Modelling the HI – Star Formation Connection

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SINGG & SUNGG

- SINGG: the Survey of Ionization in Neutral Gas Galaxies
  - Hα and R band survey
- SUNGG: the Survey of Ultraviolet emission in Neutral Gas Galaxies
  - Far and near ultraviolet (FUV, NUV) survey

- Parent sample of both is HIPASS the HI Parkes All Sky Survey

HIPASS, SINGG, and SUNGG

- HIPASS
  - HI 21cm
  - Parkes 64m
  - 4315 sources
- SINGG
  - Hα & R band
  - CTIO 1.5m (& 0.9m, ANU 2.3m)
  - 468 sources selected
  - 331 observed
- SUNGG
  - FUV & NUV
  - Galex 0.5m
  - 139 selected
  - ~200 observed

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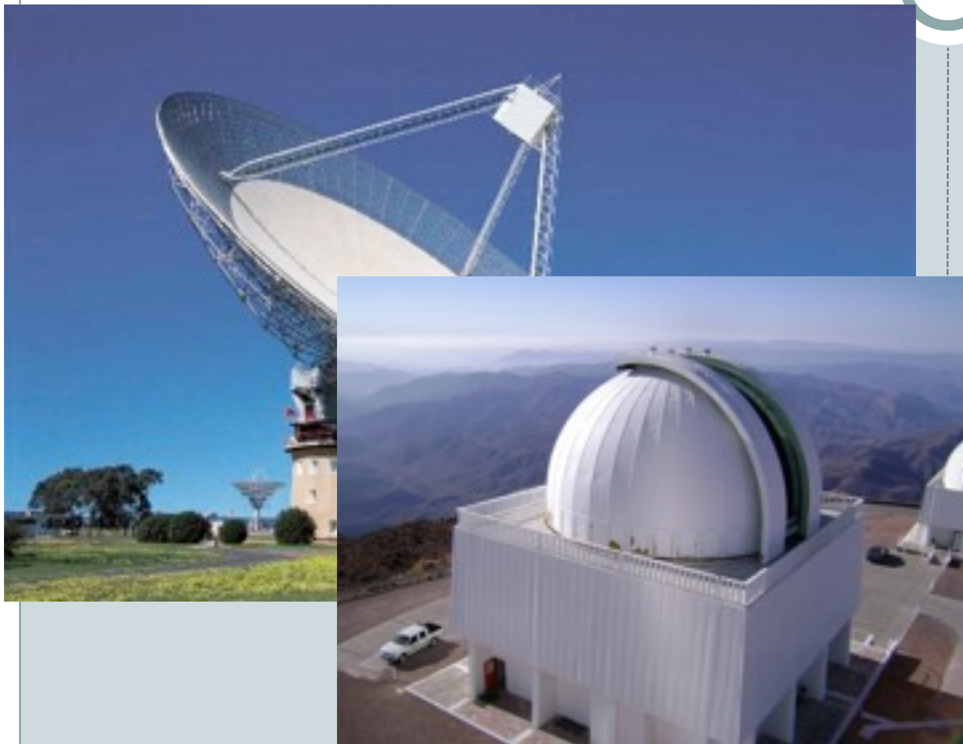

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The SINGG & SUNGG teams :

- G.R. Meurer (ICRAR/UWA) ★✲
- H.C. Ferguson (STScI) ★ ✲
- R. Webster (Melbourne) ★ ✲
- J. Bland Hawthorn (Sydney) ✲
- M. Dopita (ANU) ★
- M. Doyle (Queensland) ★ ✲
- M. Drinkwater (Queensland) ★ ✲
- K.C. Freeman (ANU) ★
- D. Hanish (IPAC/JPL) ★ ✲
- J. Heiner (Laval) ✲
- T. Heckman (JHU) ★
- R. Kennicutt (Cambridge) ★✲
- V. Kilborn (Swinburne) ★✲

- J.H. Kim (Seoul) ★✲
- P. Knezek (WIYN) ★ ✲
- B. Koribalski (ATNF) ★
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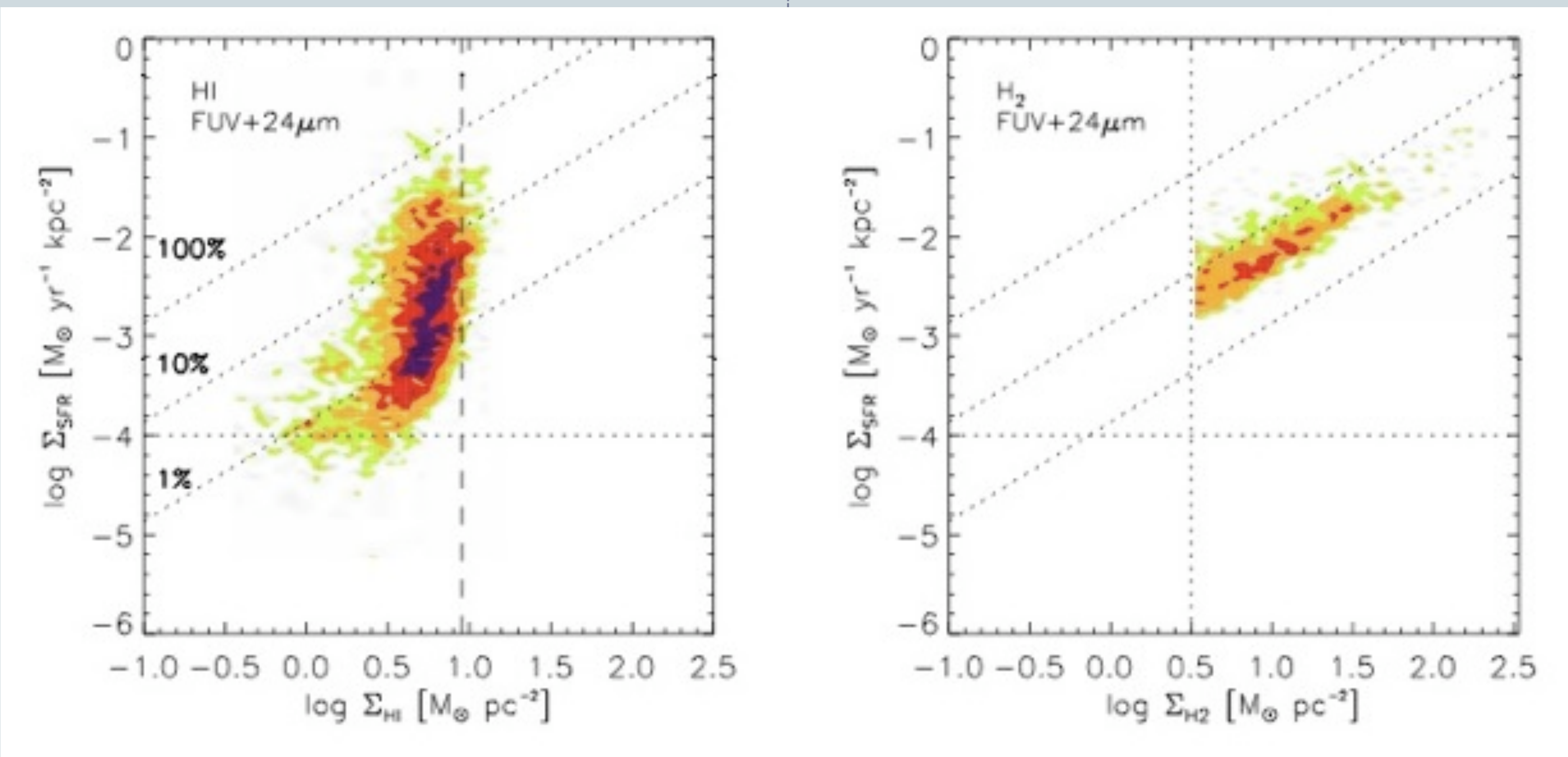
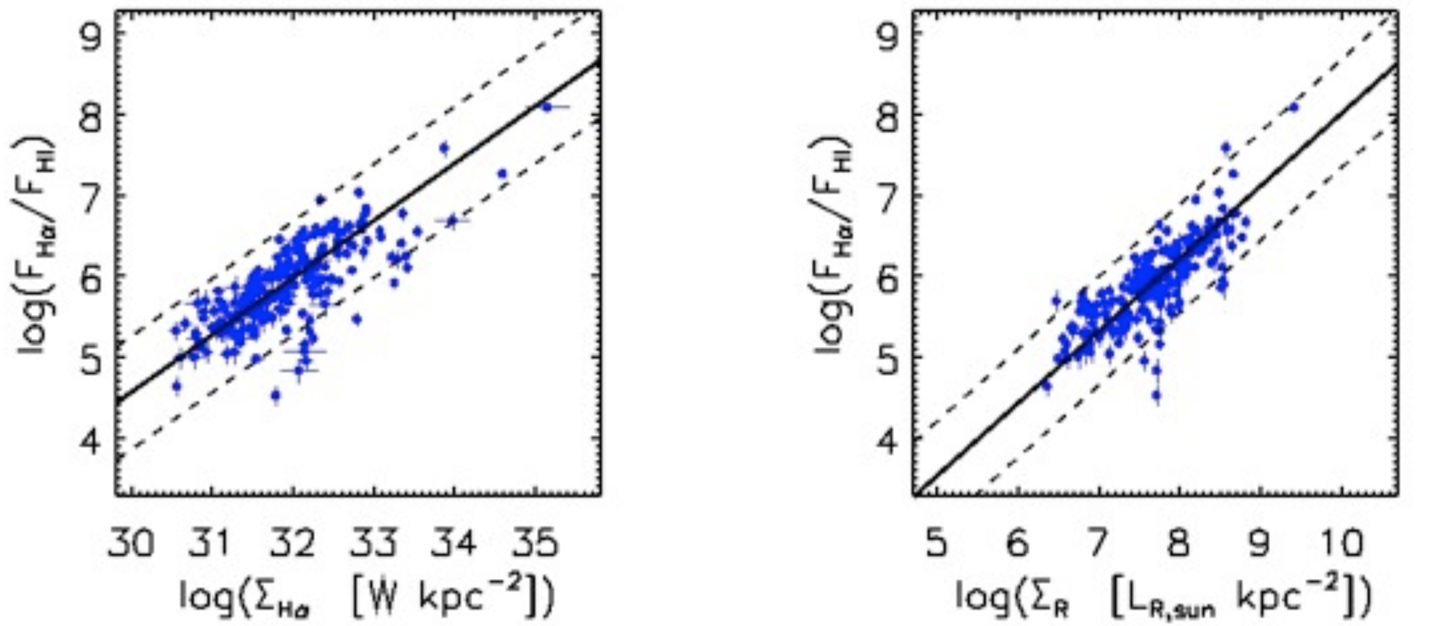
An HI – star-formation connection?

