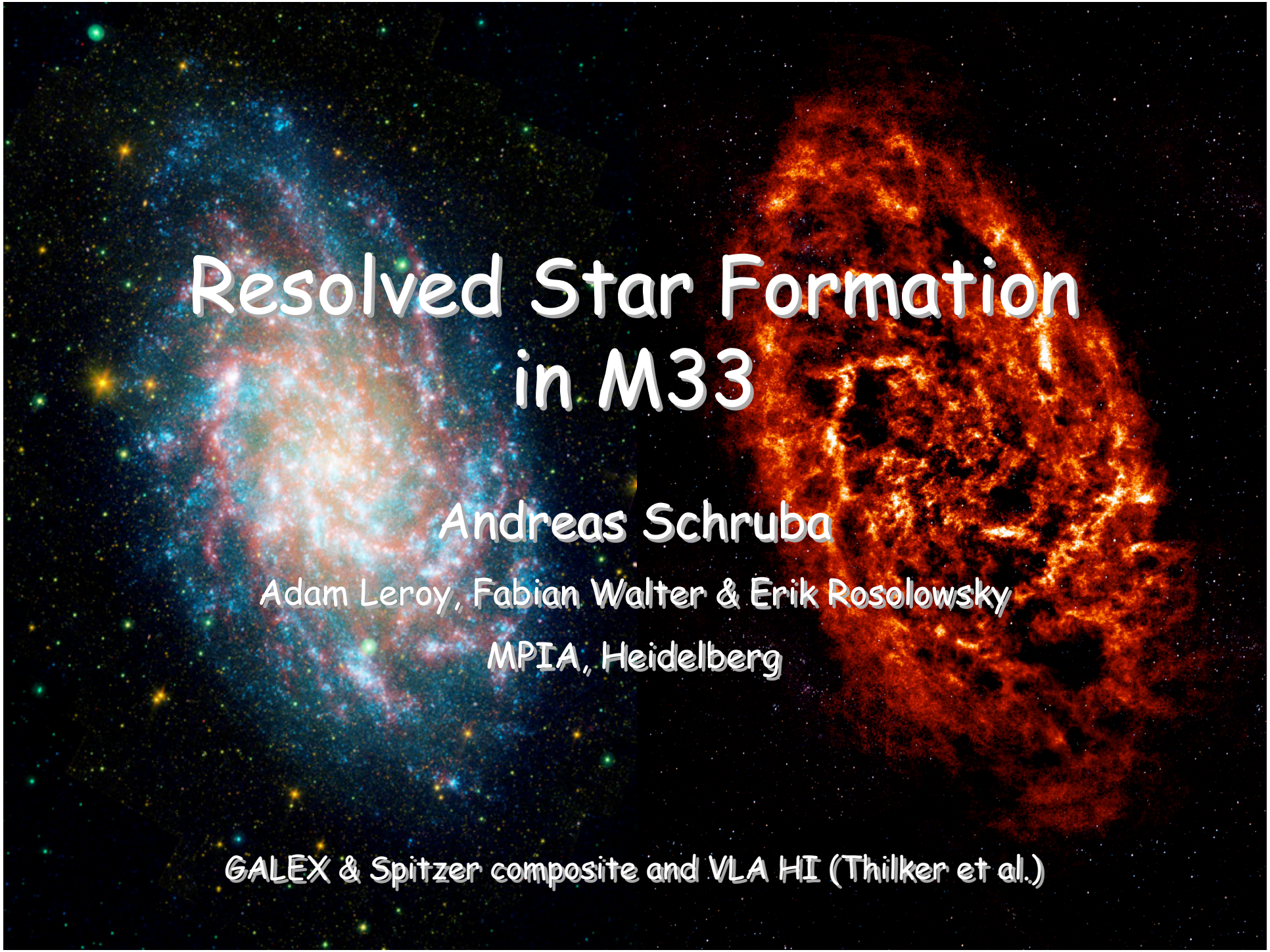
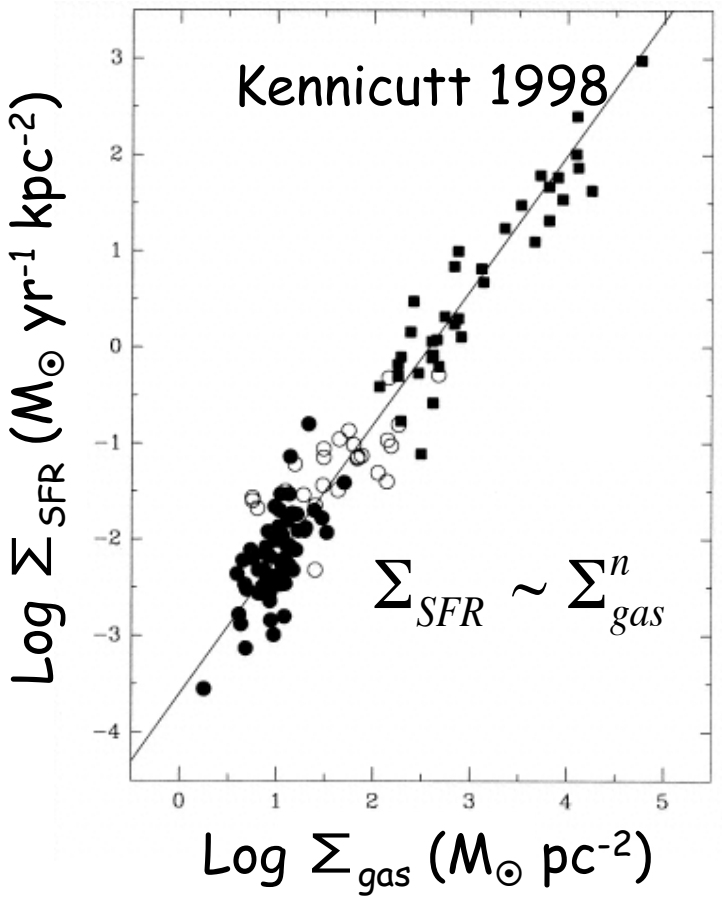

Resolved Star Formation
in M33
Andreas Schruba
Adam Leroy, Fabian Walter & Erik Rosolowsky
MPIA, Heidelberg
GALEX & Spitzer composite and VLA HI (Thilker et al.)

Star Formation Law

… the global picture

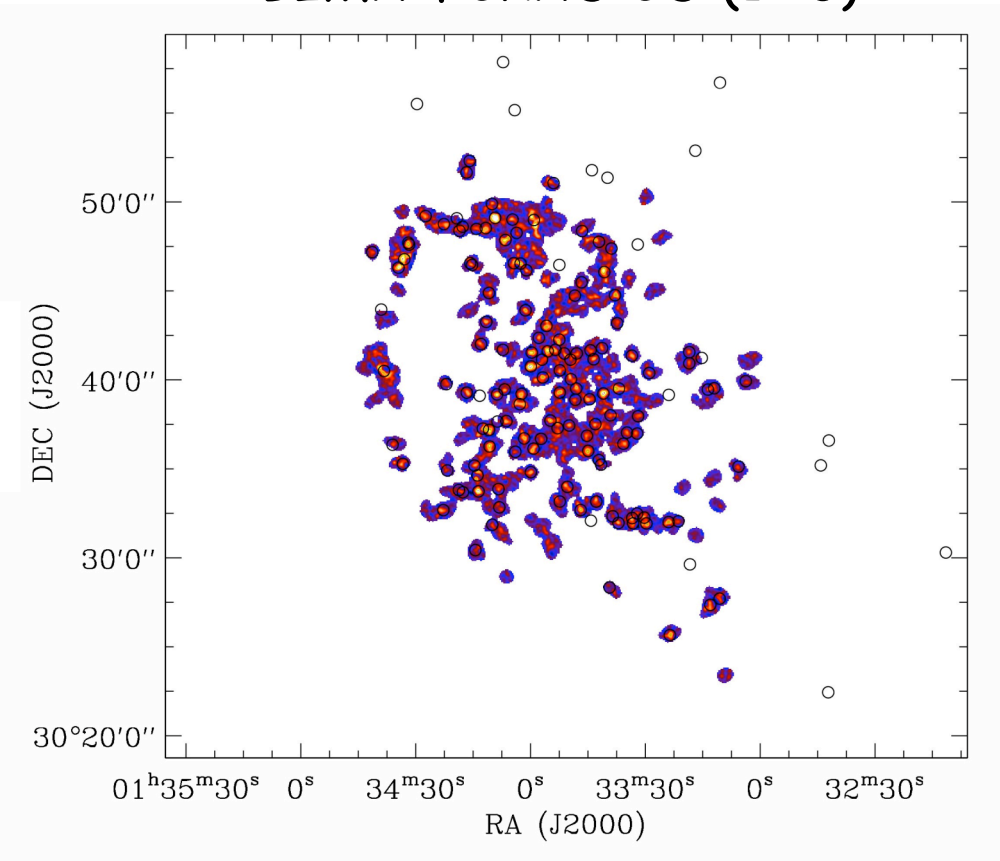


… the small scale picture

Newly formed stars and molecular gas are displaced
=> scaling relation has to end at some spatial scale

Why M33 ?

