Resolved dust-to-gas mass ratios in nearby galaxies

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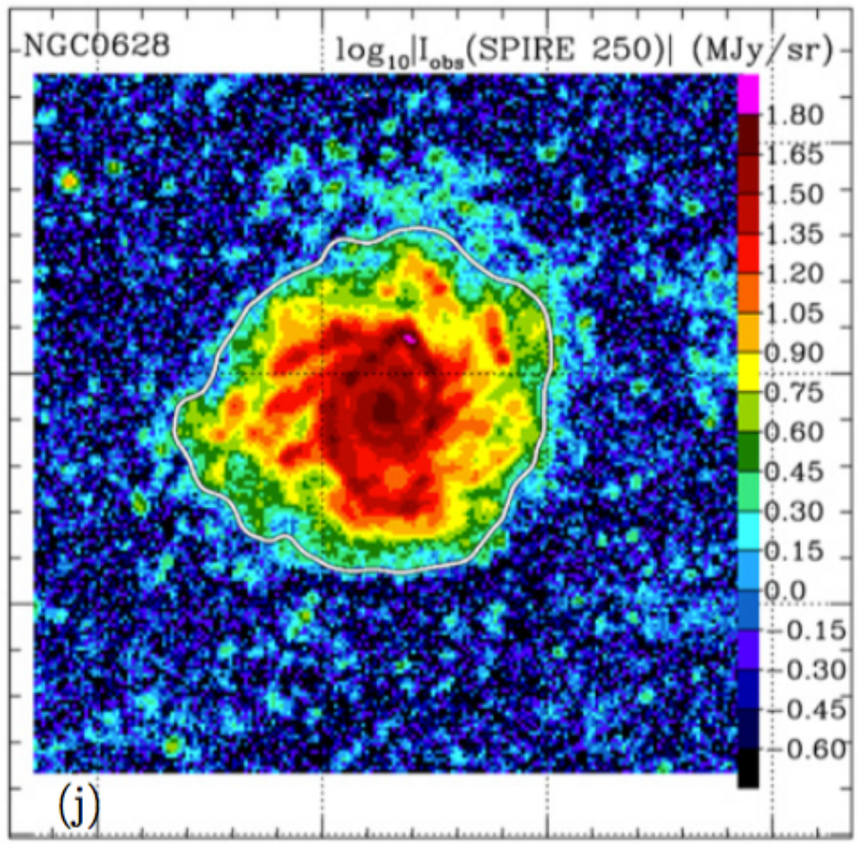
Introduction

- **Gas (atomic and molecular):** Star formation, dynamics and structure of the ISM and matter distribution.

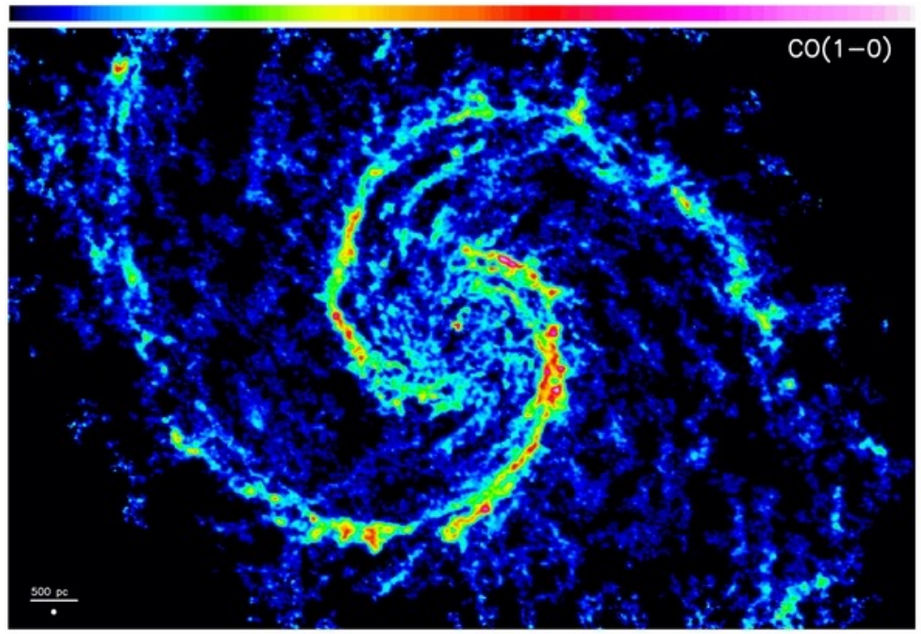
- **Dust**: agent of star formation, gas thermal balance and chemistry of the ISM.



Aniano et al. (2012)

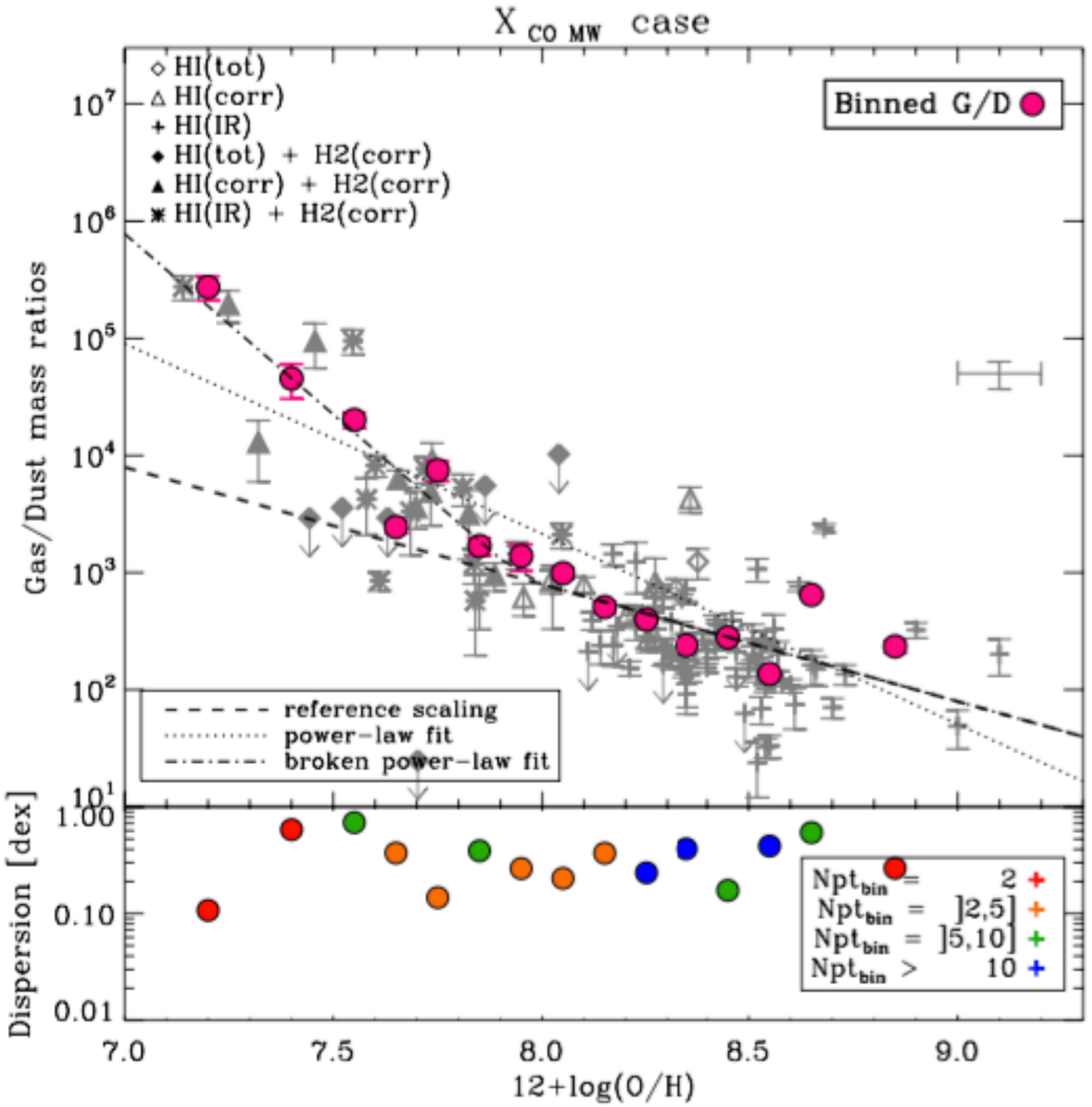
- Dust and **gas** are well mixed, so the dust-to-gas mass ratio (DGR) is constant on small scales.

