International Centre for Radio Astronomy Research

Constant-Q disk stabilities result in uniform SFE

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Curtin University

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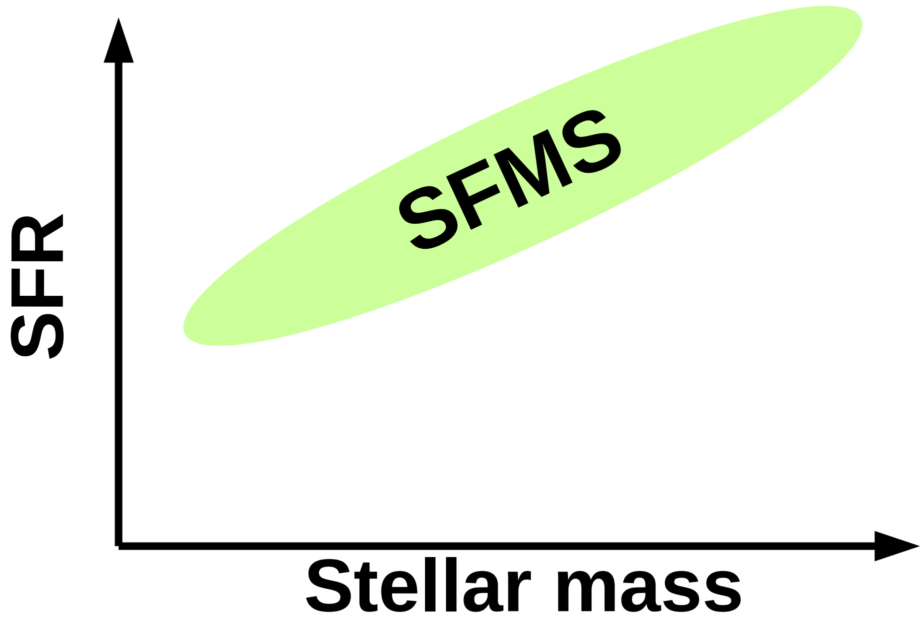
Motivation (1)

Star formation largely a local process

BUT,

many global correlations imply uniform SFE (e.g. SF "main sequence")

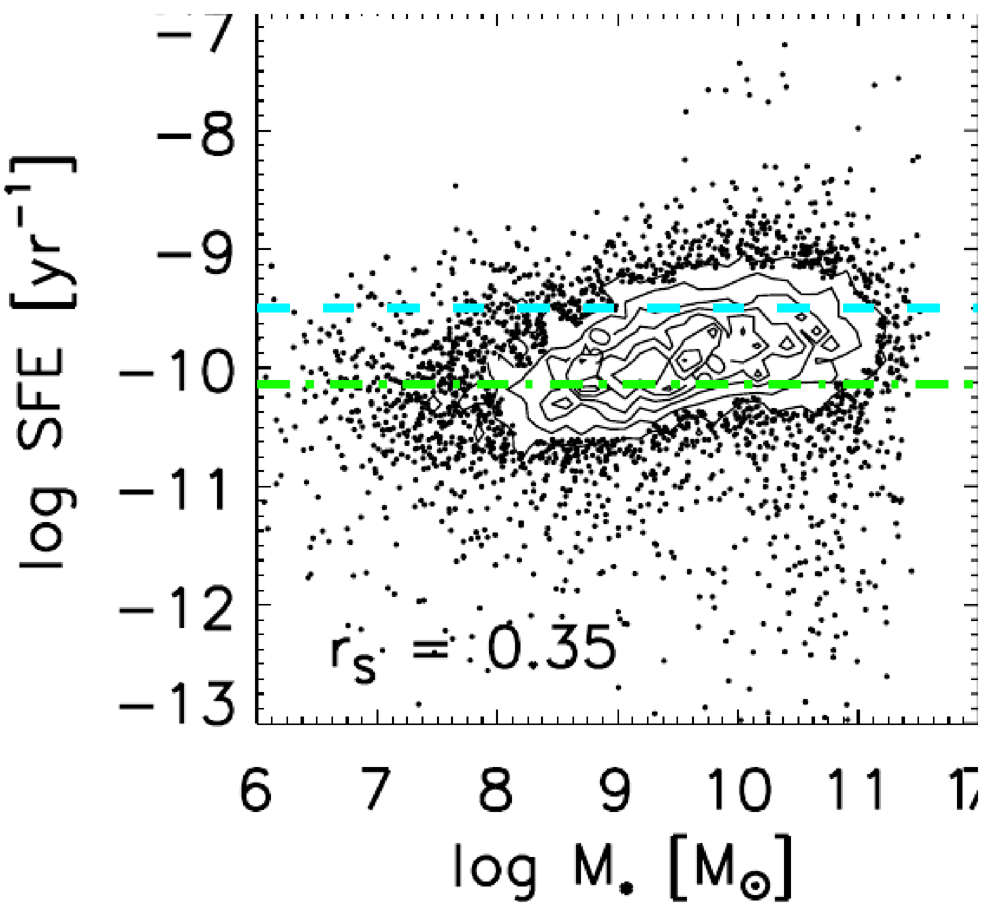


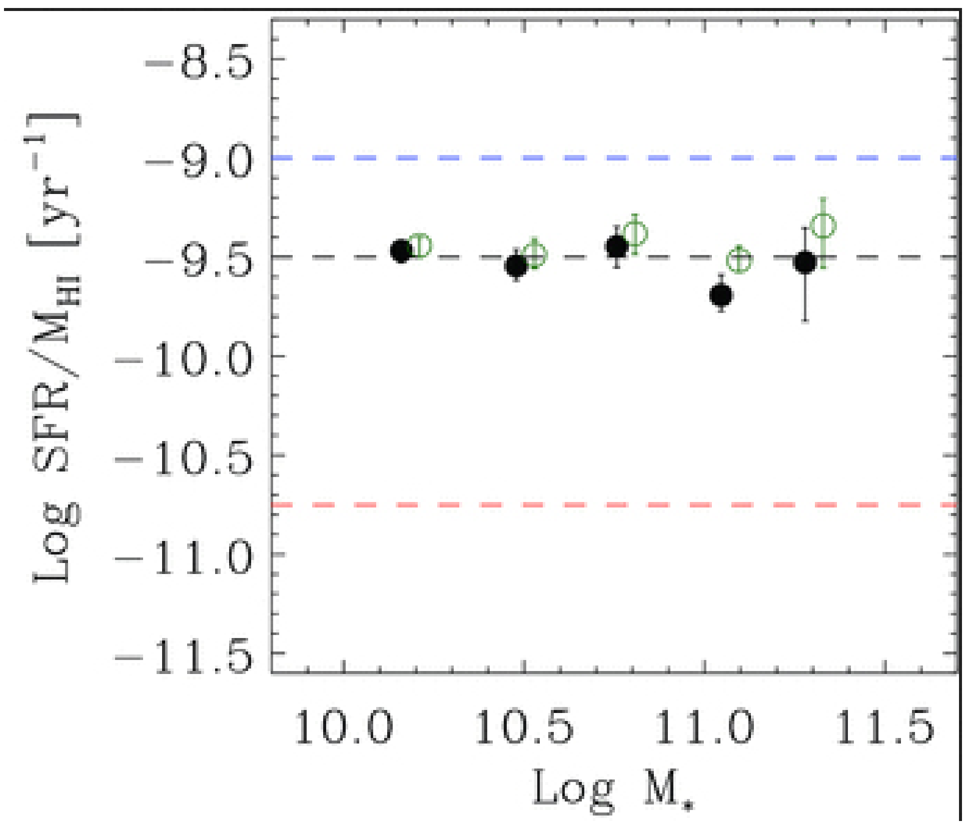
e.g. Brinchmann+(2004), Salim+(2007), Schiminovich+(2010), Whitaker+(2012), Sobral+(2014)

