



# Probing the impact of metallicity on the dust properties in galaxies

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*And with: Suzanne Madden, Frédéric Galliano, Vianney Lebouteiller, Maud Galametz, Anthony Jones*

# Outline

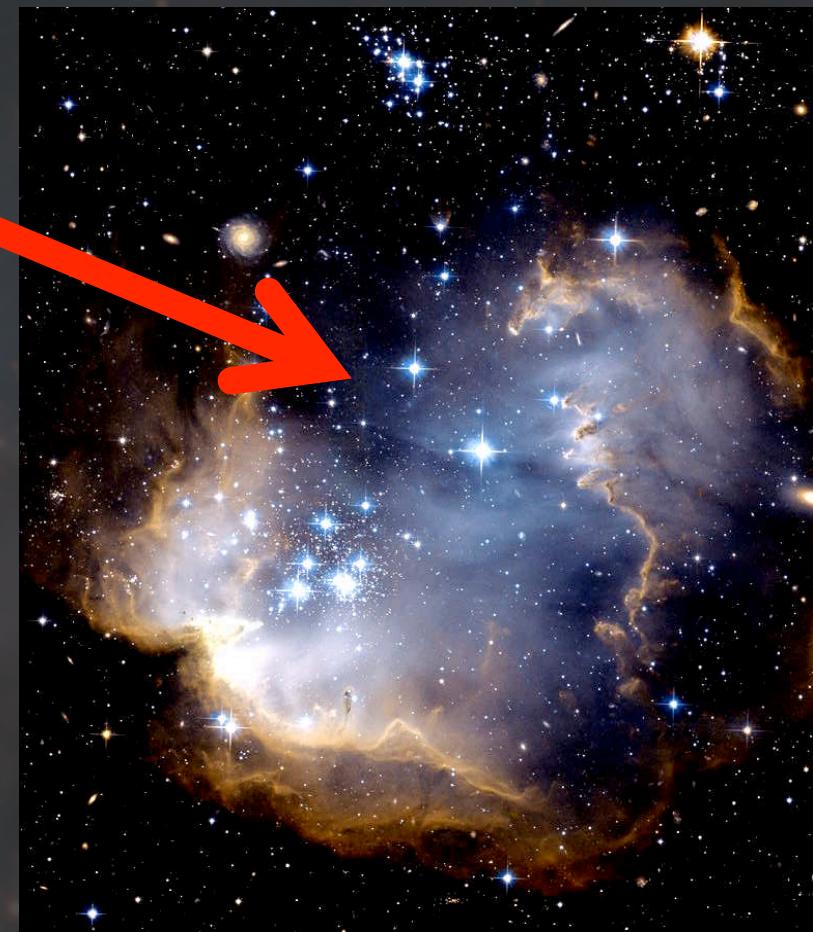
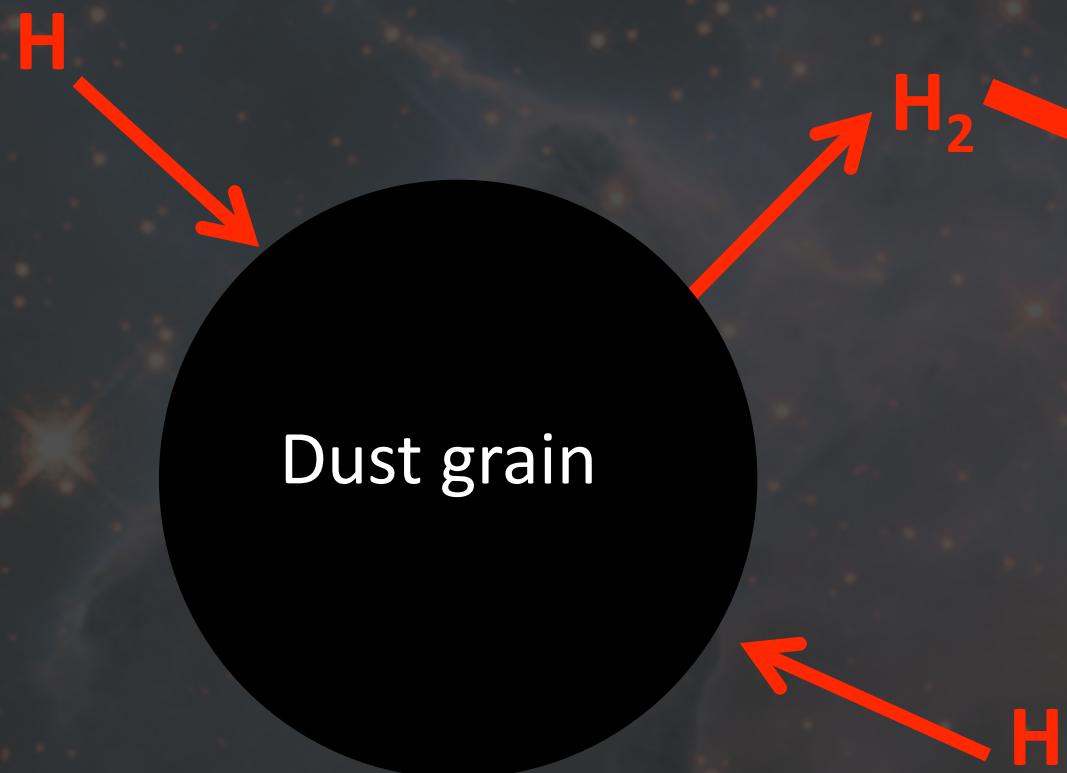
- I. Dust and dwarf galaxies
- II. Dust temperature distribution
- III. Gas-to-dust mass ratios
- IV. Summary and perspectives