- **DGR-metallicity relation:** study the evolutionary stage of a galaxy.



Schinnerer et al. (2013)

Motivation



Dust-to-gas mass ratio

$$\Sigma_{\rm DGR} = \frac{\Sigma_{\rm dust}}{\Sigma_{\rm HI} + \alpha_{\rm CO} \times I_{\rm CO}}$$

Why is the DGR-metallicity relation a tool?

Rémy-Ruyer et al. (2014)

Sample

SINGS + **LVL** : 3.6, 4.5, 5.8, 8.0 and 24 μm

KINGFISH : 70, 100, 160, 250, 350 and 500 μm

HERACLES : CO(2-1)

THINGS+**VIVA** : H I

29 Galaxies

Data processing

- Convolution to common resolution — **Exdm** (M. Albrecht)
- Masking process — S/N and r_{25} constrains
- Hierarchical Bayesian SED fitting — Dust mass
- Derivation of ISM parameters — M_*, L_{TIR}, Metallicity

Data processing

- Metallicity gradient from Moustakas et al. (2010)

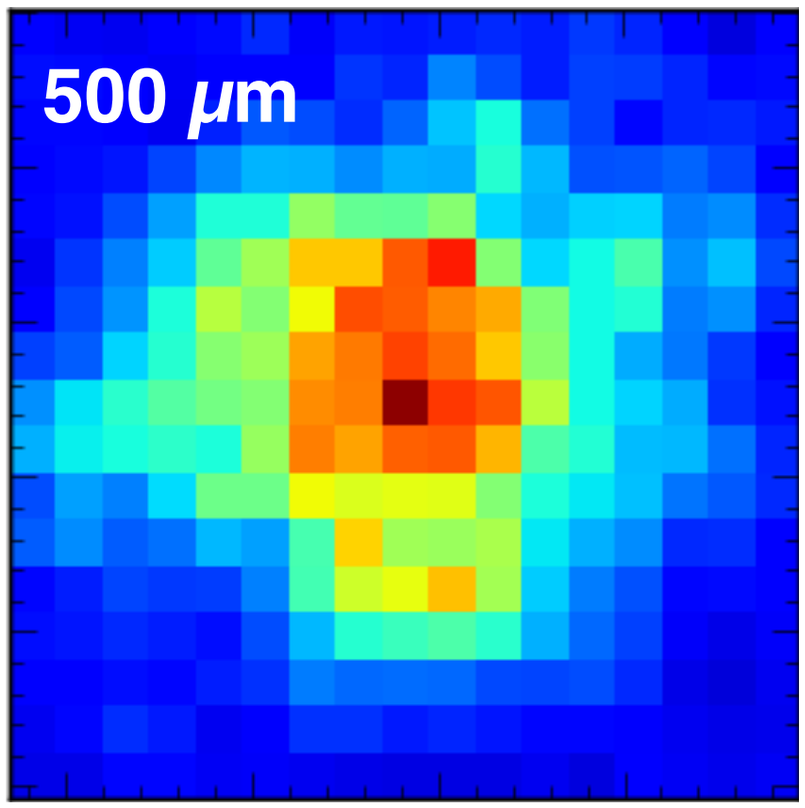
16 Galaxies

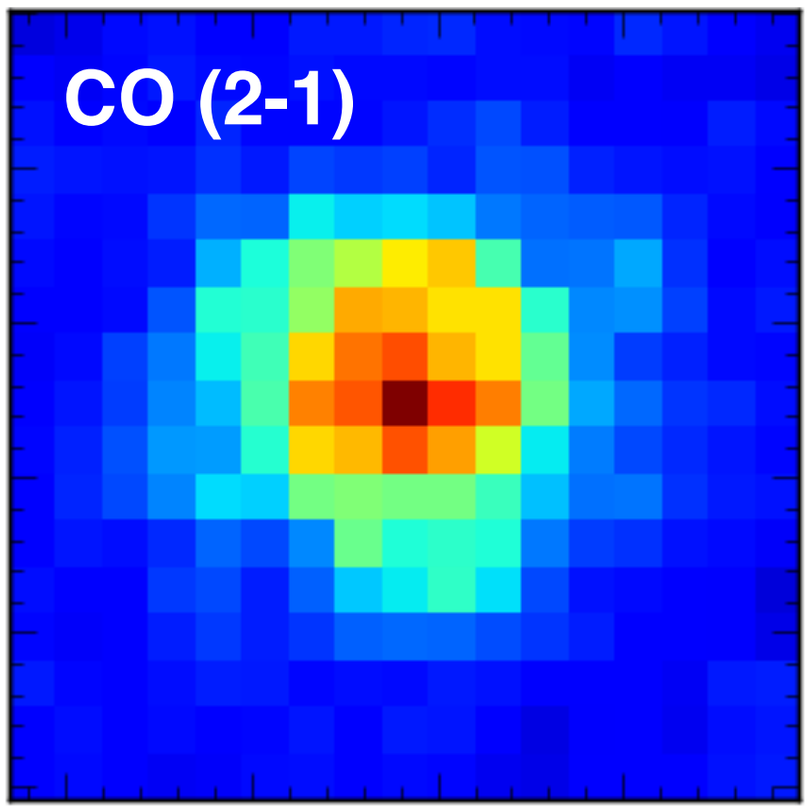
- Molecular gas (CO-to-H_2 conversion factor)
  - α_{CO} = 4.4 $M_\odot$ pc^{-2} (K km s^{-1})$^{-1}$ (Bolatto et al. 2013)
  - α_{CO} : f (metallicity)

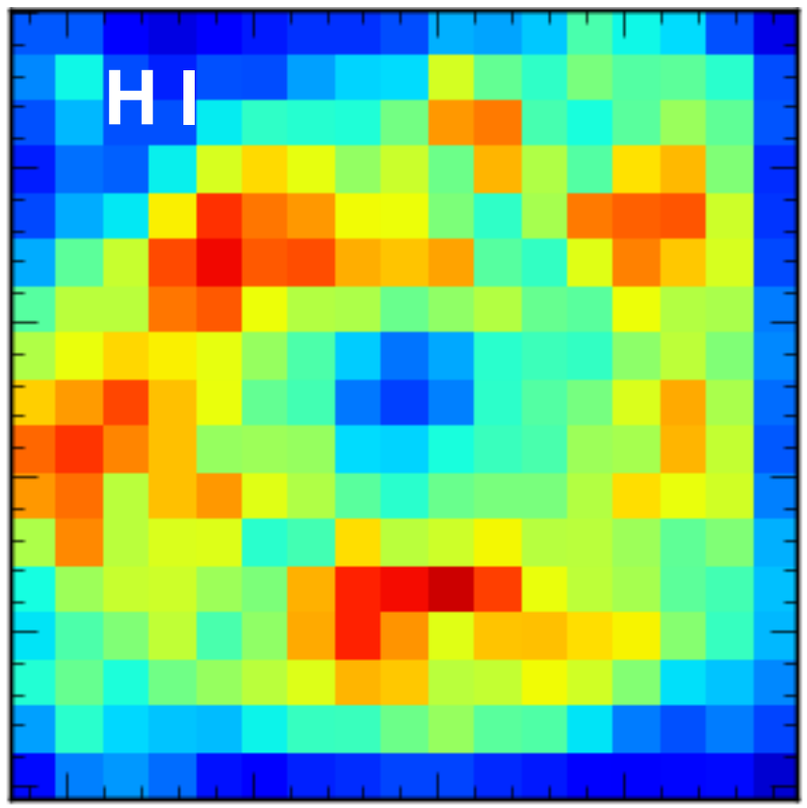
$$\log(\alpha_{CO}) = A + B \times (12+\log(O/H))$$

