Reminder

The Star Formation Law

What is a SF law?

→ A relation connecting Σ_{SFR} to Σ_{gas}: $\Sigma_{SFR} = A \cdot \Sigma_{gas}^{N}$

(going back to Schmidt 1959)

Why SF law?

→
- Derive physical insight into what drives SF (e.g. by comparing empirical relations to predictions from theory)
- SPH modeling of galaxy formation
- Predictive power: measure the gas (surface) density and estimate the SFR (surface) density

Previous studies include e.g.

- Schmidt (1959): N≈2 (Milky Way)
- Kennicutt (1989,1998): N≈1.4 (sample of ~90 nearby galaxies)
- Wong & Blitz (2002): N=1.2-2.1 (6 nearby spiral galaxies)
- Boissier et al. (2003), Heyer et al. (2004): N≈2 (16 galaxies) and N≈3.3 (M33)

Methodology

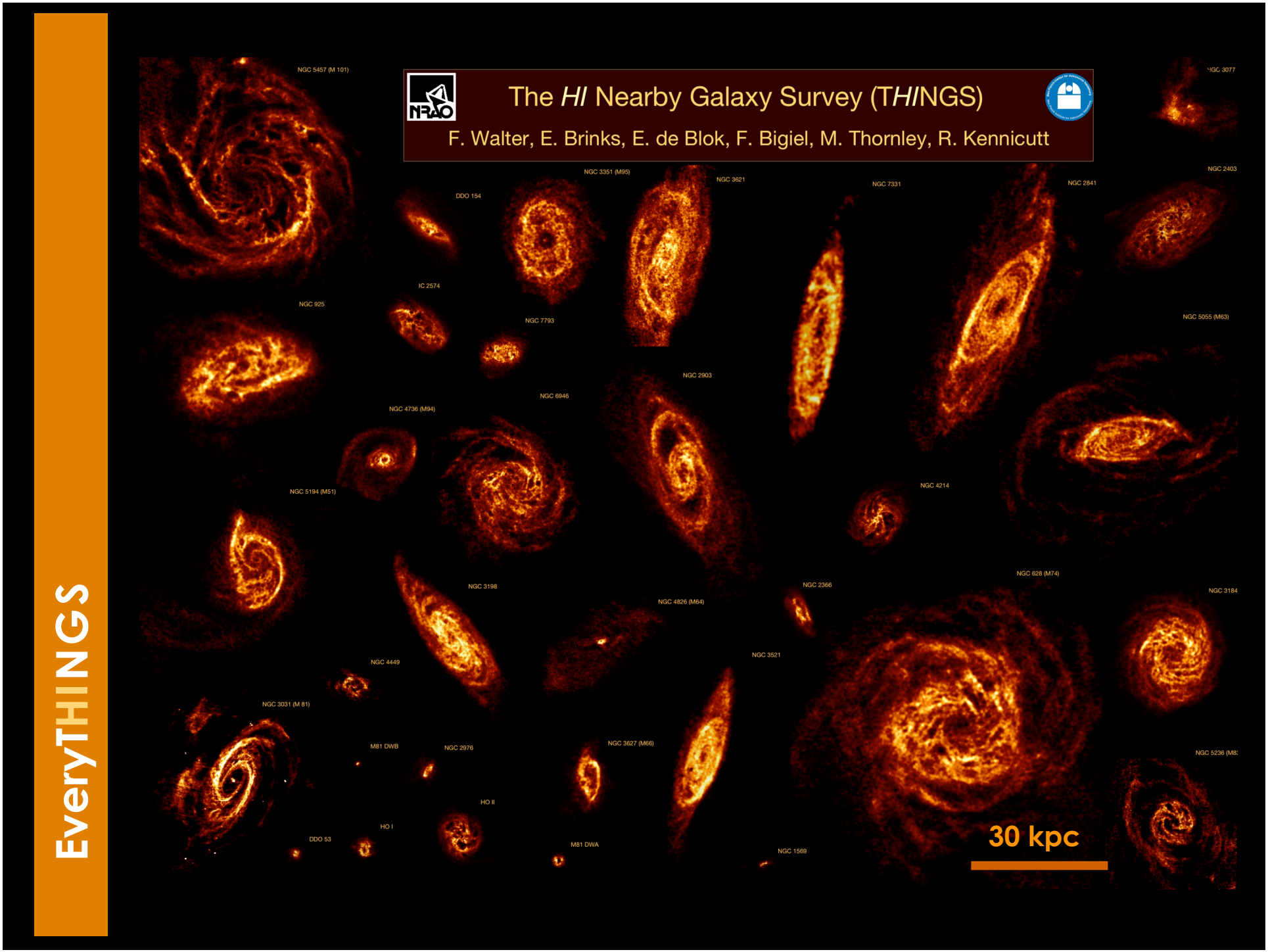
The Star Formation Law - Methodology

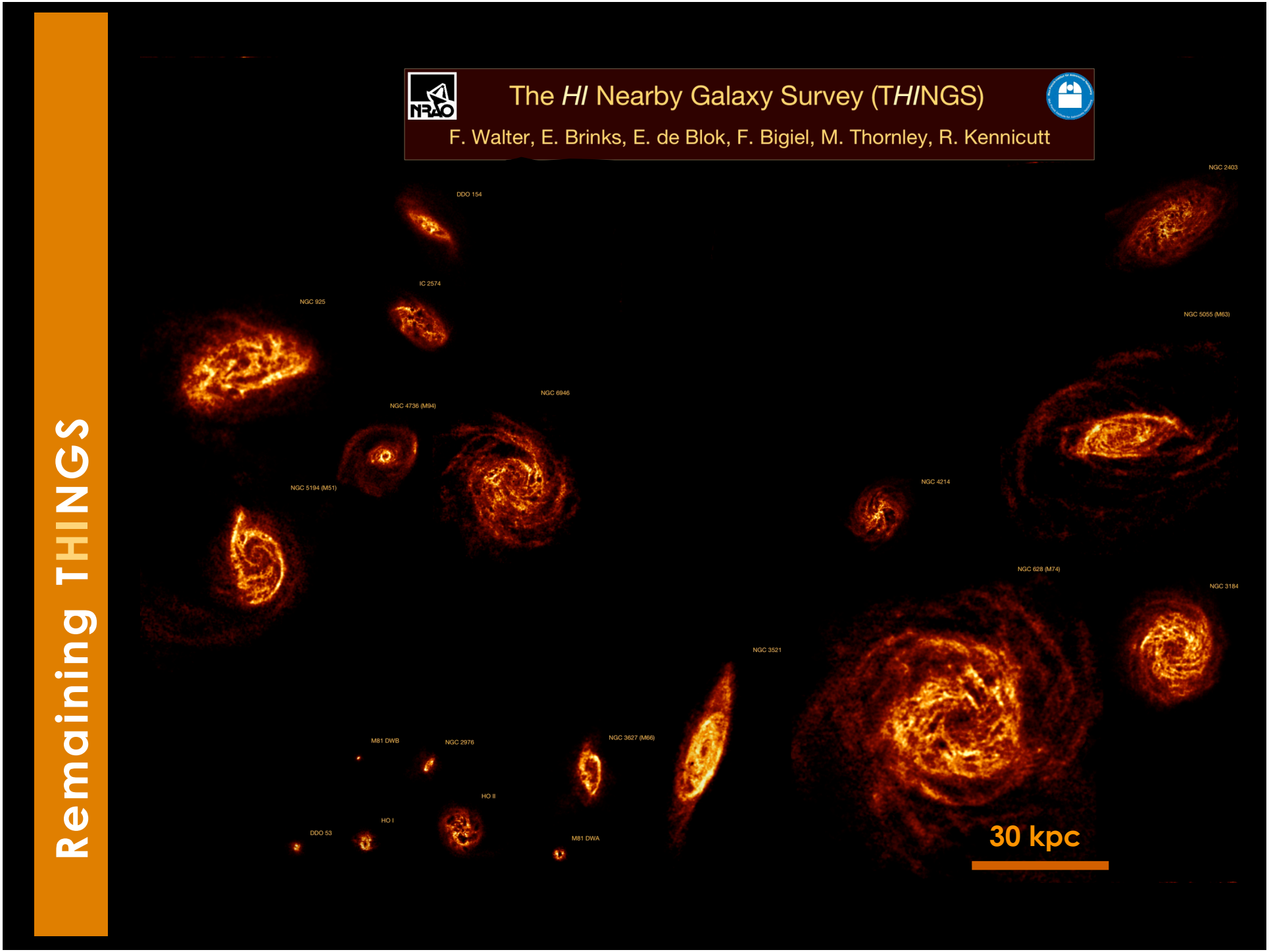
- Previous studies assessed the SF law by either
  - ➢ averaging emission across the optical disks of galaxies (e.g. Kennicutt 1998)
  - ➢ or by deriving radial profiles (azimuthal averages in tilted rings) (e.g. Wong & Blitz 2002, Boissier et al. 2003, Heyer et al. 2004)

