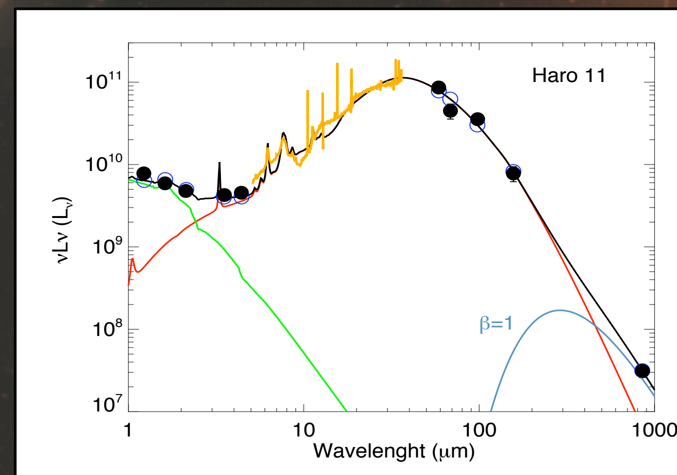
→ Adding a very cold (~ 10K) dust component
Galliano et al. 2003, 2005

SED modelling and results

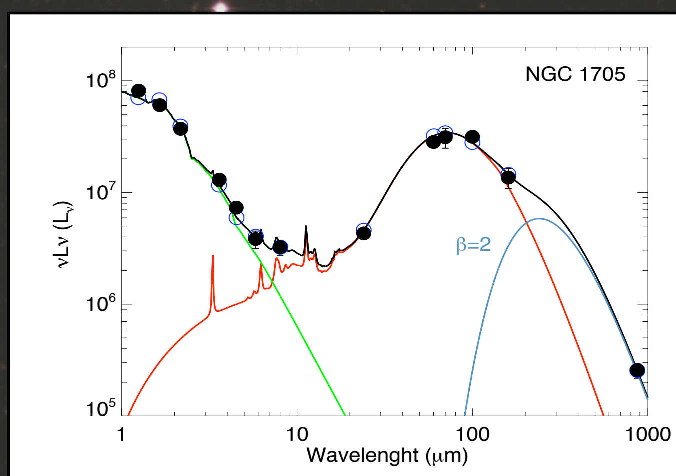
✧ Refinement of the model

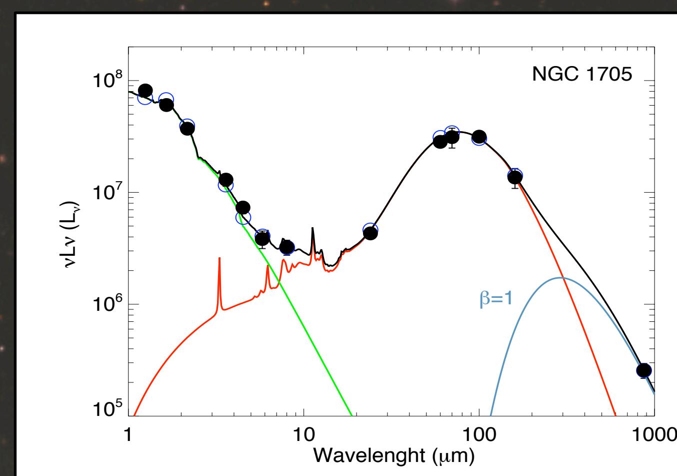
Haro 11





NGC 1705





SED modelling and results

✧ Dust mass and dust-to-gas mass ratios

- Increase in the total mass of dust with submm constraints
- Comparison with the Dust - to - Gas mass ratio expected by chemical evolution models.

Mrk 1089		Haro 11			NGC 1705		
M_{dust} without submm	$M_{dust\ with\ submm}$	M_{dust} without submm	$M_{dust\ with\ submm}$ β=2	$M_{dust\ with\ submm}$ β=1	M_{dust} without submm	$M_{dust\ with\ submm}$ β=2	$M_{dust\ with\ submm}$ β=1
3×10^7	5.1×10^7	6.2×10^6	1.3×10^8	2×10^7	2.9×10^4	1.3×10^6	1.7×10^5
Dust - to - HI mass ratios							
10^{-3}	1.9×10^{-3}	6×10^{-2}	1.3 !	0.2	7×10^{-4}	2.8×10^{-2}	4.1×10^{-3}
Dust - to - Gas mass ratios expected							
~ 10^{-3}		~ 10^{-3}			$2 - 5 \times 10^{-3}$		