- Pixel size = 36” (0.81 - 2.53 kpc)

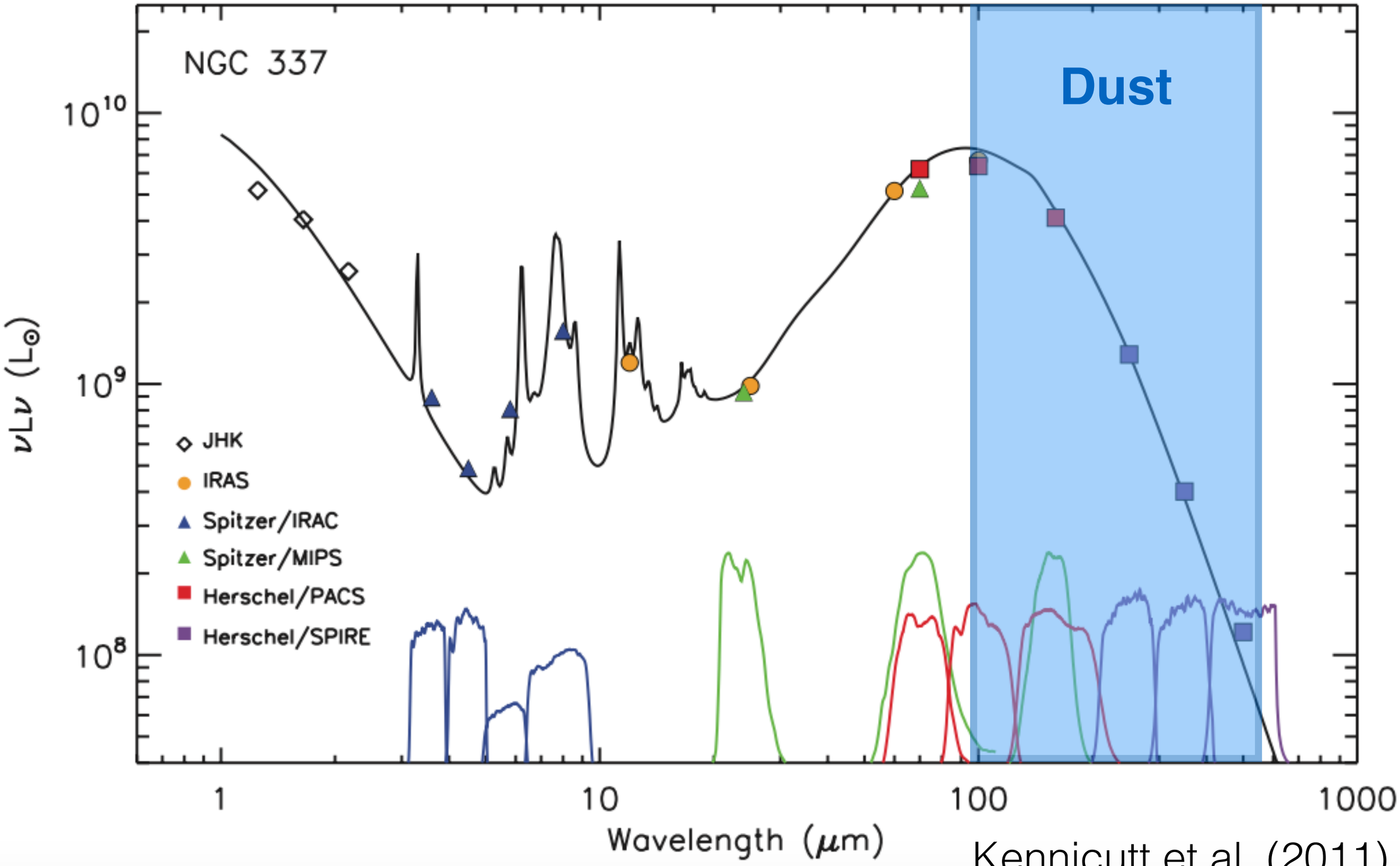
NGC 628







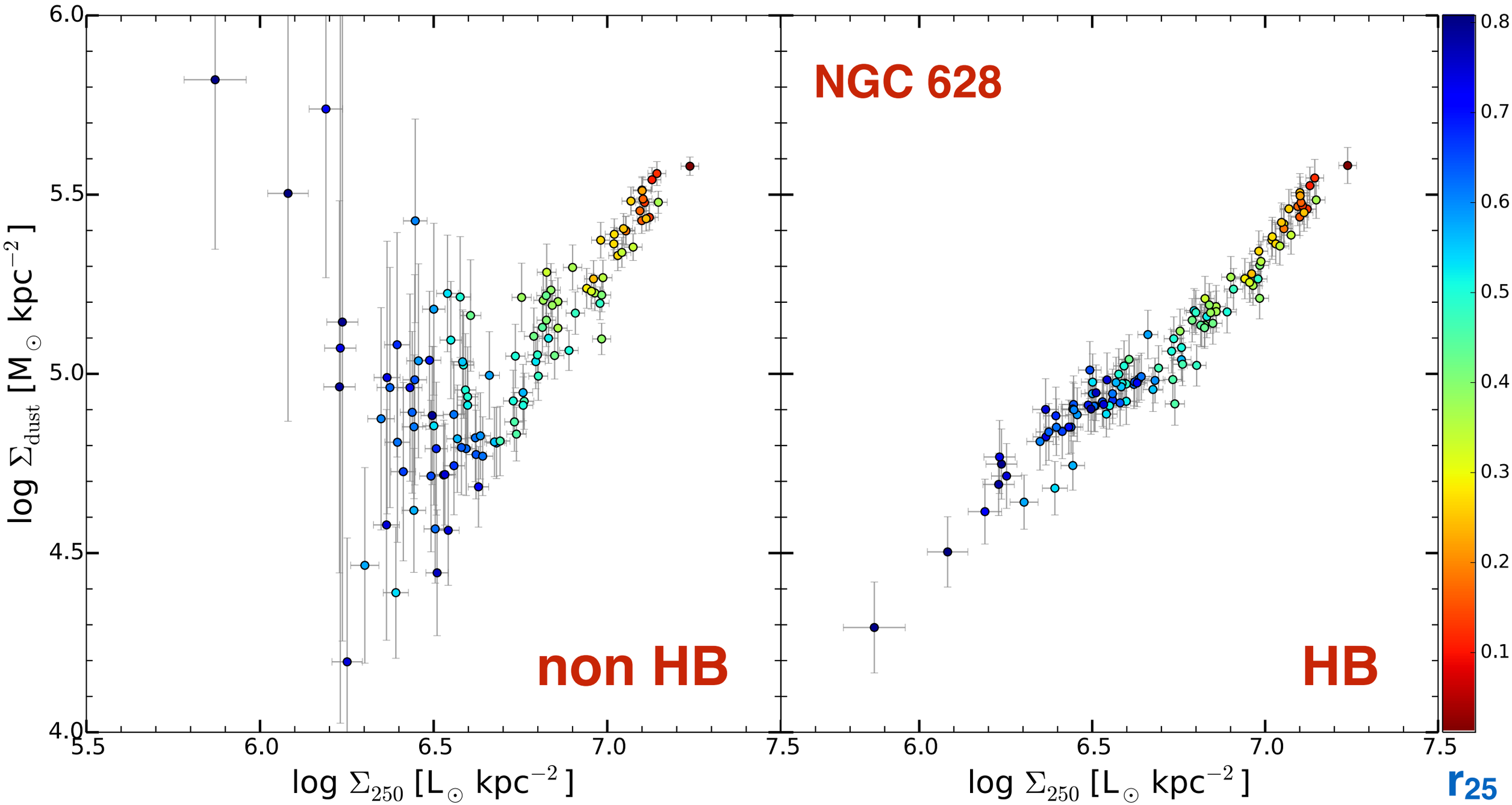
How is the dust mass determined?