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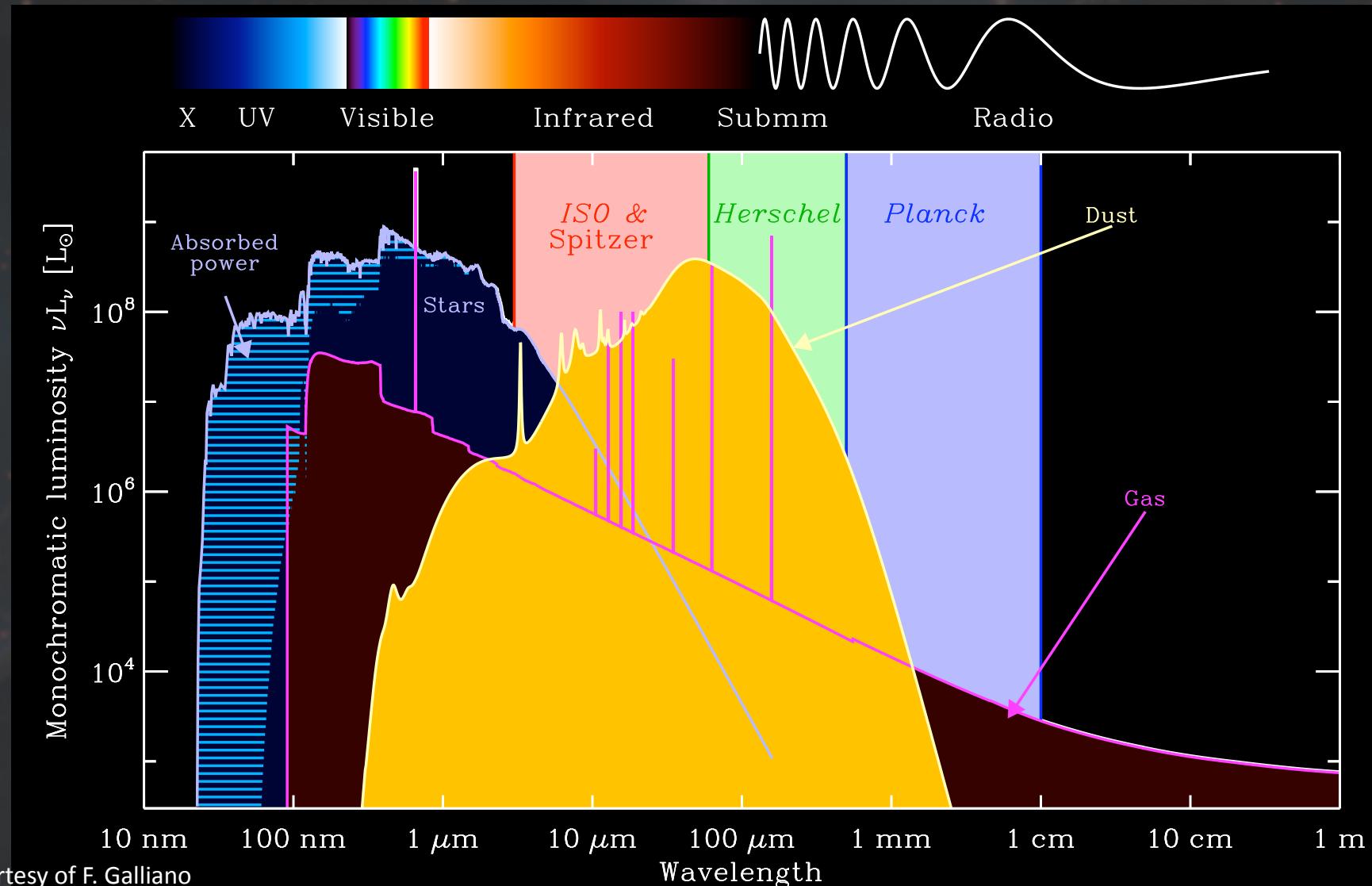
# I- Dust and dwarf galaxies: About dust

