GEE2-Acquario civico Milano

HeViCS
and the path to star formation in the cluster environment

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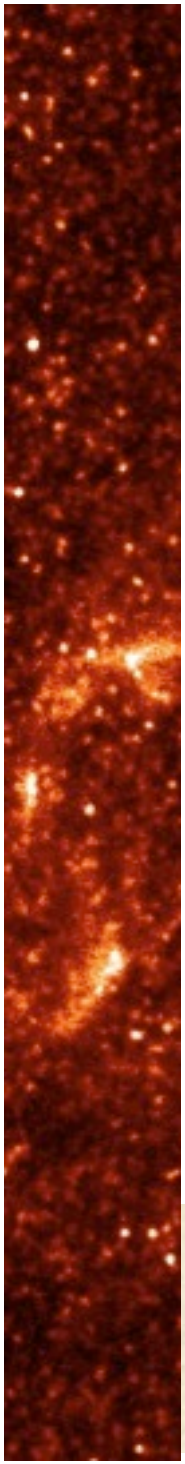
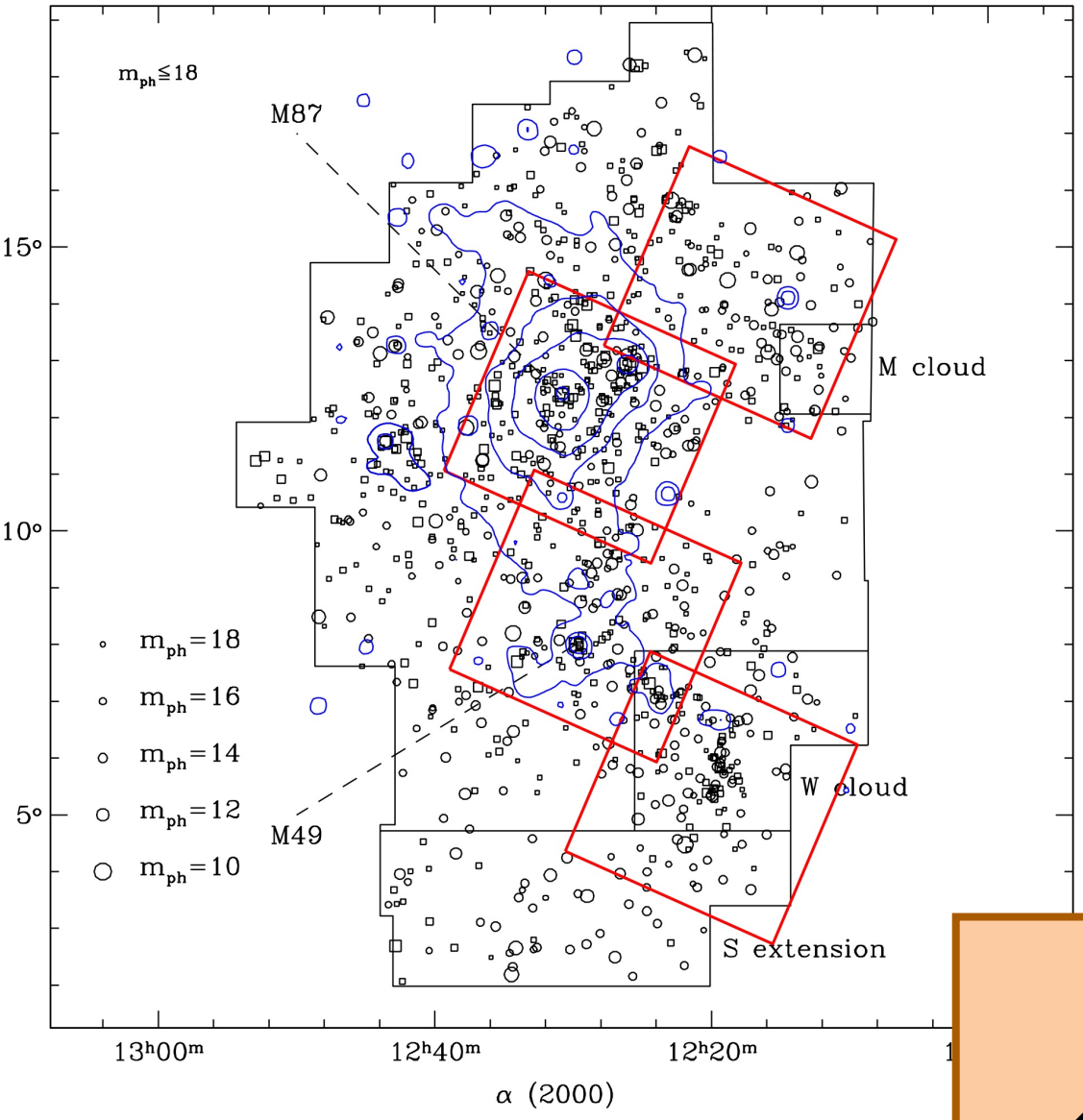




VCC (Binggeli et al. 1985)
ROSAT (Bohringer et al.1994)
Often we use the GOLDMINE database (Gavazzi G. et al, Thanks Peppo !.)

VIRGO: Survey Area ≈ 60 deg²

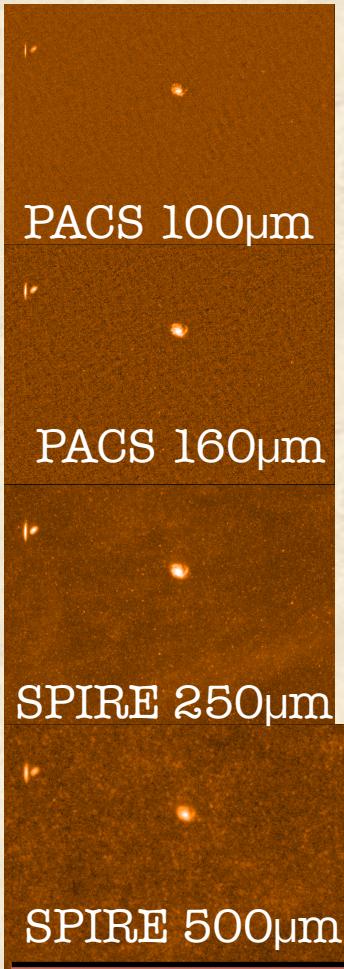
PACS/SPIRE 286 hours

Parallel mode
fast scanning

PACS B (100-μm)
PACS R (160-μm)
SPIRE (250, 350, 500-μm)

Goals

- Intercluster dust
- Dust removal in spirals
- Dust in dwarfs & ellipticals
- Background sources
- SEDs

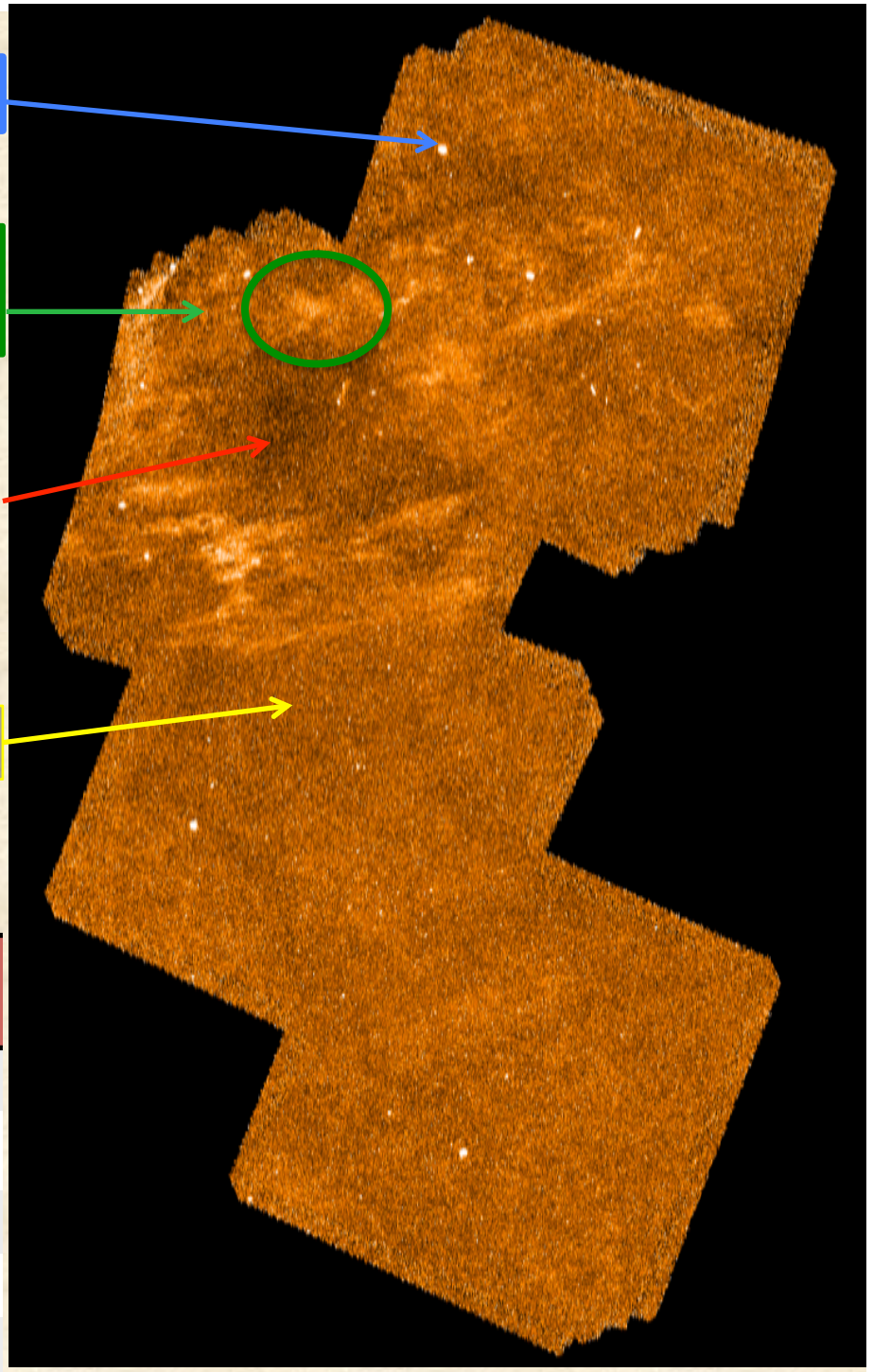


"Sources"

"Brighter Regions "

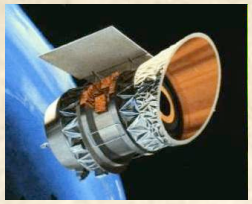
"Hole"