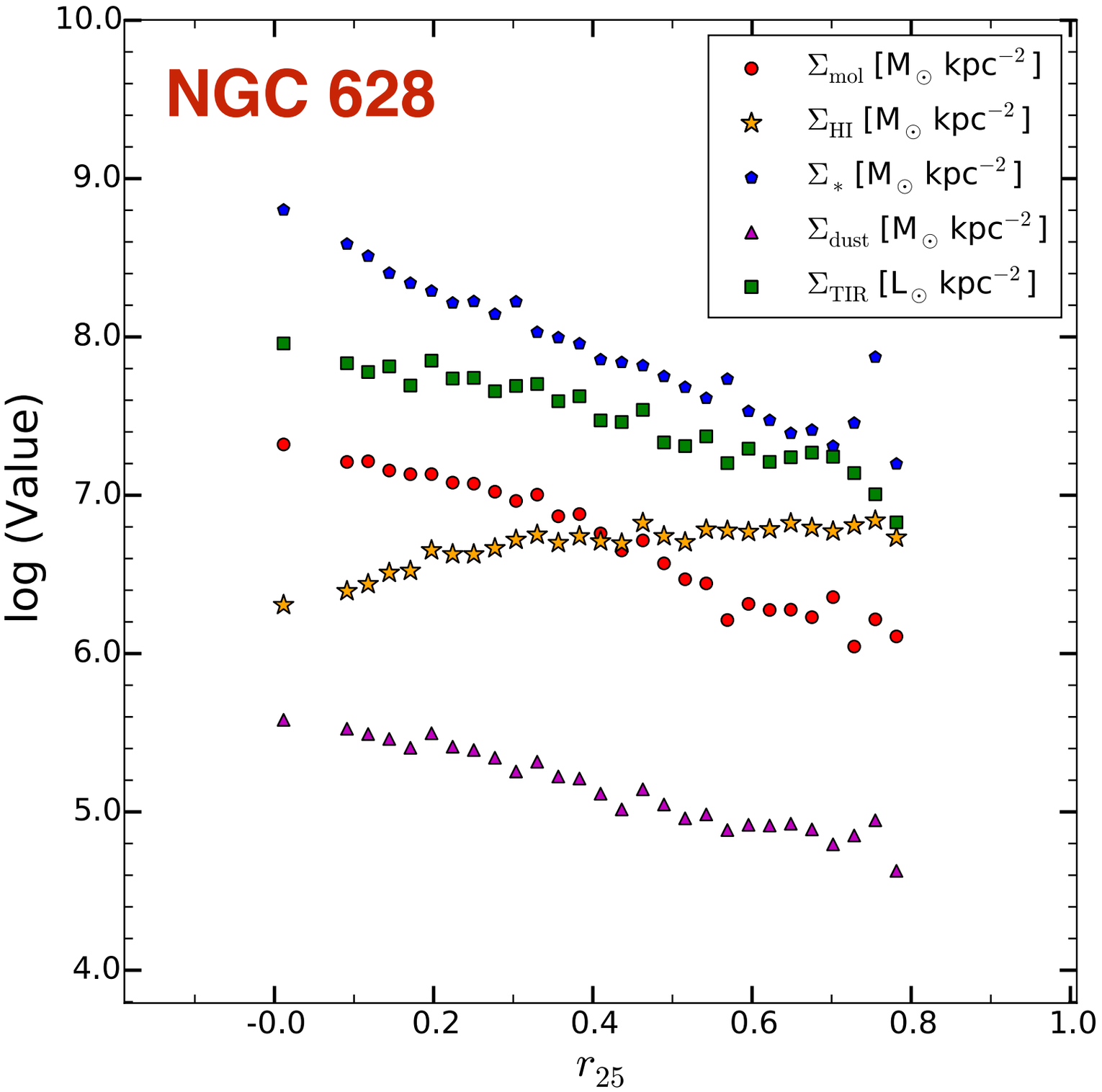
Kennicutt et al. (2011)

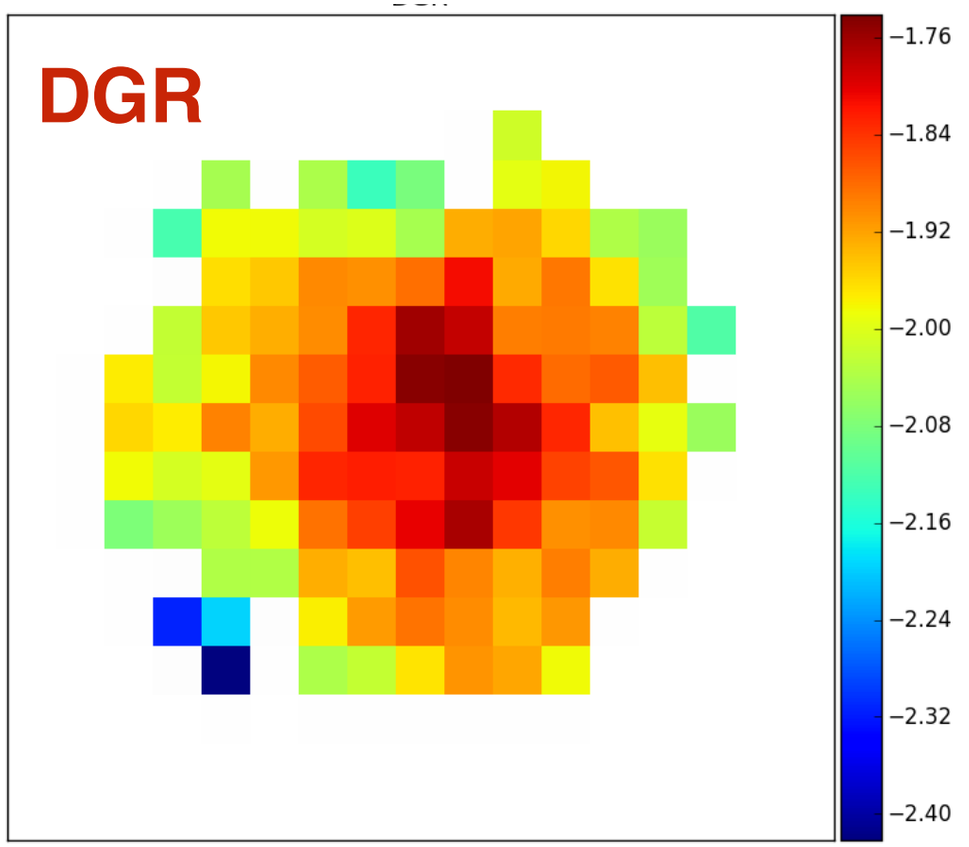
Why we used Hierarchical Bayes?

Single Modified blackbody (MBB) fitting $I_\nu = \kappa_\nu \Sigma_d B_\nu(\nu, T)$



Radial profiles (binned)