BIMA+FCRAO CO (1->0)



Distance ~850 kpc

=> resolvable at ~40pc (10″)
~ size of GMC

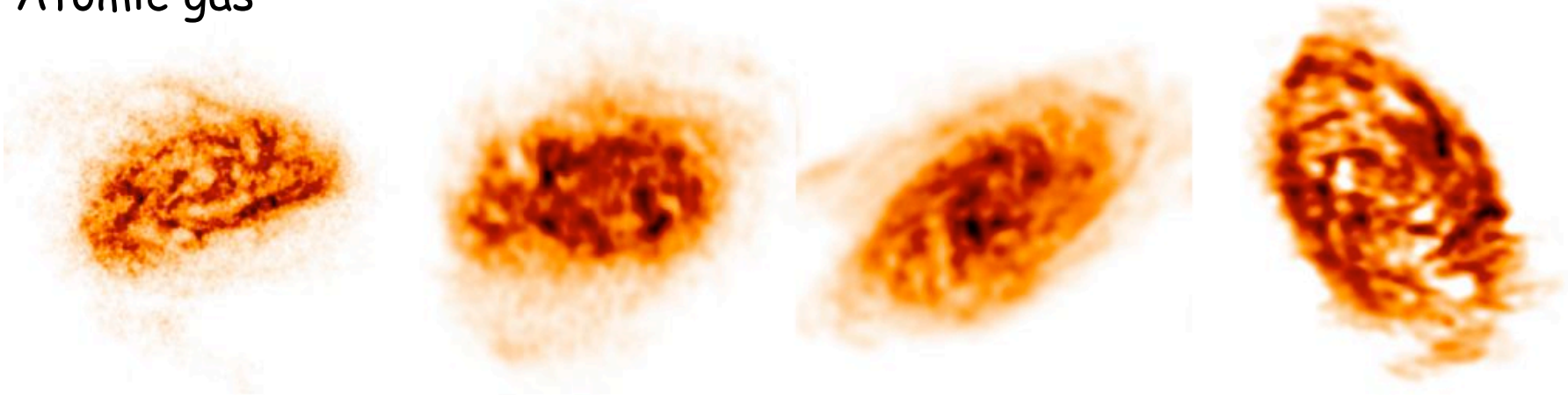
Catalog of 149 *individual GMCs* by Rosolowsky et al. 2007

- position
- cloud mass
- complete to $1.3 \cdot 10^5$ $M_\odot$

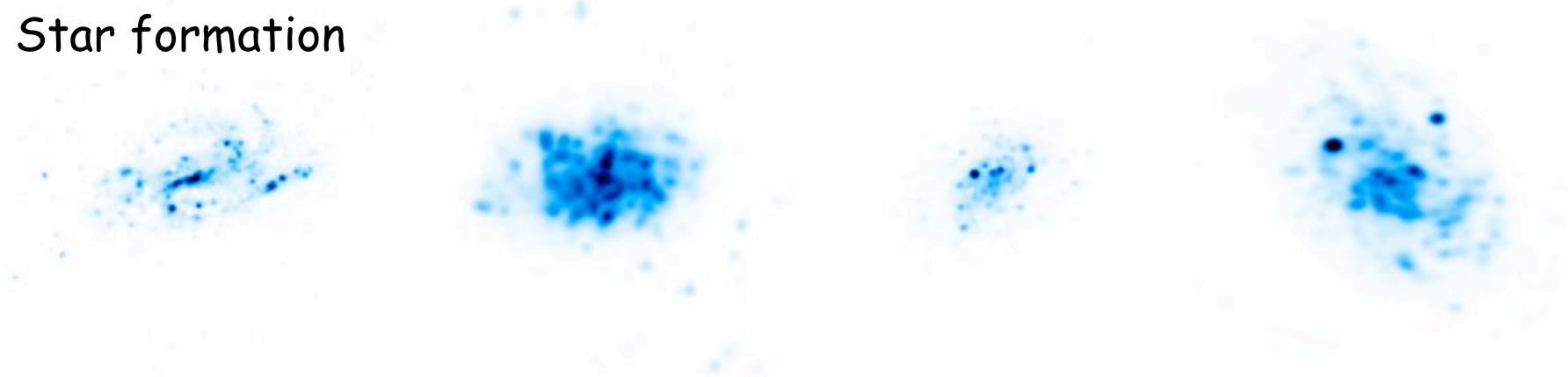
Rosolowsky et al. 2007 combining data from
BIMA: Engargiola et al. 2003 and FCRAO: Heyer et al. 2004

Is M33 special ?