- Most recent studies assess SF locally, using aperture photometry on individual HII regions (e.g. Calzetti et al. 2005, Pérez-González et al. 2006, Kennicutt et al. 2007)

- This study assesses the spatially resolved SF law **pixel-by-pixel** at 750 pc resolution across the optical disks of 19 nearby galaxies using new high resolution high sensitivity multiwavelength data

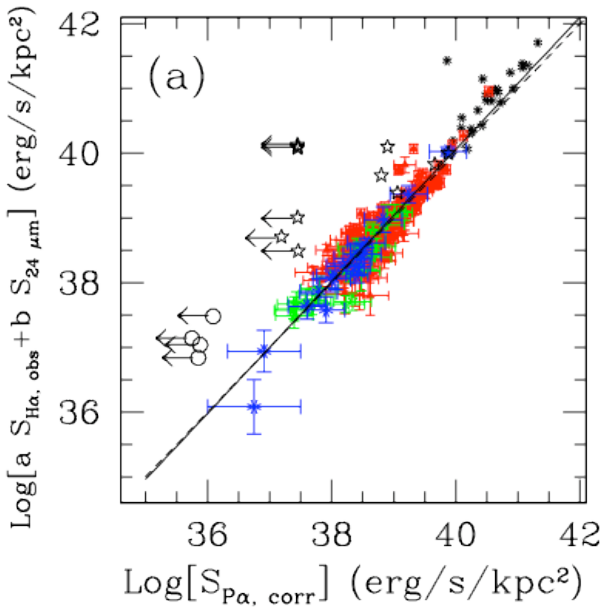
→ High resolution and high sensitivity Gas (HI and H_2) and SFR surface density maps


The HI Nearby Galaxy Survey (THINGS)
F. Walter, E. Brinks, E. de Blok, F. Bigiel, M. Thornley, R. Kennicutt
NRAO
EveryTHINGS
NGC 5457 (M 101)
NGC 3351 (M95)
NGC 3621
NGC 7331
NGC 2841
NGC 3077
NGC 2403
DDO 154
IC 2574
NGC 925
NGC 7793
NGC 5055 (M63)
NGC 2903
NGC 6946
NGC 4736 (M94)
NGC 5194 (M51)
NGC 4214
NGC 628 (M74)
NGC 3198
NGC 2366
NGC 3184
NGC 4826 (M64)
NGC 4449
NGC 3521
NGC 3031 (M 81)
M81 DWB
NGC 2976
NGC 3627 (M66)
NGC 5236 (M8
HO II
HO I
DDO 53
M81 DWA
NGC 1569
30 kpc