r_{25}: Galactocentric radius

Gas and dust surface densities correlation

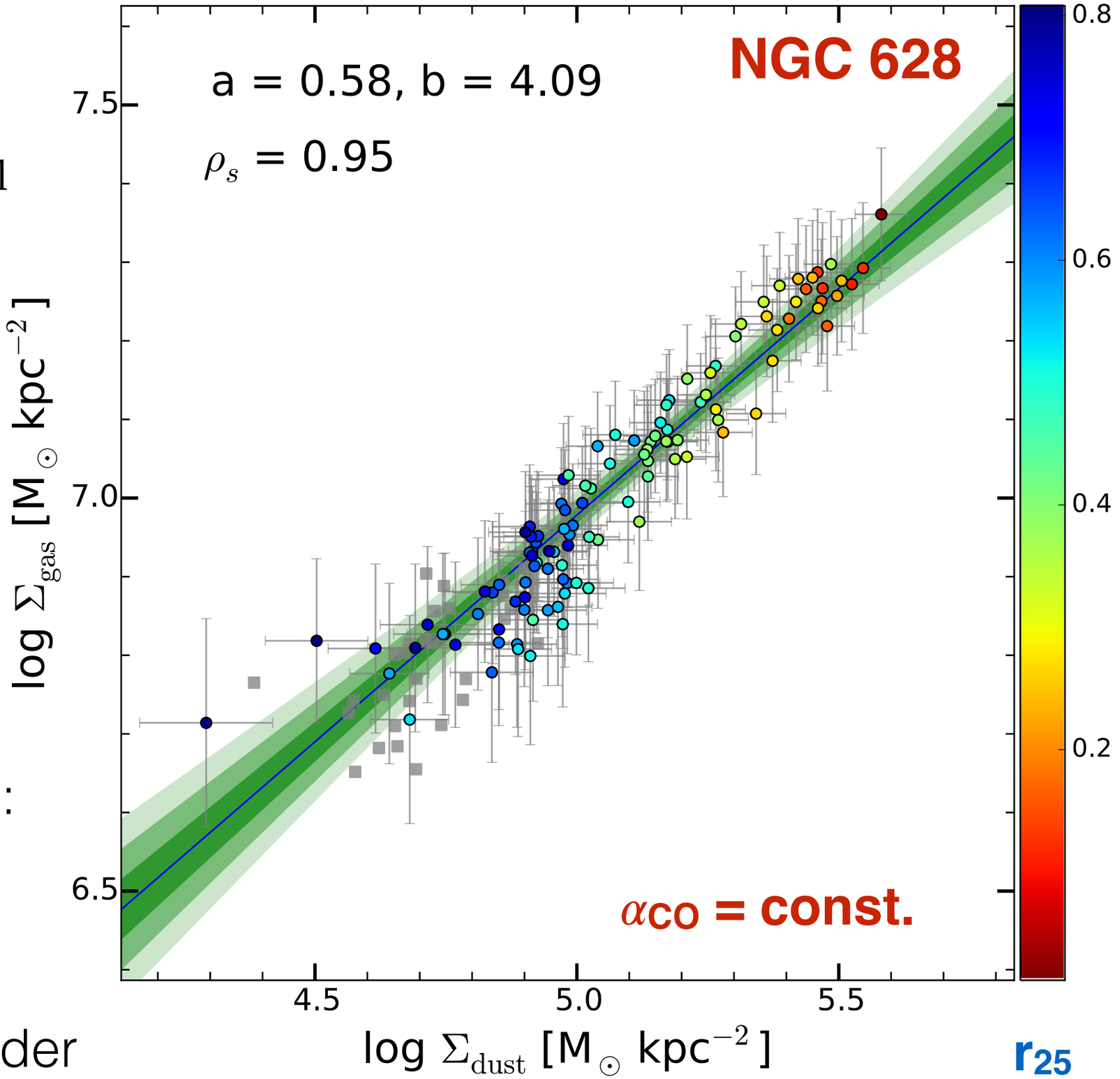
Definition of gas

$$\Sigma_{\rm gas} = \Sigma_{\rm HI} + \Sigma_{\rm mol}$$

Grey squares:
$S/N_{CO} < 2$

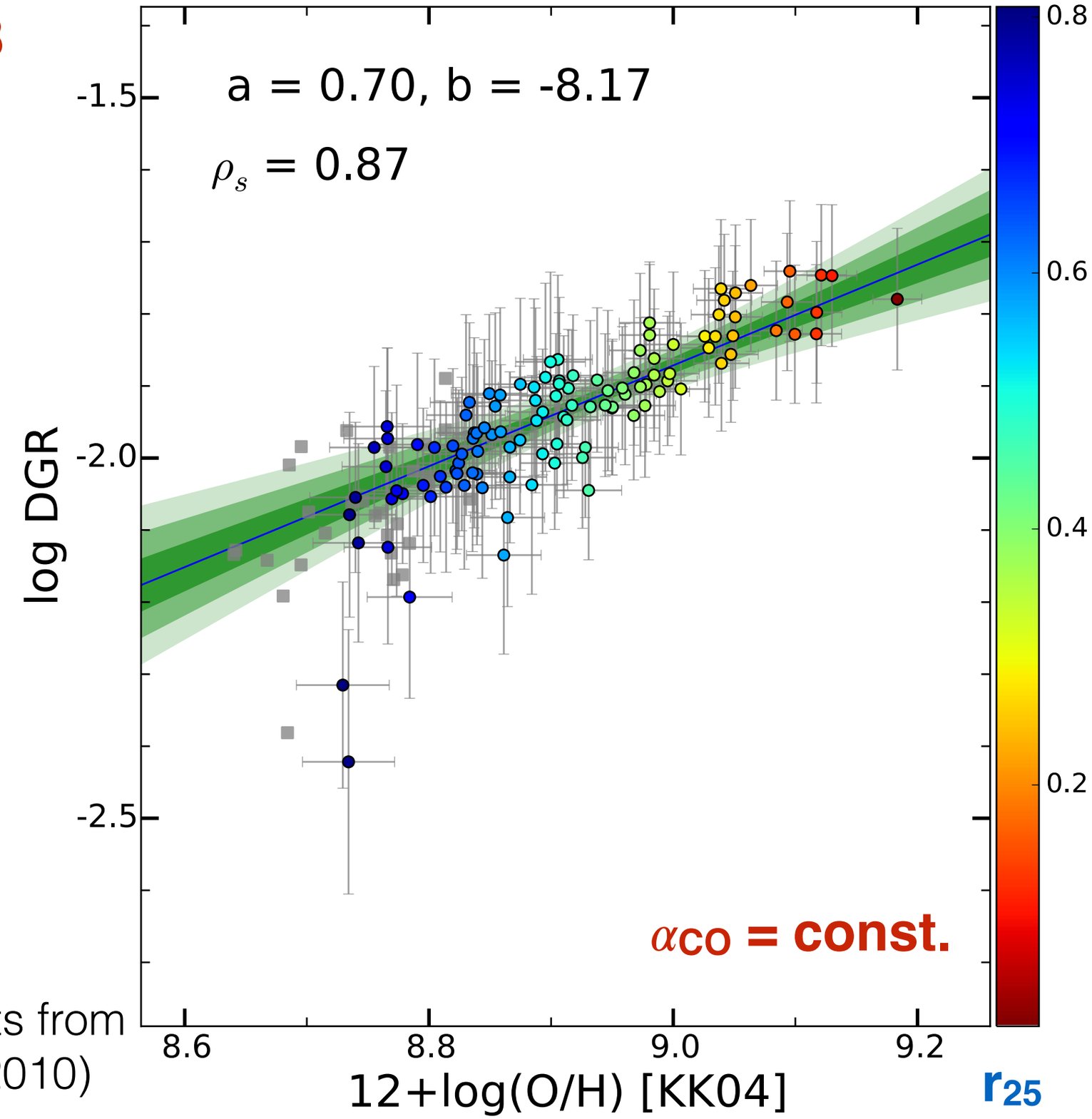
Bayesian lineal fitting:
1, 2 and 3σ (**green** shaded regions)

ρ_S : spearman-rank order



DGR - metallicity relation

NGC 628



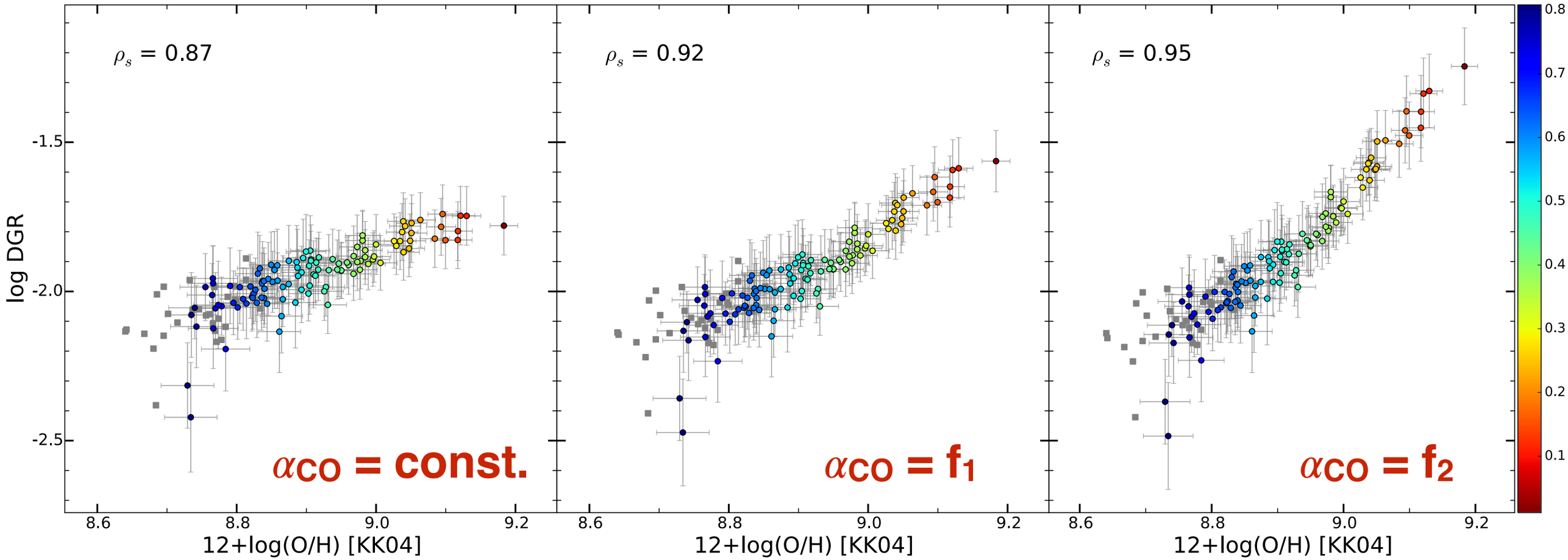
Metallicity gradients from Moustakas et al. (2010)