Motivation (2)

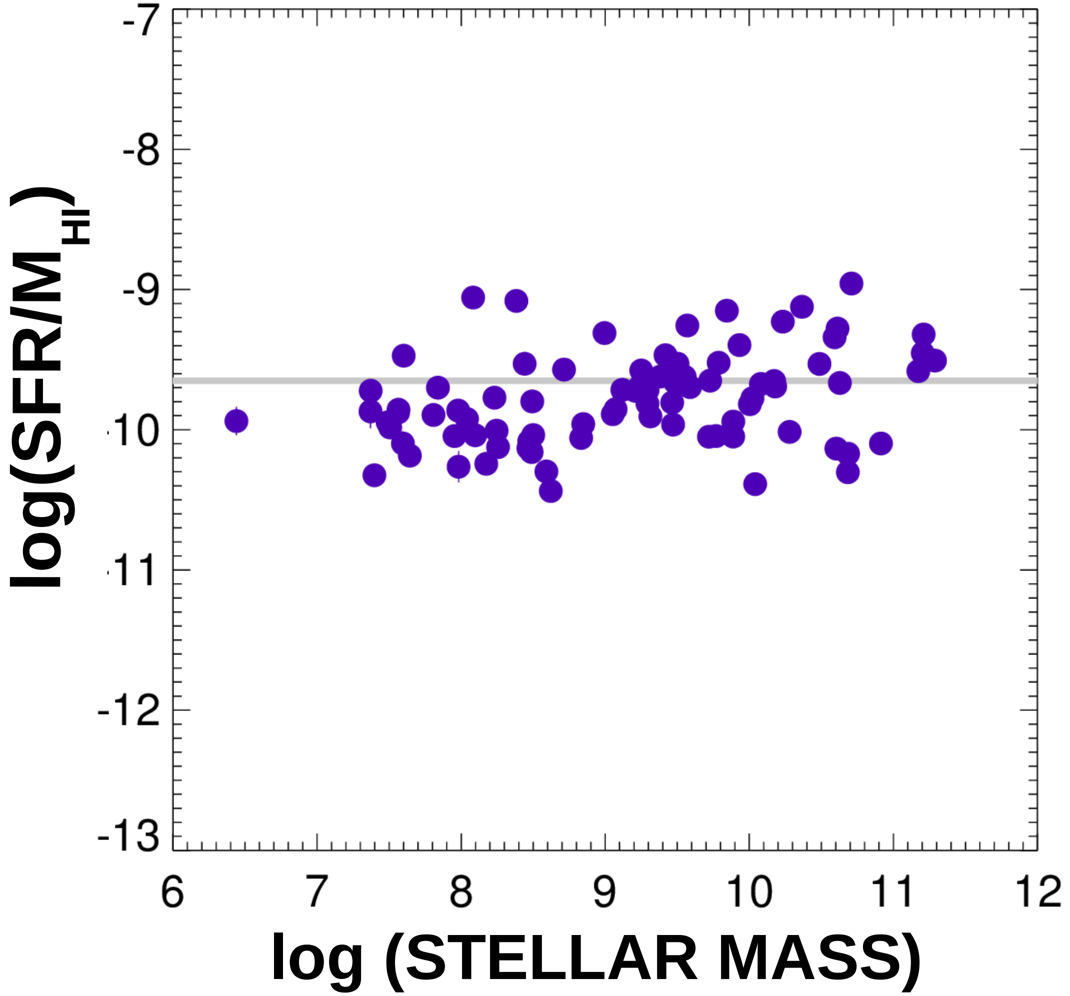
- **Detailed multiwavelength mapping of gas & stars (eg THINGS)**
  → SFR/H2 ~constant *but* HI/H2 varies