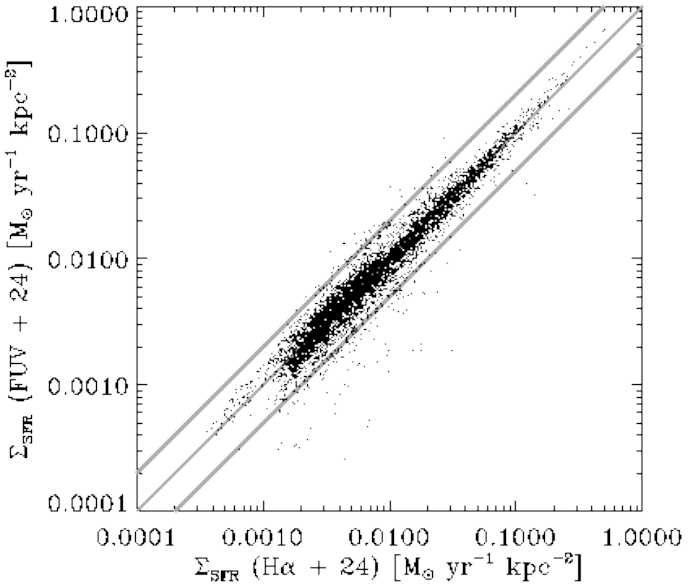

The HI Nearby Galaxy Survey (THINGS)
F. Walter, E. Brinks, E. de Blok, F. Bigiel, M. Thornley, R. Kennicutt
Remaining THINGS
DDO 154
IC 2574
NGC 925
NGC 2403
NGC 5055 (M63)
NGC 6946
NGC 4736 (M94)
NGC 5194 (M51)
NGC 4214
NGC 628 (M74)
NGC 3184
NGC 3521
M81 DWB
NGC 2976
NGC 3627 (M66)
HO II
HO I
DDO 53
M81 DWA
30 kpc

Calibrating SFRs

- Combined FUV and 24 μm maps:
  - ➢ Following idea in Kennicutt et al. (2005, 2007).
  - ➢ Based on Hα + 24 μm calibration by Calzetti et al. (2007).
  - ➢ Pixel-by-pixel approach at 750 pc.