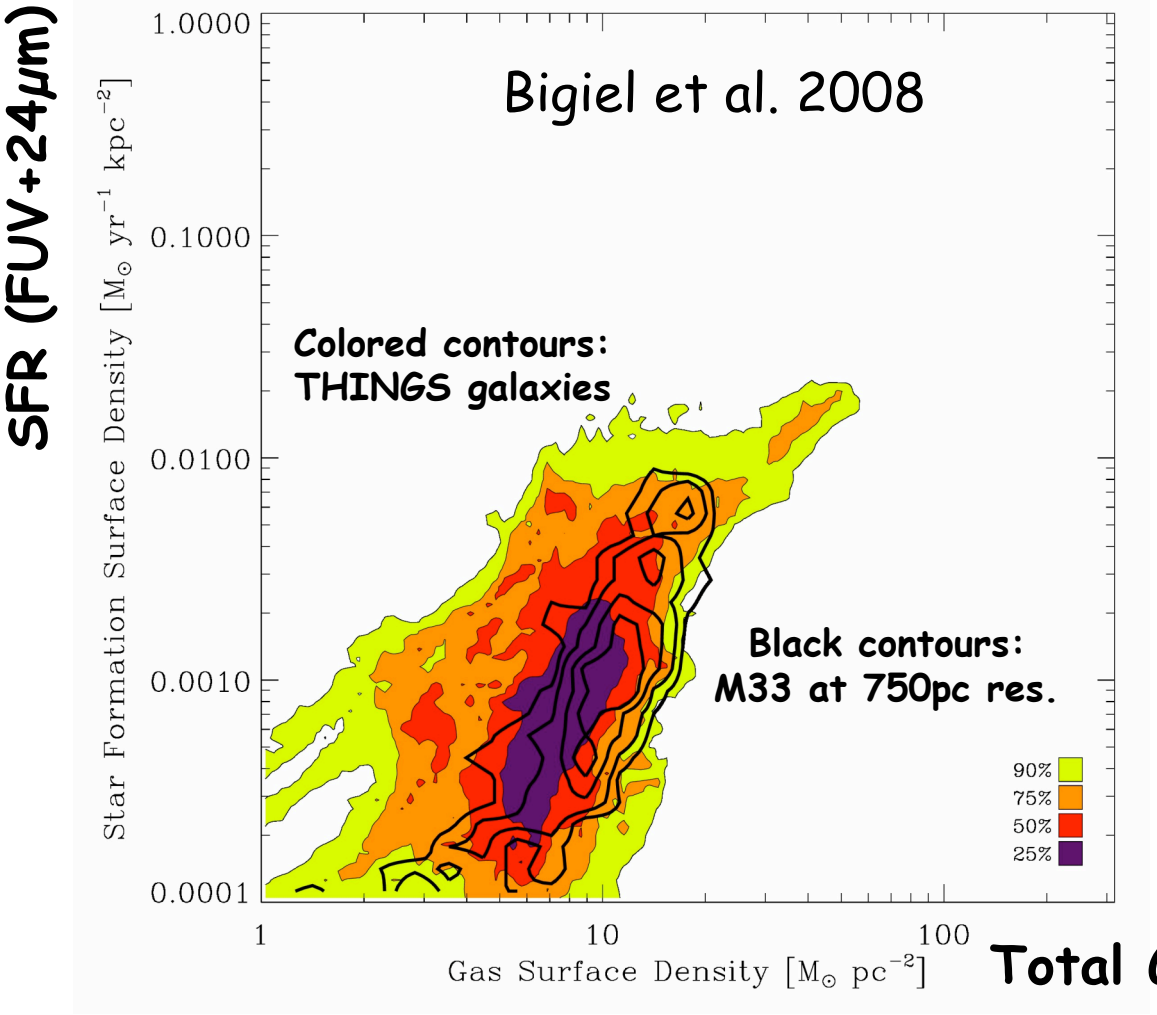
Atomic gas



Star formation

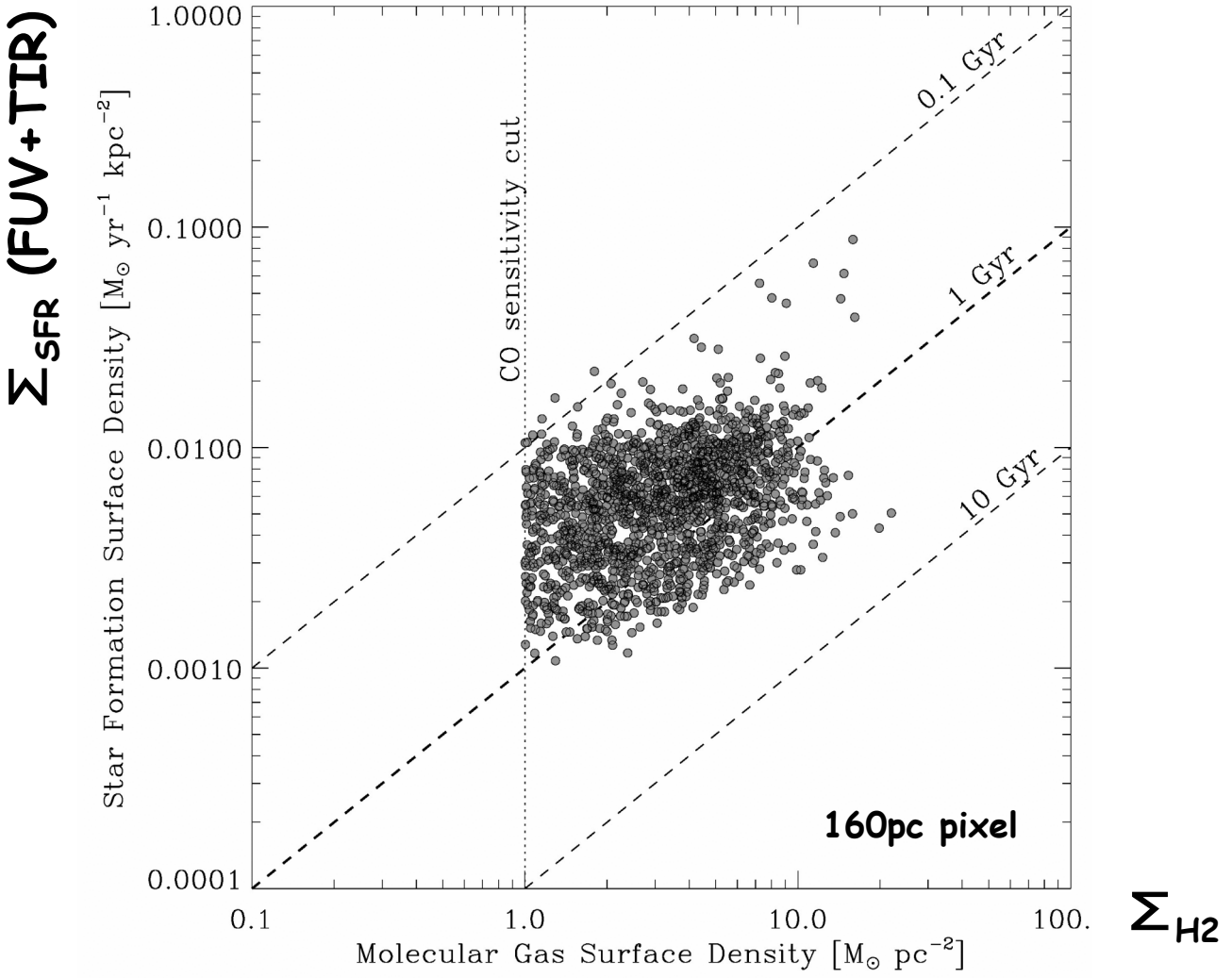


M33 and nearby galaxies

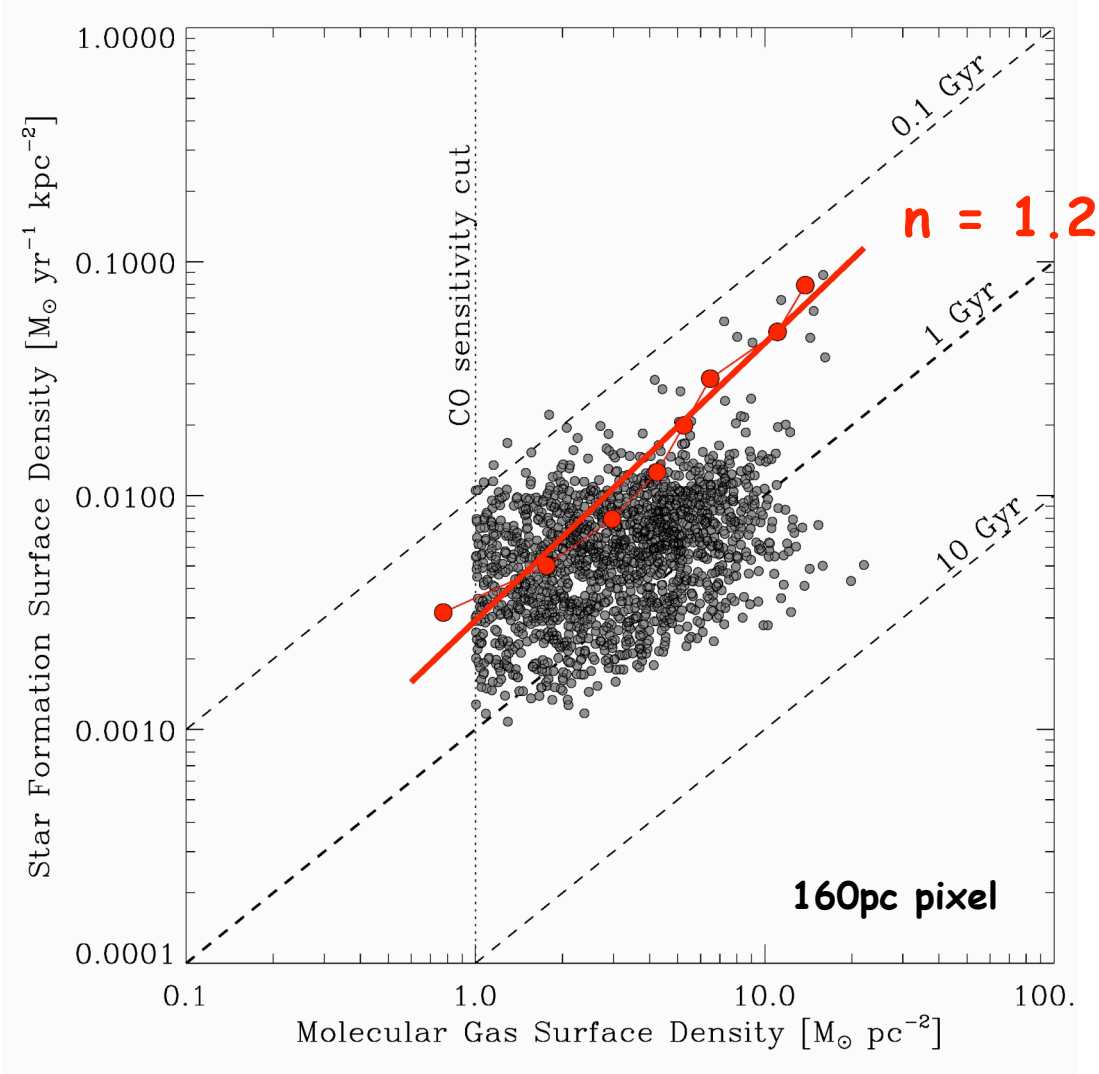


HI: Deul & van der Hulst; CO: Rosolowsky et al. ; IR: Gerhz et al. ; FUV: Thilker et al.