- Stars form out of the molecular ISM, not HI
- So why should there be ***any*** connection?



Bigiel et al. (2008, AJ, 136, 2846)

Correlations from SINGG



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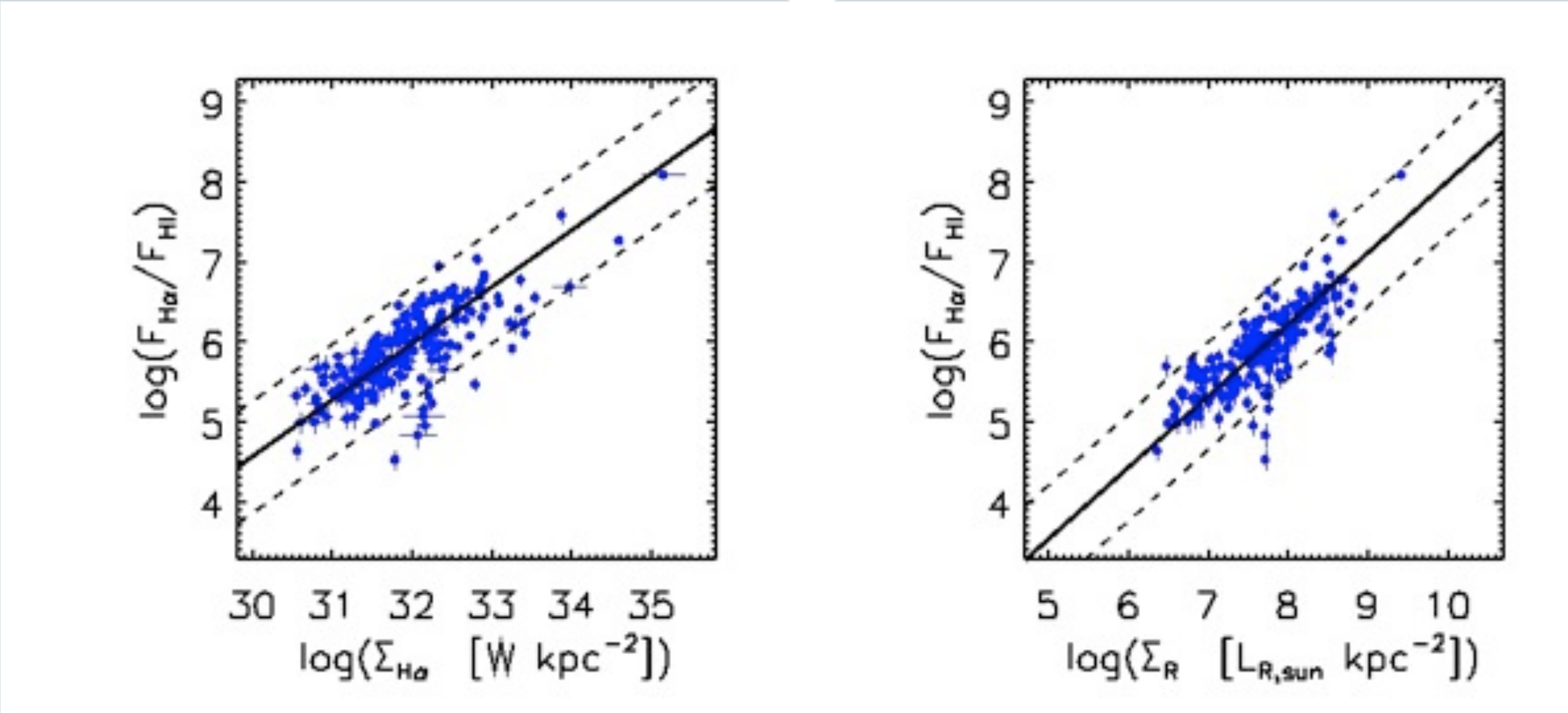

- X-axis Σ_{SFR} Σ_{R}
- r_{xy}
  0.76 0.80
- Slope 0.71 0.89
- σ_y
  0.28 0.27
- σ...