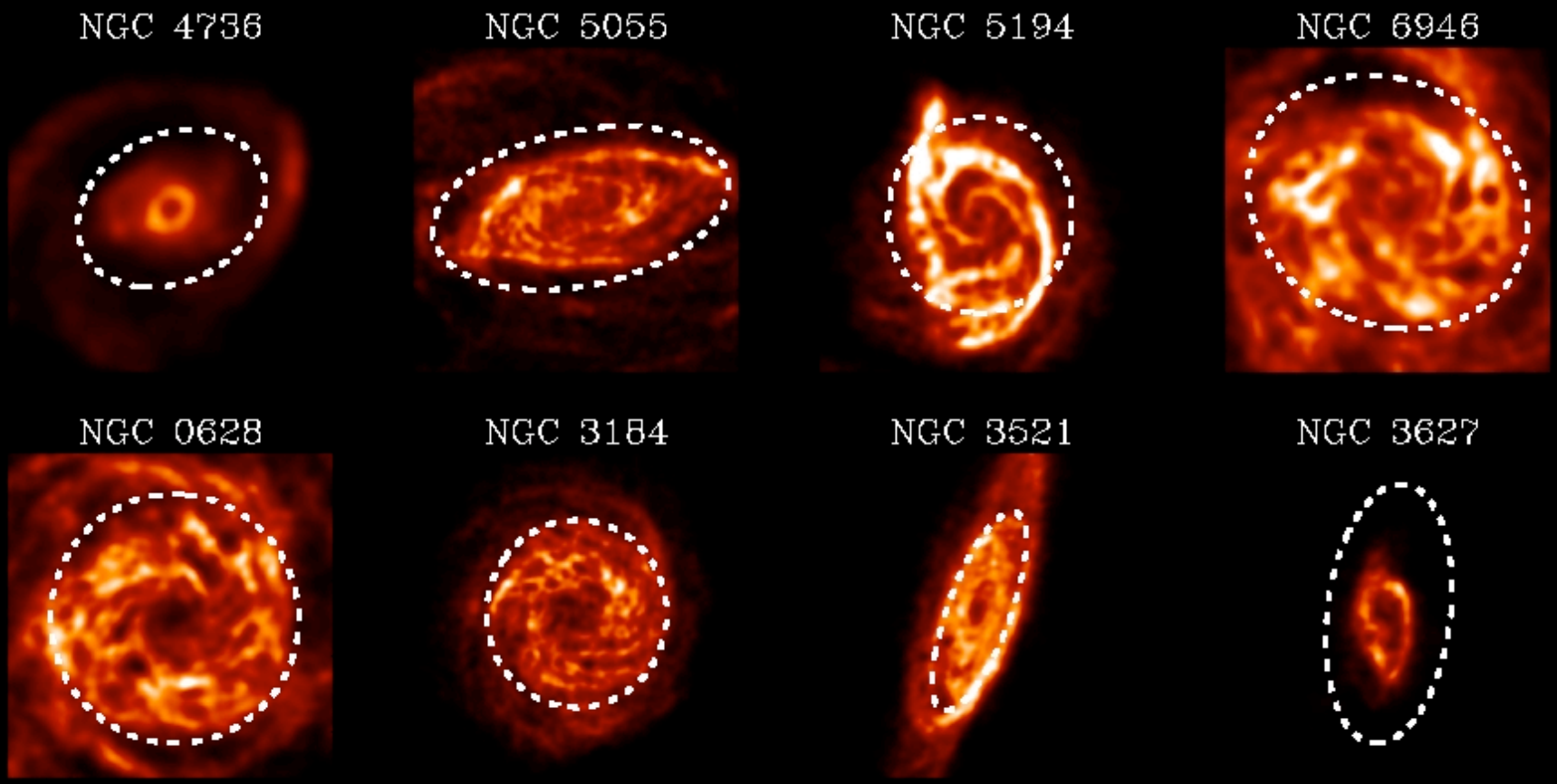


Calzetti et al. (2007) calibrated Hα + 24μm against Pα in apertures.