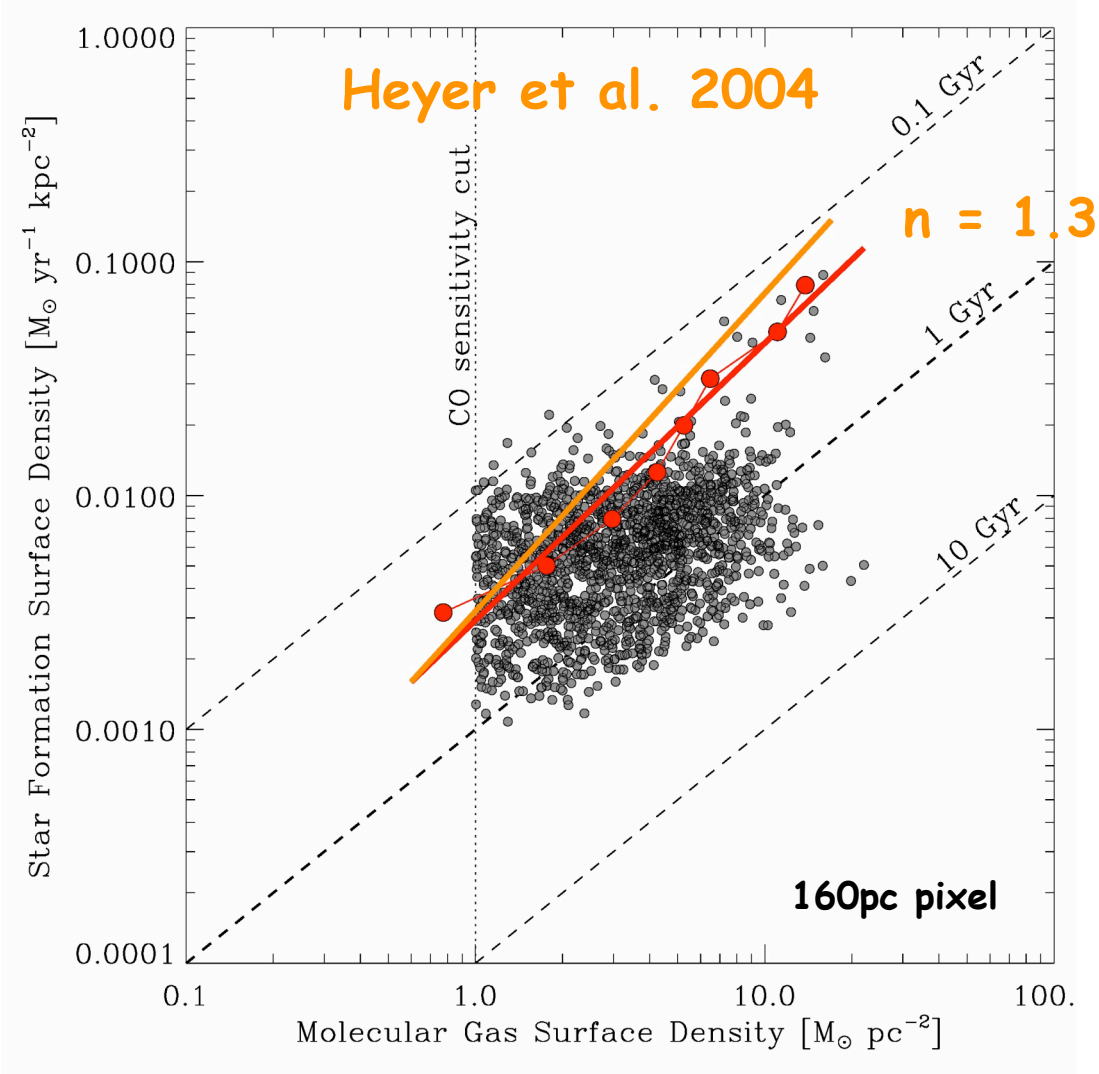
SFR vs. H_2 Pixel-by-Pixel



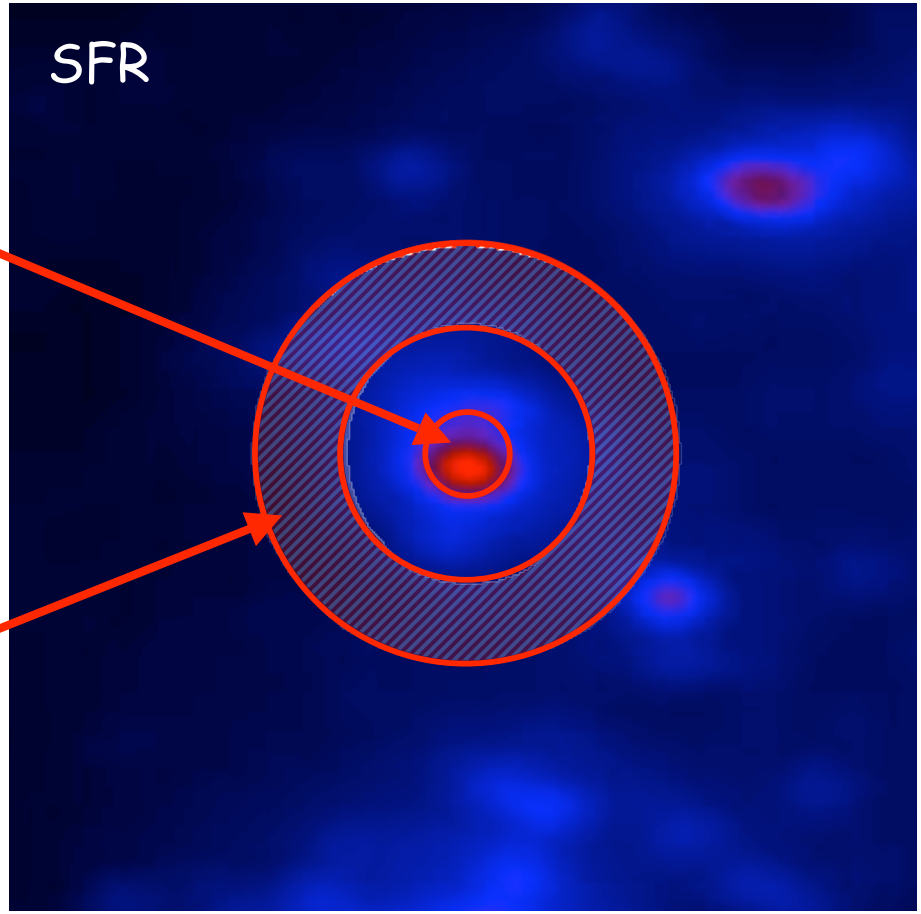
SFR vs. H_2 binned by SFR



SFR vs. H_2 Radial Profile



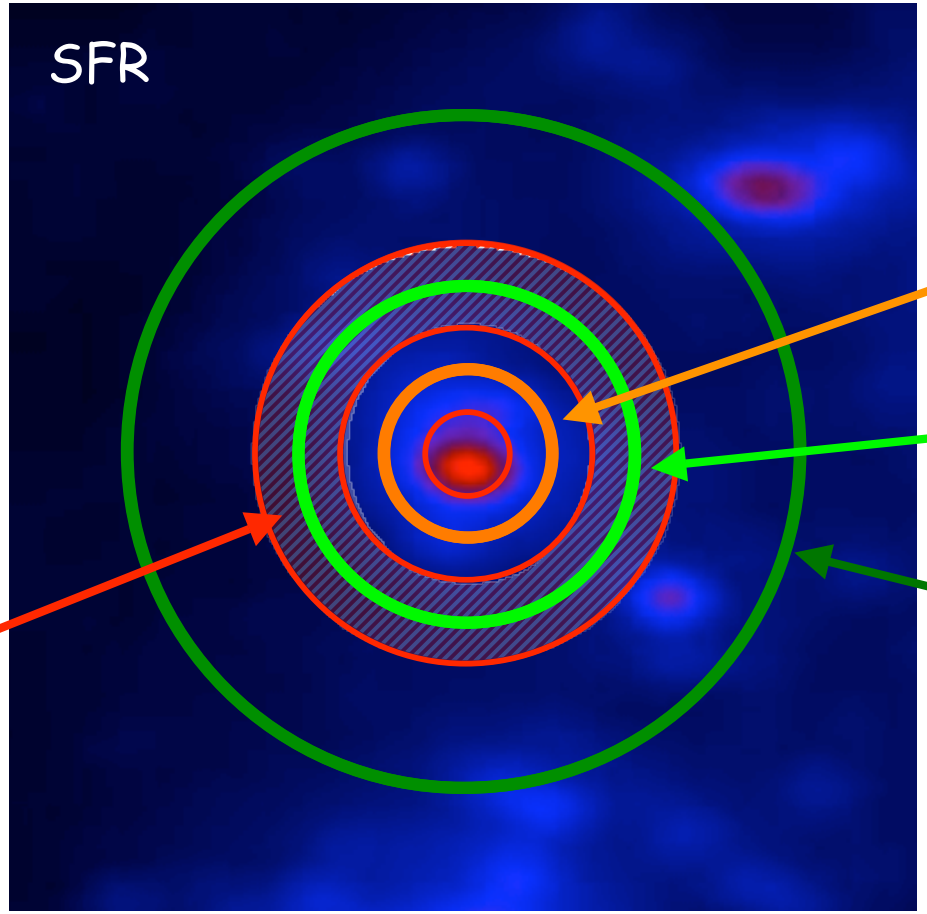
75pc Aperture



Catalog by Rosolowsky et al.
- GMC position
- GMC mass

Aperture:
- local SFR

Larger Apertures



diameter of…

150pc

300pc

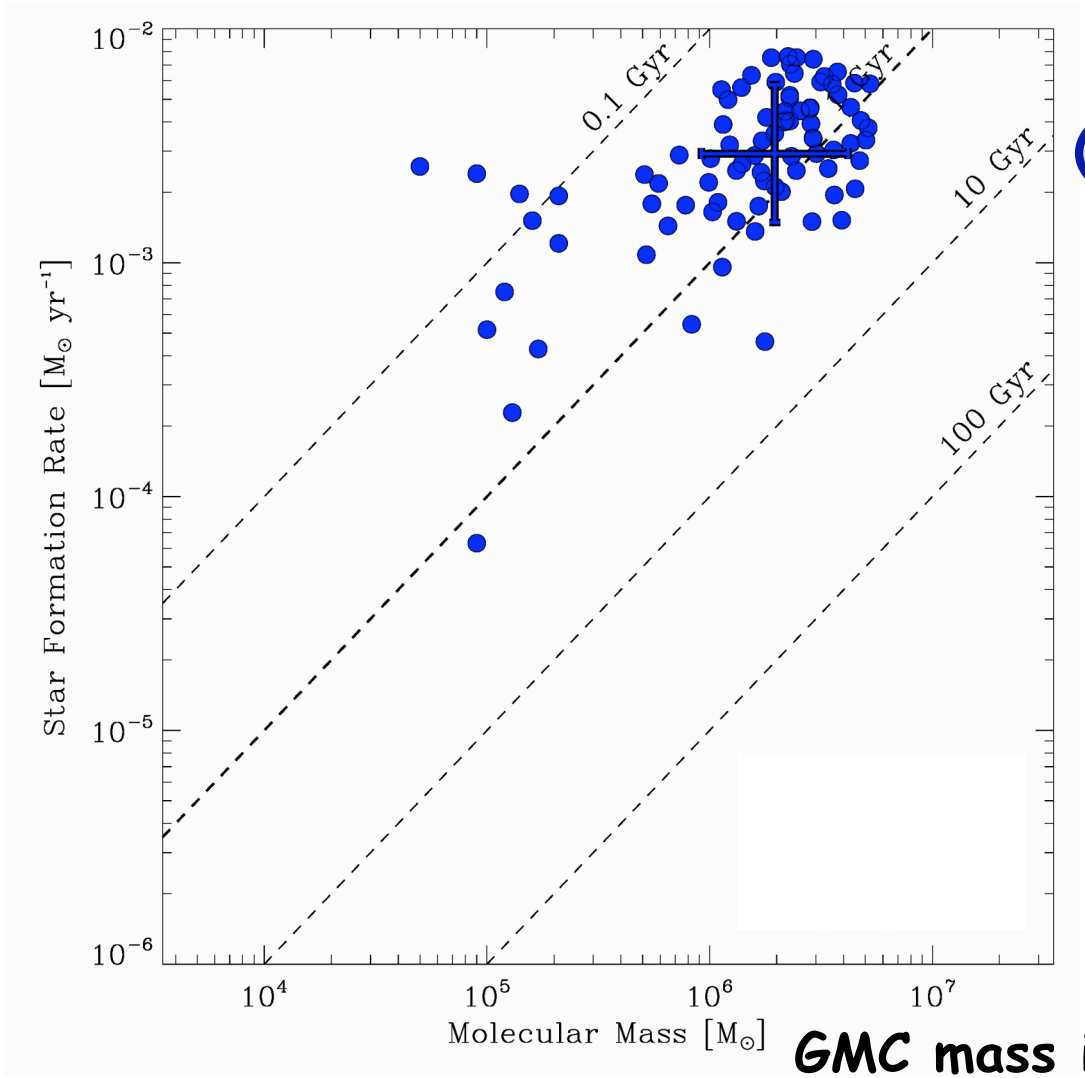
600pc

1200pc

background measurement stays the same

Aperture Measurements

SFR in aperture

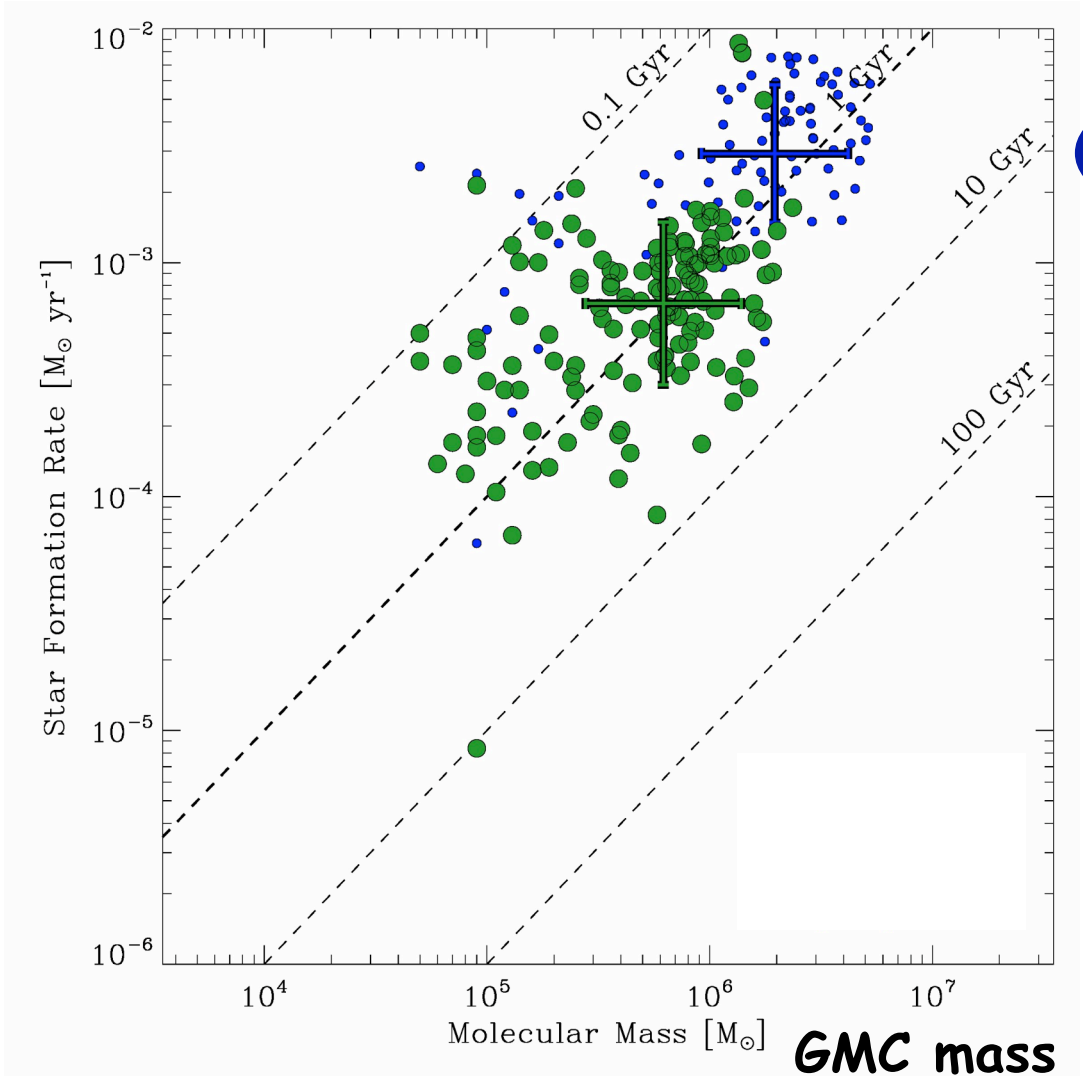