- ***So what is driving SFR/HI to be constant?***



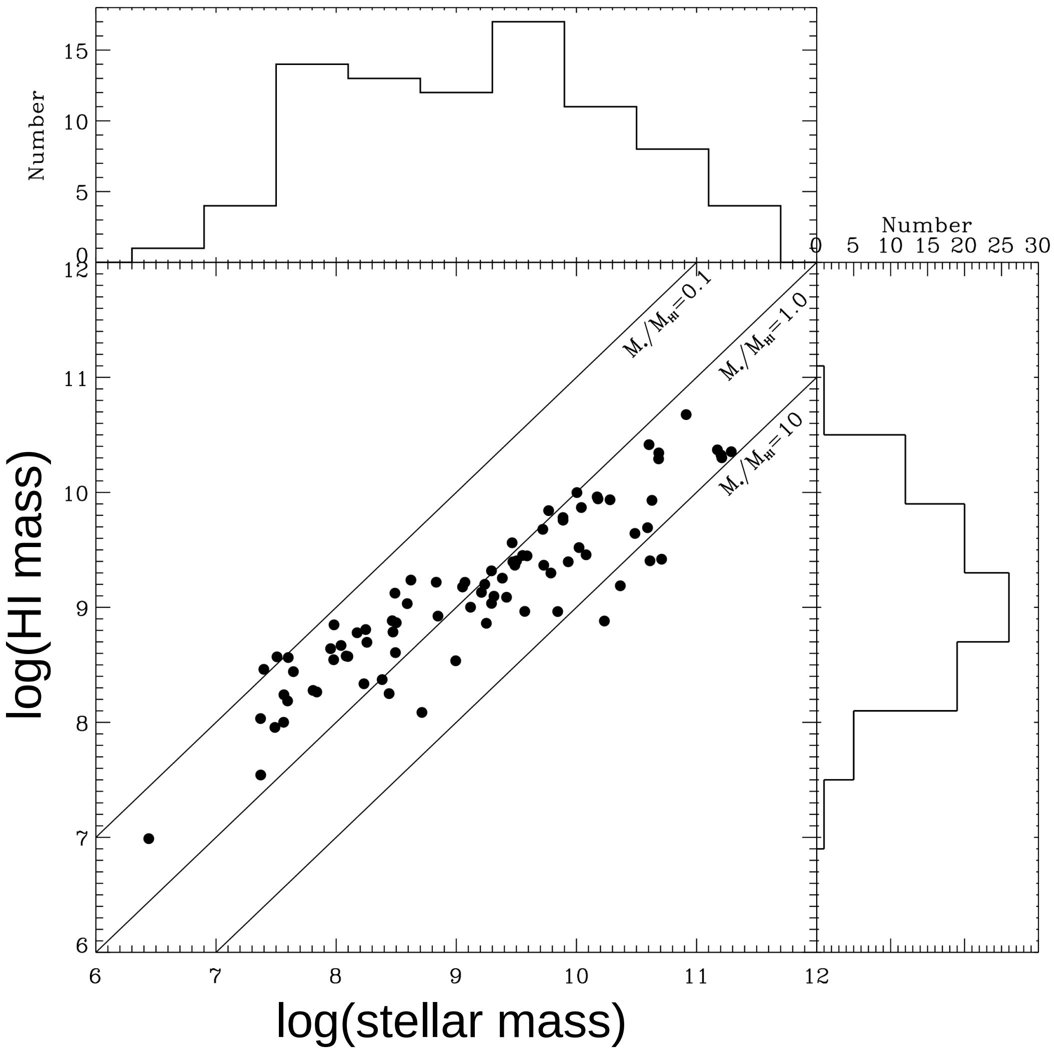


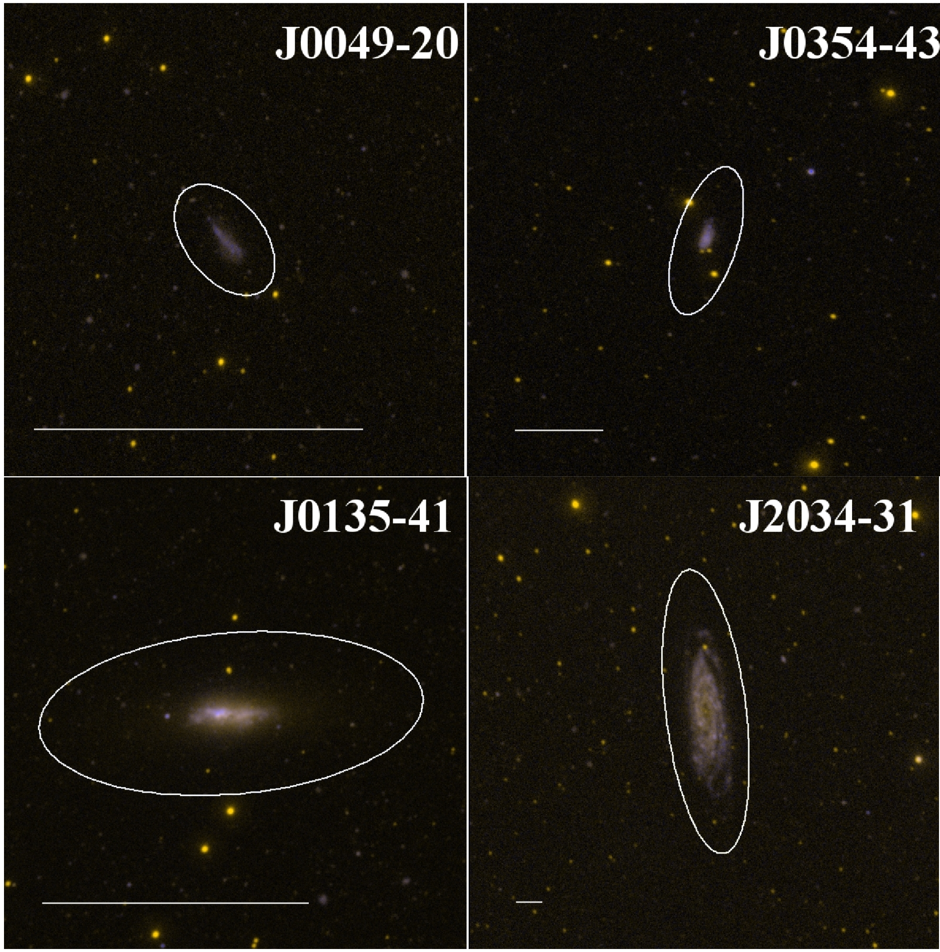
We see this in our sample too



Wong et al (2016)

HI- selected sample (z<0.02)





Wong et al (2016)

What is driving the global SFE to remain uniform ?

Regulation of SF in a disk via constant Q

Gas clouds collapse → forms stars

Q > 1
(stable)

SF regulated → SF winds reduced

Q << 1
(unstable)

Wong et al (2016), Zheng et al (2013), Meurer et al (2013)