SED modelling and results

✧ Star formation Rate

$$SFR\,(M_\odot\,yr^{-1}) = 4.5\times10^{44}\,L_{FIR}\,(erg\,s^{-1})$$

Kennicutt 1998

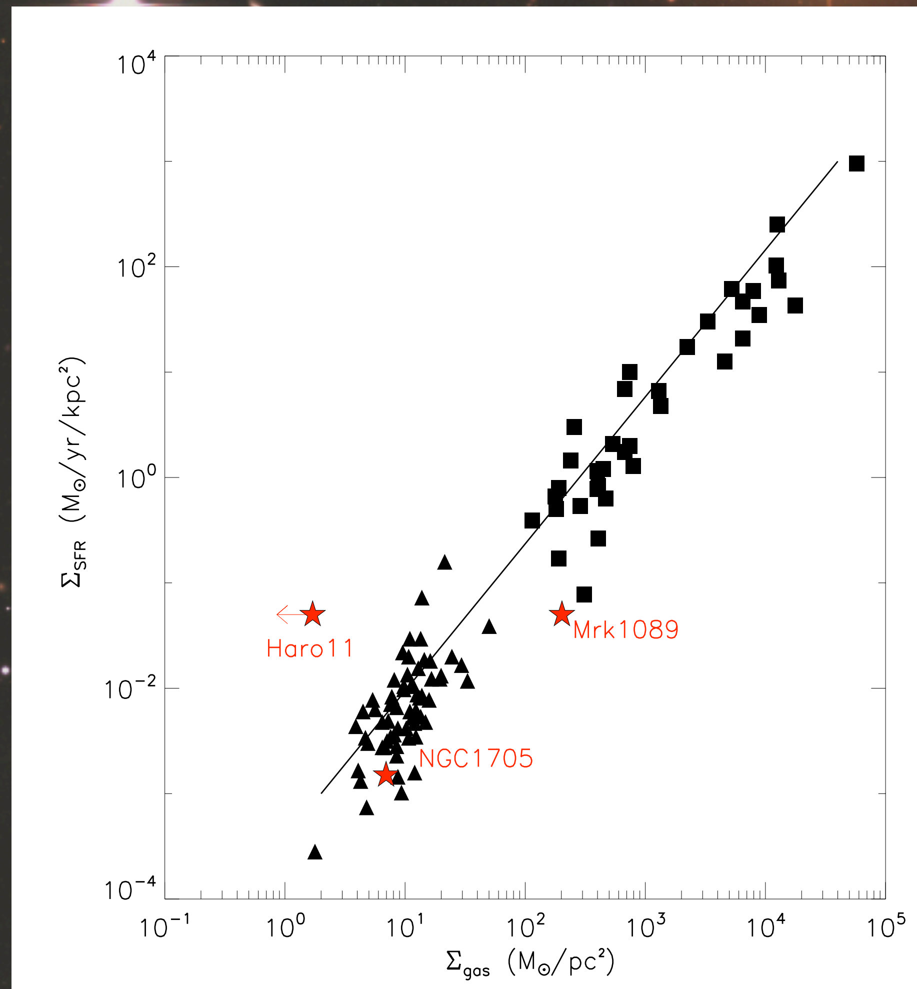
- Consistent for two galaxies

- Discrepancy for Haro 11

Amount of gas mass required?