1200pc

GMC mass in aperture

Aperture Measurements

SFR in aperture



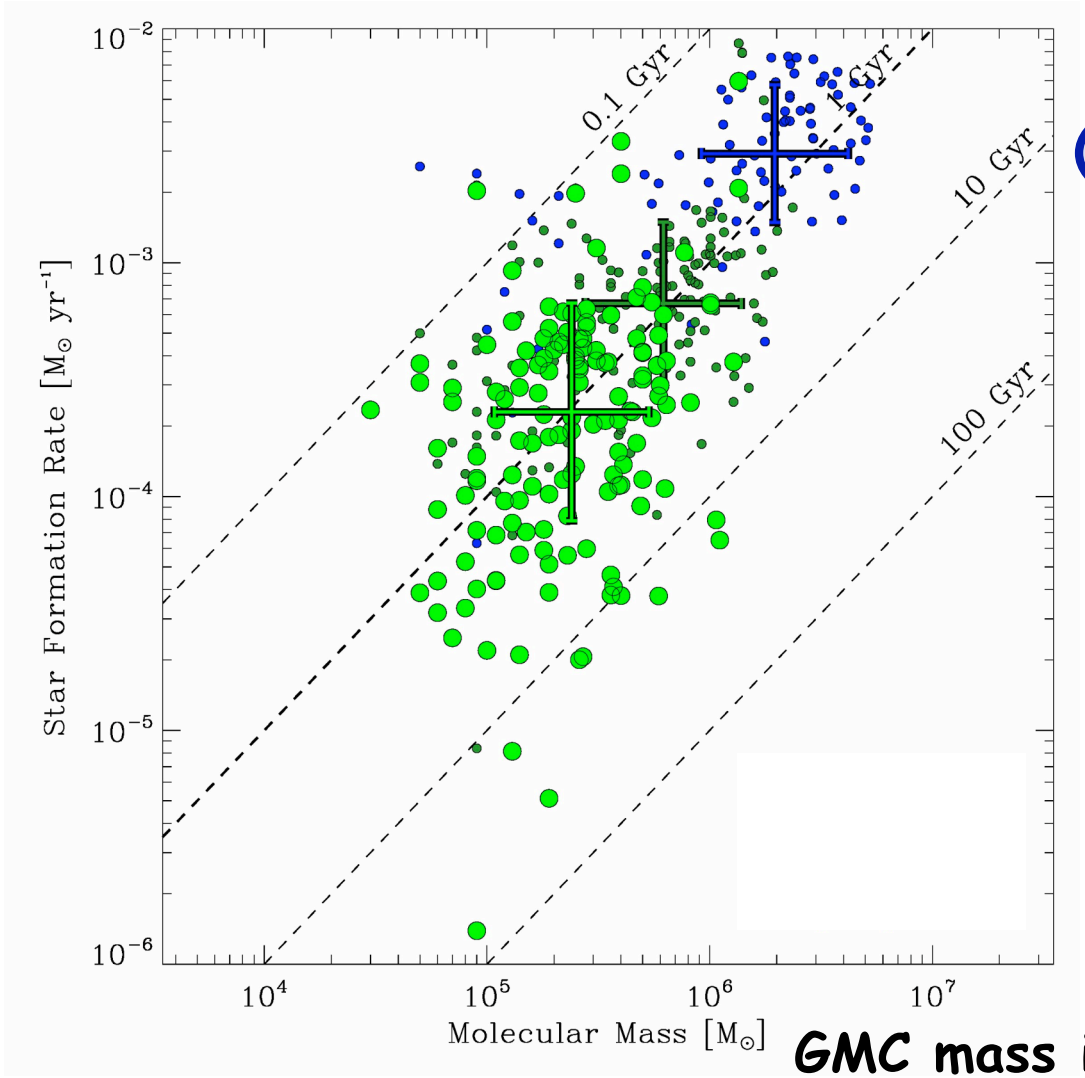
1200pc

600pc

GMC mass in aperture

Aperture Measurements

SFR in aperture



1200pc

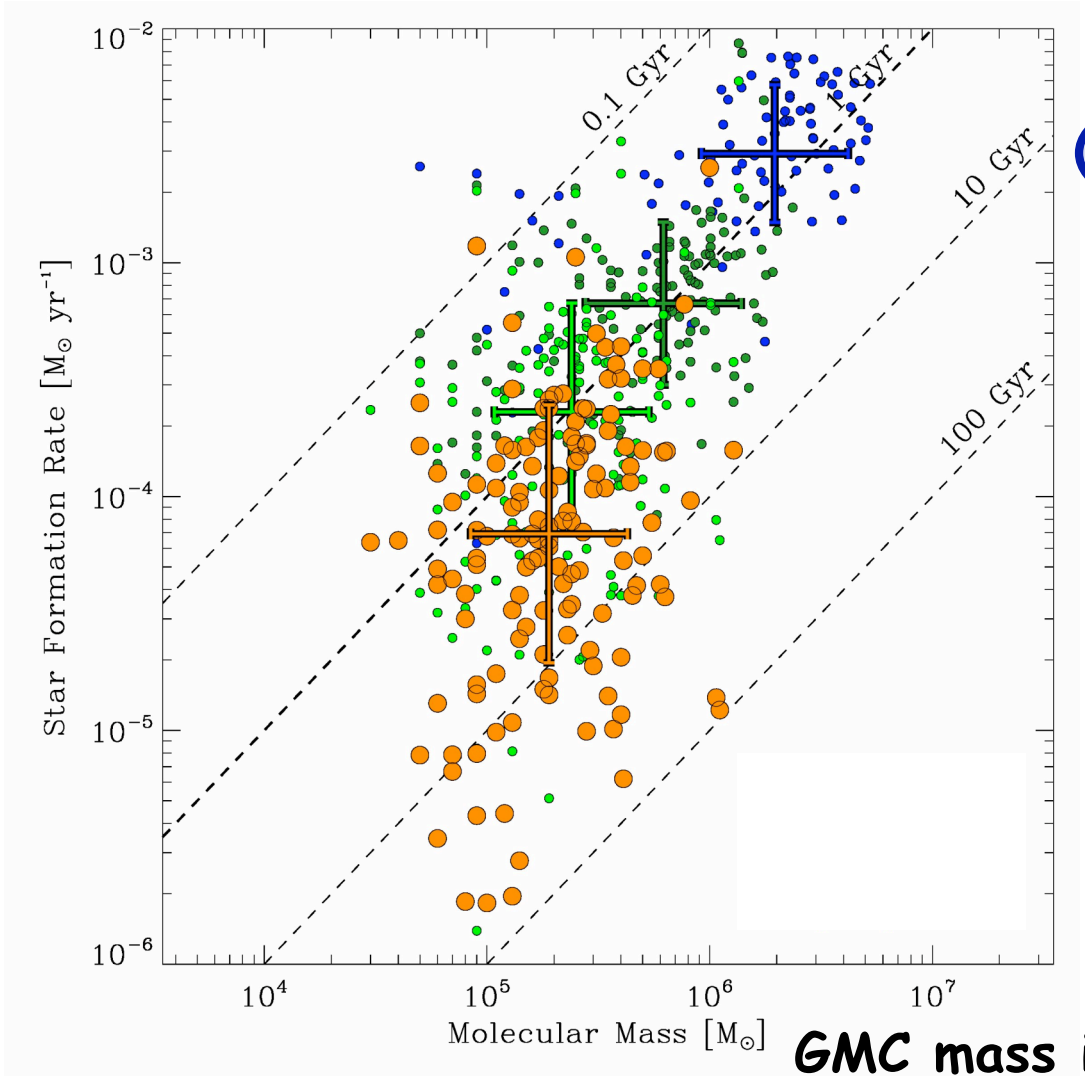
600pc

300pc

GMC mass in aperture

Aperture Measurements

SFR in aperture



1200pc

600pc

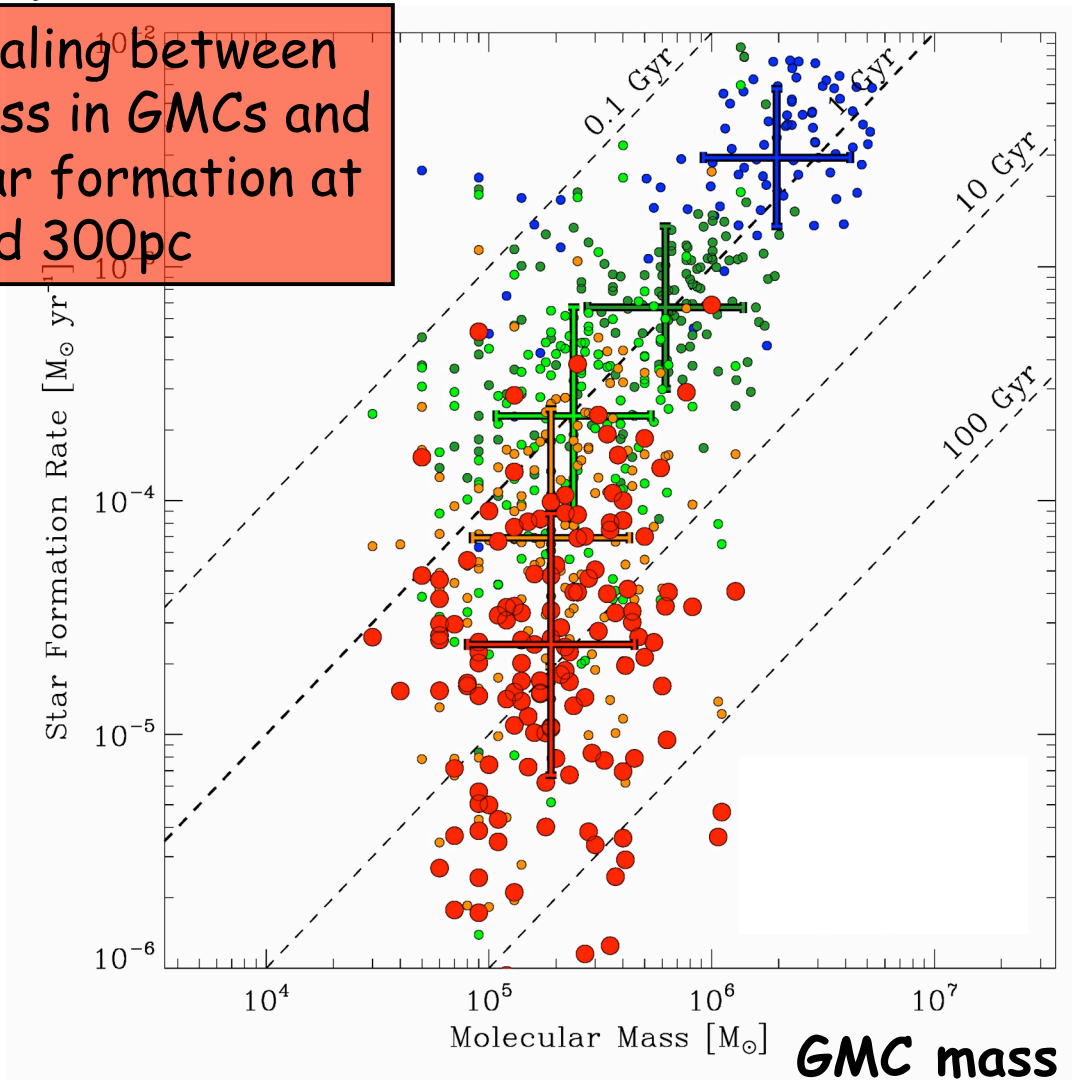
300pc

150pc

GMC mass in aperture

Aperture Measurements

Break of scaling between molecular mass in GMCs and observed star formation at around 300pc