Defining disk stability Q

$$Q \propto \frac{\sigma \kappa}{\Sigma}$$

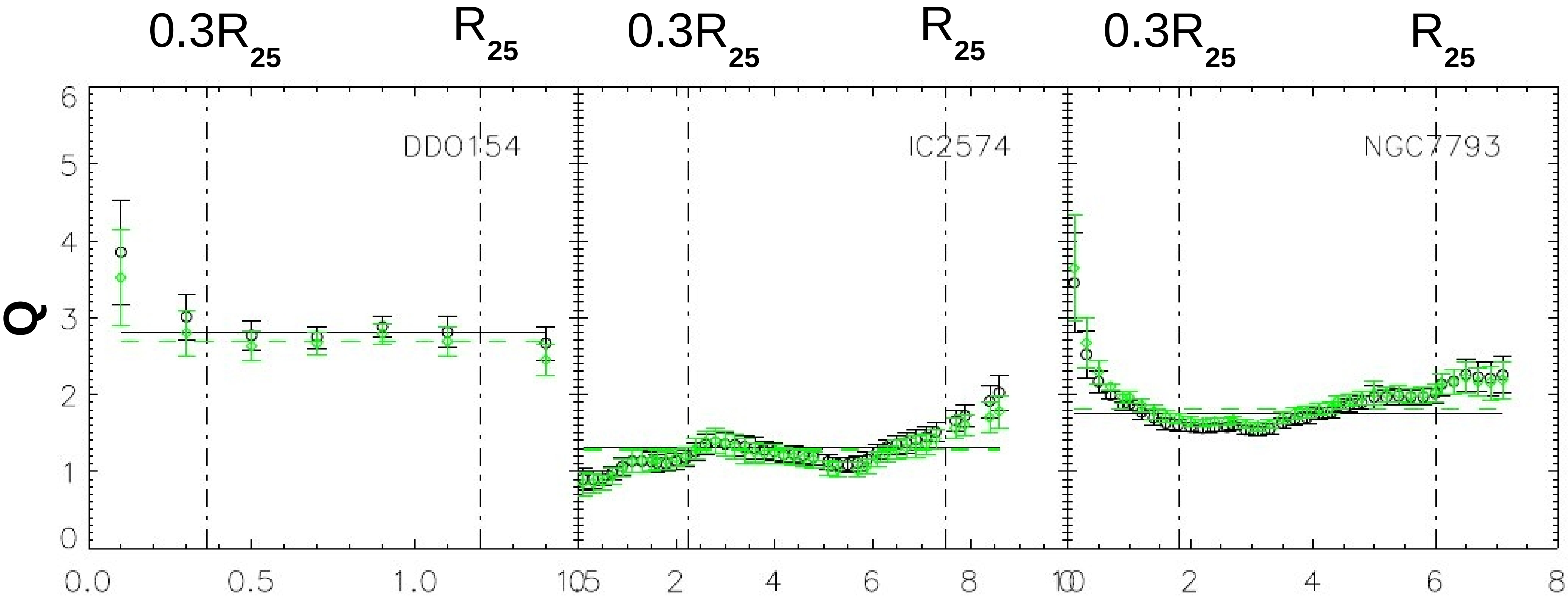
Toomre (1964), Wang&Silk (1994), Rafikov (2001)

2-fluid Q_{ws} (Wang&Silk 1994): $$\frac{1}{Q_{WS}} = \frac{1}{Q_{gas}} + \frac{1}{Q_{stars}}$$

where $$Q_{gas} = \frac{\sigma_{gas}\kappa}{\pi G \Sigma_{gas}}, \quad Q_{stars} = \frac{\sigma_s \kappa}{\pi G \Sigma_s}$$

Zheng et al (2013)

Constant Q = 1.6

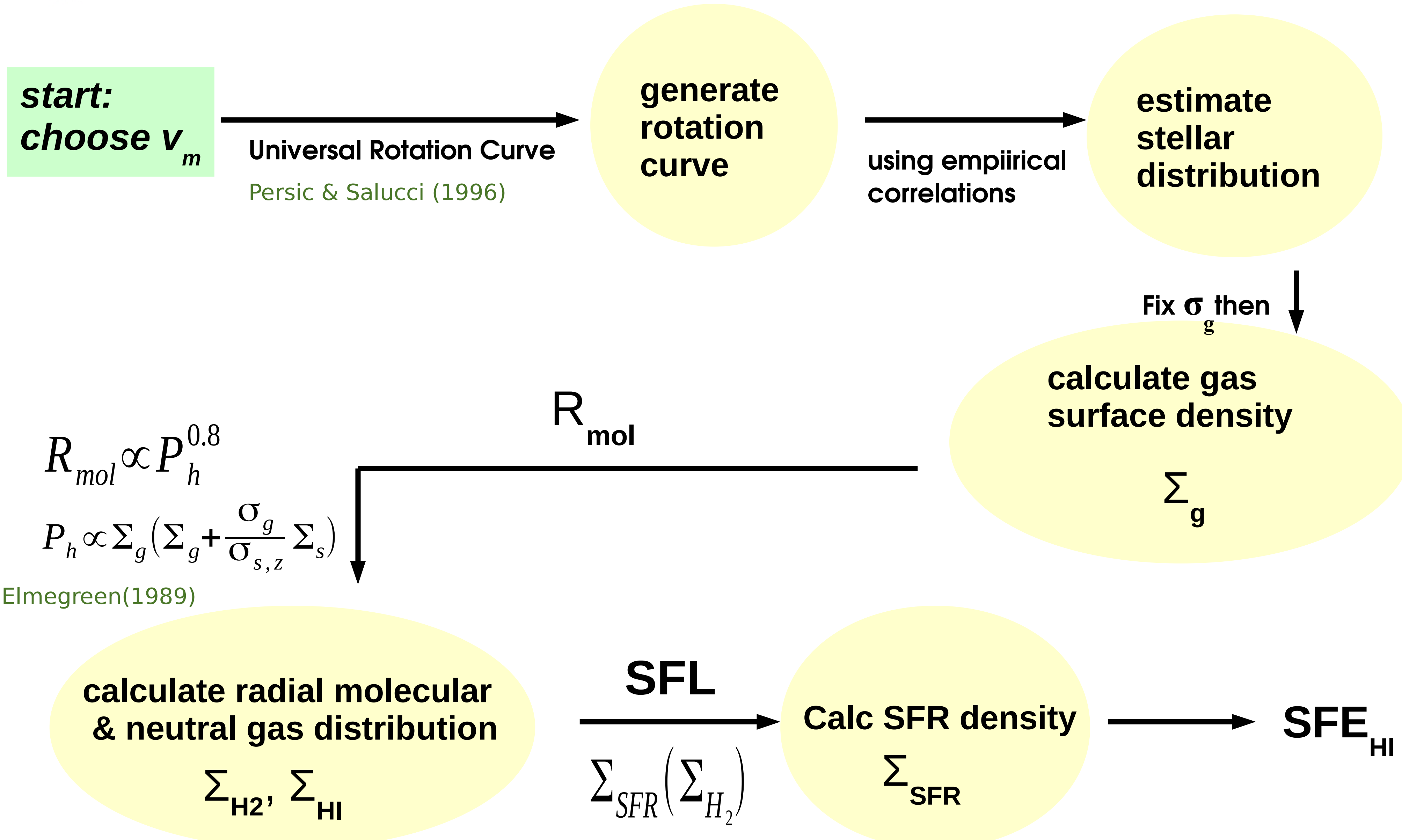


σ_g = 11 km/s (Leroy+2008)