The THINGS SFL

1. $\Sigma_{SFR} \sim \Sigma_{H2}$ (N = 1.0) → Linear relation between molecular gas and SFR
- $R_{mol} = \Sigma_{H2}/\Sigma_{HI} \sim \Sigma_R$ → molecular fraction set by hydrostatic pressure
- Q(2 Fluids) = constant → ISM disks maintained at constant stability

Leroy et al. (2008, AJ, 136, 2782) , Bigiel et al. (2008, AJ, 136, 2846)

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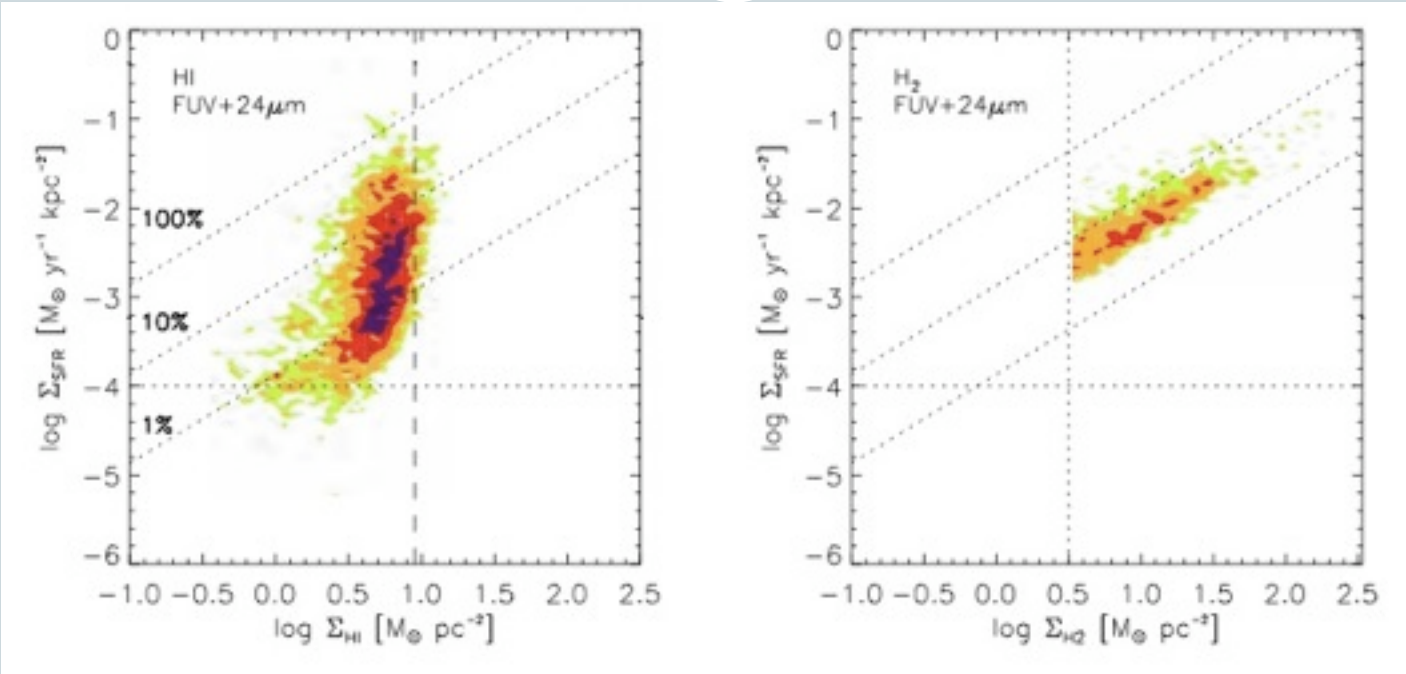

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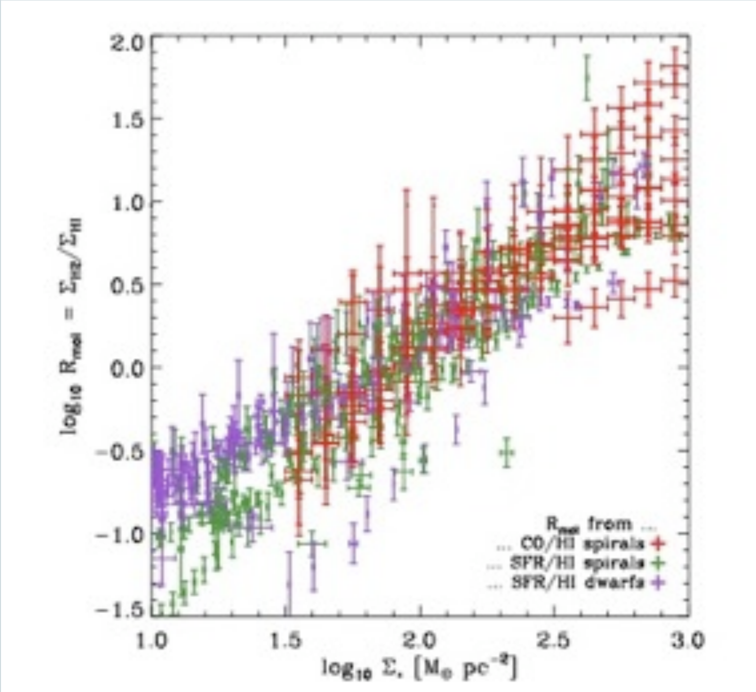

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Wednesday, 5 May 2010

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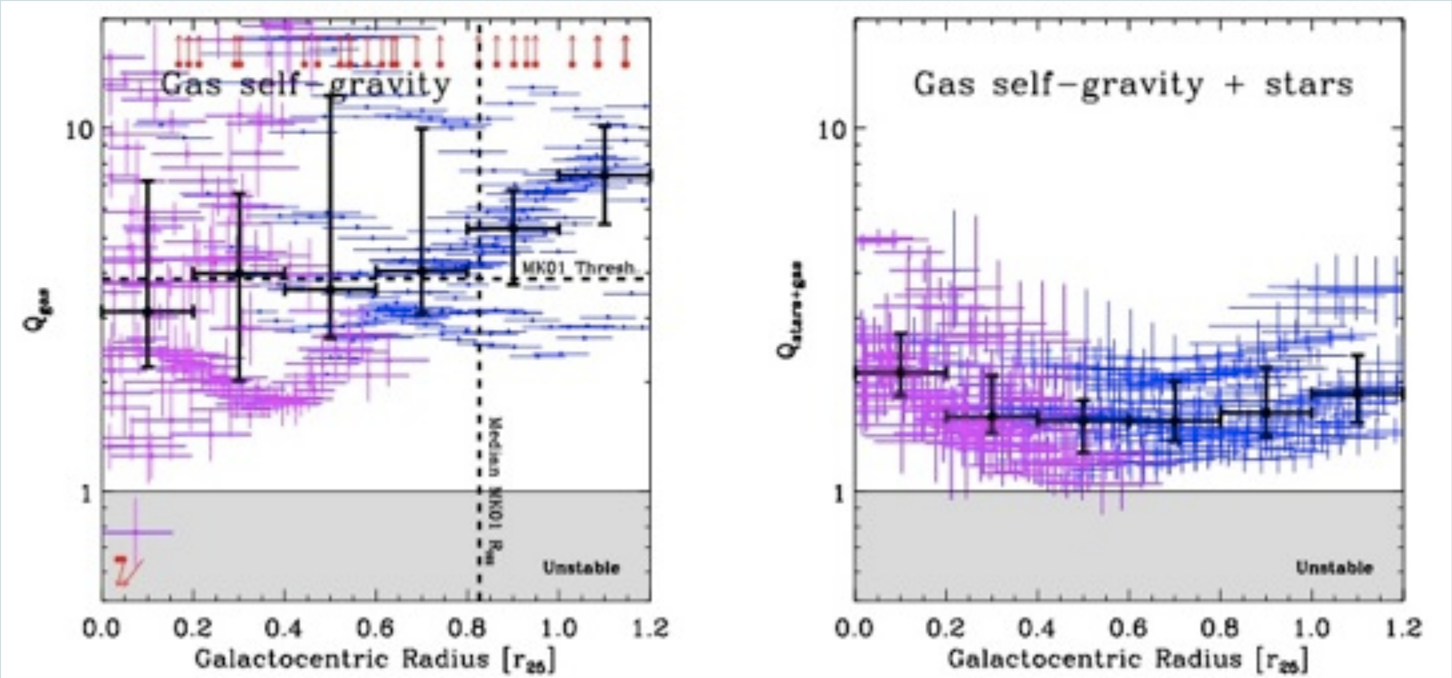