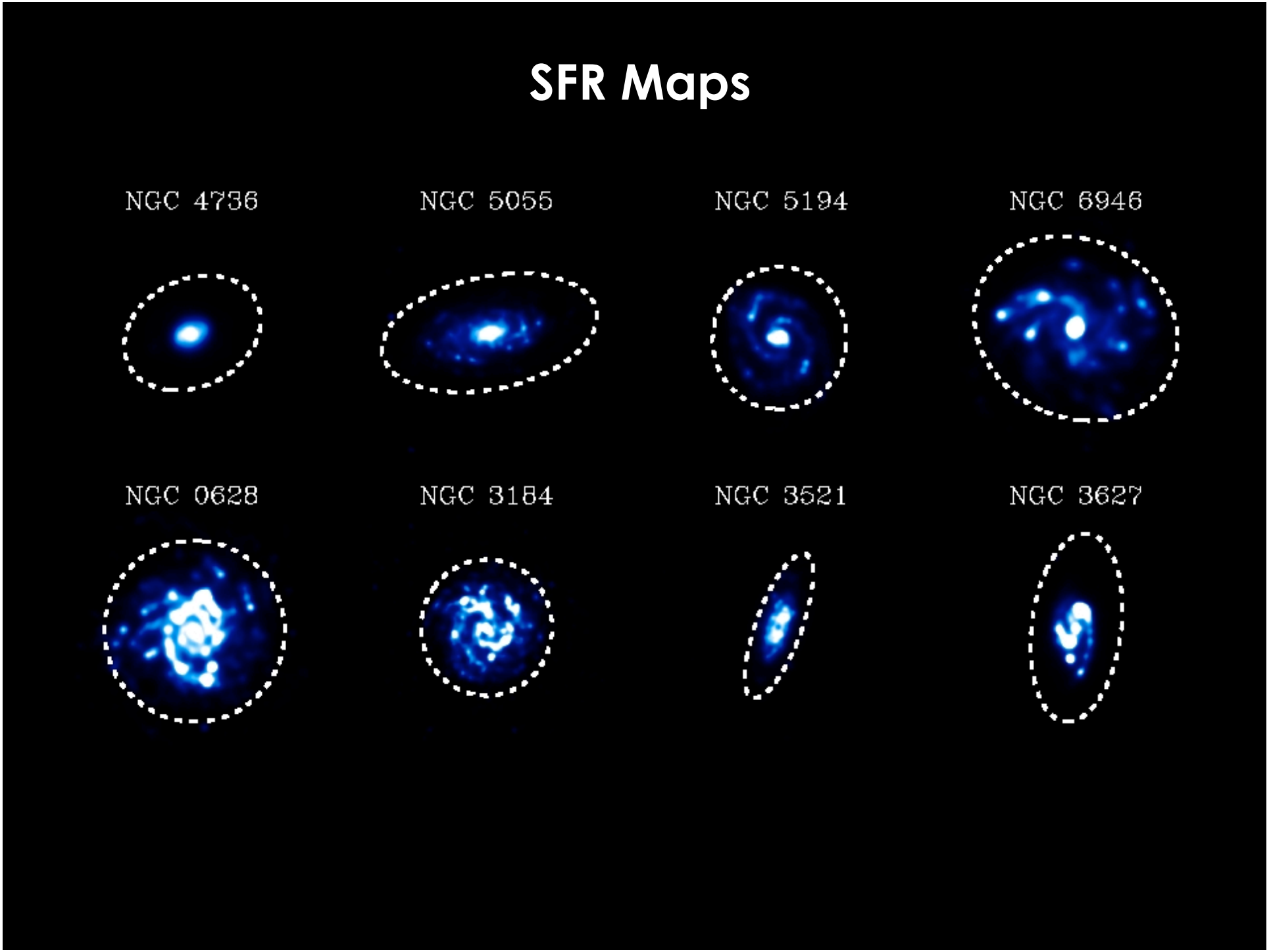


Pixel-by-pixel at 750pc: our FUV + 24μm as a function of Hα + 24μm.