measured σ_g

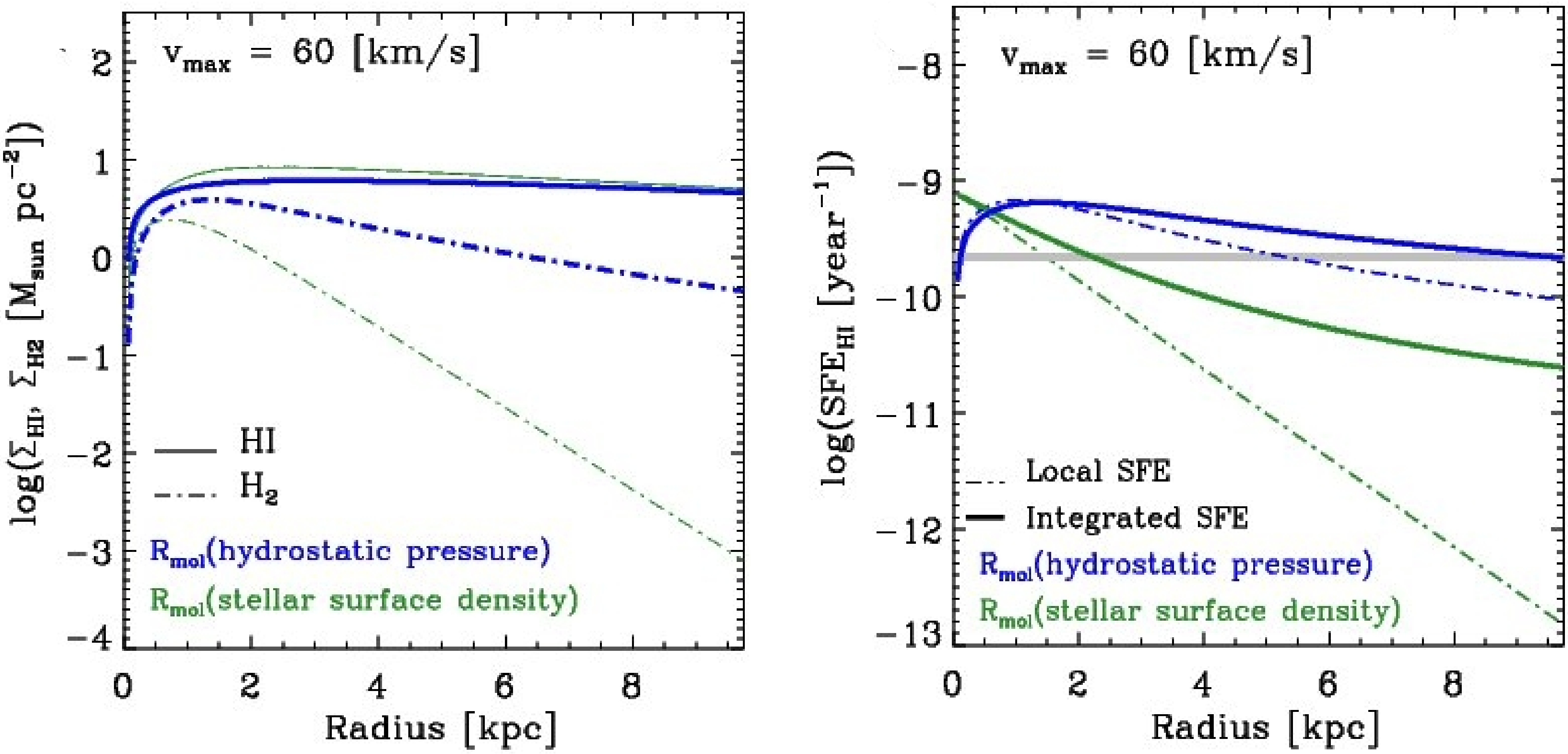
Zheng et al (2013)

Our toy model assuming $Q_{2f} = 1.6$



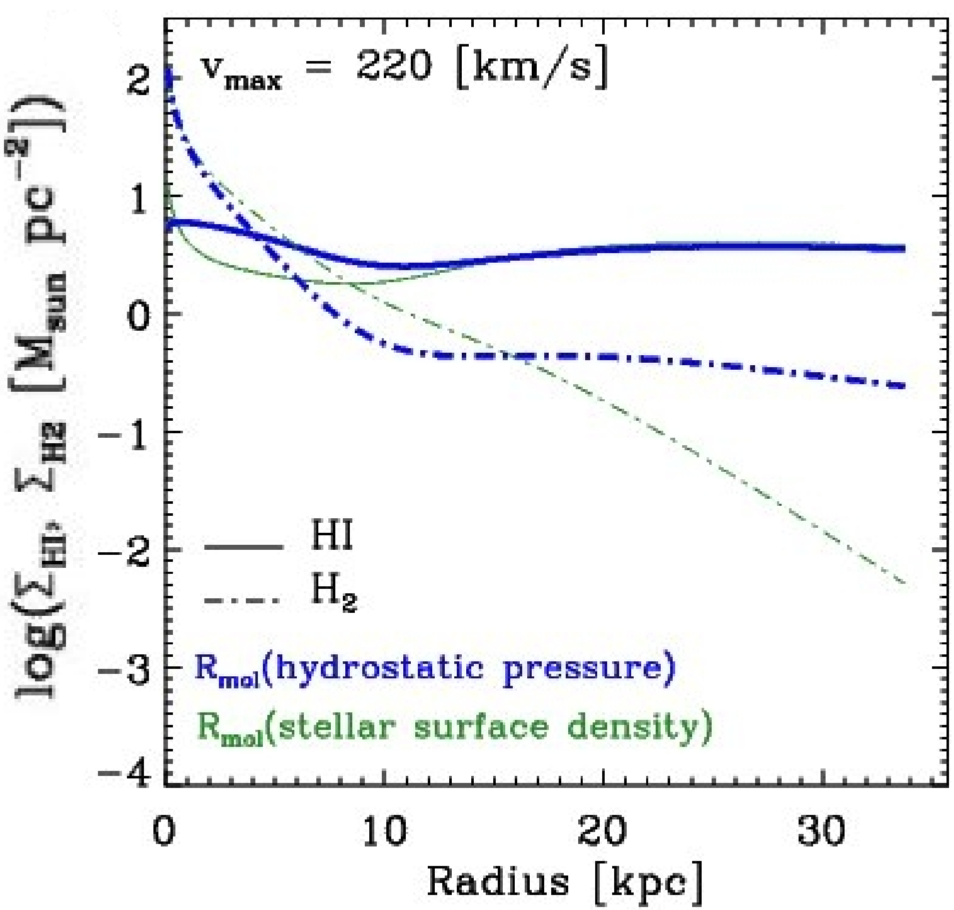
Wong et al (2016)