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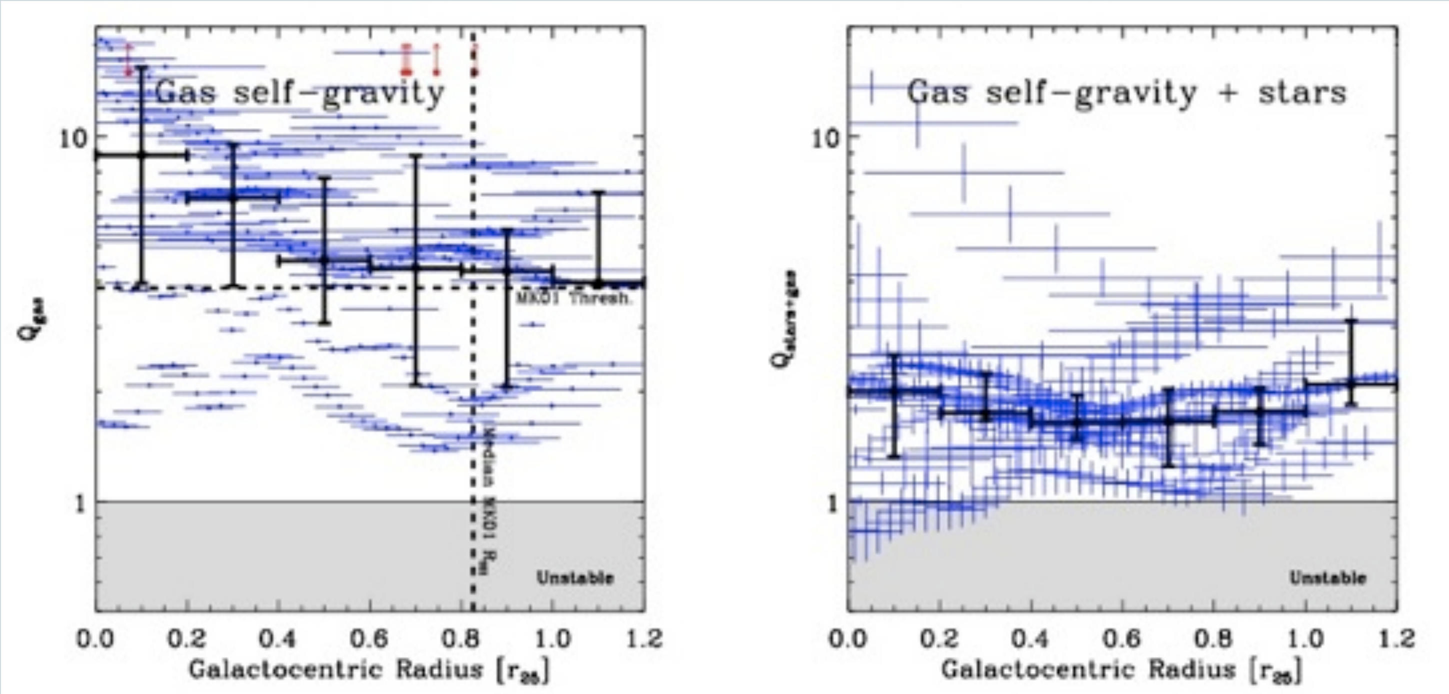

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A new paradigm?

- ISM disks self regulate to constant Q
- Hydro-static pressure sets ISM phase balance in disk
  - WNM
  - CNM
  - Molecular gas
- Star formation traces densest phase

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ISM and SF distribution can be directly inferred from distribution of dark matter and stars

Test with SINGG global properties

- $H\alpha/HI \rightarrow SFR/HI \rightarrow H_2/HI \rightarrow R_{mol} \rightarrow P$(!)
- Expect 1:1 correlation with Σ_R

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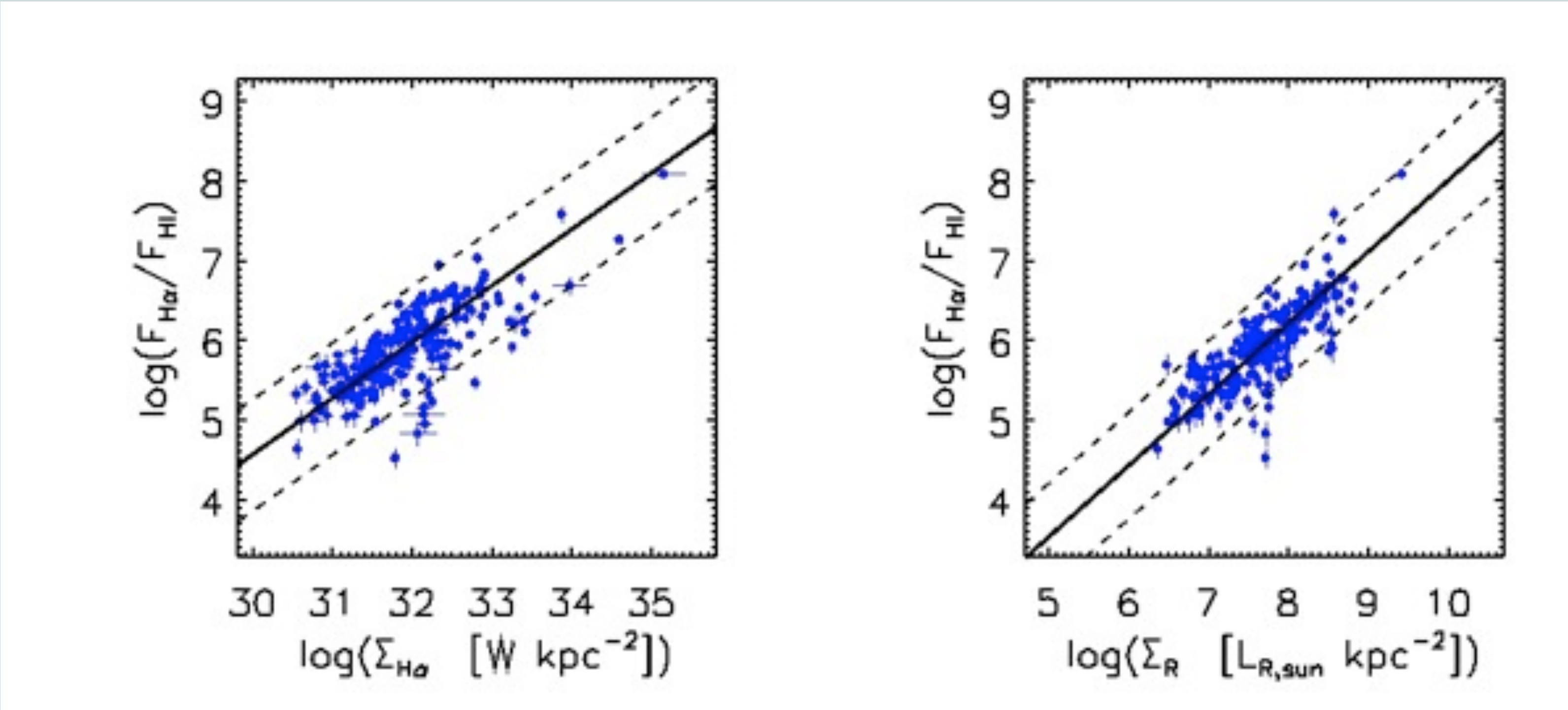