"Background"



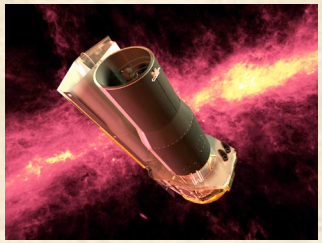
	λ [μm]	FWHM [arcsec]	VIRGO [kpc]
PACS	100	7 x 13	0.6x1.1
	160	12 x 16	1.0x1.3
SPIRE	250	18	1.5
	350	24	2.0
	500	36	3.0

Herschel photometry with PACS & SPIRE
-Colder dust seen with better resolution
-Colder dust make most of the dust mass

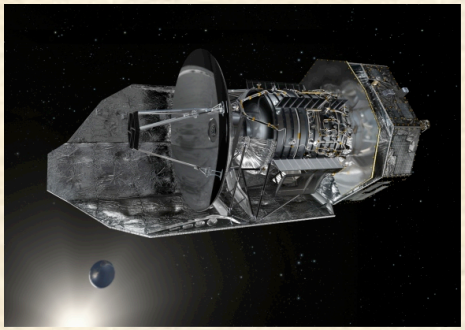


1980s: IRAS, λ_{max} =100μm
Devereux & Young (1990): G/D=1000

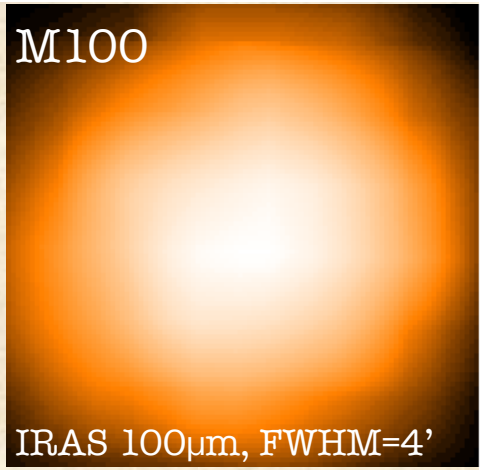
1990s: ISO, λ_{max} =200μm
Alton et al. (1998): G/D=220

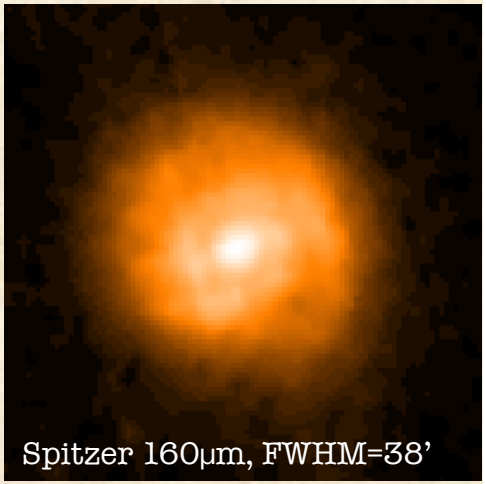


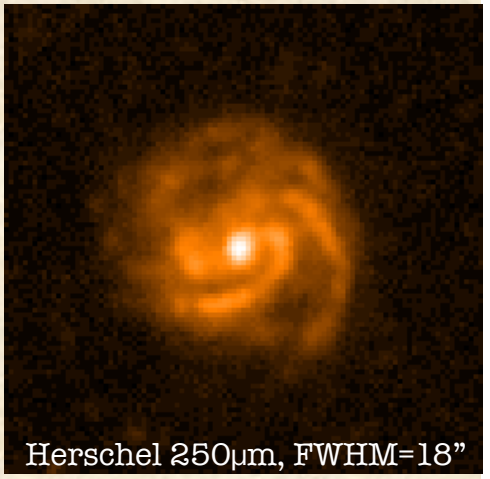
2000s: Spitzer, λ_{max} =160μm
Draine et al. (2007): G/D=190