1200pc

600pc

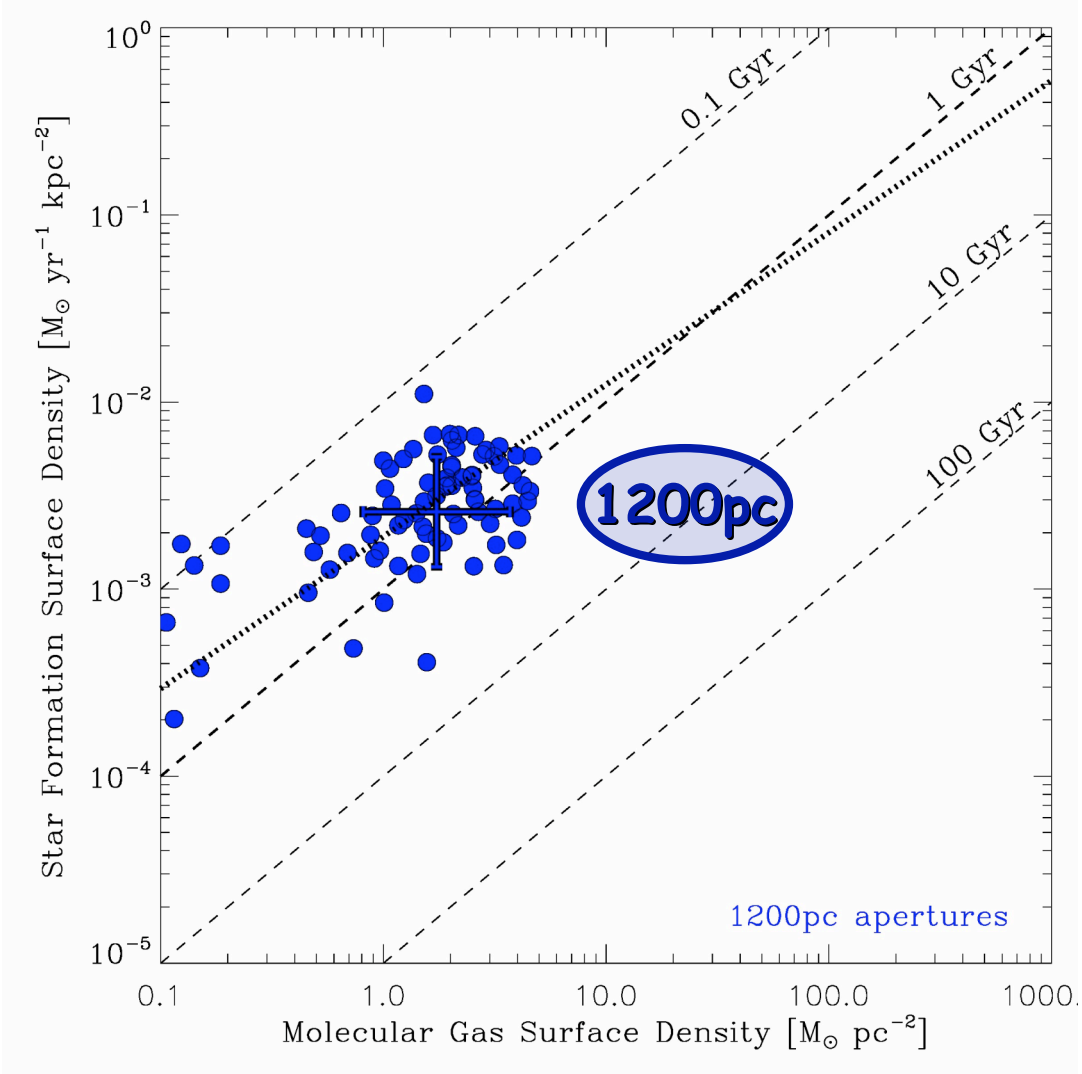
300pc

150pc

75pc

GMC mass in aperture

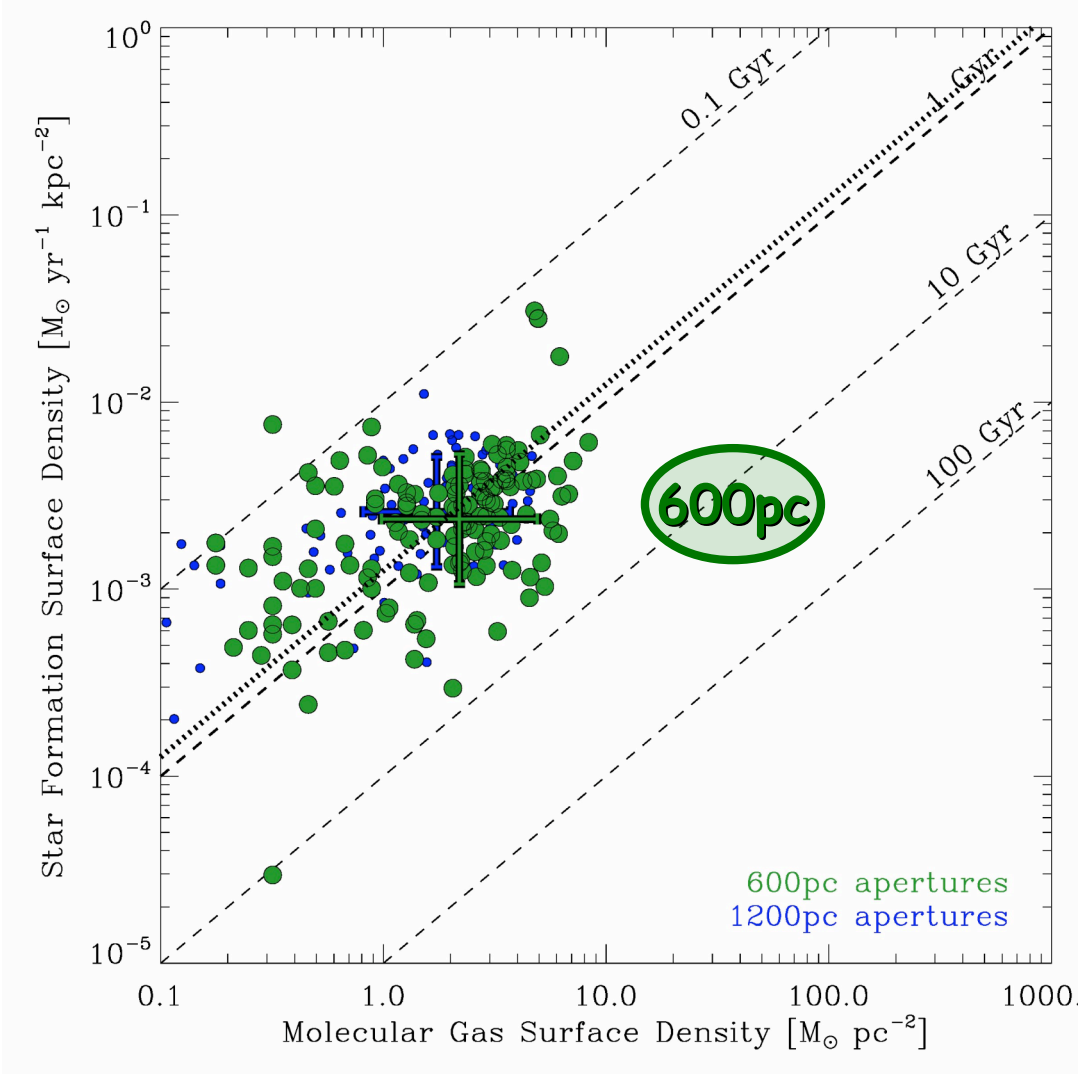
Gas & SF Surface Density



Rank corr.
0.5

Slope:
0.8 ± 0.3

Gas & SF Surface Density



Rank corr.

0.52

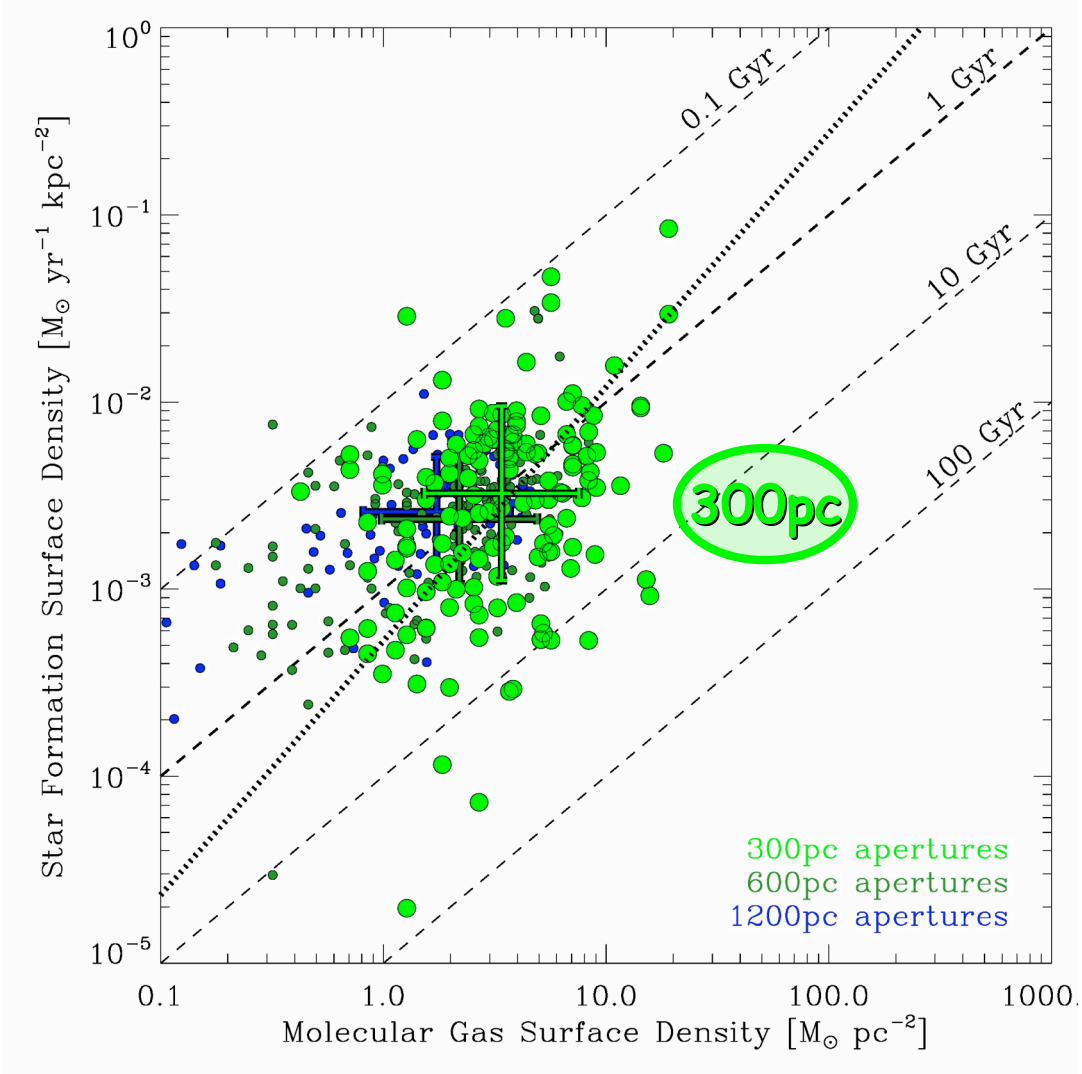
0.49

Slope:

0.8 ± 0.3

1.0 ± 0.4

Gas & SF Surface Density



Rank corr.