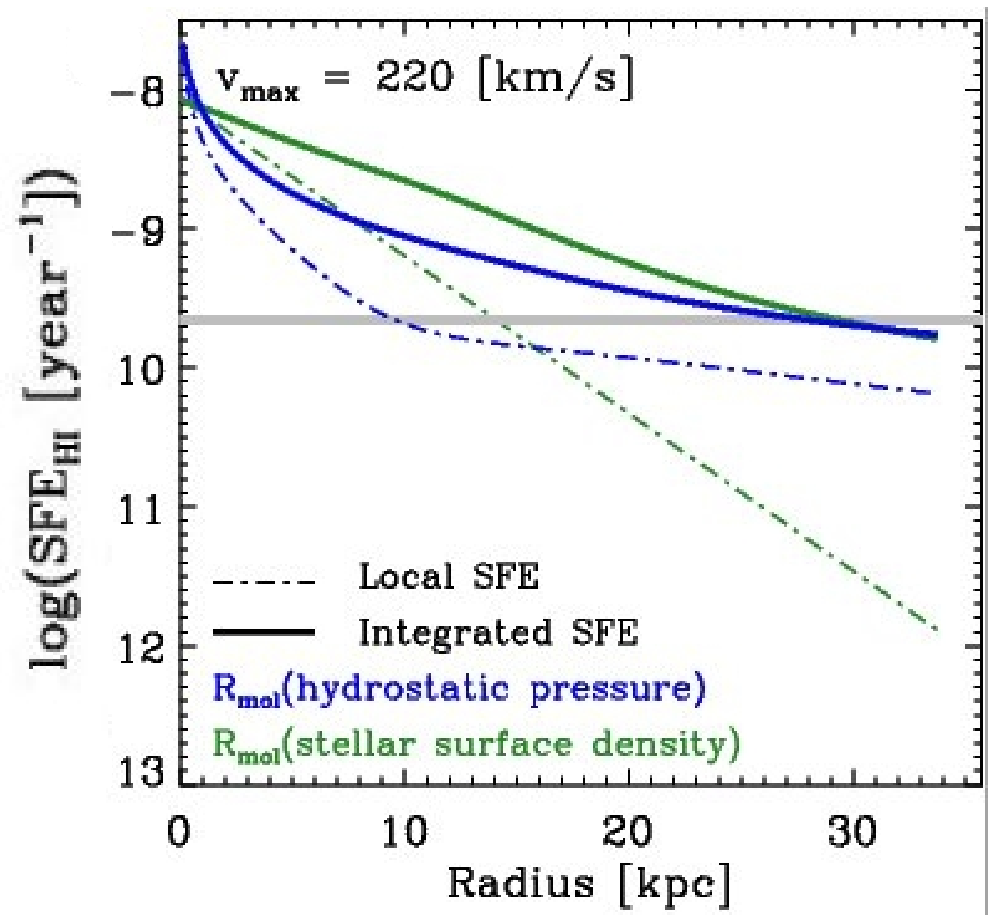
Example model of a small disk galaxy



Wong et al (2016)

Example Milky Way



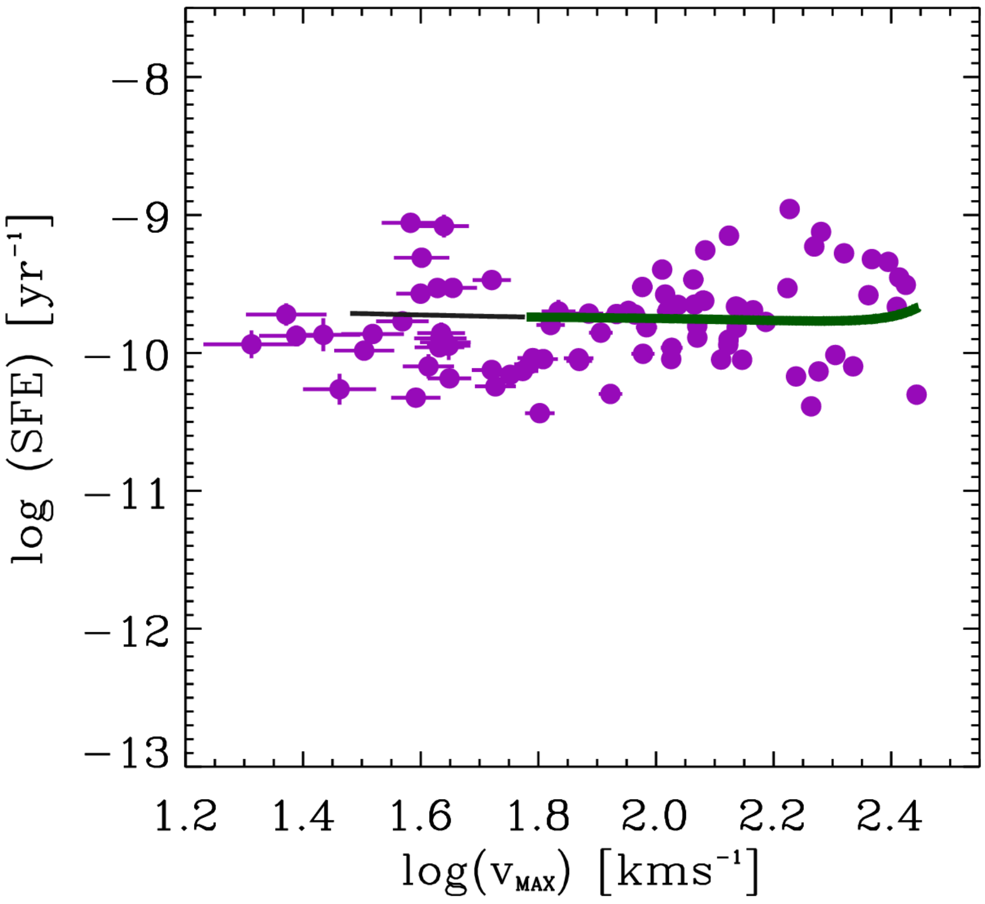


Wong et al (2016)

Toy model works even for smaller galaxies!