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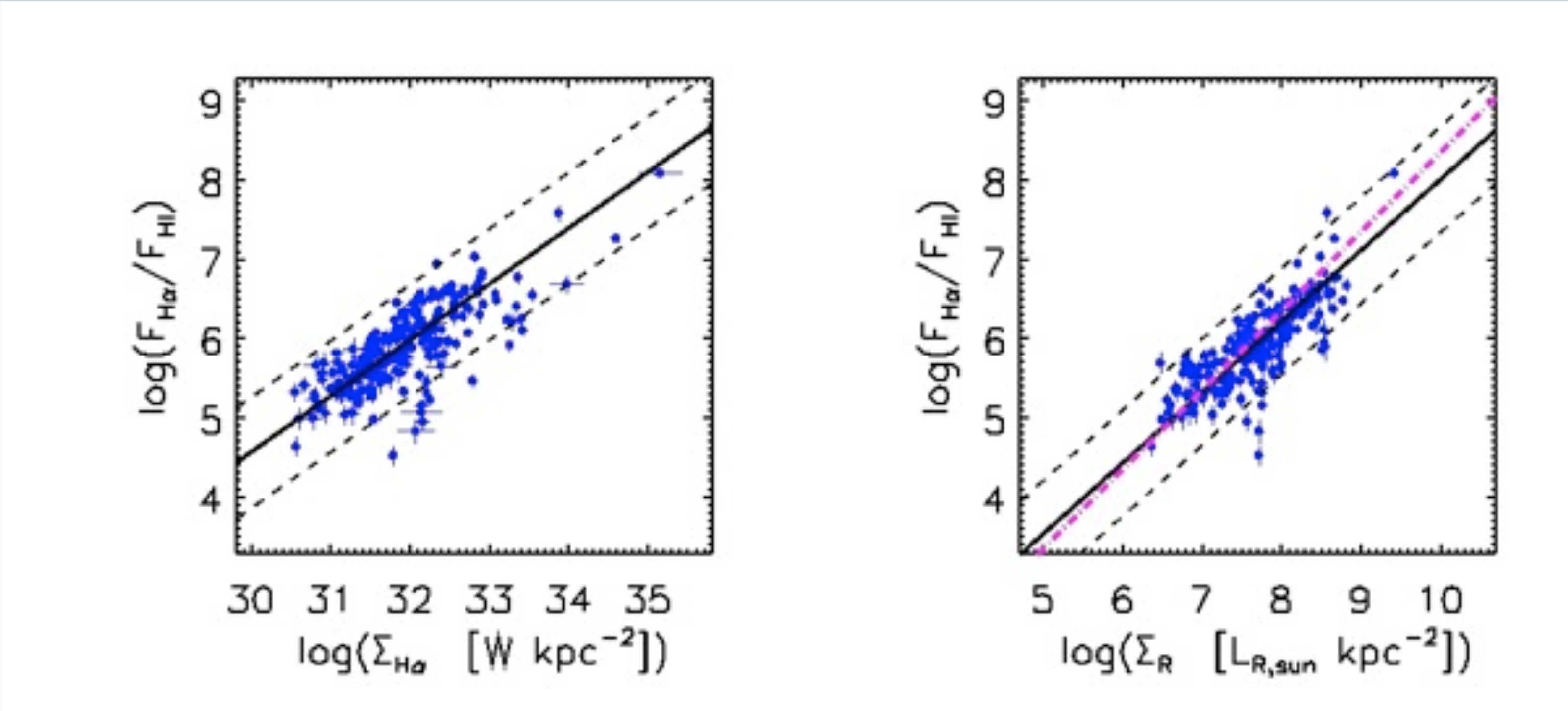

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Alogorithm for calculating Σ_{SFR}, Σ_{HI} profiles

- Use rotation curve to derive Σ_{gas} for a disk at constant Q_{2f}
  - Assume constant σ_{gas} = 11 km/s
  - Derive stellar scale height from R band scale length
  - Assume constant scale height stellar disk to derive σ_{stars} from Σ_{stars}
  - Assume constant scale length for "most unstable mode"
- Derive H2/HI from Σ_{stars}
  - Use correlation from Leroy et al.
  - Assume constant M/L for stars
- Yields Σ_{HI} and Σ_{H2}
- Derive Σ_{SFR} from Σ_{H2} using constant SFR/H2

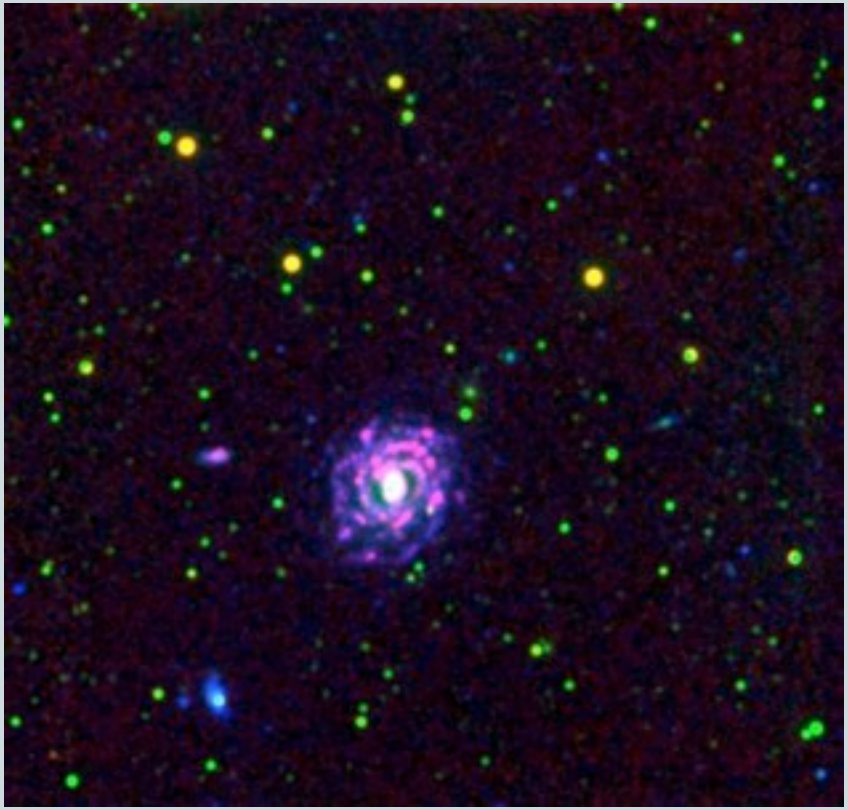
Two test case for testing dynamical SFL

- UGC8041 = HIPASS J1255+00
- NGC4897 = HIPASS J1300-13

Parameter	UGC8041	NGC4897
Distance [Mpc]	15	39
Morphology	Sc/Sd	Sbc
Log($L_R/L_{R,sun}$)	9.48	10.52
Log(M_{HI}/M_{sun})	9.09	10.04
Log($SFR_{H\alpha/FUV}$ [Msun/year])	0.30/0.43	2.7/2.8
Adopted inclination [deg]	50	40