- Dust affects star formation
  - Through molecular gas formation



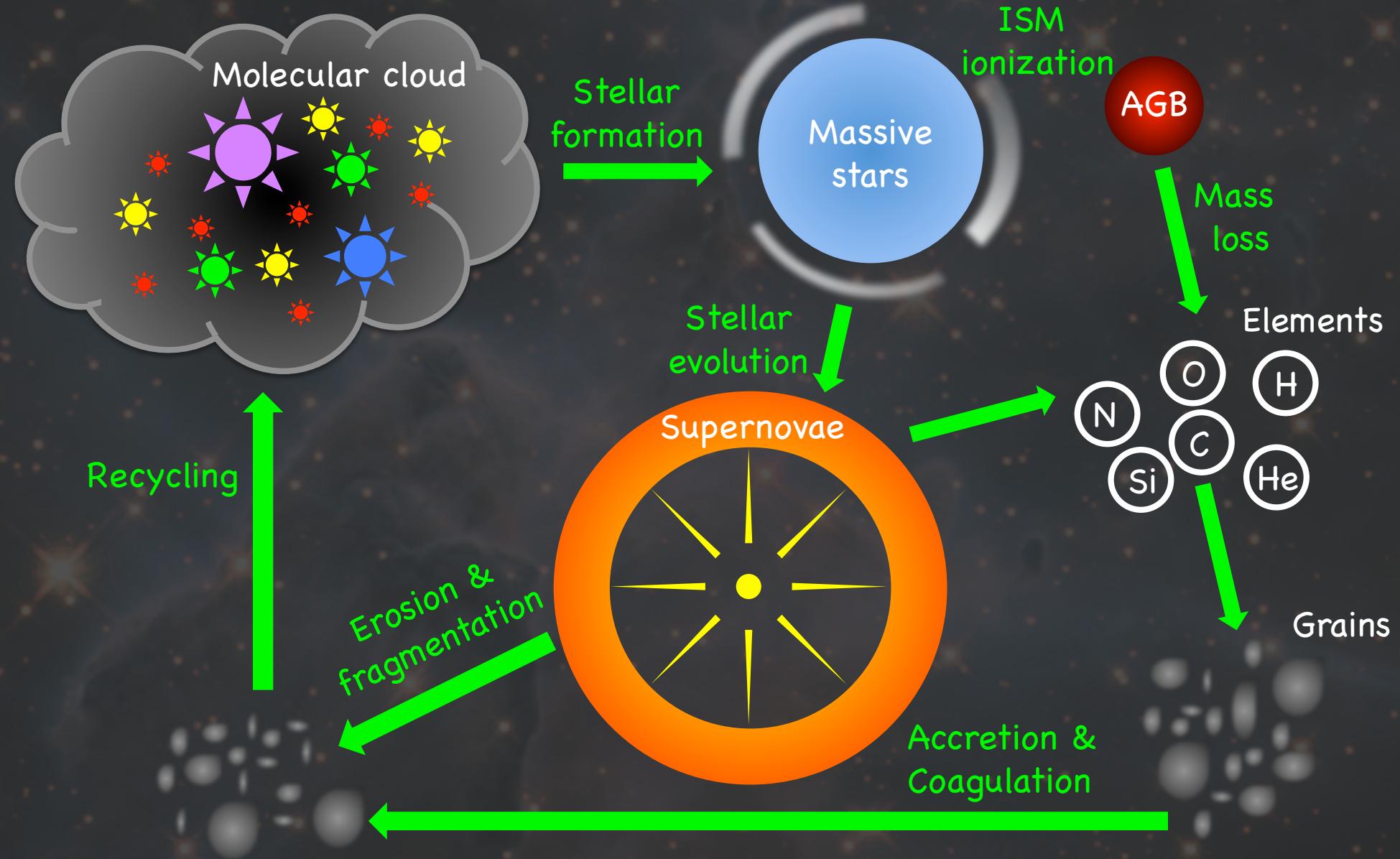
# I- Dust and dwarf galaxies: About dust

- Dust has a large contribution the energy budget of a galaxy
  - In our Galaxy : less than 1% in mass but ~30% in luminosity



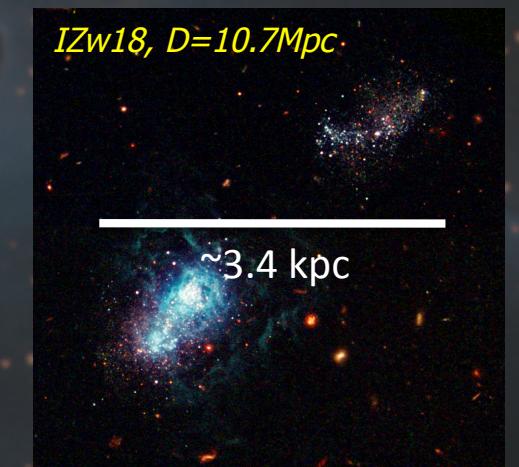
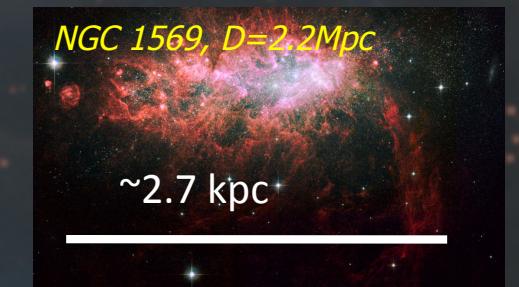
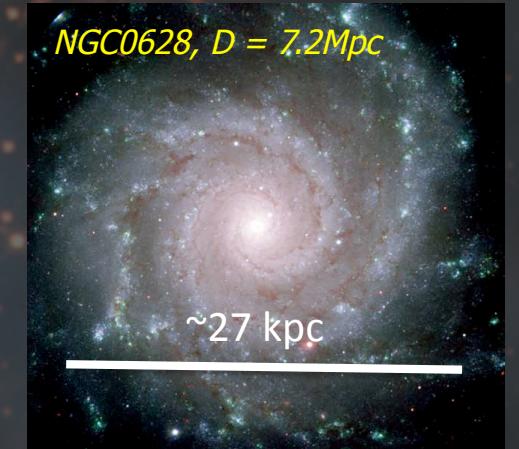
# I- Dust and dwarf galaxies: About dust