0.52

0.49

0.34

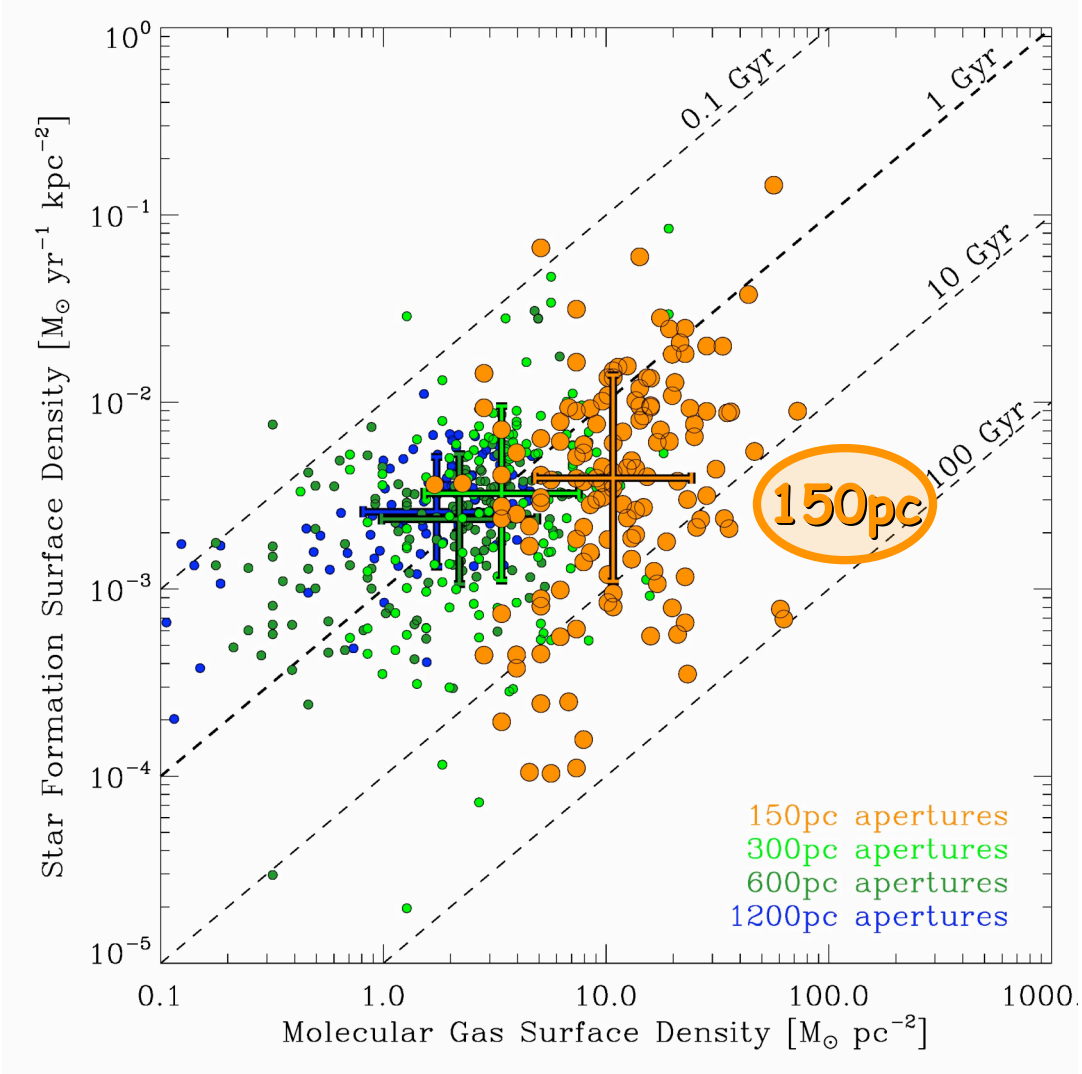
Slope:

0.8 ± 0.3

1.0 ± 0.4

1.4 ± 0.6

Gas & SF Surface Density



Rank corr.

0.52

0.49

0.34

0.28

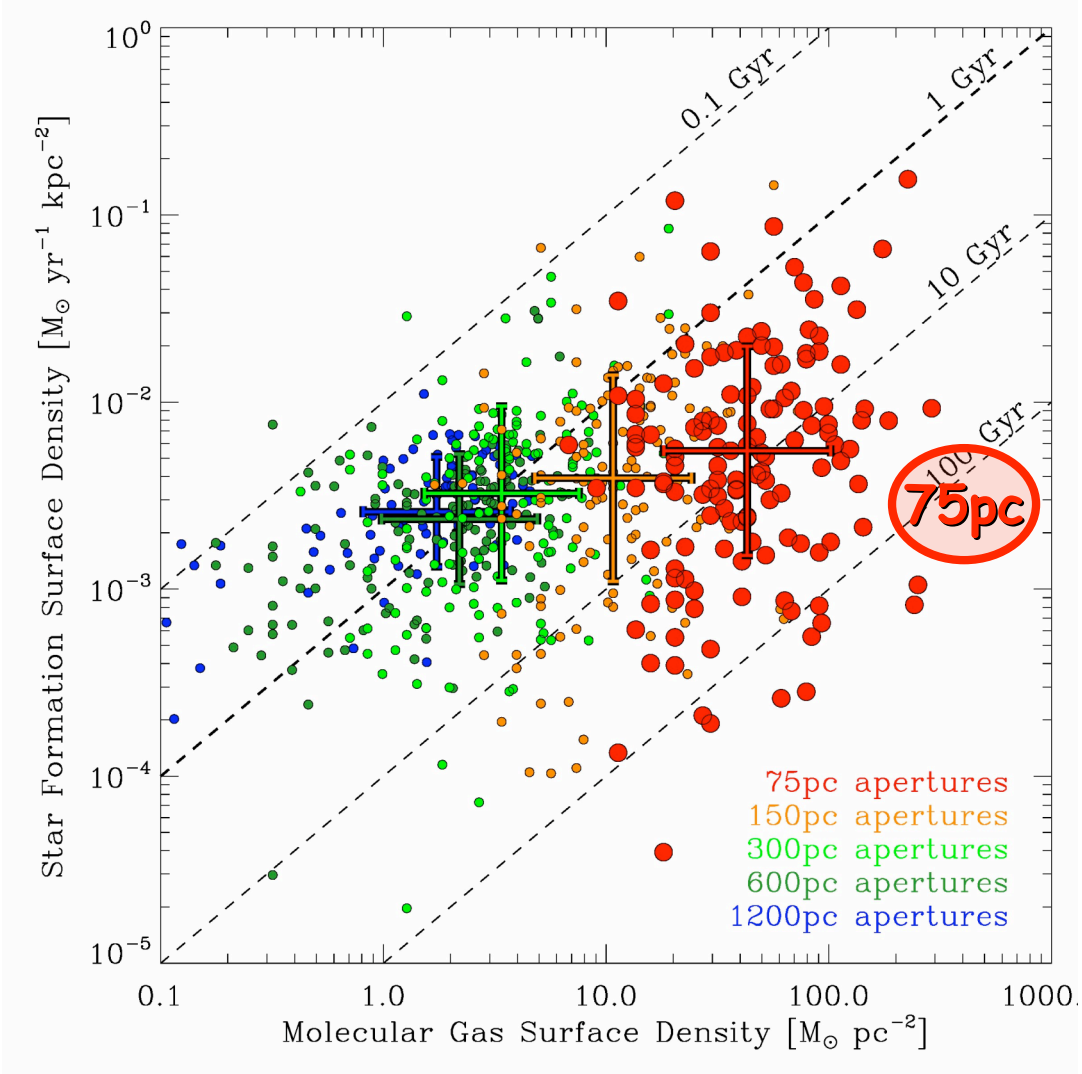
Slope:

0.8 ± 0.2

1.0 ± 0.3

1.4 ± 0.5

Gas & SF Surface Density



Rank corr.