⇕

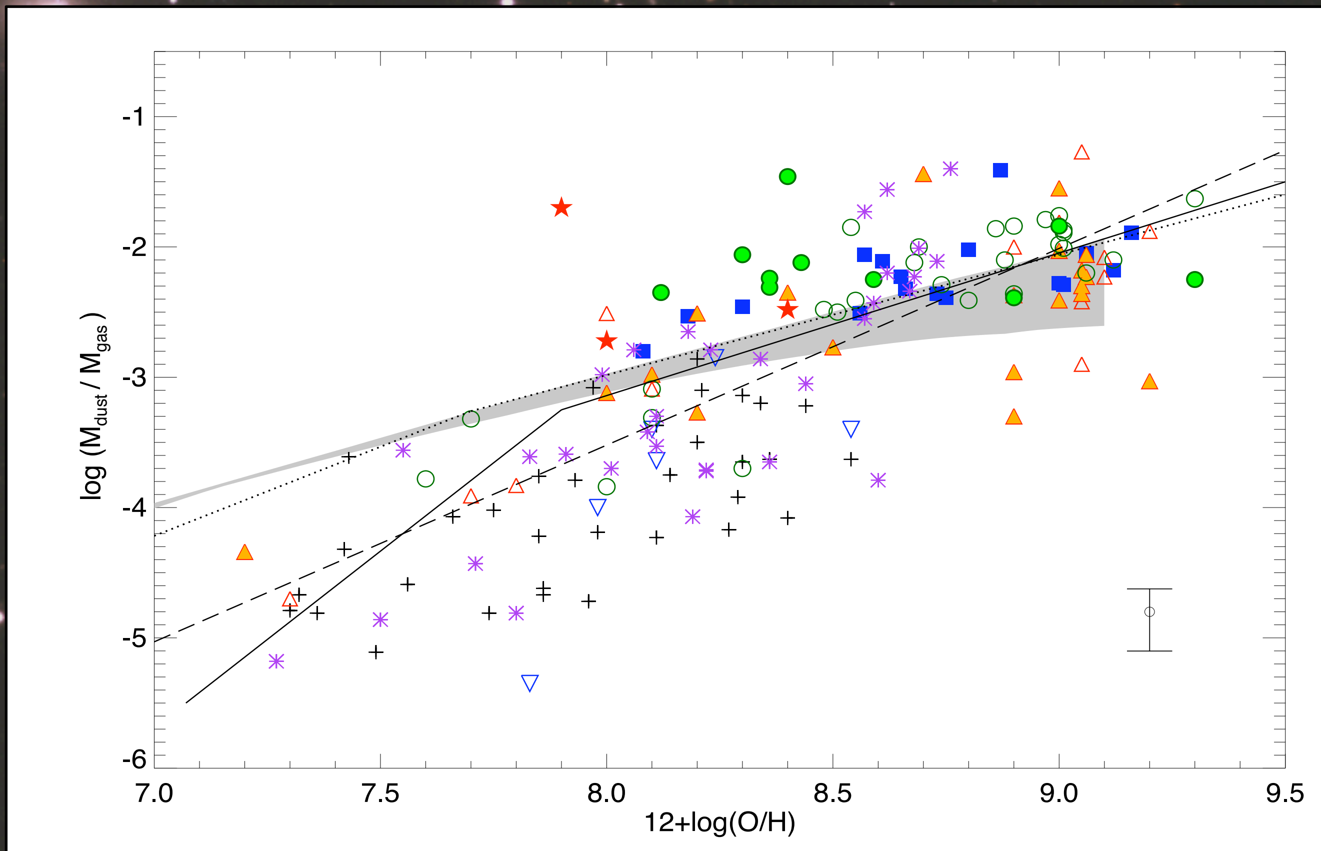
$10^{10}\,M_\odot$ again !



4 Evolution of the D/G mass ratio

✧Dust-to-gas mass ratios = f(Z)

- *Datasets from: Lisenfeld & Ferrara, 1998, James et al. 2002, Hirashita et al. 2008, Engelbracht et al., 2008, Galliano et al. 2008, Draine et al., 2007.*
- *Models from: Edmunds, 2001, Galliano et al. 2008*