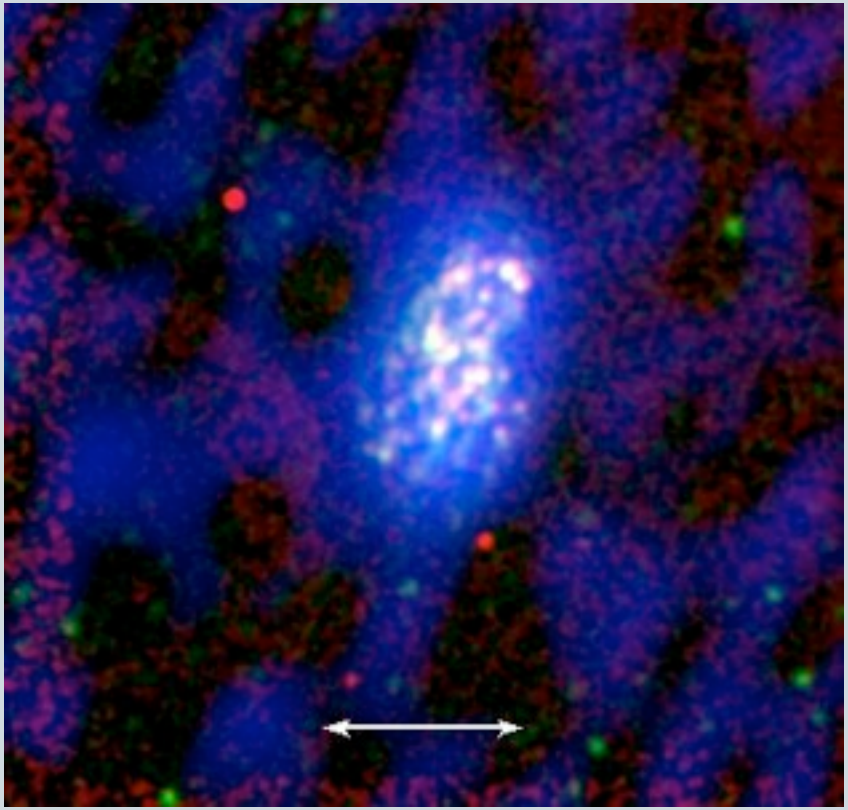
Hα, R, FUV images

UGC8041 | **NGC4897**

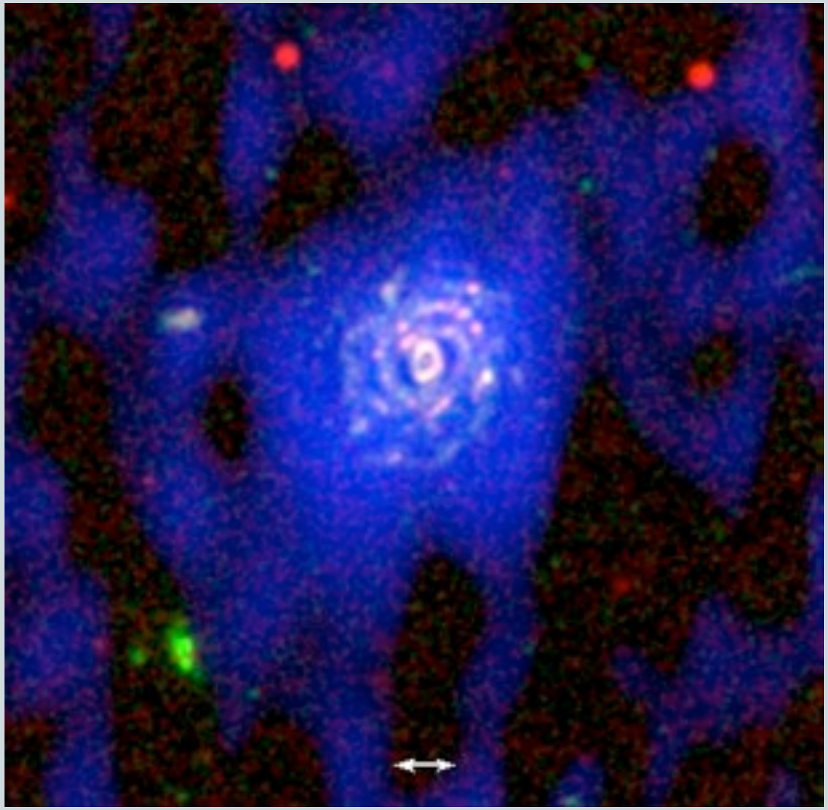


Hα, R, HI (VLA D array) composites

UGC8041

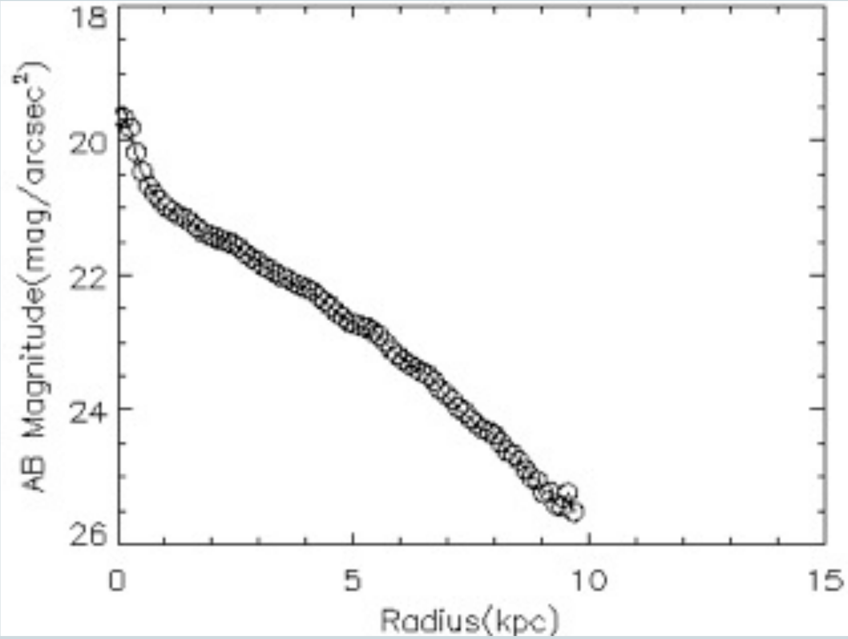


NGC4897



R surface brightness profiles

UGC8041



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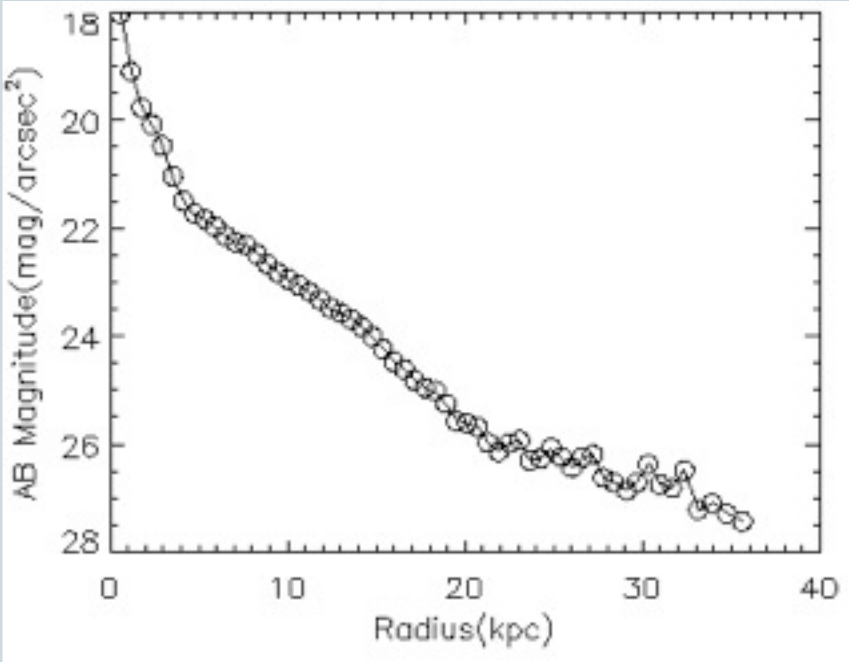
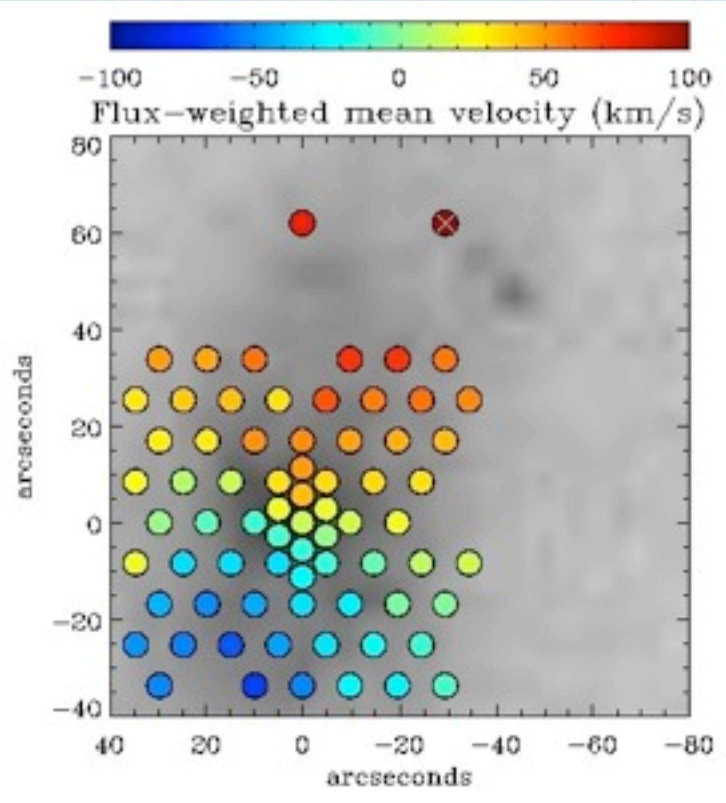