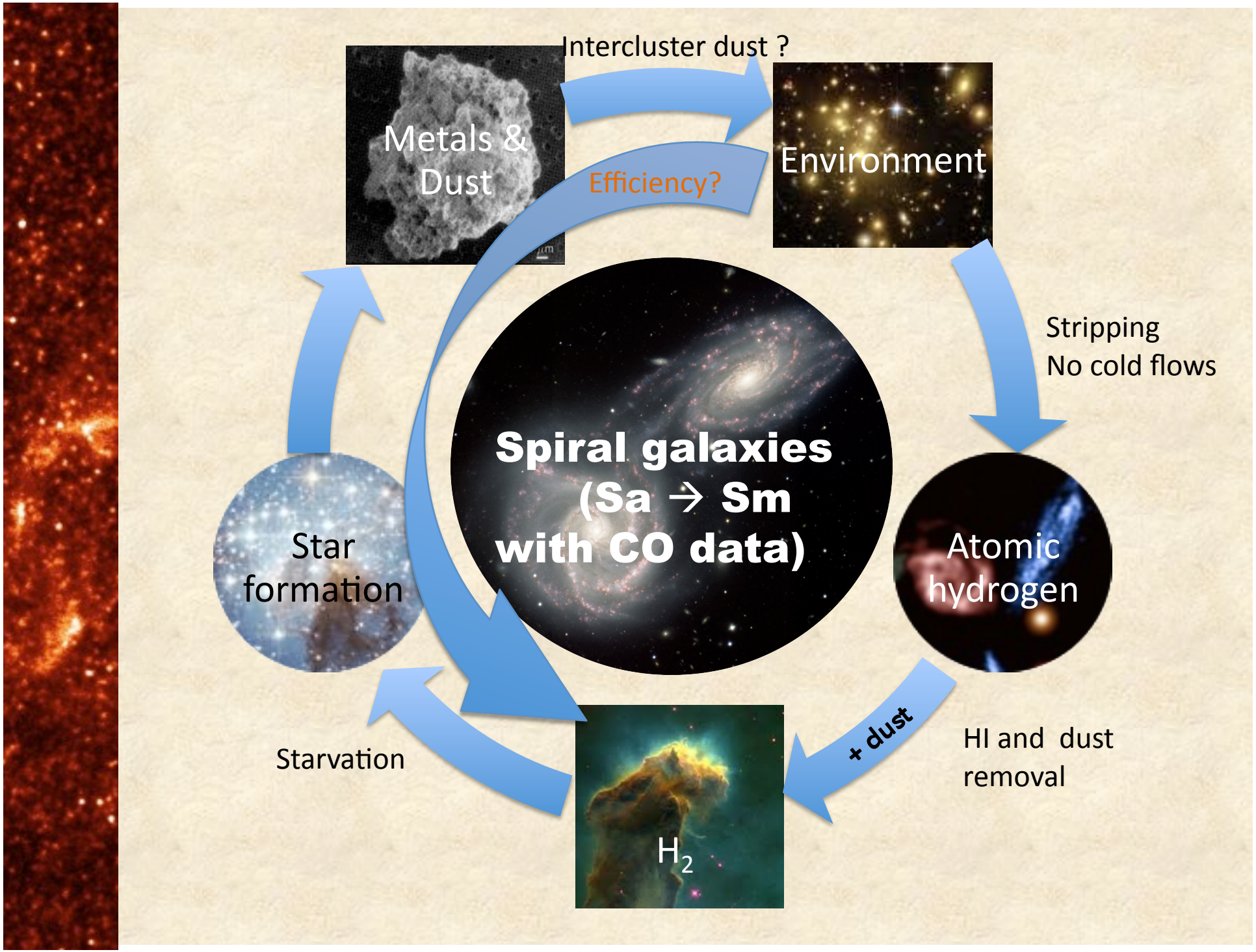


2010s: Herschel, λ_{max} =500μm
Corbelli et al. (2011): G/D=100



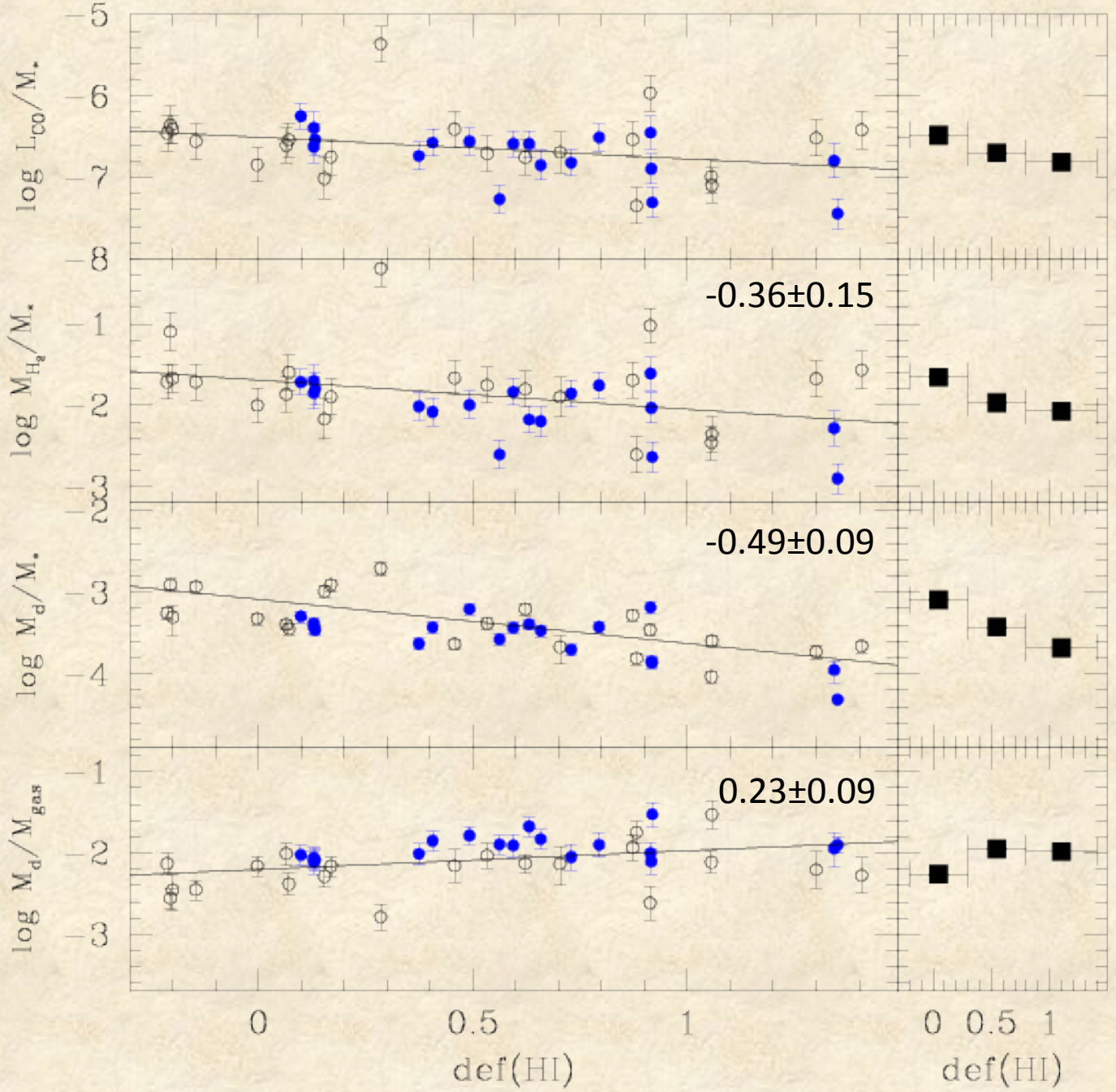


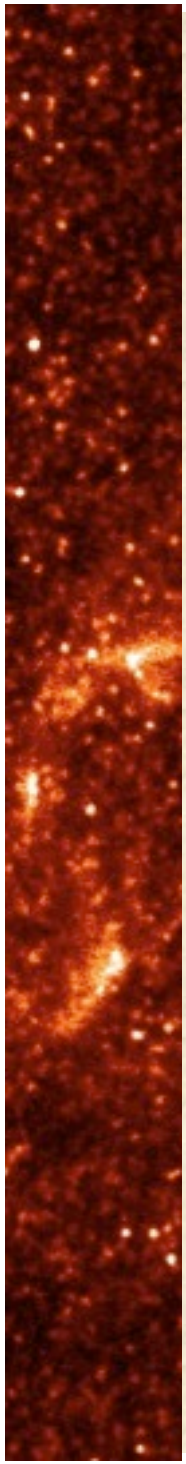



Intercluster dust ?
Metals & Dust
Environment
Efficiency?
Stripping
No cold flows
Spiral galaxies (Sa → Sm with CO data)
Star formation
Atomic hydrogen
Starvation
+ dust
HI and dust removal
H_2

Global balance: the environment (Corbelli et al. 2011)

Bright galaxies fully mapped in CO





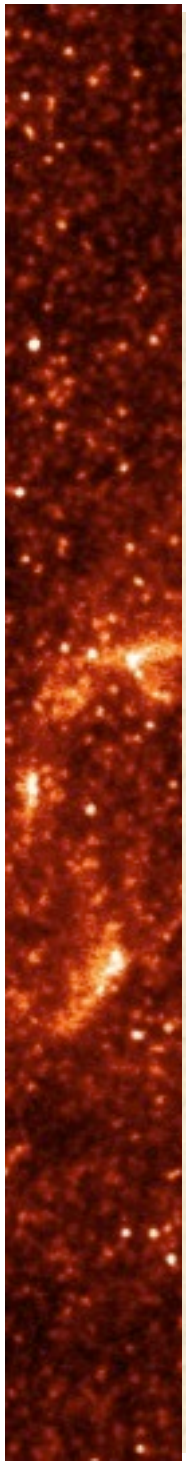
Global balance: the environment affects the atomic gas more than the dust. In galaxies with a low or medium HI deficiency (i.e. not strongly perturbed) the dust-to-gas ratio decreases as the HI deficiency increase. The gas, namely the HI, is lost from external regions.

1. HI

2.dust

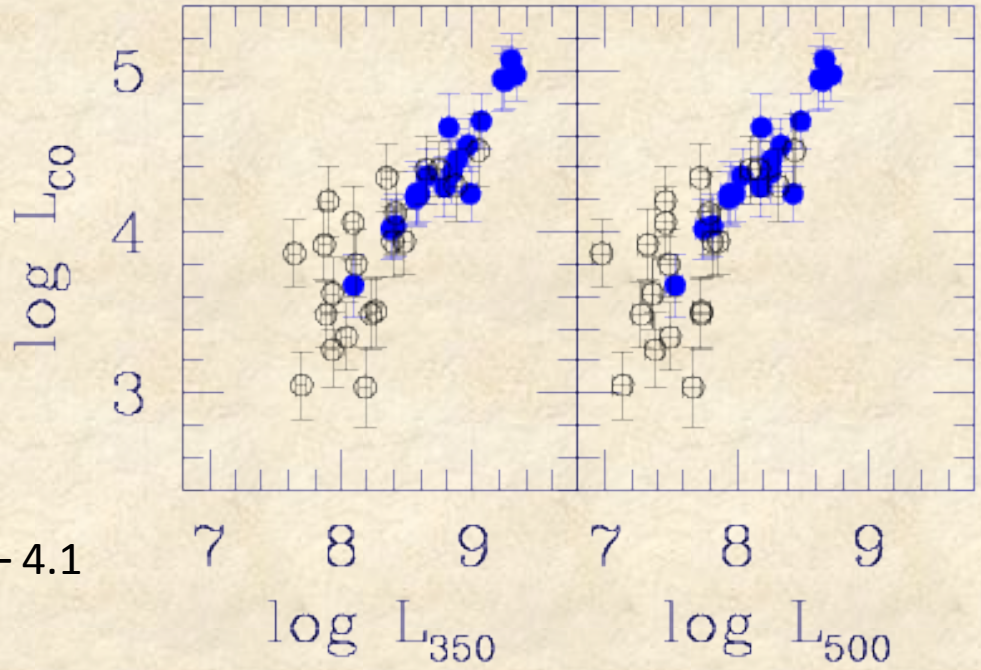
3. H_2

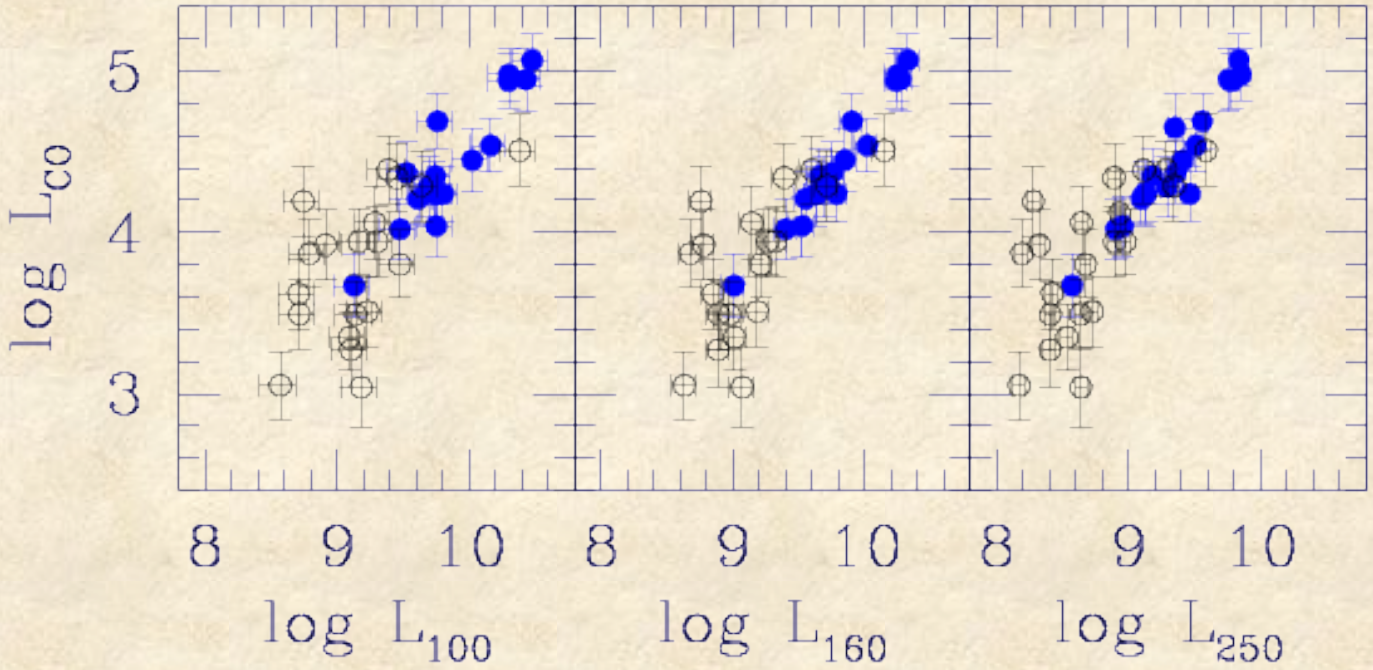
H_2 forms on dust, but it is more deeply bound in the potential well, being mostly at low latitudes and closer to galaxy centers. Per unit stellar mass the global molecular content decreases as a function of the HI deficiency but to a less extent than dust.

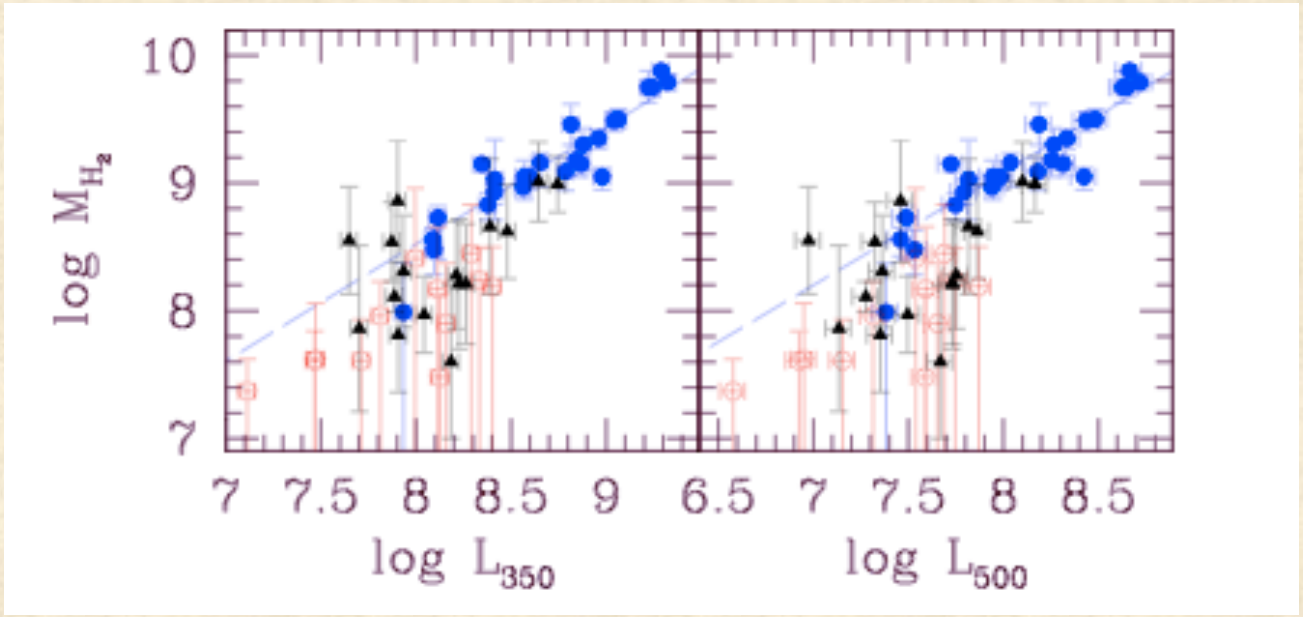


The good FIR-CO Correlation:

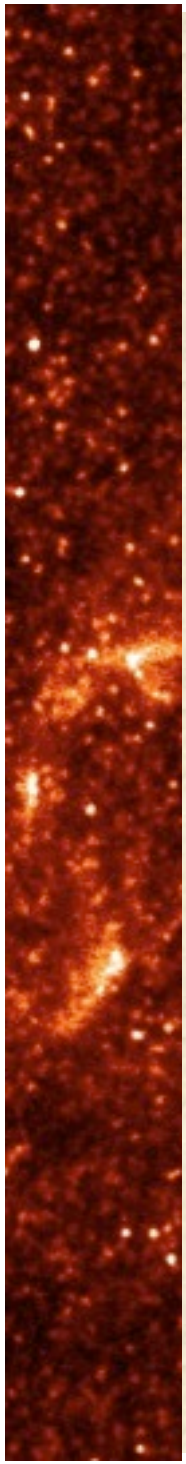
$\log L_{CO} = 0.91 \log L_{250} - 4.1$







Since H_2 forms on dust: can we use the dust content to trace the molecular content?
No because dim galaxies have converted only a small fraction of atomic gas in molecular gas despite their 'normal' dust content.
This is not an environment effect!

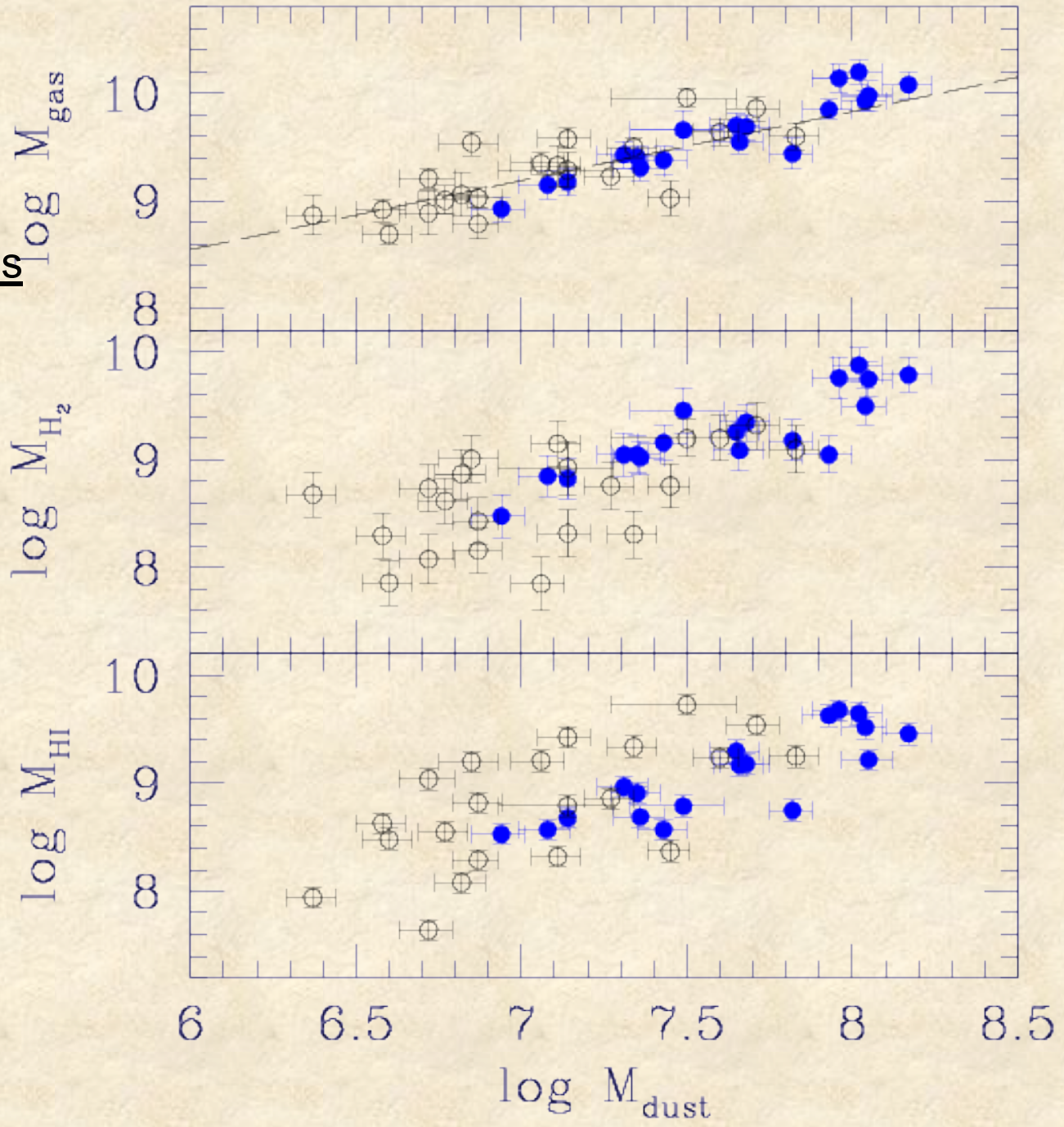


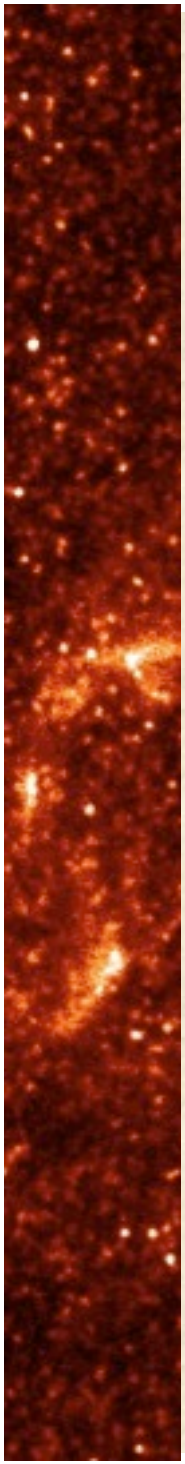
The dust-to-gas correlation:

Best with <u>total gas</u>

slope=0.64-0.8

(range due to X_{CO} uncertanties)



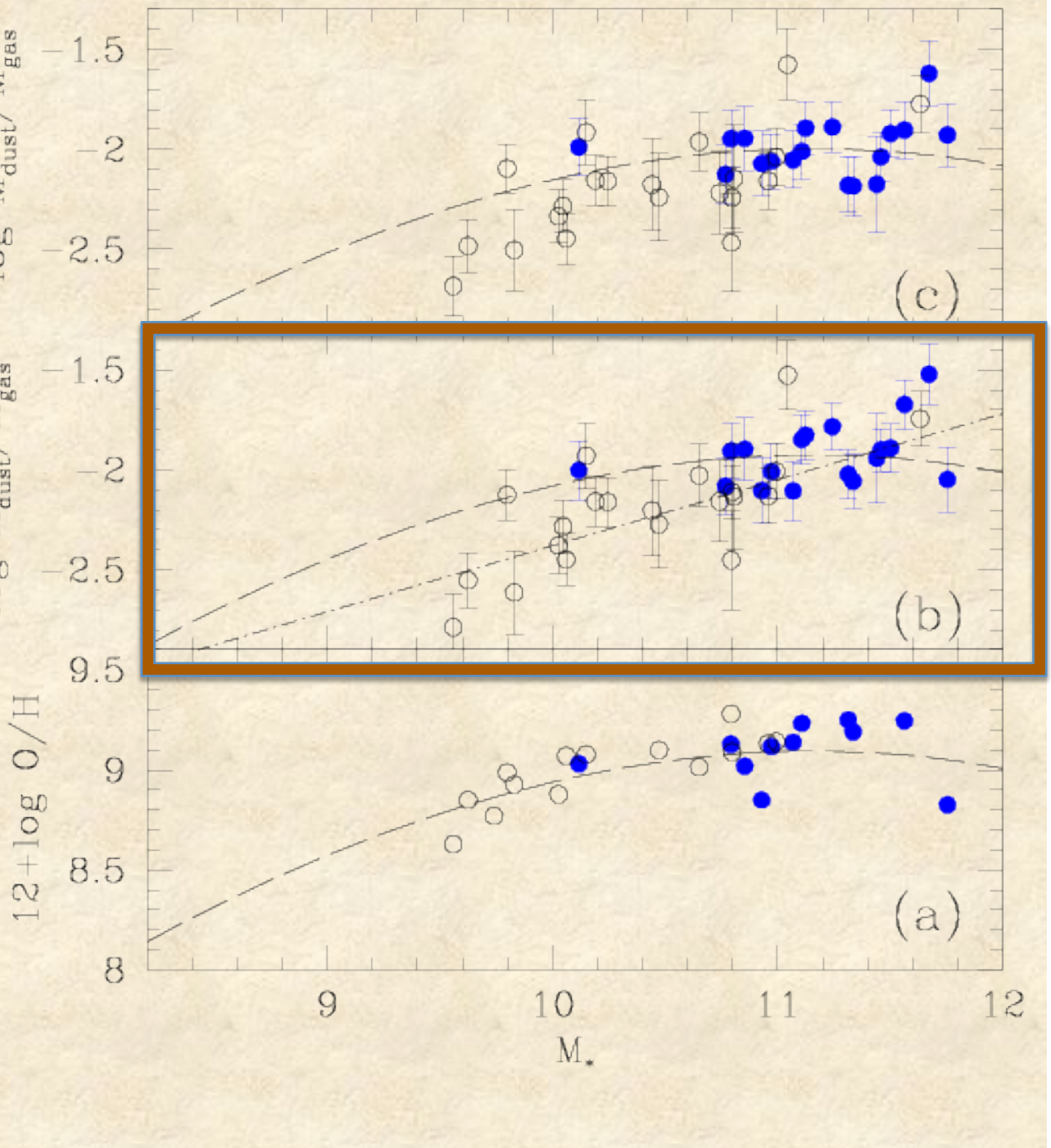


Is the dust-to-gas ratio a good metallicity indicator ?