Impact of α_{CO} in DGR-metallicity relation

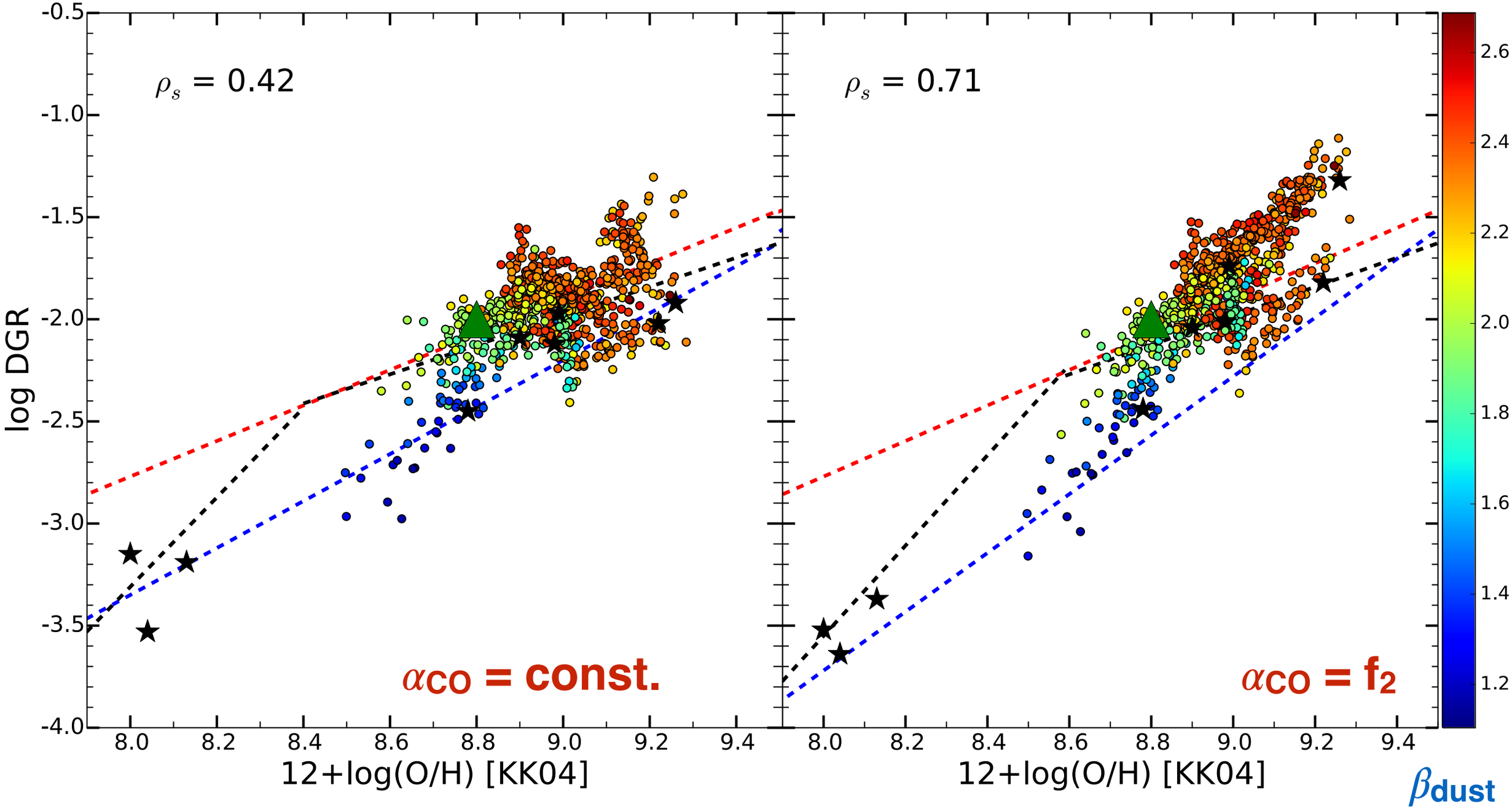
$$\log(\alpha_{CO}) = A + B \times (12+\log(O/H))$$

Galametz et al. (2011): **f_1**
Schruba et al. (2012) : **f_2**

NGC 628



DGR-metallicity relation (all sample)



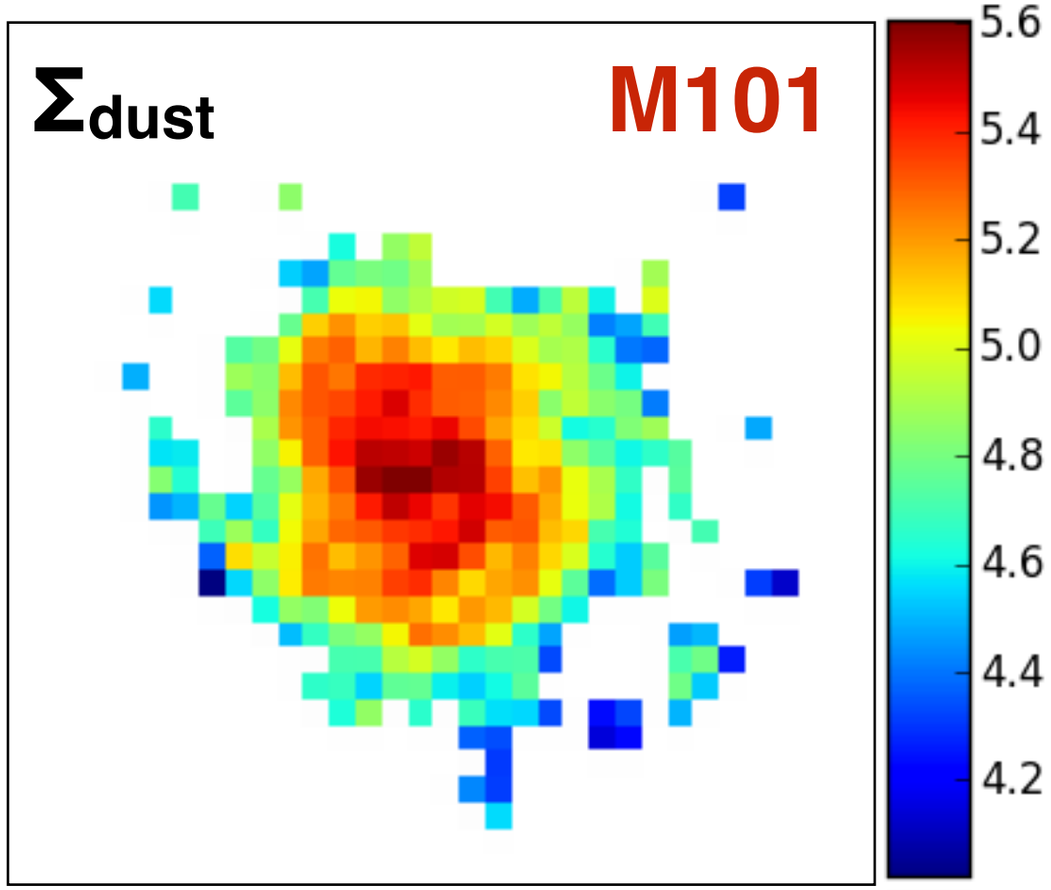
Red dashed line: Sandstrom et al. (2013)
Black dashed line: Rémy-Ruyer et al. (2014). **Blue** dashed line: Rémy-Ruyer et al. (2014)
Green triangle: Milky way. **Black** stars: Galaxies of the sample with no metallicity gradient