0.52

0.49

0.34

0.28

0.22

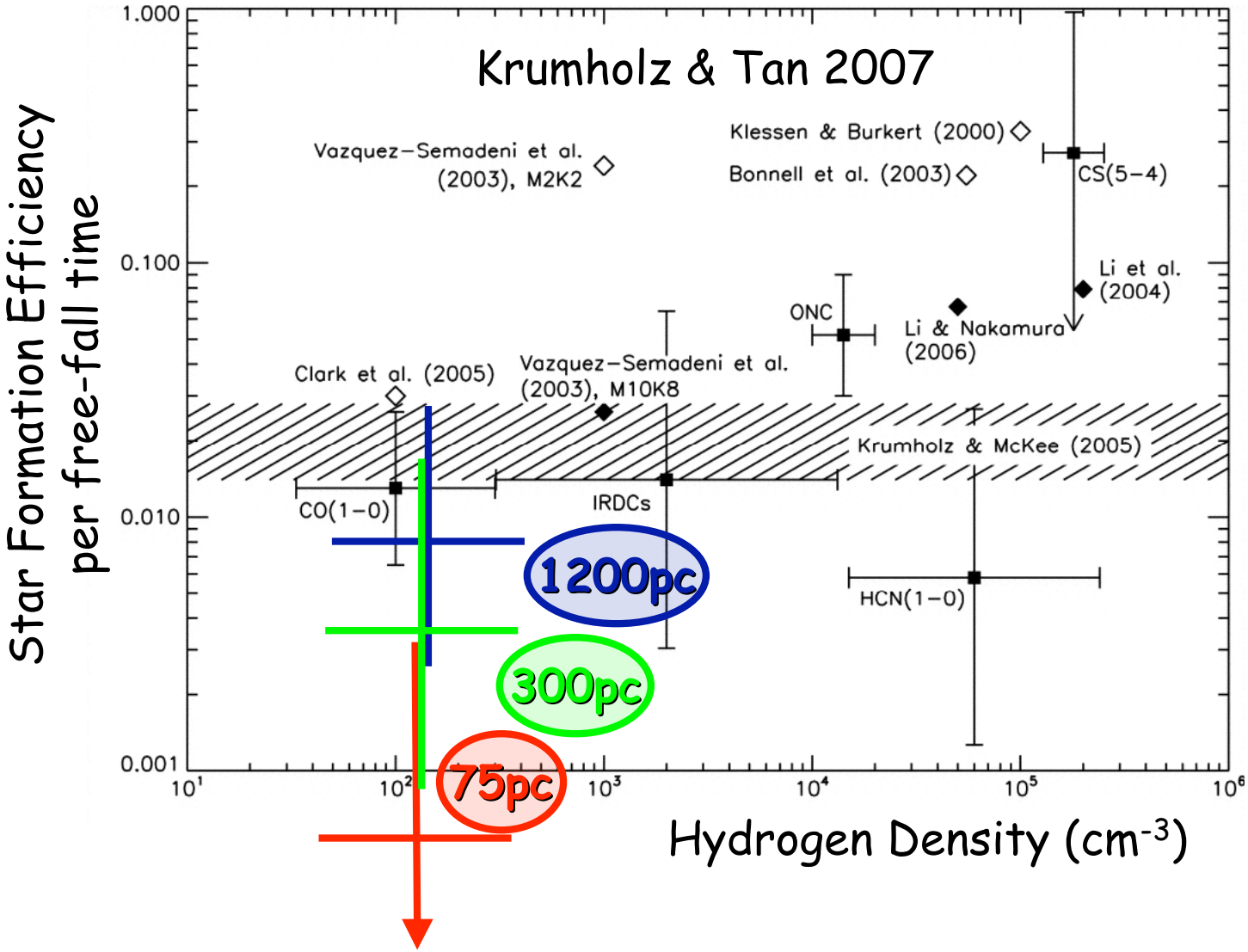
Slope:

0.8 ± 0.2

1.0 ± 0.3

1.4 ± 0.5

Free-Fall Time driving SFE ?



Summary

- Relating SFR to individual GMCs (down to 75pc)
- At kpc scales we recover the Kennicutt-Schmidt Law and depletion times of 0.5…1 Gyr
- At around 300pc the "local SFR (FUV+TIR) is seen to no longer scale with molecular mass in GMCs"
- On average GMCs convert ~0.5% of its mass into stars per free-fall time

Summary

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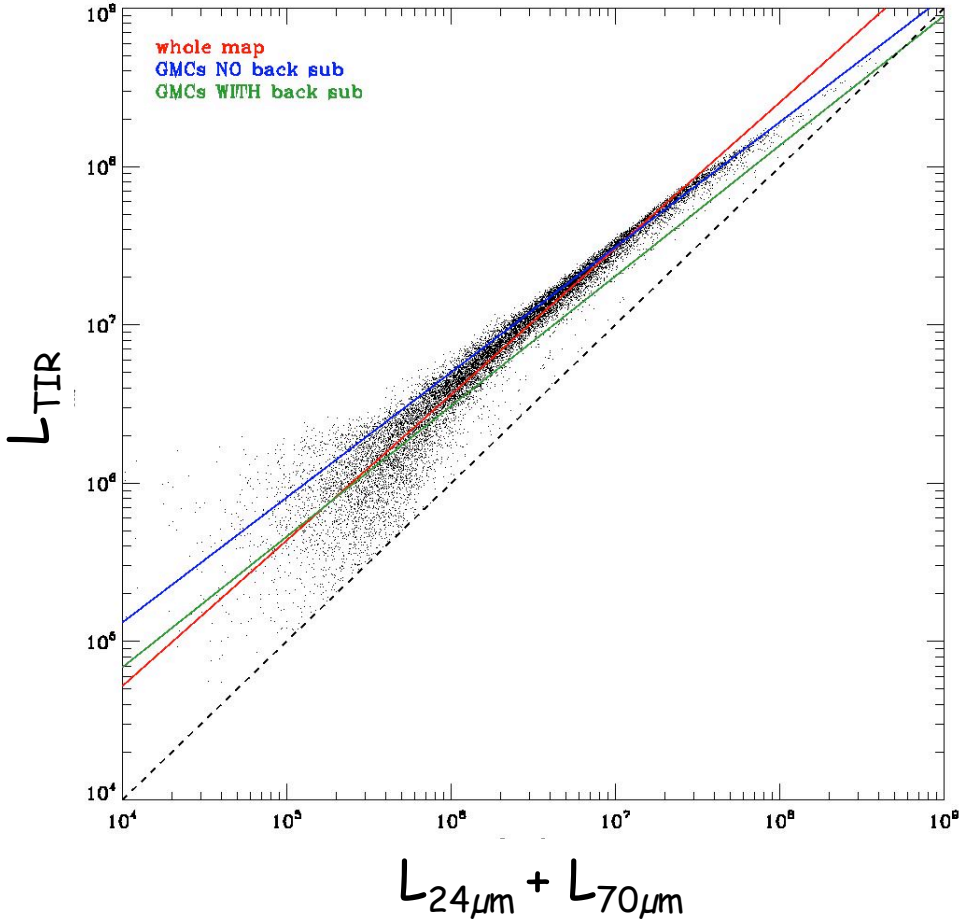
THANKS !

TIR from 24 & 70μm only



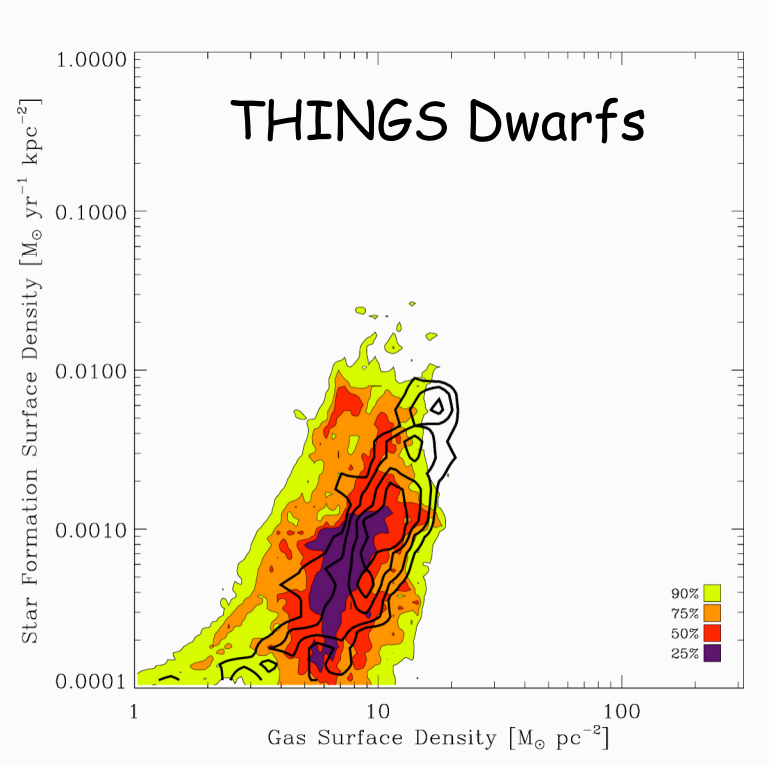
Dots: pixel plot of M33

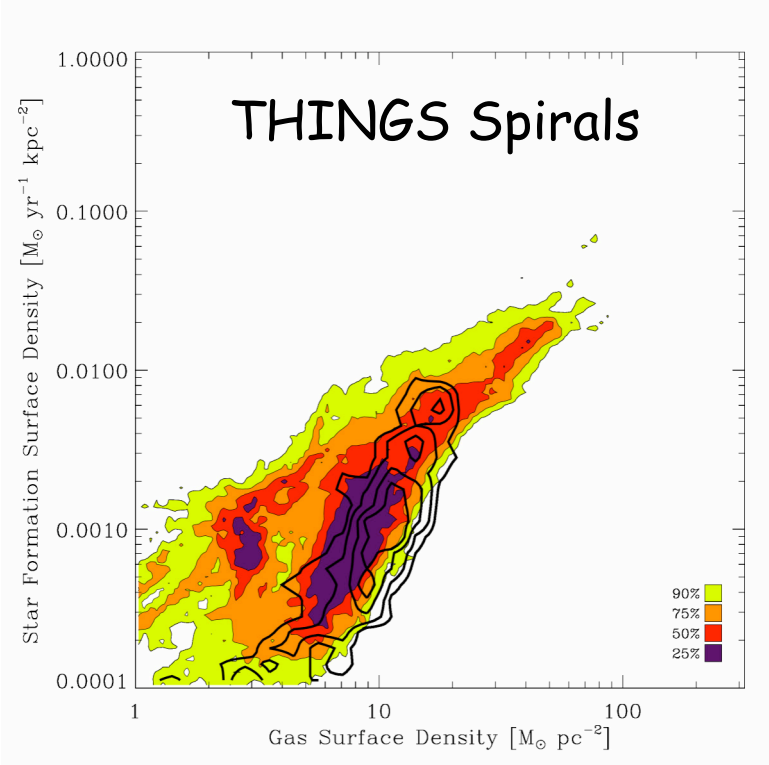
Red fit: fit all pixel

Blue fit: fit all GMC measurements w/o backgr. subtraction

Green fit: fit all GMC measurements with backgr. subtraction

Gas & SF SD for more THINGS





M33 Parameters

- v_{max}~82.2 km/s (LEDA)
- atomic mass: ? (HI-dominated)
- molecular mass: 2.6e8 (H04), 1.2e8 (R07, G08)
- stellar mass ?
- SFR = 0.2…0.7 $M_\odot$/yr

Data & SF Formulae

Atomic gas: VLA (Thilker et al.), Westerbork (Deul & van der Hulst)

Molecular gas: CO (1->0) from BIMA (Engargiola et al.) & FCRAO (Heyer et al.), combined map from Rosolowsky 2007

Star Formation: FUV + TIR

- **FUV:** GALEX (Thilker et al.)
- **IR:** Spitzer MIPS (Gerhz et al.)
- TIR from Dale et al. 2002 & 2007
- SFR(FUV+TIR) from Leroy et al. 2008