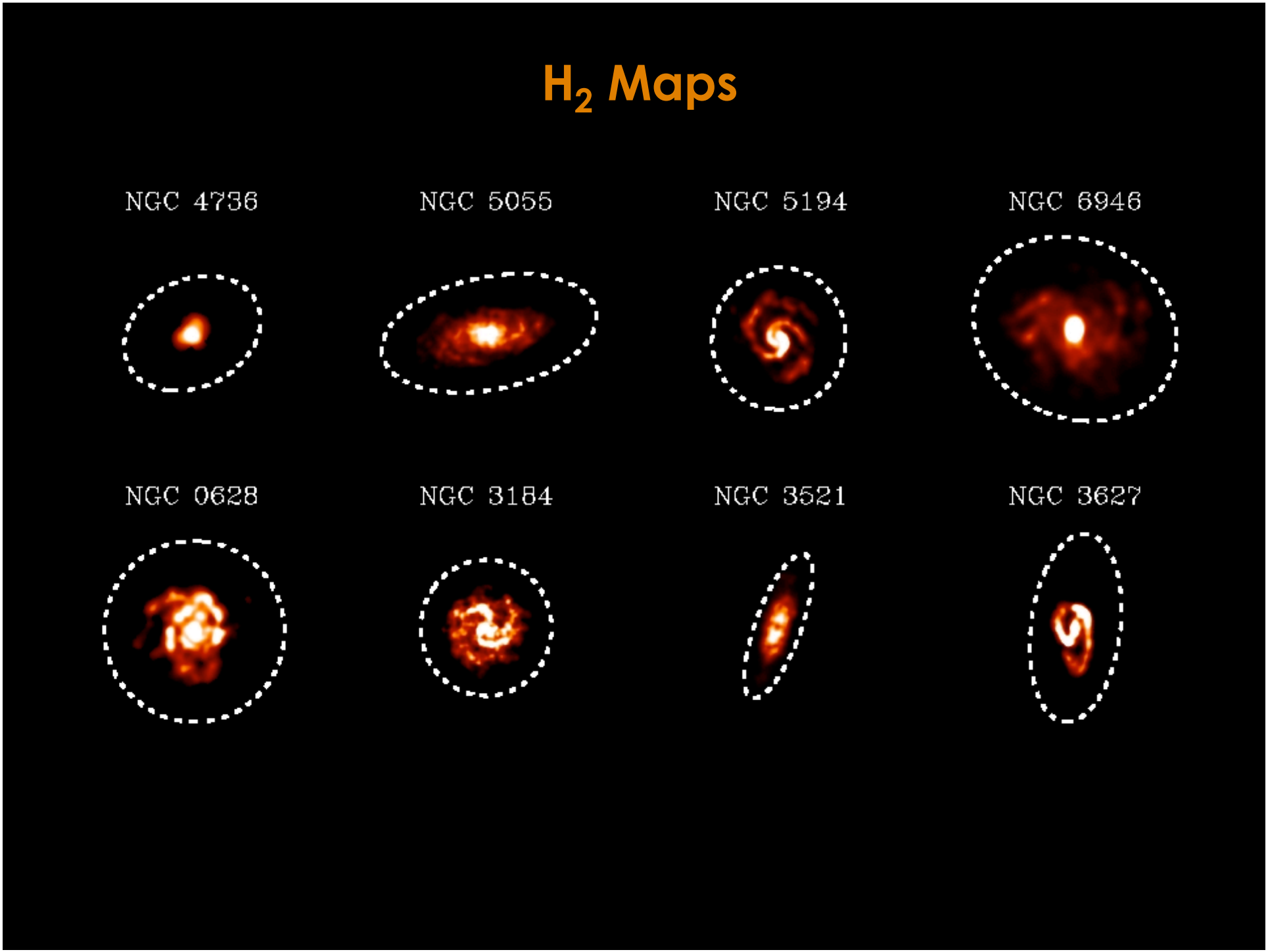
HI Maps


NGC 4736
NGC 5055
NGC 5194
NGC 6946
NGC 0628
NGC 3184
NGC 3521
NGC 3627

SFR Maps


NGC 4736
NGC 5055
NGC 5194
NGC 6946
NGC 0628
NGC 3184
NGC 3521
NGC 3627

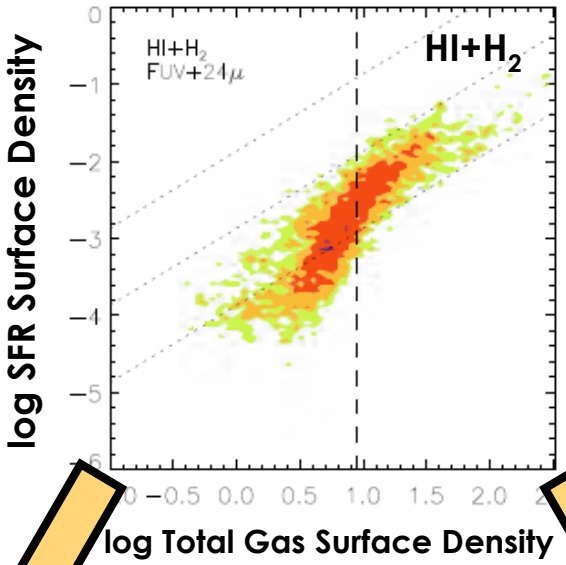
H_2 Maps


NGC 4736
NGC 5055
NGC 5194
NGC 6946
NGC 0628
NGC 3184
NGC 3521
NGC 3627

The SF Law in THINGS

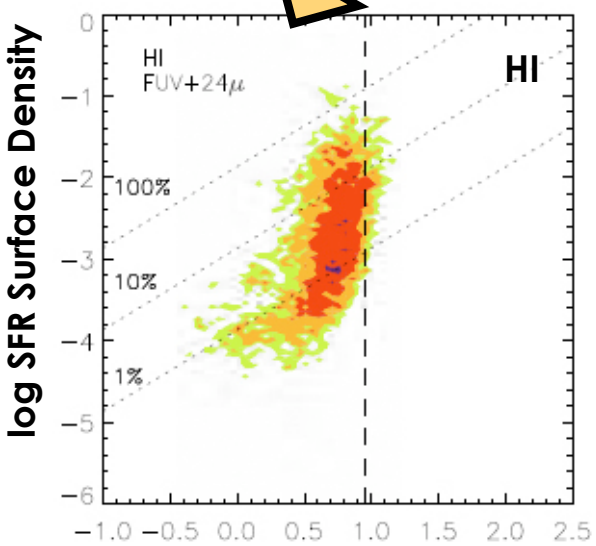
… And In All Spirals Combined

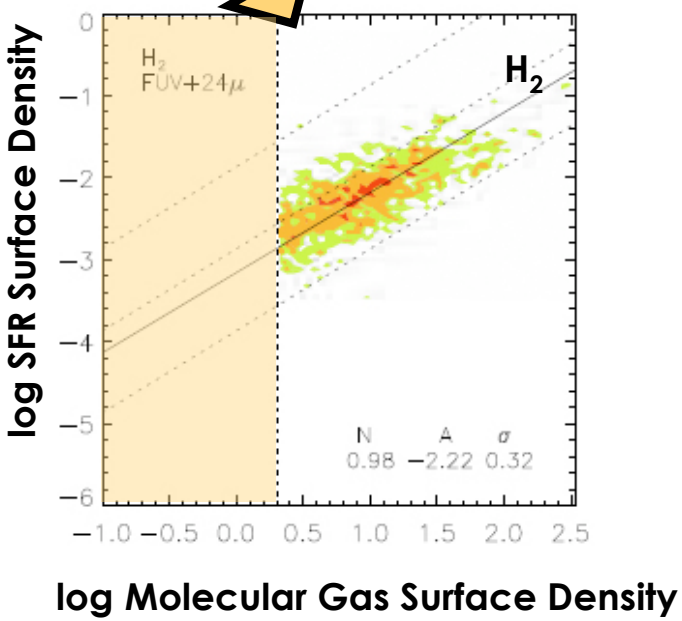
• A saturation of Σ_{HI} is evident at ~ 9 $M_\odot$ pc^{-2}