- Dust traces the internal chemical evolution



# I- Dust and dwarf galaxies: About dwarf galaxies

- Low metallicity as low as  $1/50 Z_{\text{sun}}$
- $L_{\text{tot}}$  as low as  $10^5 L_{\text{sun}}$  (MW:  $10^{10} L_{\text{sun}}$ )
- $M_{\text{tot}}$  as low as  $10^5 M_{\text{sun}}$  (MW:  $10^{11} M_{\text{sun}}$ )
- Small: radius < 5kpc (MW: 18kpc)



➤ Ideal candidates to study the influence of metal enrichment on the ISM properties

# Outline

- I. Dust and dwarf galaxies
- II. Dust temperature distribution
  - ❖ Sample
  - ❖ Dust model
  - ❖ Characterisation of the dust temperature distribution
- III. Gas-to-dust mass ratios
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## II- Dust temperature distribution: Sample

DGS : Dwarf Galaxy Survey

Madden, Rémy-Ruyer+13

48 galaxies

- Low metallicity, star forming, gas-rich dwarf galaxies

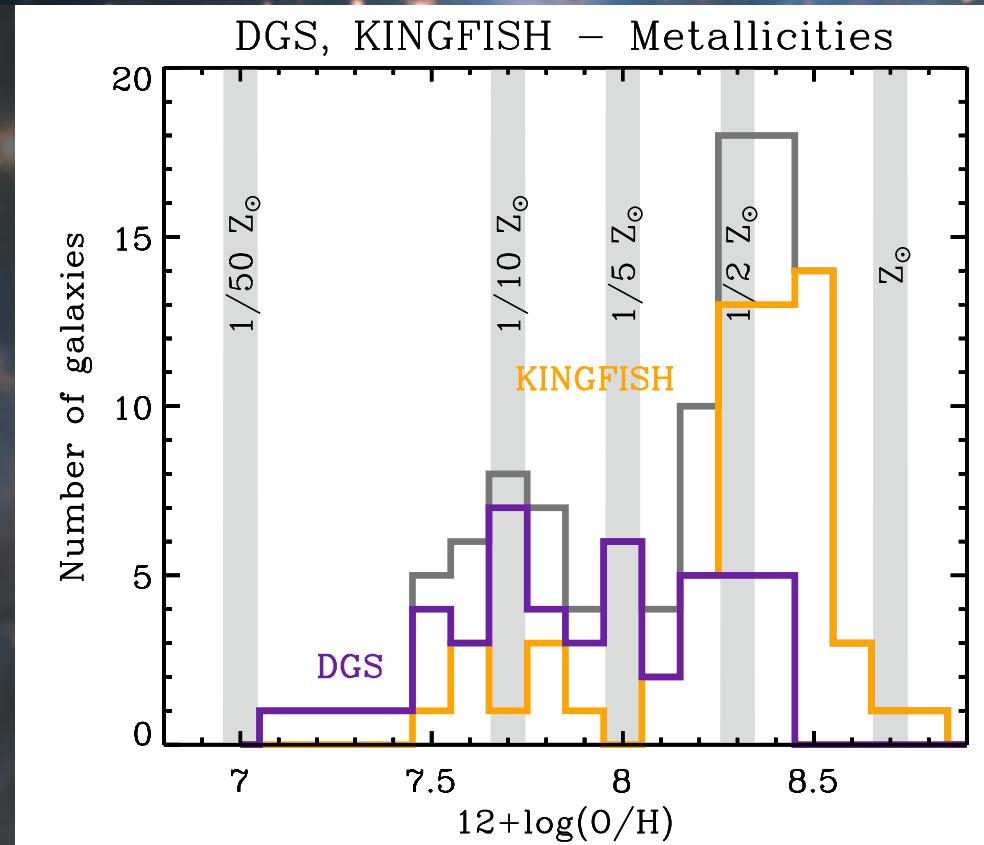
KINGFISH

Kennicutt+11, Dale+12



61 galaxies

- More metal-rich systems



Metallicities: Use a « strong line » method:

$$12+\log(O/H) = F(R_{23})$$

$$\text{With } R_{23} = (\text{OII} + \text{OIII})/\text{H}\beta$$

And Pilyugin&Thuan05 calibration

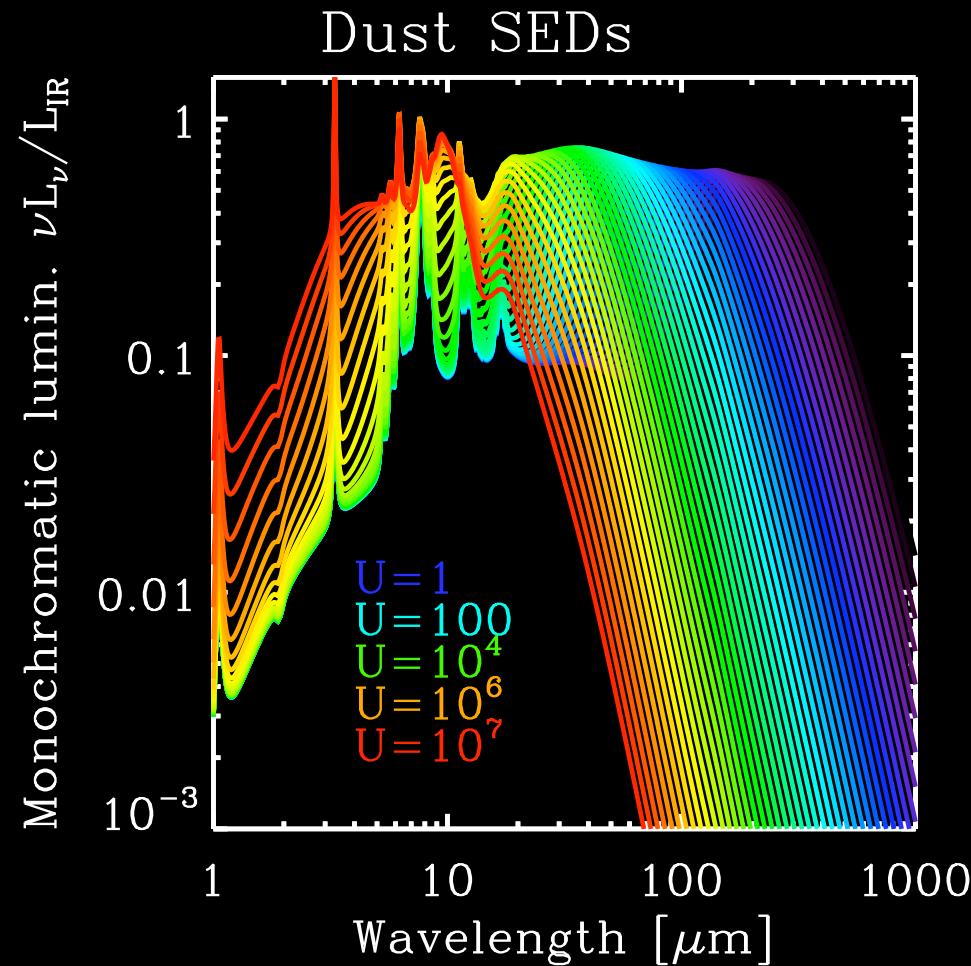
Observed with *Herschel*

PACS : 70/100/160  $\mu\text{m}$

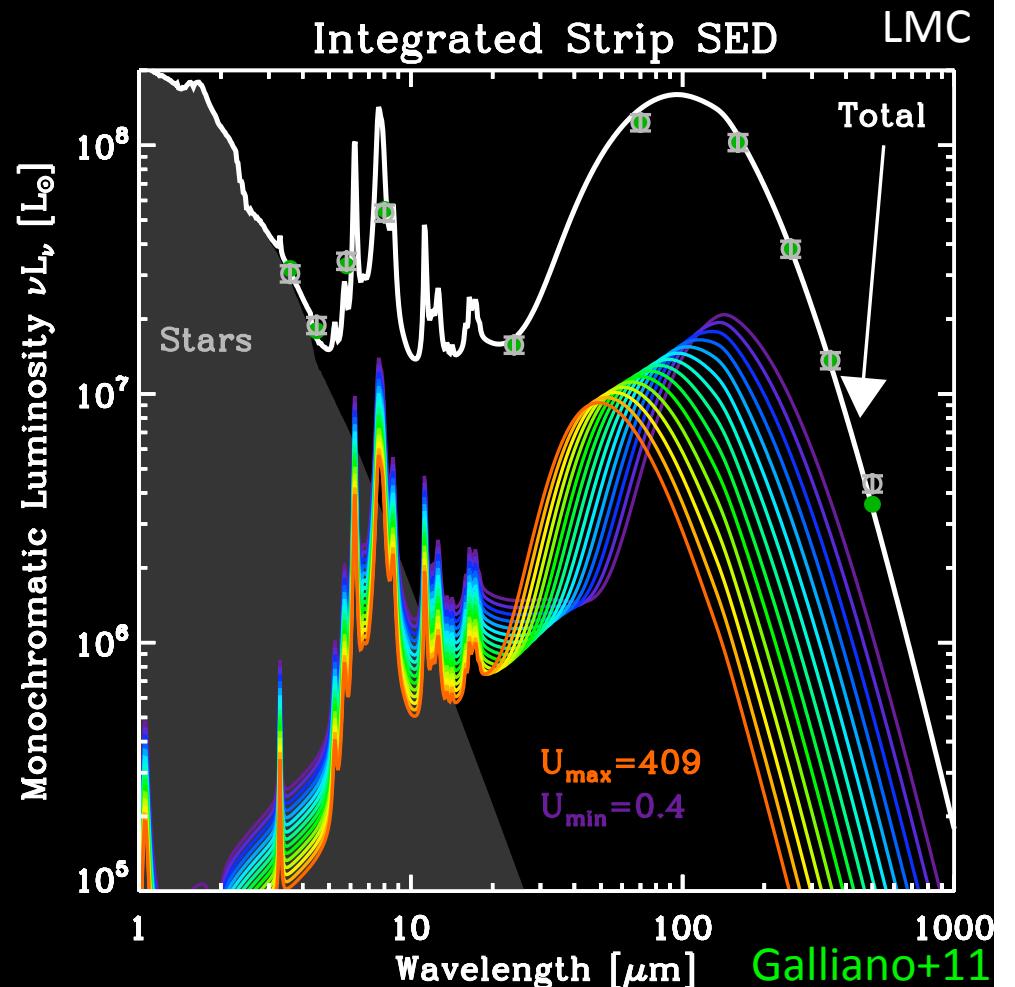