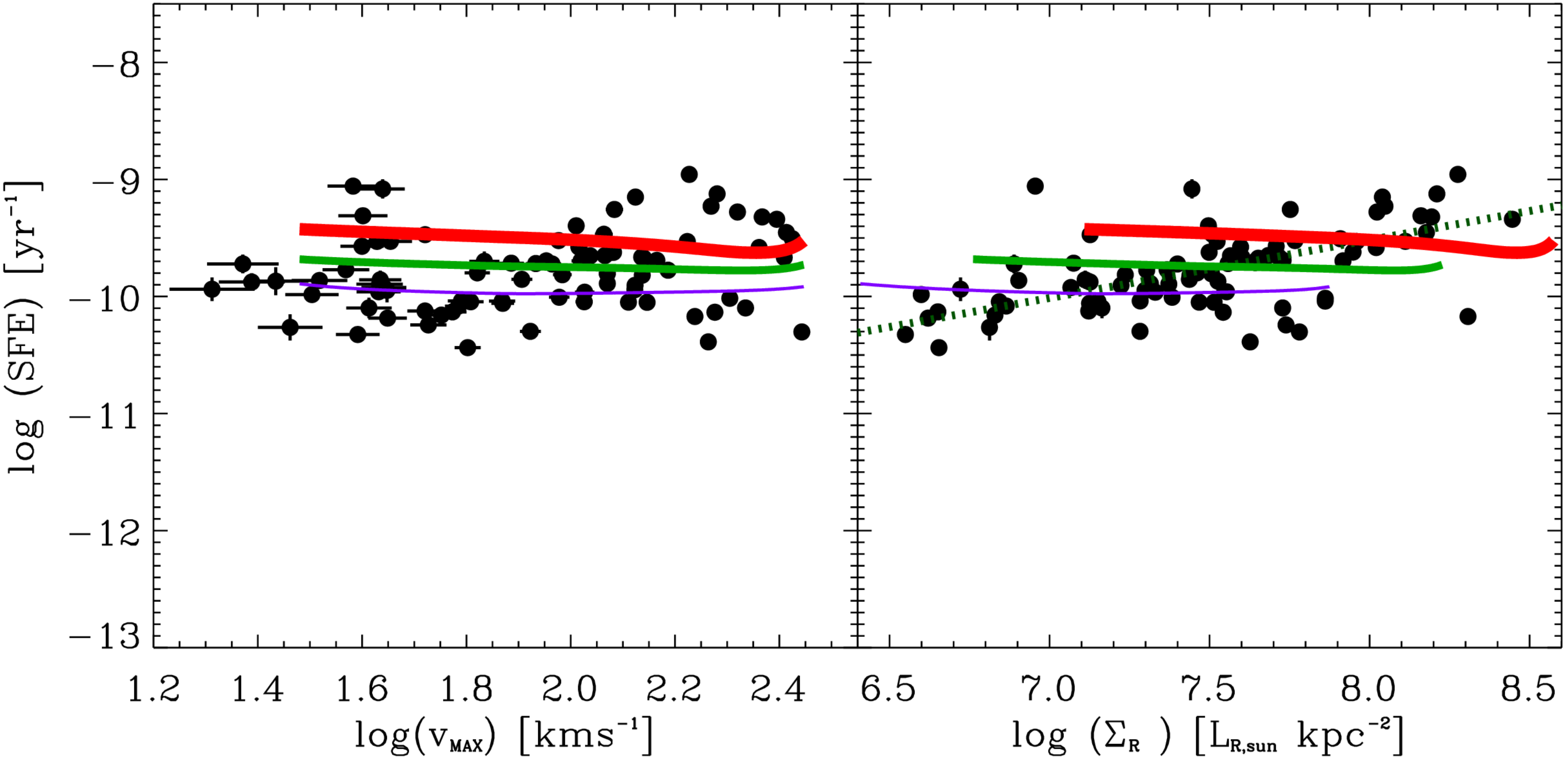
Shows that uniform global SFE(HI) can be produced by:

→ a constant marginal disk stability + hydrostatic disk pressure



Wong et al (2016)

Scatter due to variations in intrinsic surface brightness distributions



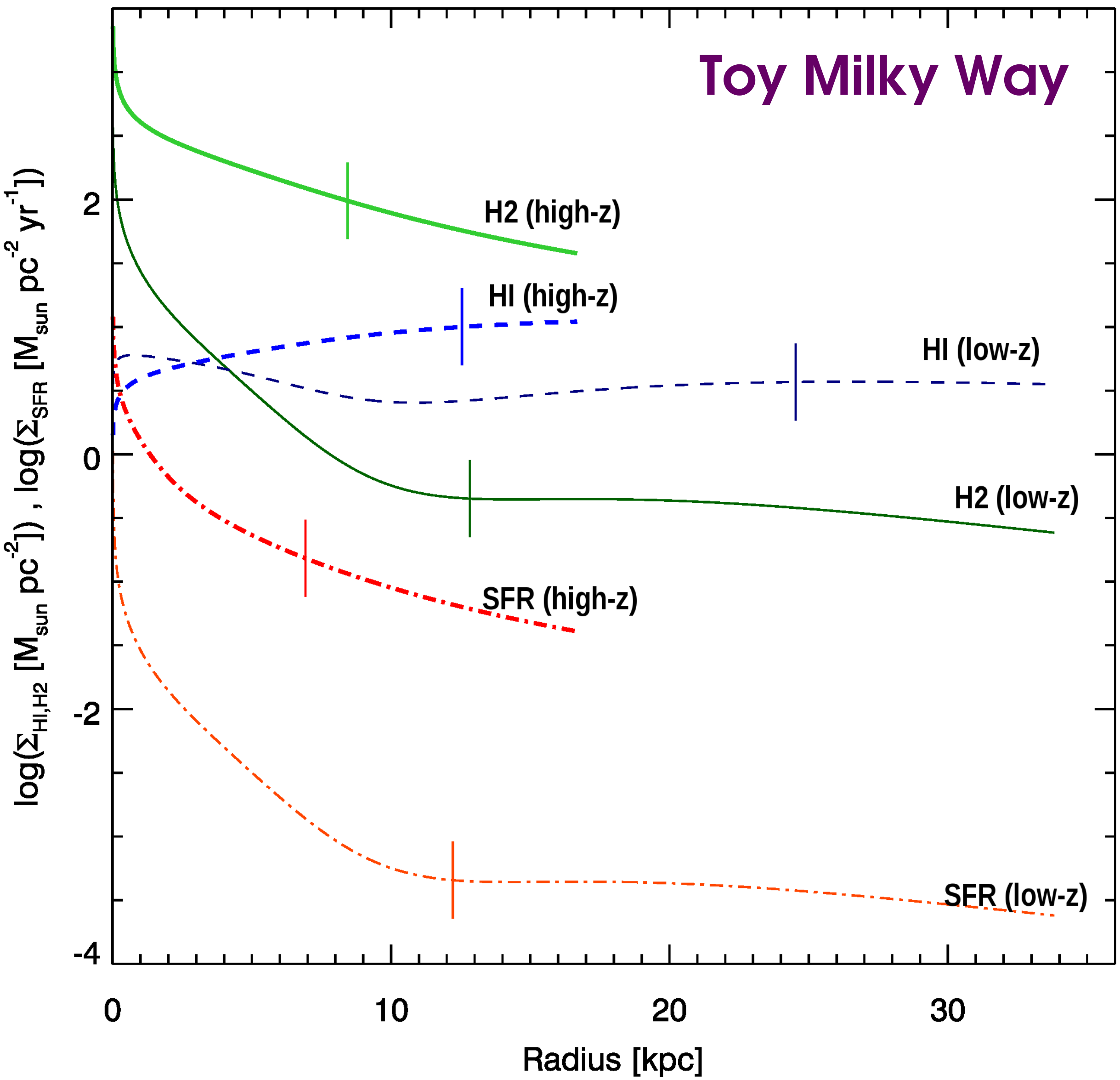
Wong et al (2016)

What about galaxies @ higher-z ?