Difficult task because

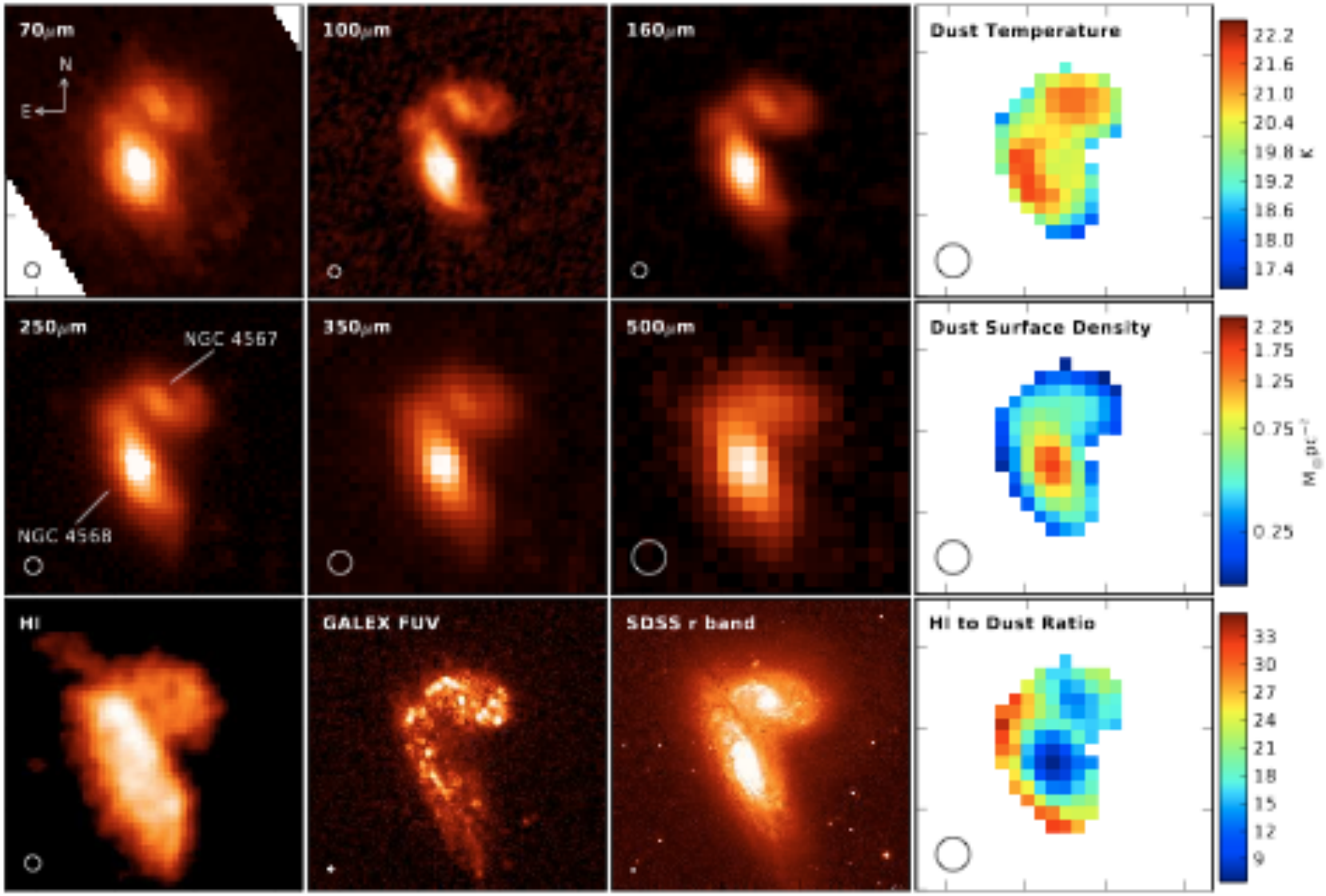
-environment: dust and gas not equally affected

-gradients: metallicities often refers to central regions, dust-to-gas to the whole disk



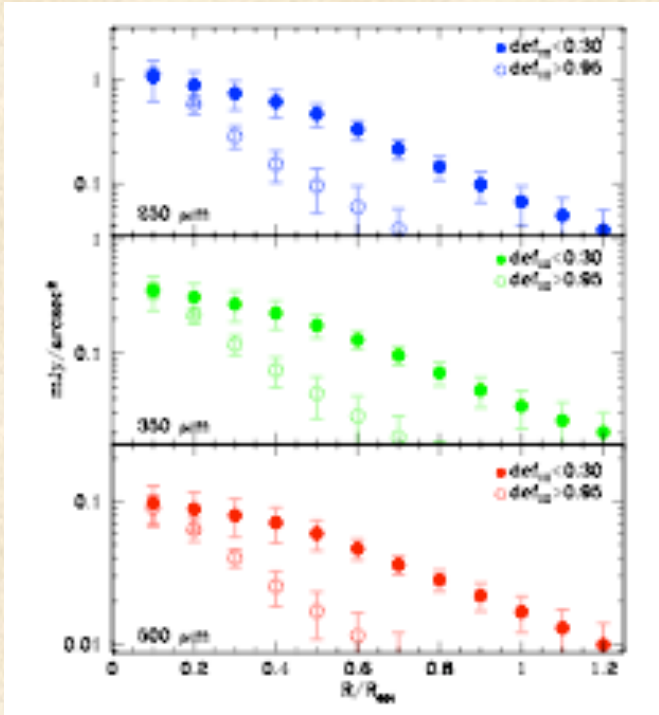
At higher resolution

Smith et al. 2010



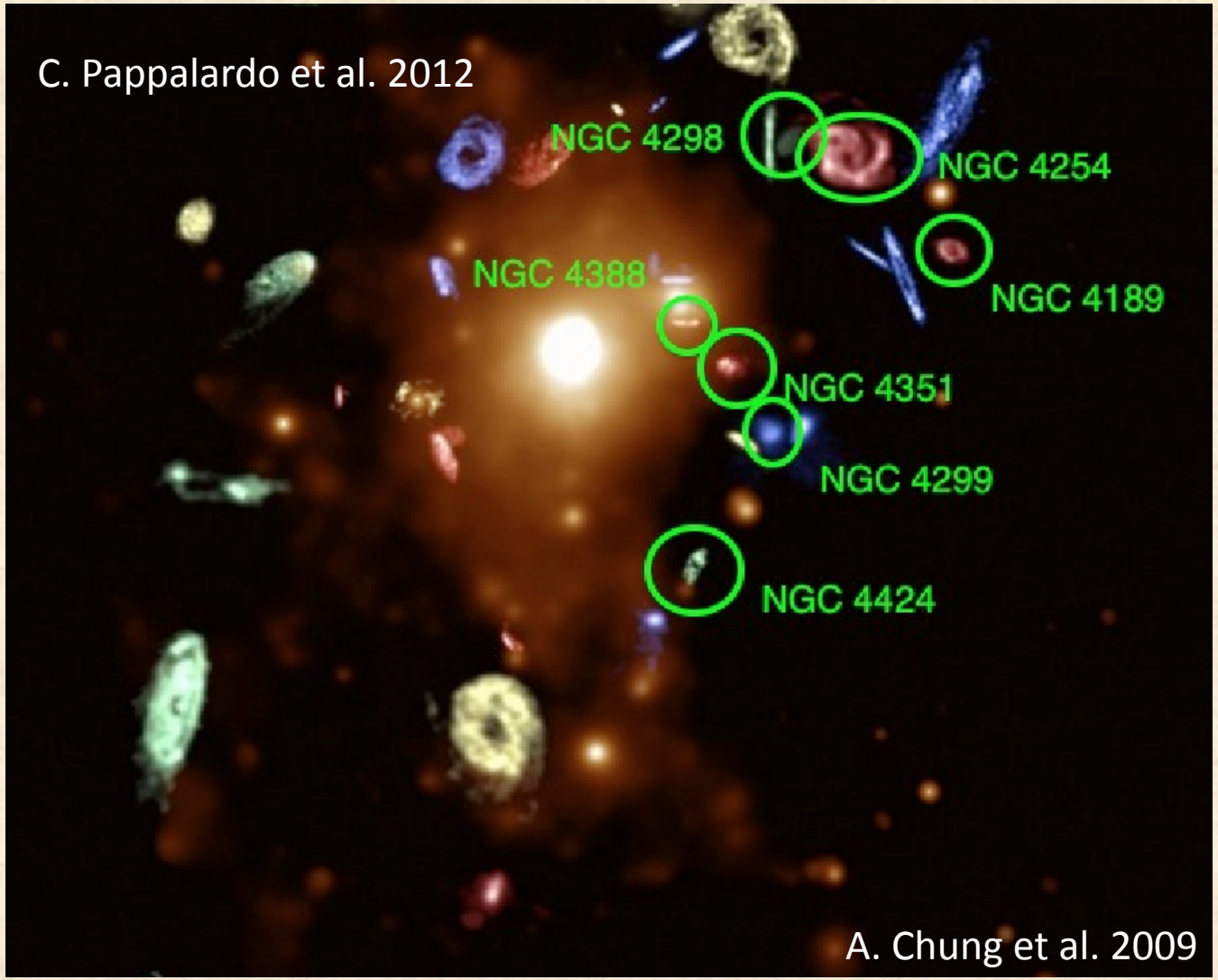
HI and dust removal

In Virgo, thanks to HeViCS we can look at HI as well as to the dust emission and mass. How does the environment affect the radial distribution of dust?
L.Cortese et al. 2010