SPIRE : 250/350/500  $\mu\text{m}$



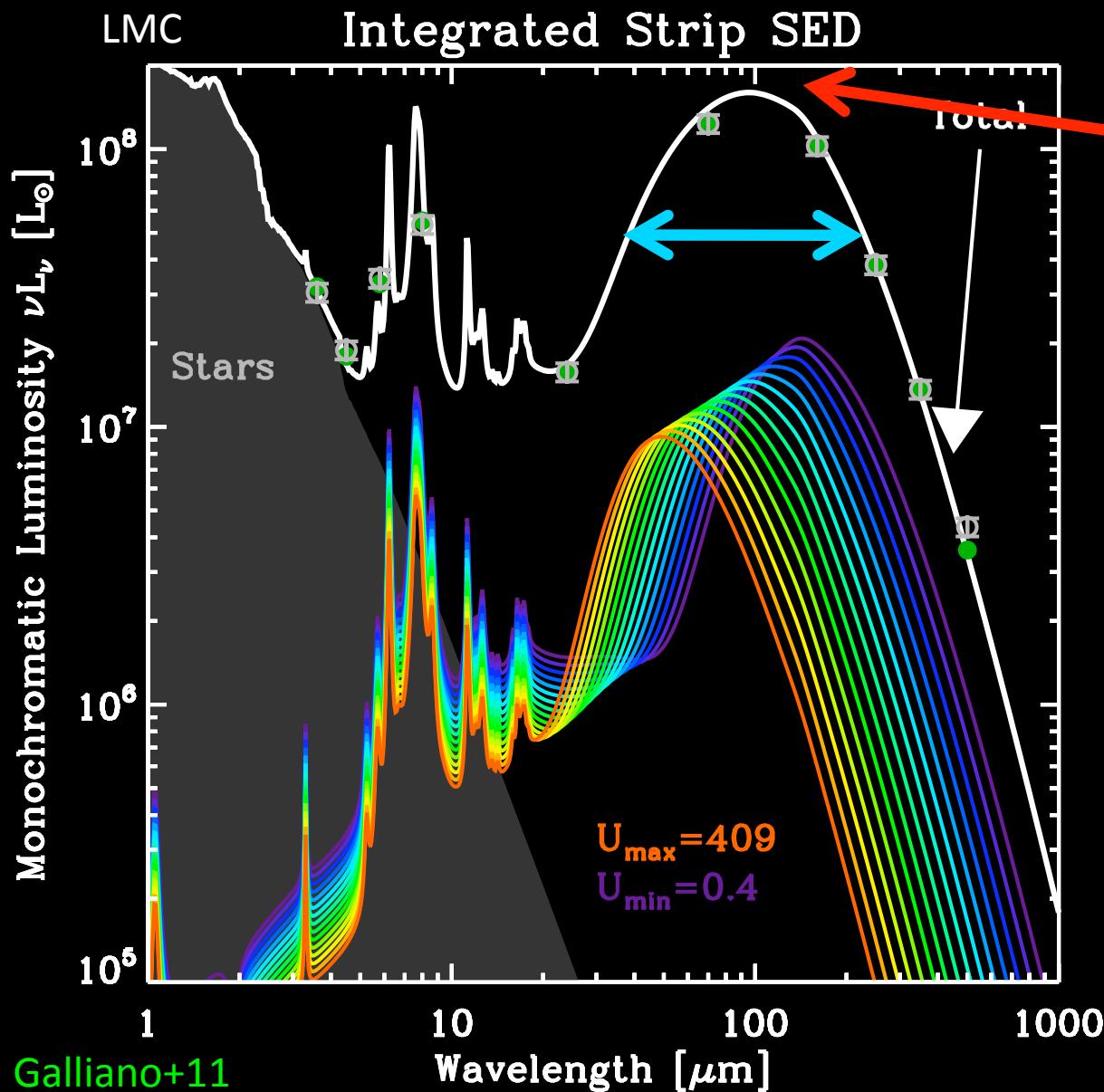
## II- Dust temperature distribution: Dust model



- Use model by [Galliano+11](#)
- Grain size distribution ([Zubko+04](#))
- Immerse dust into different radiation fields spanning a range of intensities.