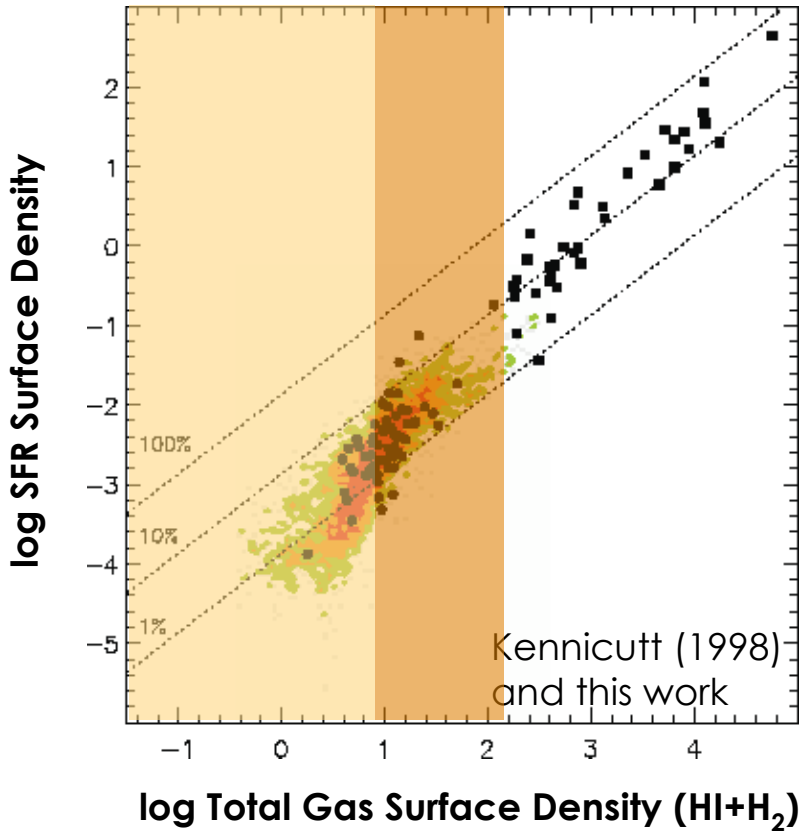
• Σ_{H2} is tightly correlated with Σ_{SFR} (N_{H2} = 1.0 ± 0.2)

• Data are compatible with a **molecular gas** Schmidt Law, showing a constant SFE (τ~2*10^9 yrs)





The Kennicutt / Schmidt Law …



$$\Sigma_{SFR} = 2.5 \cdot 10^{-4} * \Sigma_{gas}^{1.4}$$

- Resolved data overlaps normal starforming spirals from Kennicutt (1998)
- Obtaining resolved data for high gas columns and SFRs is key for complete assessment of SF law