CO: the IRAM-VLA sample

B<13mag
27 HeViCS

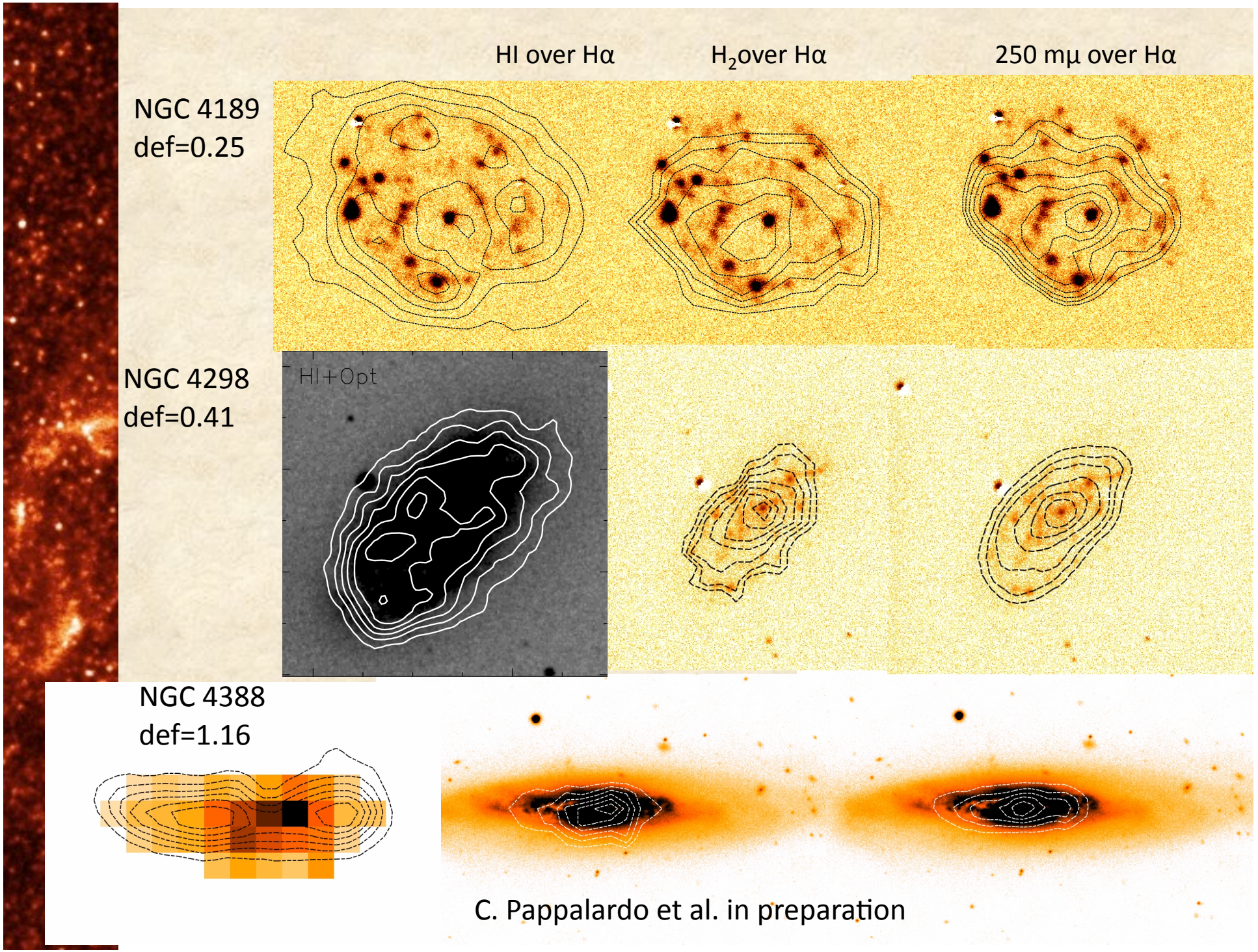


HI+H2 maps:
18 galaxies

HI+H2 det:
5 galaxies

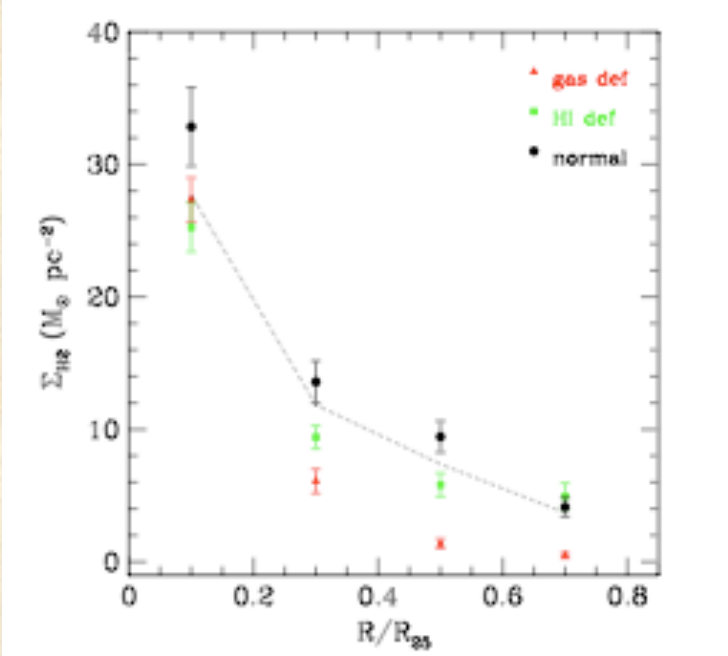
HI only:
4 galaxies

Goals:
-D/G
-SF eff.


HI over Hα
H_2over Hα
250 mμ over Hα
NGC 4189
def=0.25
NGC 4298
def=0.41
HI+Opt
NGC 4388
def=1.16
C. Pappalardo et al. in preparation

HI and H2 removal

Comparing field and cluster galaxies Fumagalli et al. 2008,2009 have shown that highly HI deficient galaxies have truncated H2 disks and SFR.



Molecular gas is often traced by

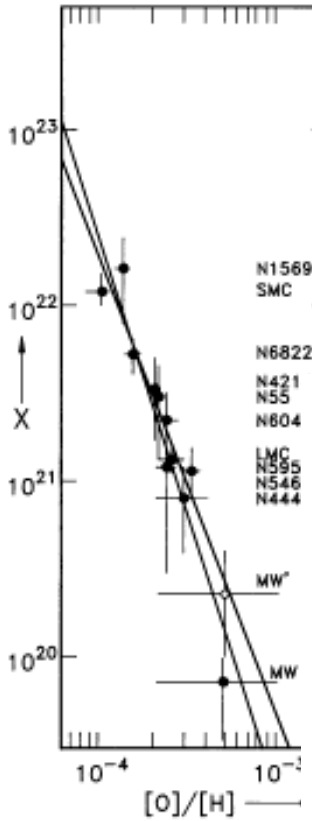
CO

The next most common molecule after H_2

Variations of metallicity and ISM conditions make the CO-H_2 relation non-linear

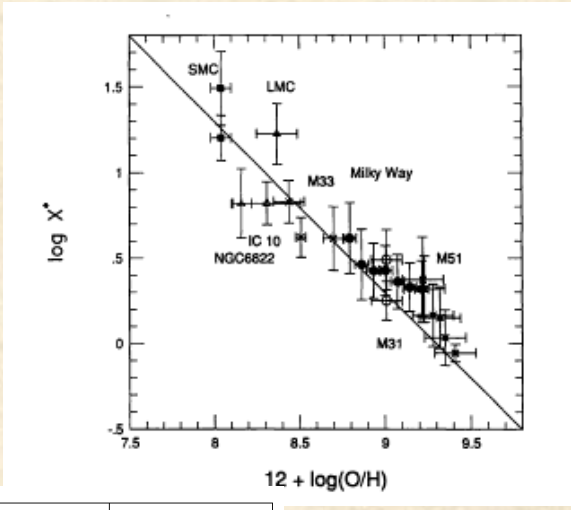
X_{CO} =Ratio of H_2 column density to CO intensity

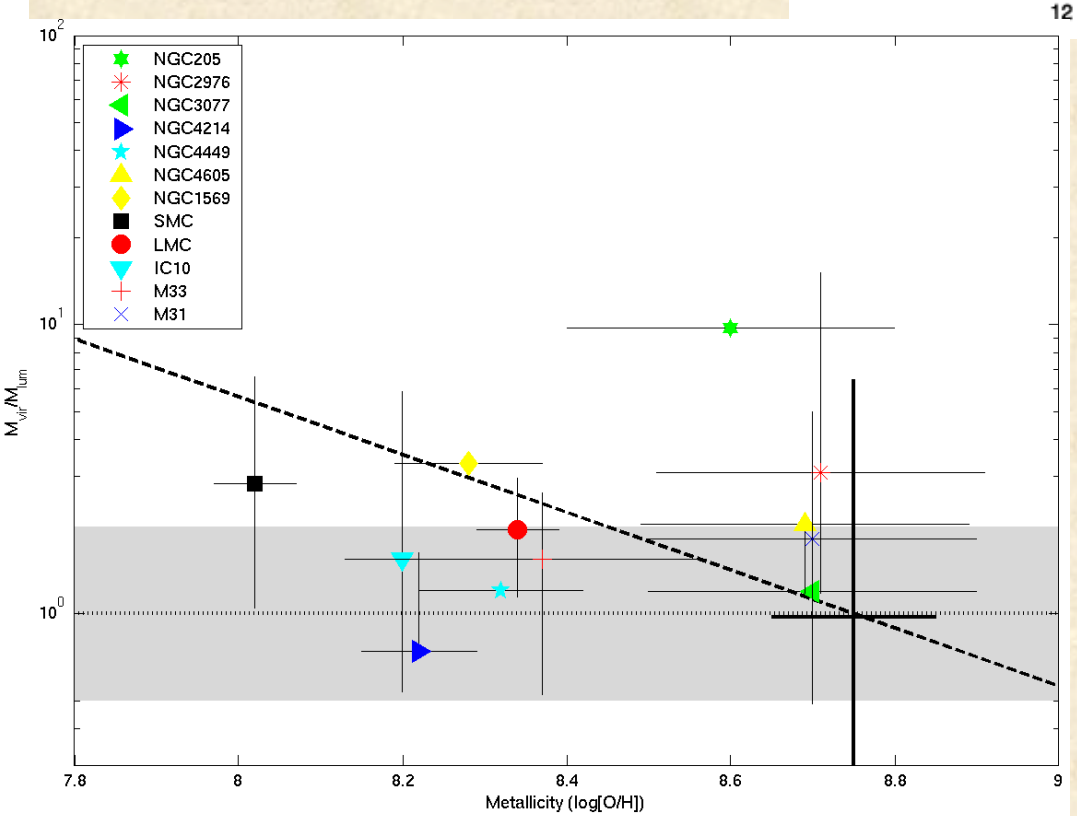
There is disagreement !