## II- Dust temperature distribution : Parameters



Position of the  
peak given by the  
average starlight  
intensity  $\langle U \rangle$

Width of the peak  
given by  $\sigma^2 U$

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### III- G/D vs Z: Observed relation

Atomic gas mass : HI

Molecular gas mass : H<sub>2</sub>, use X<sub>CO,Z</sub>  
from Schruba+12

Same « strong line » method for  
the whole sample

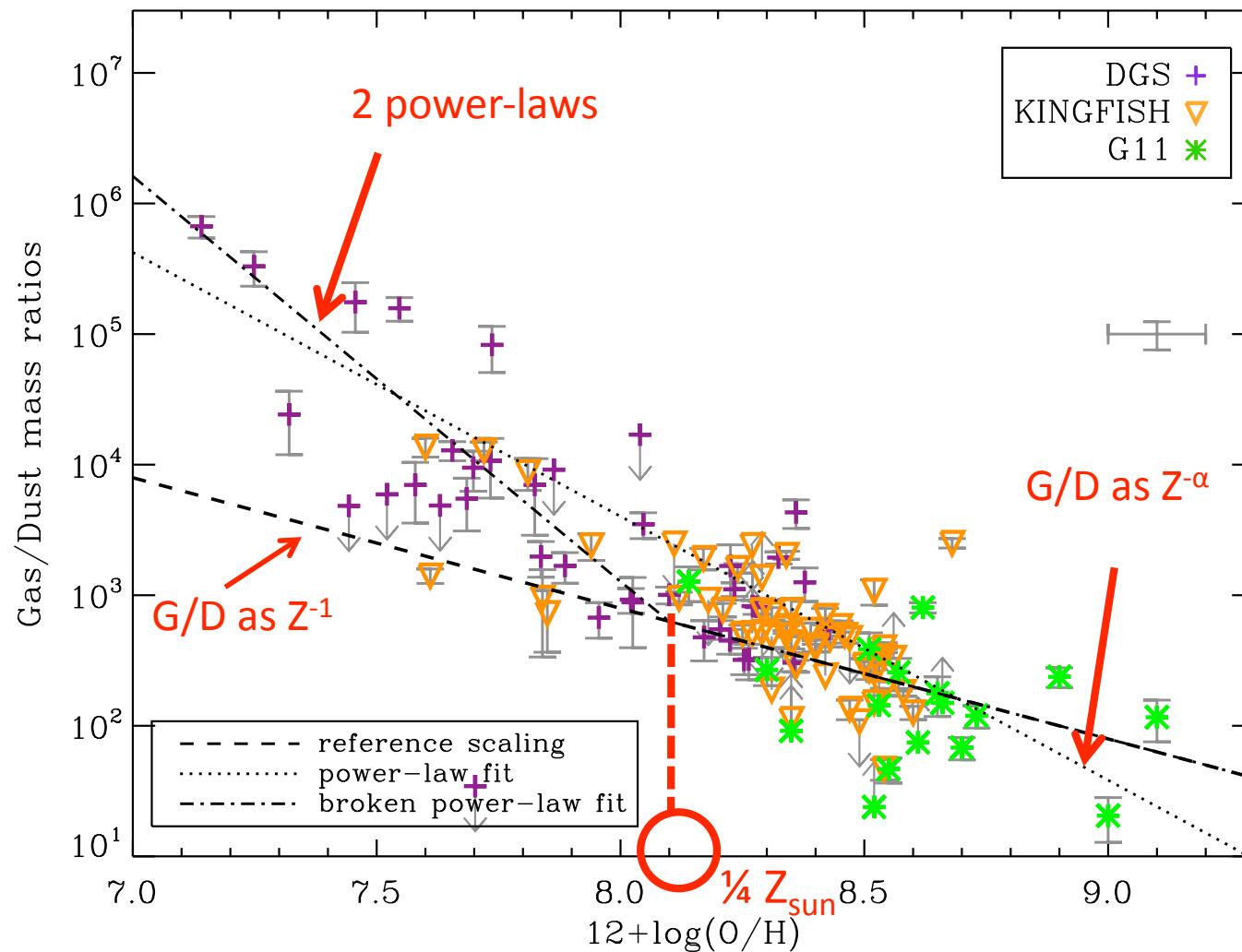
$\frac{G}{D}$  as a function of metallicity