Take away message…

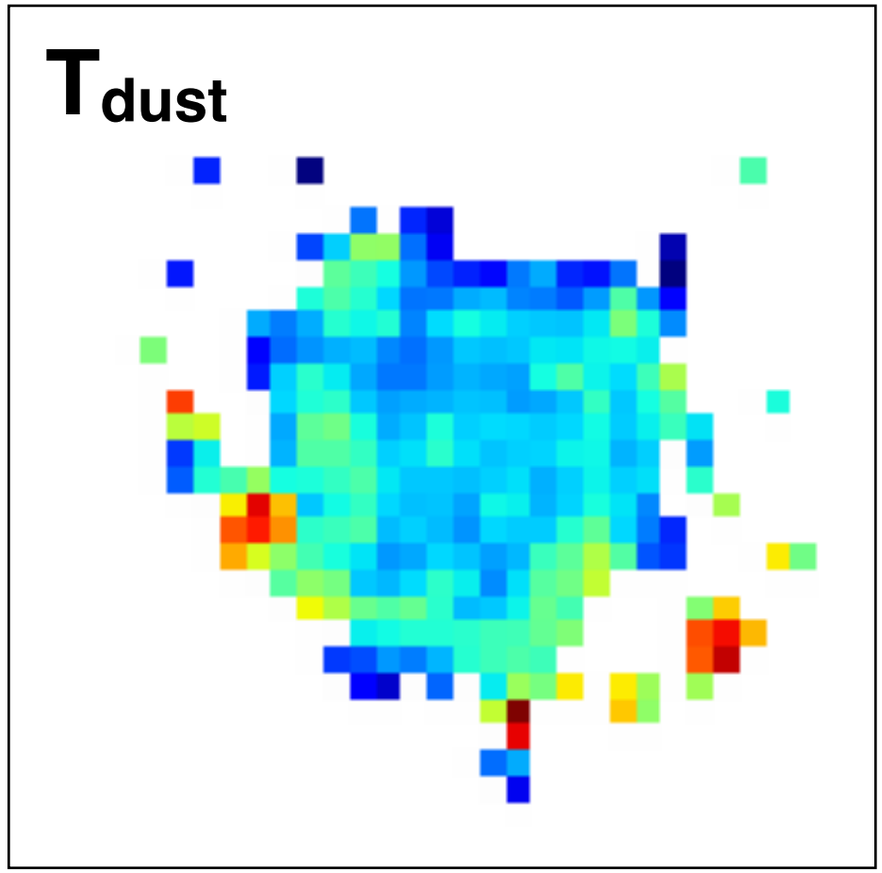
- Resolved studies helps us to better understand the internal physical processes.

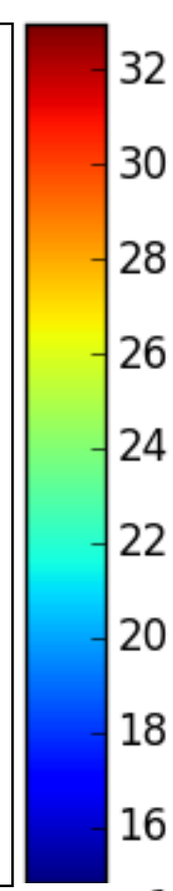
- The Hierarchical bayesian SED fitting allows us to improve our dust mass estimates.

- The DGR - metallicity relation depends strongly on the conversion factor (α_{CO}).