Israel (1997)

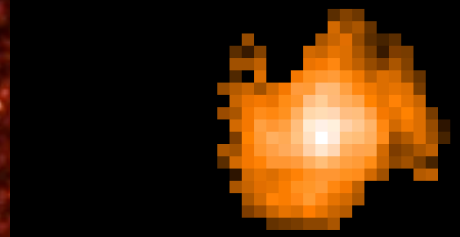
Bolatto et al. (2008)



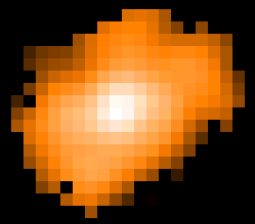


Arimoto+ '96

Dust-to-gas ratio versus metallicity: a constrain for Xco



Dust surface density map
Magrini et al. (2011)



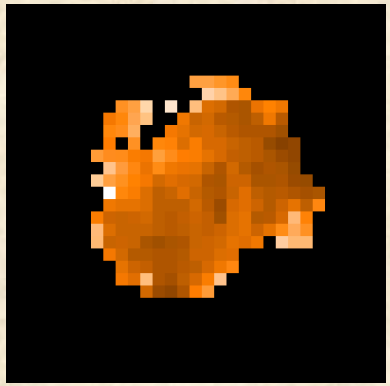
CO – Kuno et al. (2007)

HI – VIVA (Chung et al. 2009)

X_{CO}

H2
+
HI
surface
density

NGC 4321 – M100



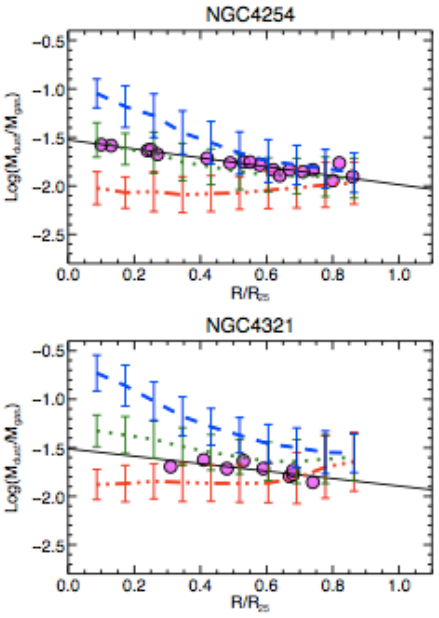
Dust to gas
Mass Ratio

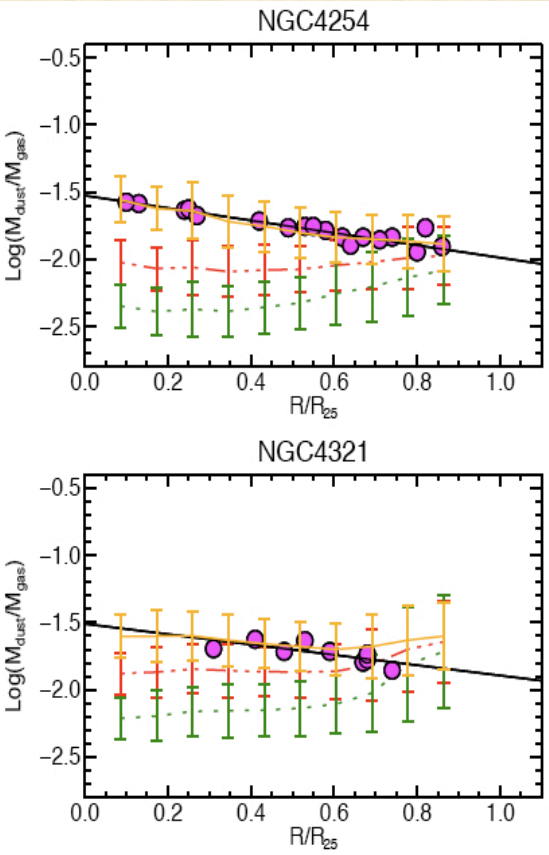
O/H radial gradient (center 9.1,9.25)
(Moustakas 2010)

Xco=1.8 10^{20}

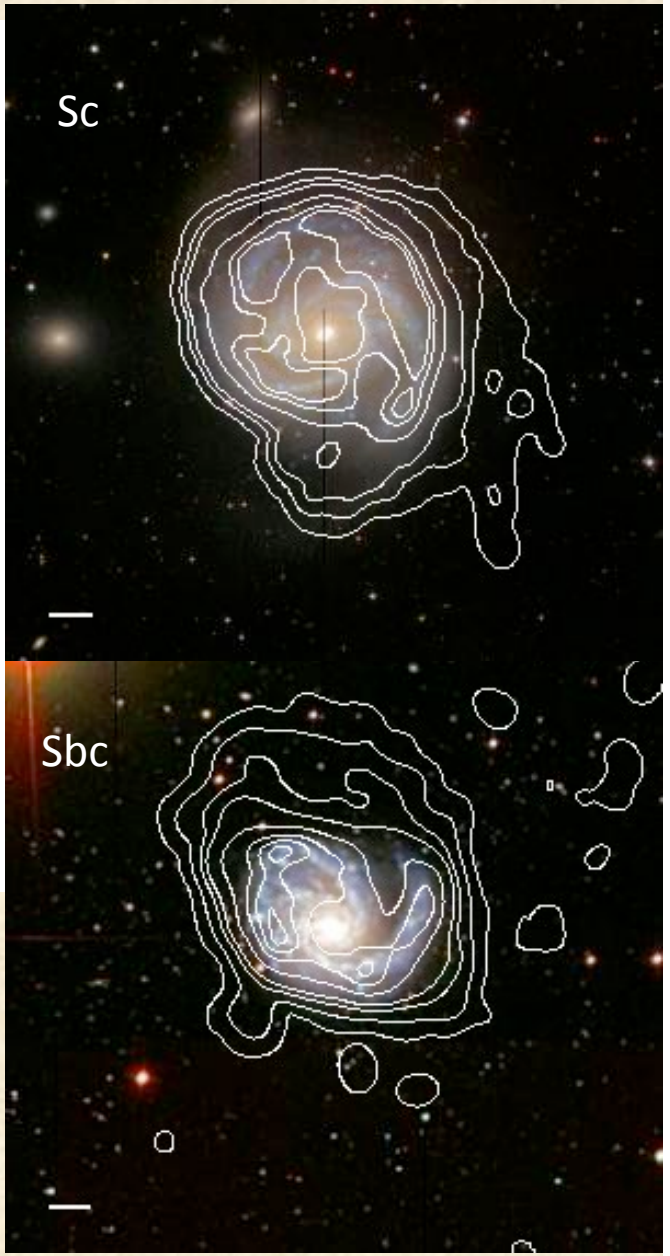
Xco=4 10^{20}

Xco=0.1-0.5 10^{20}
Best agreement O/H and dust-to gas





Xco linearly dependent on metallicity is OK



Magrini L. et al. 2011, A&A,535,13

Is the environment affecting the SF efficiency ?

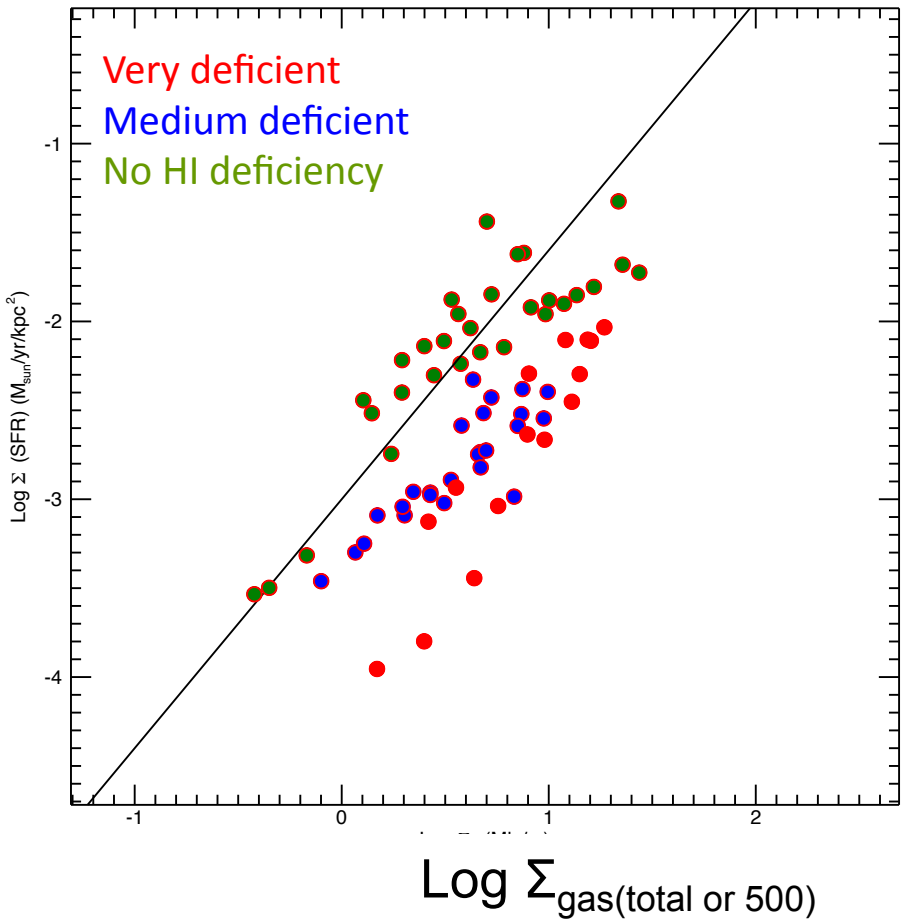
K-S law in bright galaxies

(Magrini et al. 2012)