From previous dust model

Sample : DGS, KINGFISH, and a few targets from Galametz+11

### III- G/D vs Z: Empirical relations

Rémy-Ruyer+14

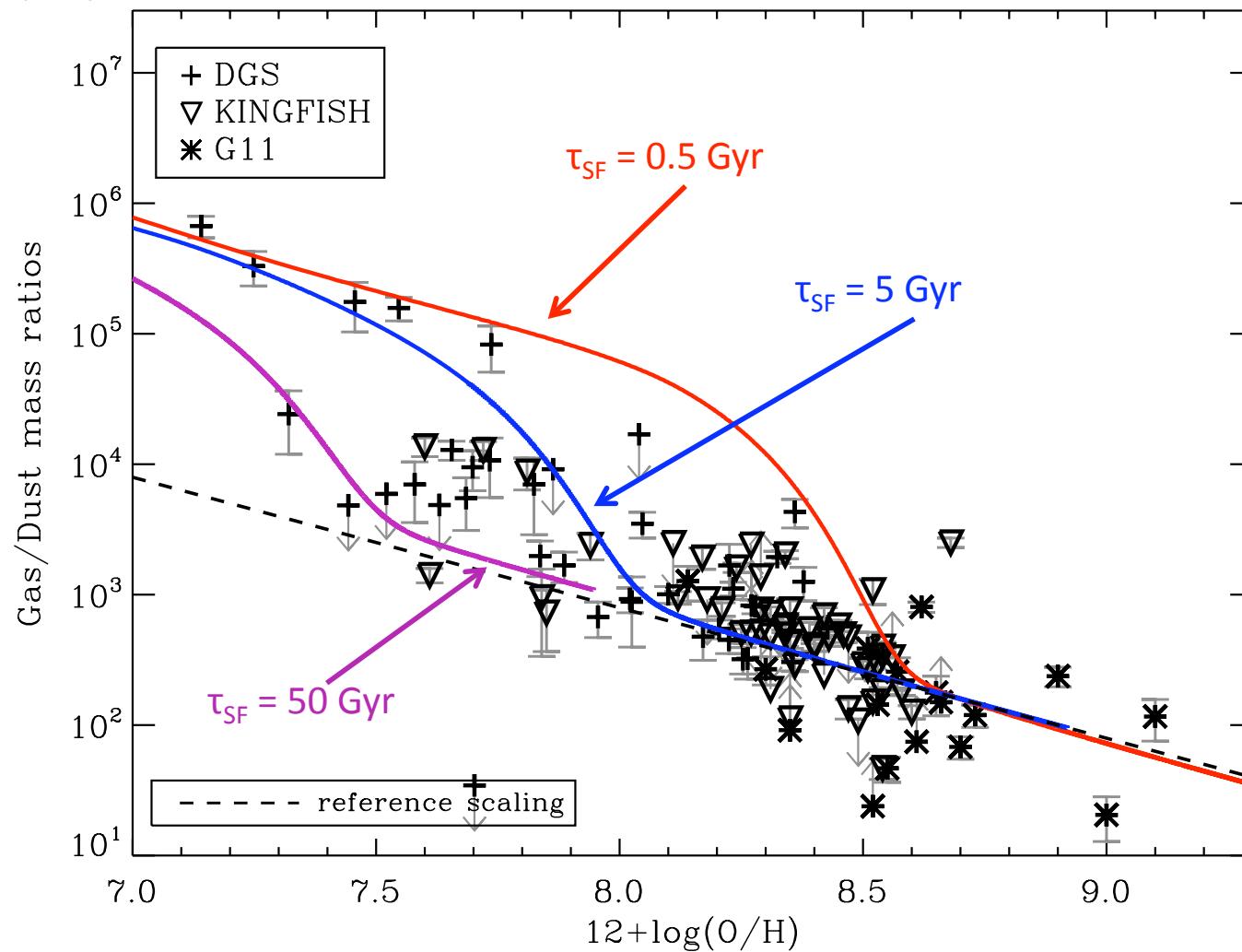


- Large scatter
- Power law :  
 $G/D \text{ as } Z^{-\alpha}$
- Get  $\alpha = 2.0 \pm 0.3$
- 2 power laws :  
 $G/D \text{ as } Z^{-\alpha_L}$  at low metallicities
- Get  $\alpha_L = 3.1 \pm 1.3$
- Transition at  
 $12+\log(\text{O/H}) = 8.10$

➤ Best consistent empirical estimates of the G/D from metallicity available so far

### III- G/D vs Z: Chemical evolution models

Rémy-Ruyer+14



- Chemical evolution model by Asano+13
- « Critical » metallicity over which dust growth is the main process in the dust mass evolution
- Depend on the star formation timescale

- Dust growth in the ISM is fundamental
- Scatter can be explained if you account for the different star formation histories of the sources

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## V- Summary: Take away messages

- **Dust temperature in low-metallicity environments:**

- Warmer dust, larger range of dust temperatures

- Joint effect of low-metallicity and high star-formation activity

Rémy-Ruyer+13, A&A, 557, A95

Rémy-Ruyer et al., in prep.

- **Gas/Dust mass ratios**

- Strong NON LINEAR metallicity dependance, explained including dust growth processes in the ISM in models
  - Large scatter can be explained with different star formation histories
  - New empirical relation to estimate the G/D from metallicities

Rémy-Ruyer+14, A&A, 563, A31

- **Perspectives**

- Refine the dust properties: amorphous carbons, dust growth -> core-mantle structure (see Jones+13)



Thank you !

Aurélie Rémy-Ruyer