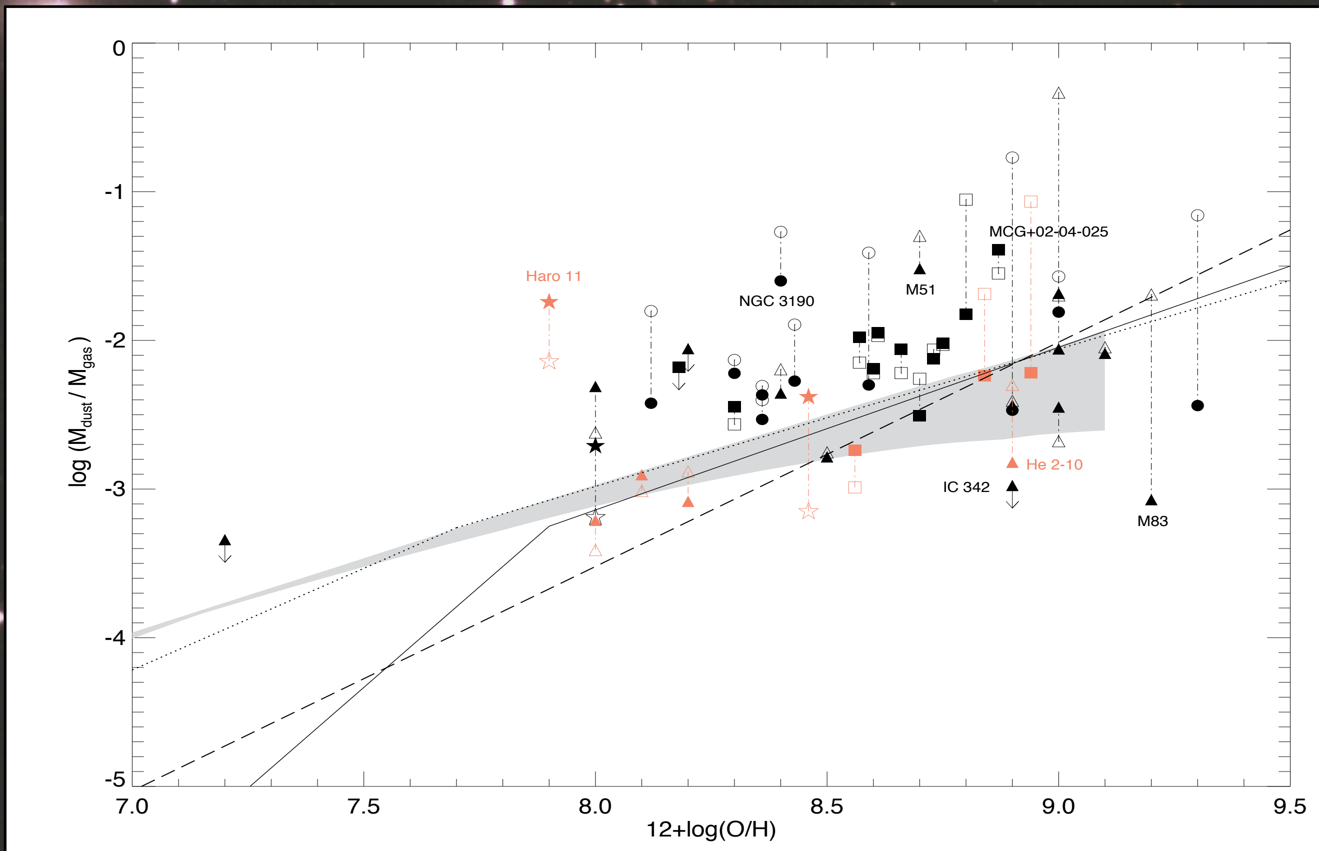


Galametz et al. 2009B in prep

4 Evolution of the D/G mass ratio

✧Dust-to-gas mass ratios = f(Z)