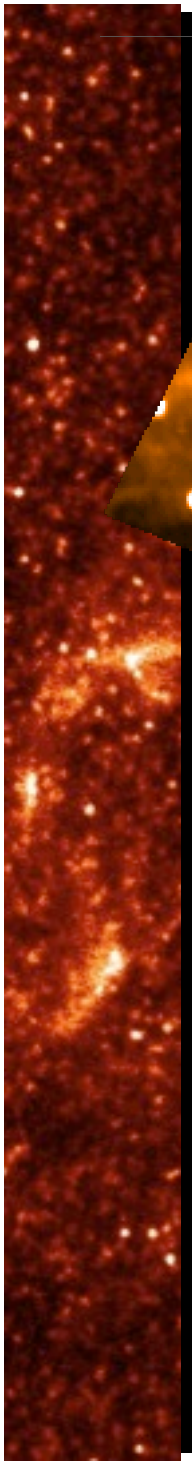
-Use Hα to trace SFR

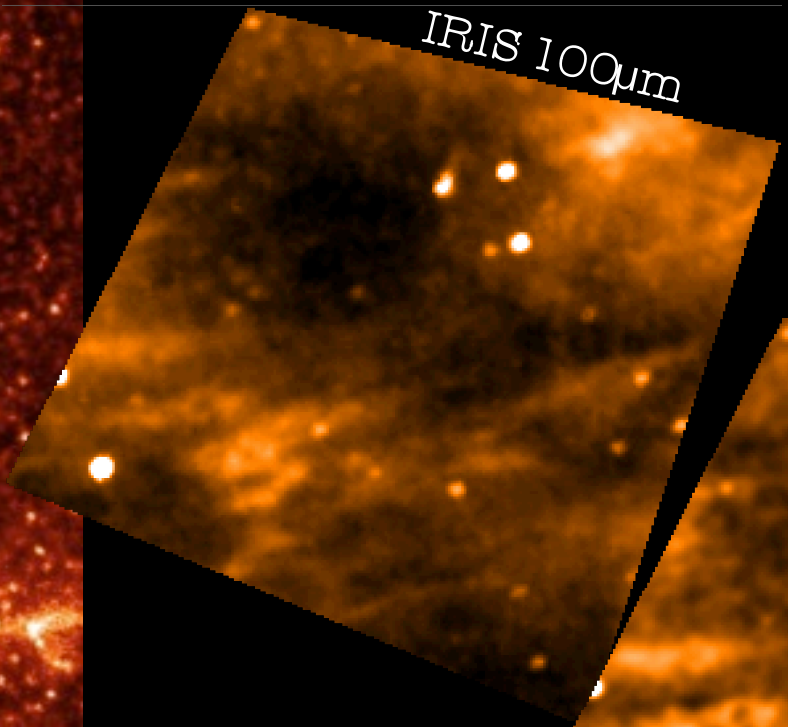
-Use HI+H_2 (from CO) or 500μm emission to trace the gas

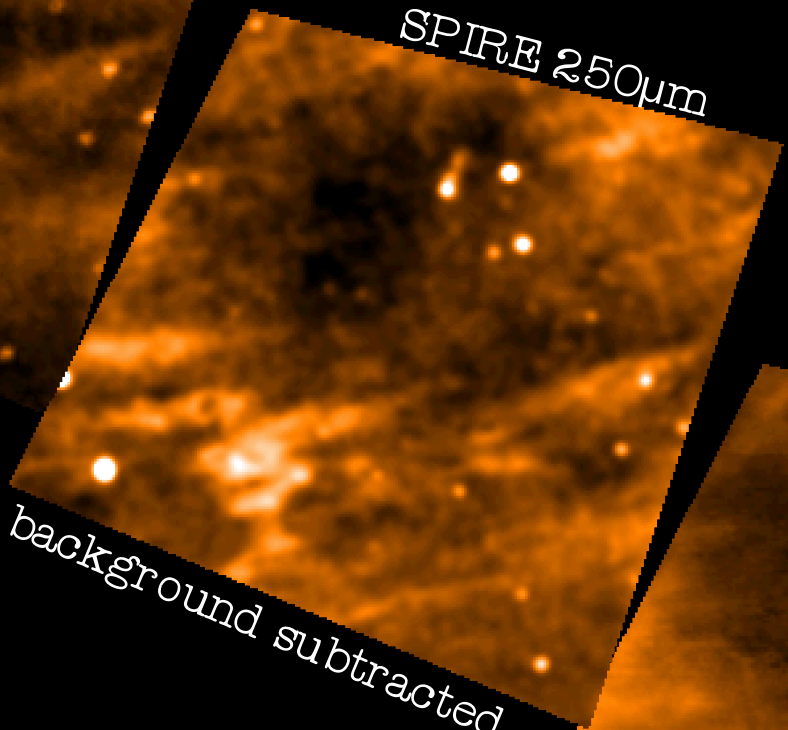
Work in progress…..

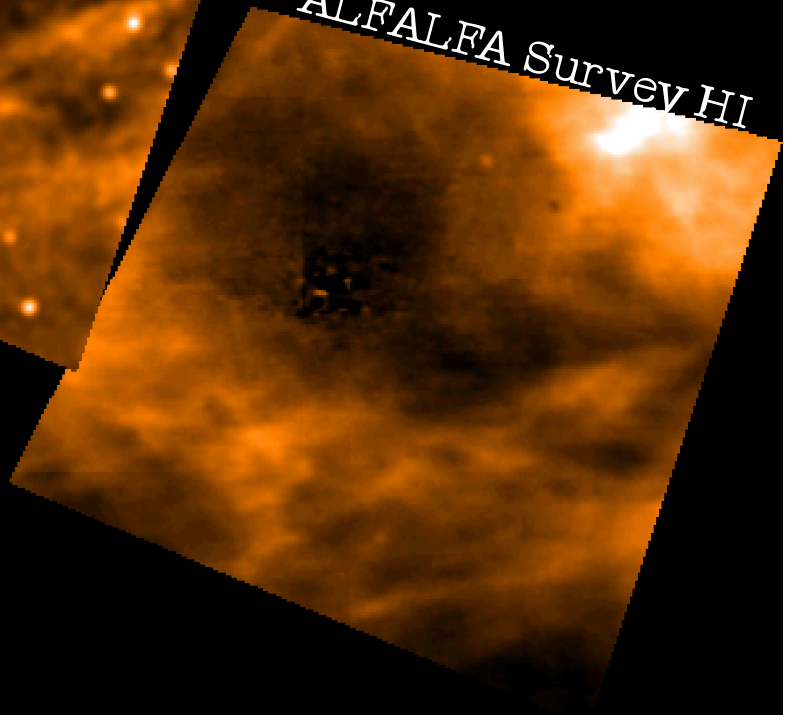


The intercluster dust





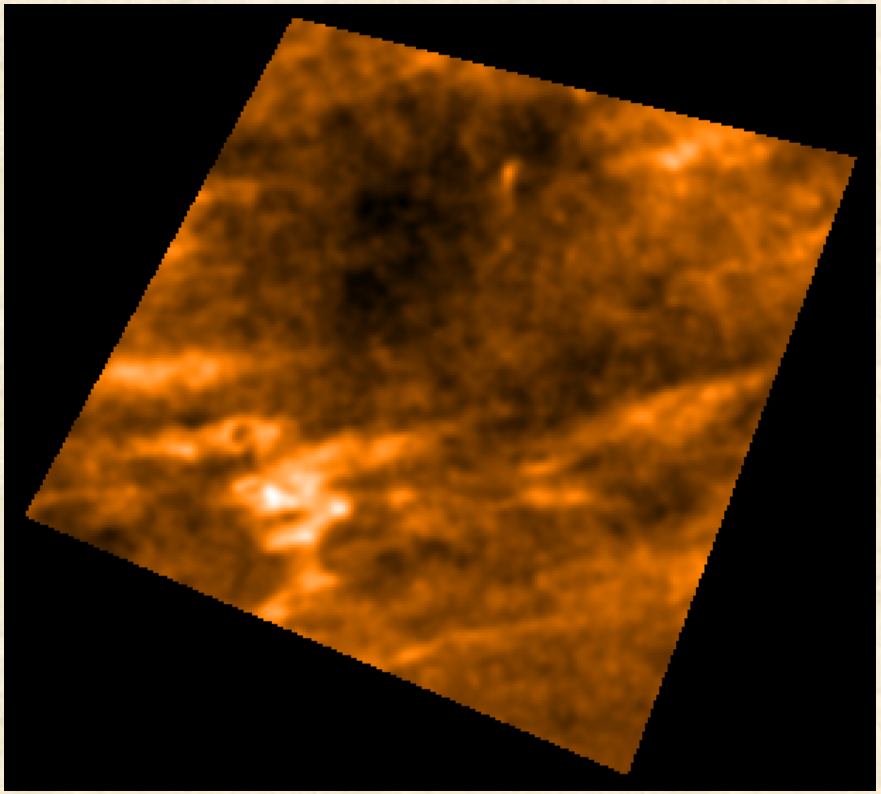




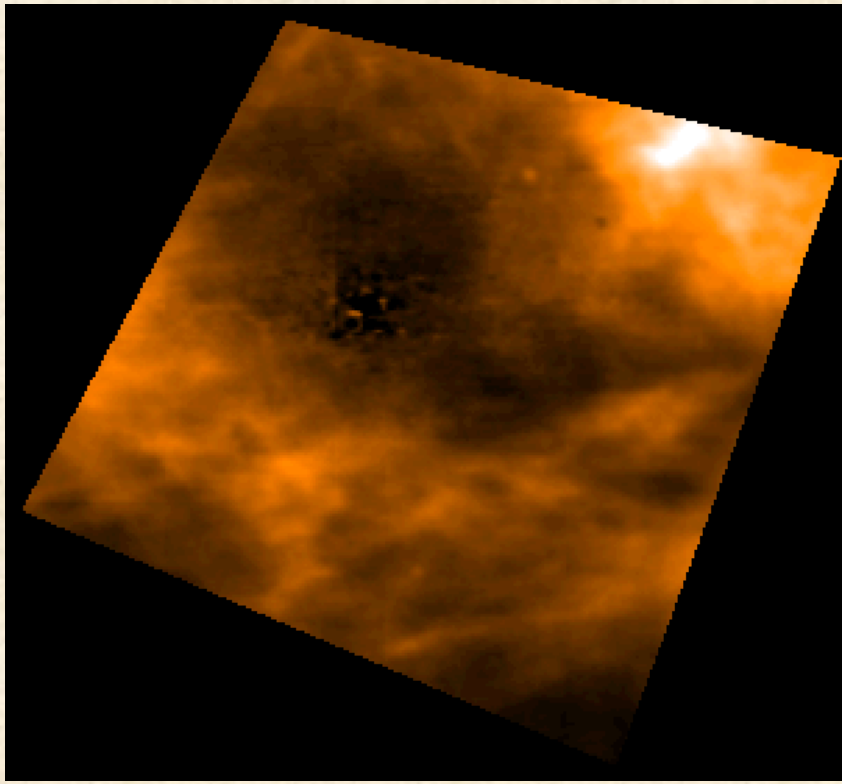
Work in progress (Bianchi,Giovanardi):
derive T, M and
dust emissivity τ/N_{HI}

SPIRE to HI: do we see intercluster dust ?

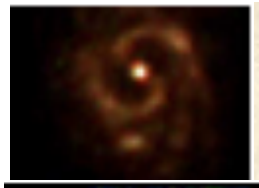
- mask all VCC objects (excluding dE and BCDs)
- convolution to ALFALFA beam



SPIRE 250μm, convolved to ALFALFA resolution



HI from ALFALFA (*all MW velocity channels)*



...but we do see many galaxies and background sources!!
(e.g.VCC, F_{500}>0.1Jy, D>1.4' Davies et al. 2011)