Σdust
M101

5.6
5.4
5.2
5.0
4.8
4.6
4.4
4.2


Tdust


32
30
28
26
24
22
20
18
16

ΣHI

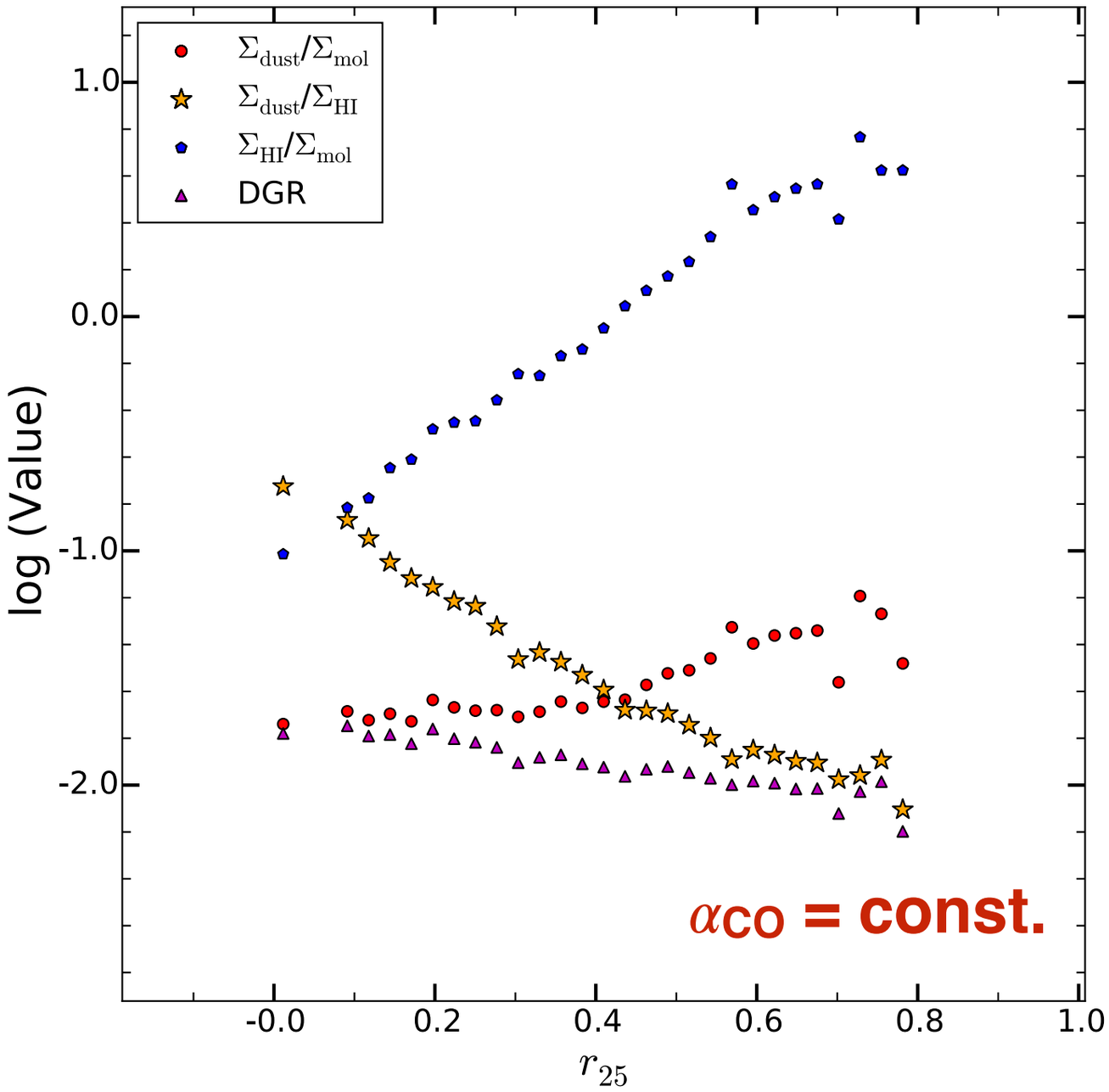
7.20
7.05
6.90
6.75
6.60
6.45
6.30
6.15

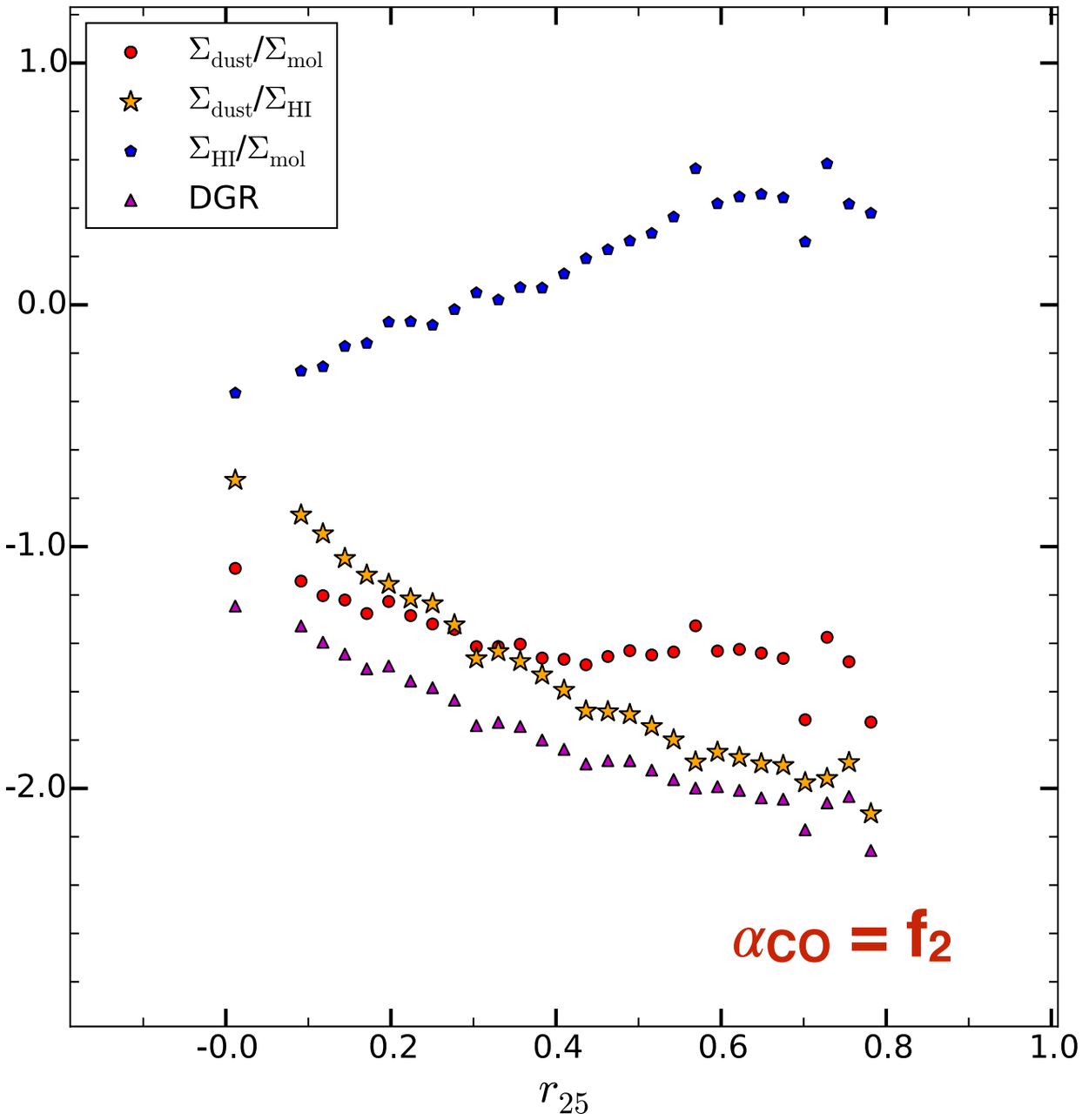
ΣDGR

−1.50
−1.65
−1.80
−1.95
−2.10
−2.25
−2.40
−2.55
−2.70
−2.85

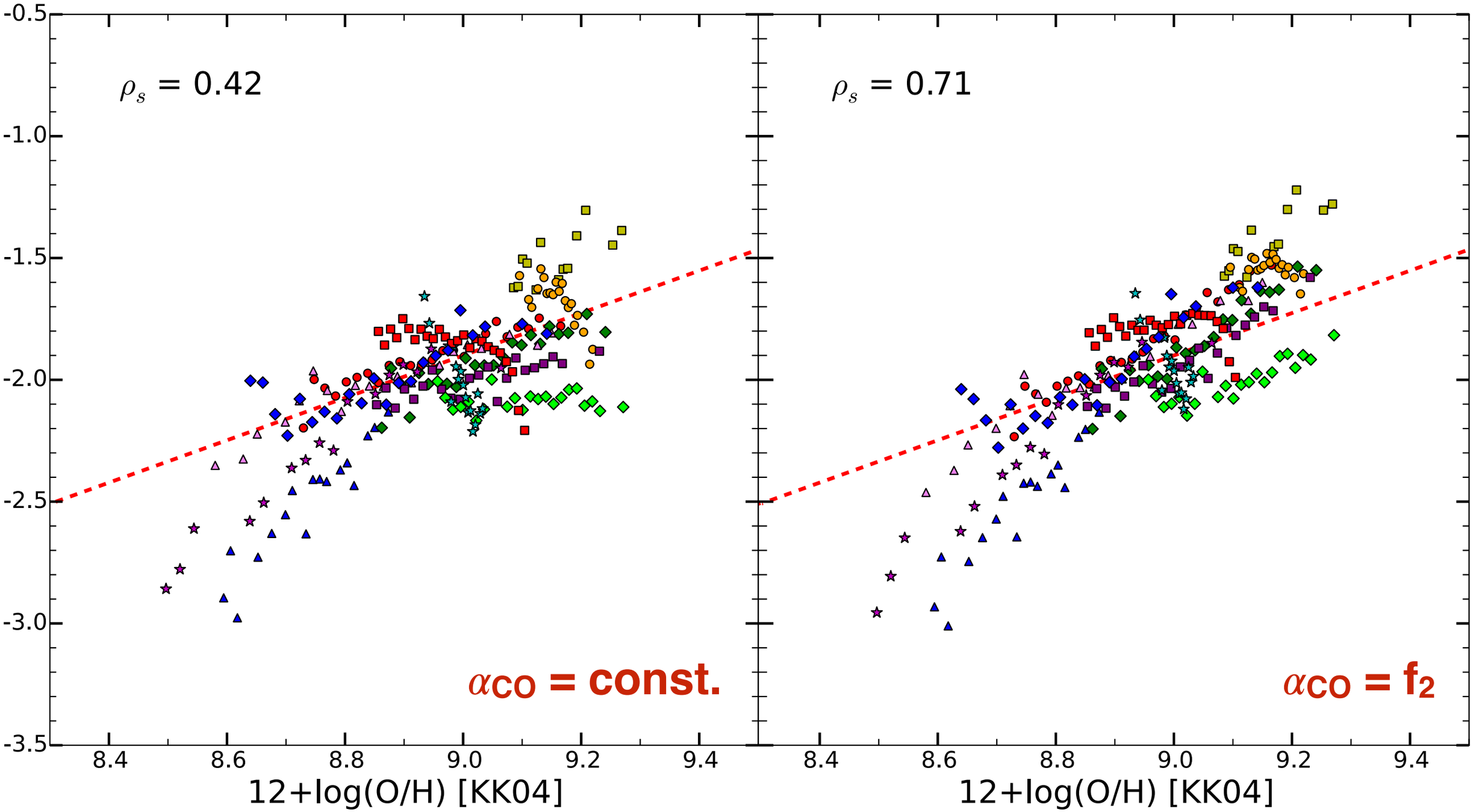
Influence of α_{CO} on fractions

NGC 628





DGR-metallicity relation (binned)



Red dashed line: Sandstrom et al. (2013)

DGR and other galaxy parameters

NGC 628