- Use the same modelling process
- Run with and without submm constraints

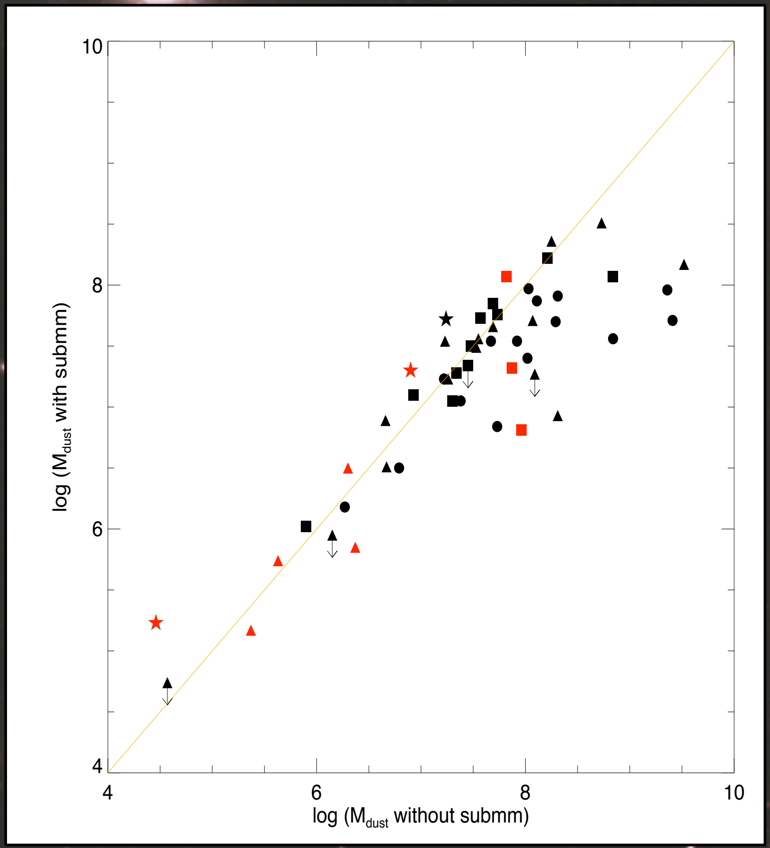


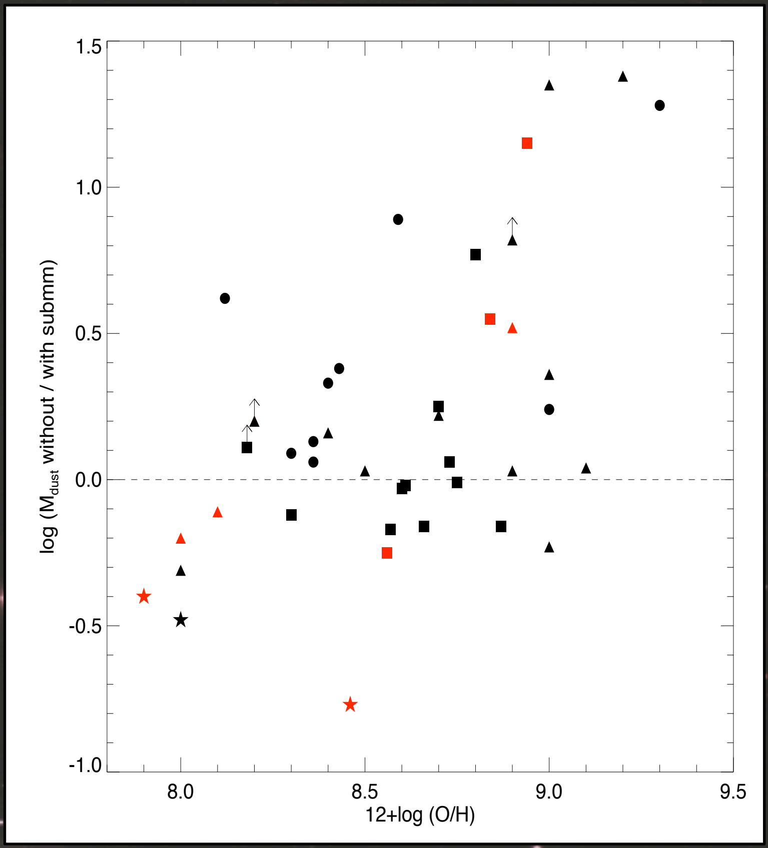
Galametz et al. 2009B in prep

Evolution of the D/G mass ratio

➔ Effects of the submm constraints

- Submm constraints affect the M_{dust} for high-Z galaxies
- When $M_{dust\ with\ /\ without\ submm}$ >0 : usually dwarf galaxies.





Galametz et al. 2009B in prep

5

Summary

- We present the first LABOCA images of faint galaxies

- For 2 galaxies, we choose to include an independant cold dust component with T=10K.

- In all cases, we observe an increase of the dust mass while using the submm 870 μm constraint.

- While using a cold dust component, we note that using an emissivity β=2 leads to unrealistic D/G mass ratios.

- For Haro 11, the observed gas mass leads to a higher D/G mass ratio that expected by current chemical evolution models. It also does not fall on the SK law.

- We enlarge the sample and study the effects of using the submm constraint in the dust mass estimate of a galaxy. This effect could be linked with the metallicity of the galaxy.

Thank you for your attention

References:

- *Bendo, G. et al. 2006, ApJ, 652, 283*
- *Dale, D. A., Helou, G. et al. 2001, ApJ, 549, 215*
- *Draine, B. T. et al. 2007, ApJ, 663, 866*
- *Draine, B. T. & Li, A. 2007, ApJ, 657, 810*
- *Edmunds, M. G. 2001, MNRAS, 328, 223*
- *Engelbracht, C. W. et al. 2008, ApJ, 678, 804*
- *Galliano, F. et al. 2005, A&A, 434, 867*
- *Galliano, F., Dwek, E., & Chanial, P. 2008, ApJ, 672, 214*
- *Hirashita, H., Kaneda, H., Onaka, T., & Suzuki, T. 2008, ArXiv e-prints*
- *James, A., Dunne, L., Eales, S., & Edmunds, M. G. 2002, MNRAS, 335, 753*
- *Lisenfeld, U. & Ferrara, A. 1998, ApJ, 496, 145*
- *Mathis, J. S., Mezger, P. G., & Panagia, N. 1983, A&A, 128, 212*
- *Zubko, V., Dwek, E., & Arendt, R. G. 2004, ApJS, 152, 211*