WIYN SparsePAK data

UGC8041



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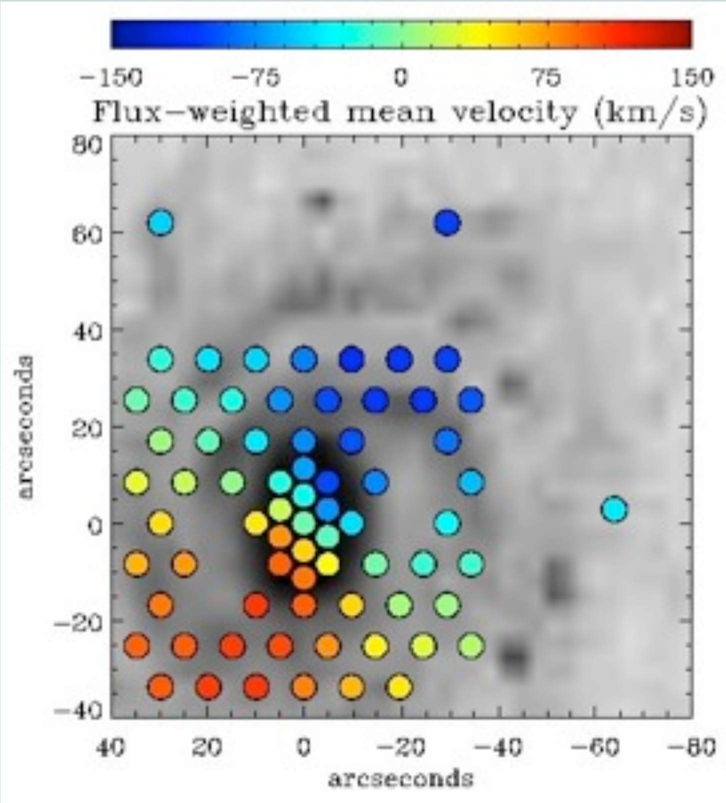
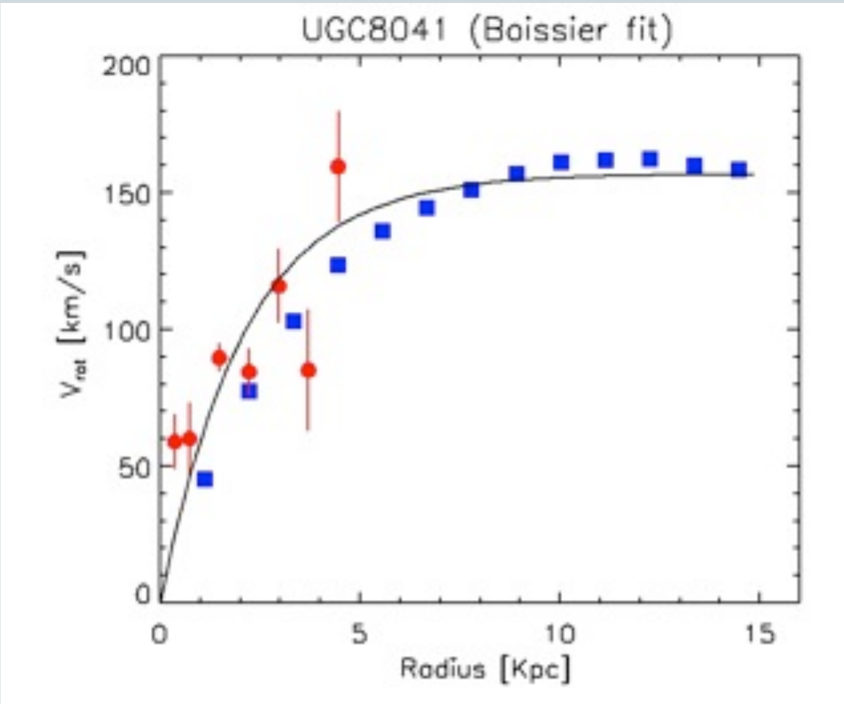
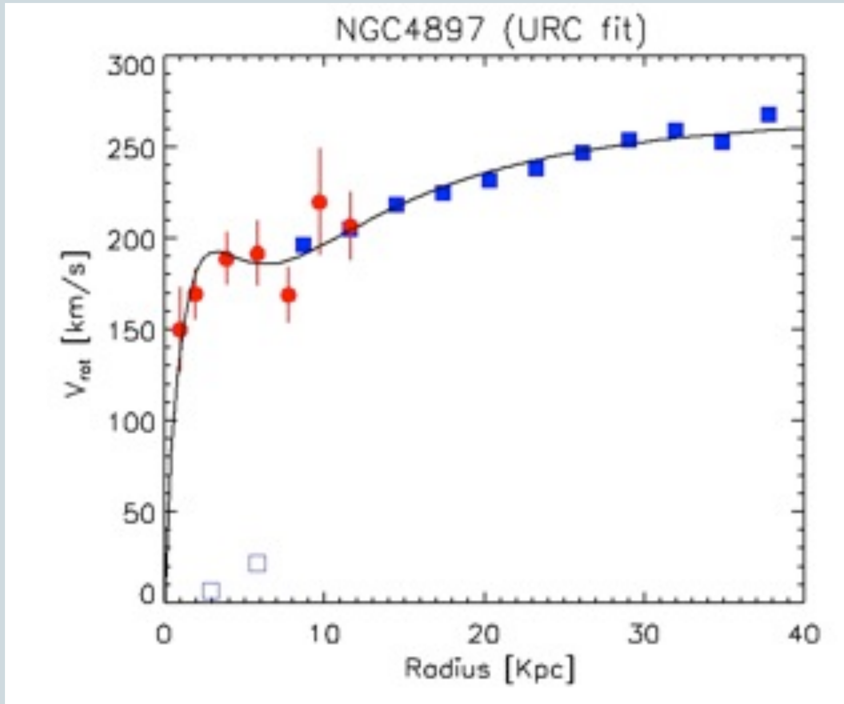