We begin solely with $M_b = M_g$ && σ_g=60 km/s

→ toy high-z galaxies are smaller with high SFRs

→ consistent with SINS (z=2 star-forming spirals)



Wong et al (2016), Foerster-Schreiber et al (2006, 2009)

Summary & conclusions

Our simple toy models with constant marginal disk stability + hydrostatic disk pressure can produce:

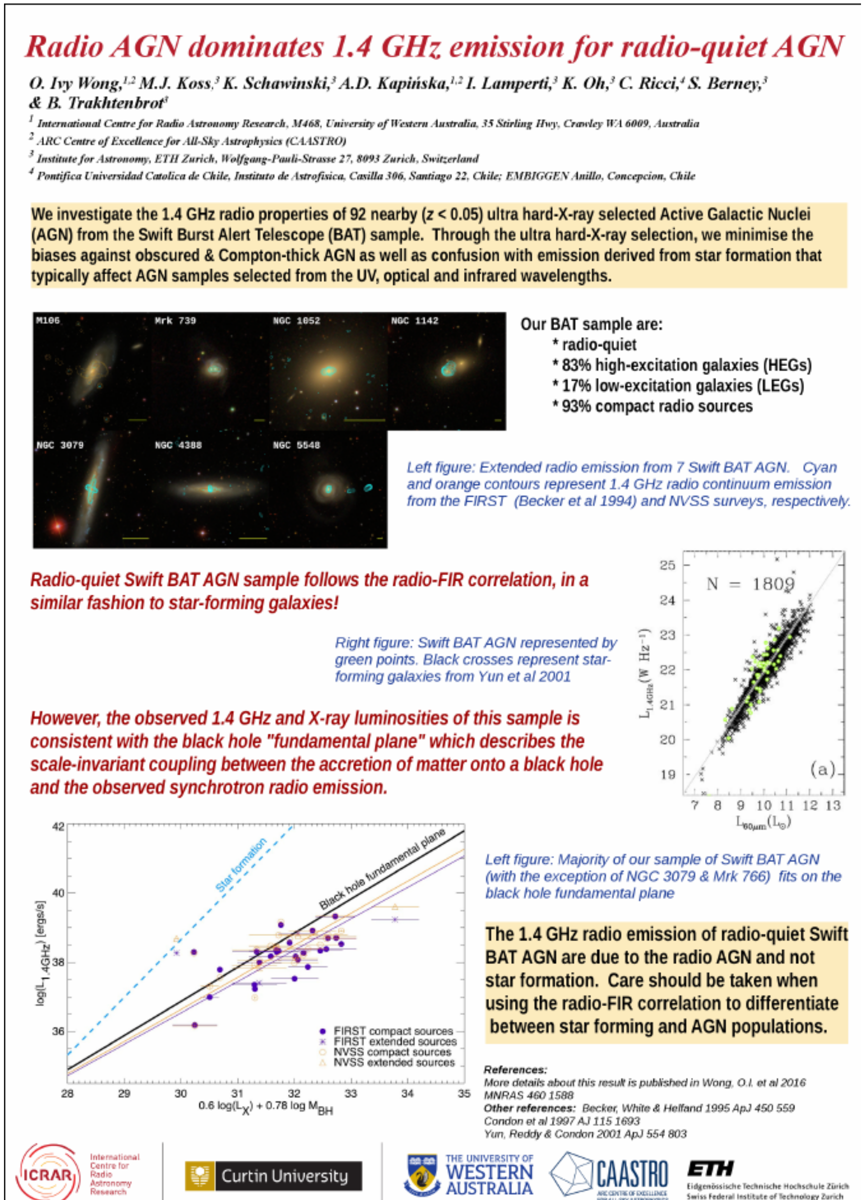
→ uniform global SFR/HI (SFE) in the Local Universe

→ SFE scatter due to intrinsic variations in disk scale lengths

→ reasonable SF props of high-z galaxies too!

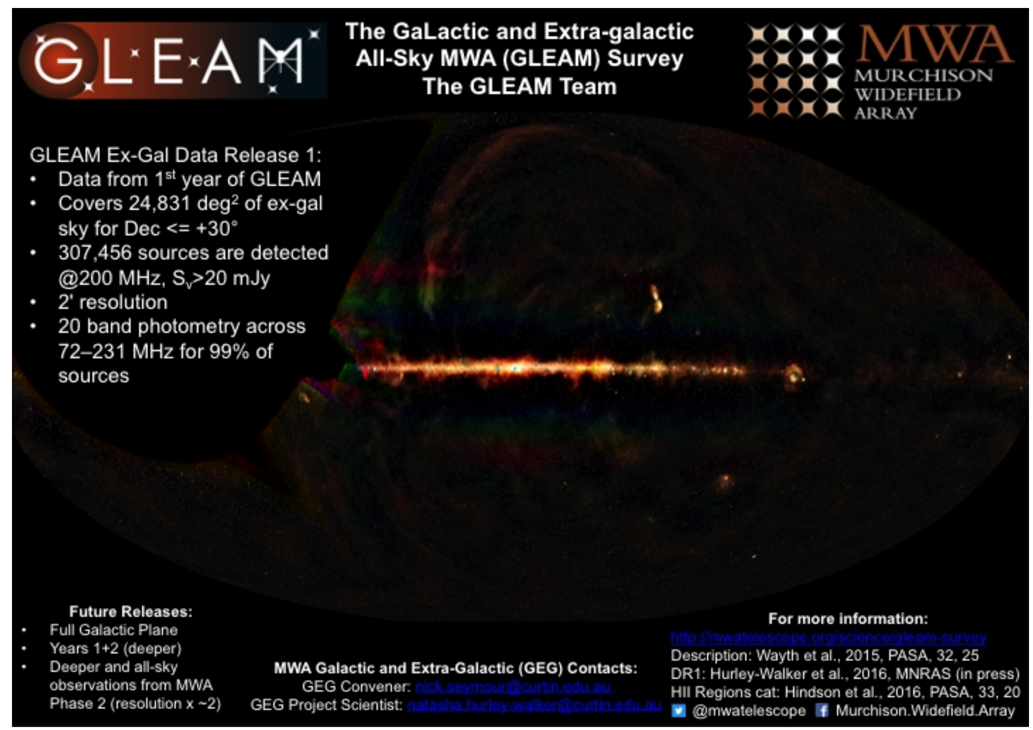
Reference: Wong, O.I. et al 2016 MNRAS, 460, 1106

In other news:



AGN hiding in radio-FIR correlation ...

Reference: Wong, O.I. et al 2016 MNRAS, 460, 1588



Reference: Hurley-Walker,N et al 2016 *submitted MNRAS*