Adopted rotation curves

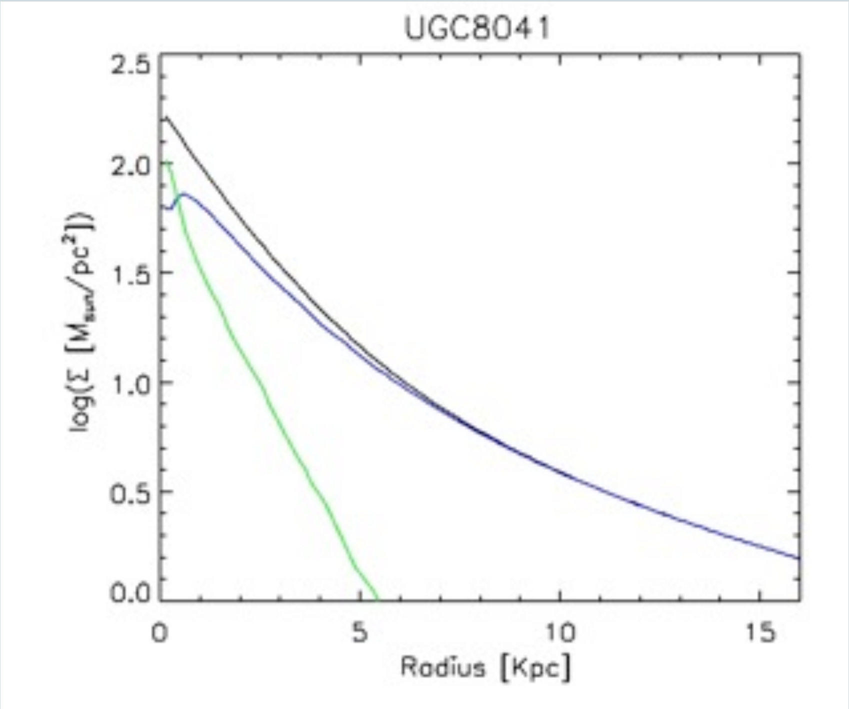
UGC8041 | **NGC4897**





Modeled ISM profiles

UGC8041



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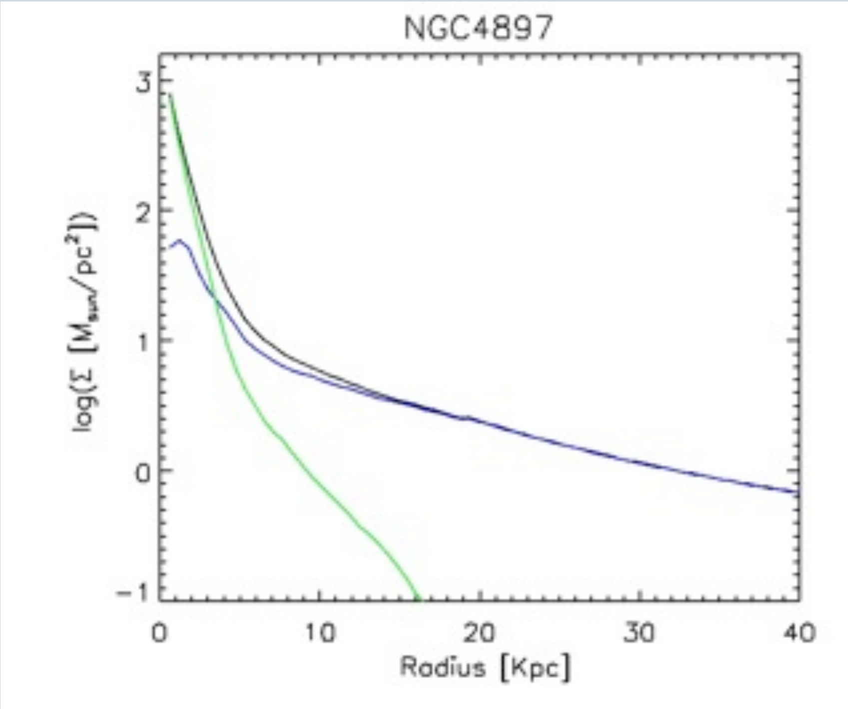
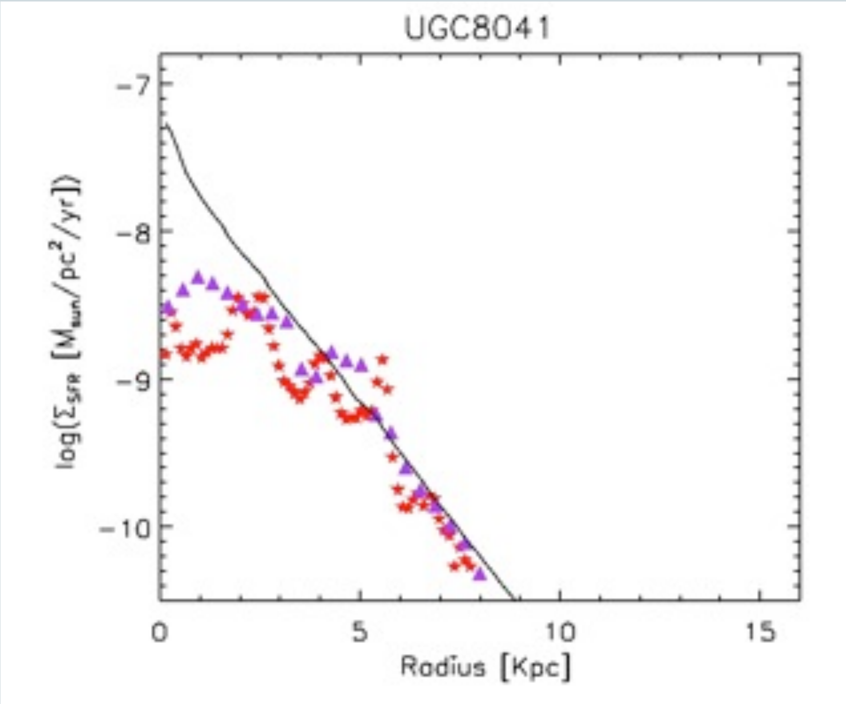
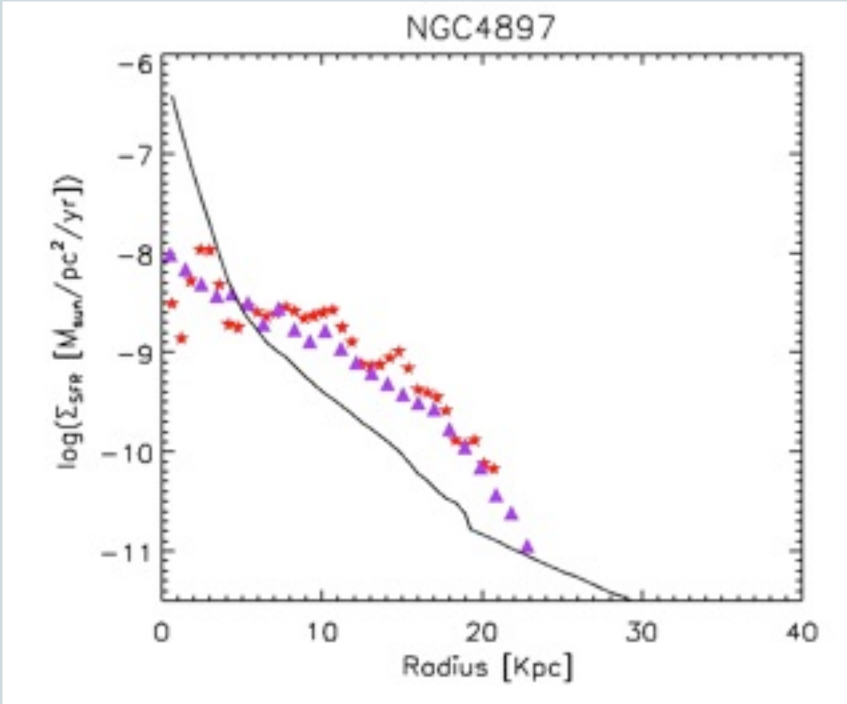


Model versus observed SFR profiles

UGC8041 | **NGC4897**





Plusses and Minuses

- Strengths
  - Strong physical and empirical basis
  - Accounts for more extended HI relative to H2 and SFR
  - Straightforward to calculate
  - Can extend to other observables
    - Total SFR
    - HI velocity profiles
    - ...
  - Should be easy to implement for simulations

- Open issues/weaknesses
  - Model Σ_{HI} too high near centres
  - How do you deal with bulges?
  - Not calibrated/tested beyond optical disks
  - Why should σ_{gas} be constant?
    - Tamburro et al. (THINGS) find radial drop-off in σ_{gas}
    - Correlates with SFR
  - How do you calculate k ? (wave number of most unstable mode?)
  - Dust corrections
  - IMF variations
  - Needs more testing

Summary

- Results from the THINGS team suggest that ISM and star formation distributions can be derived from total mass distribution and disk mass distribution
- We are turning this into a practical model
- Testing on SINGG galaxy sample
- Still have issues to iron out
- Stay tuned...