A direct estimate of the radial growth of stellar discs

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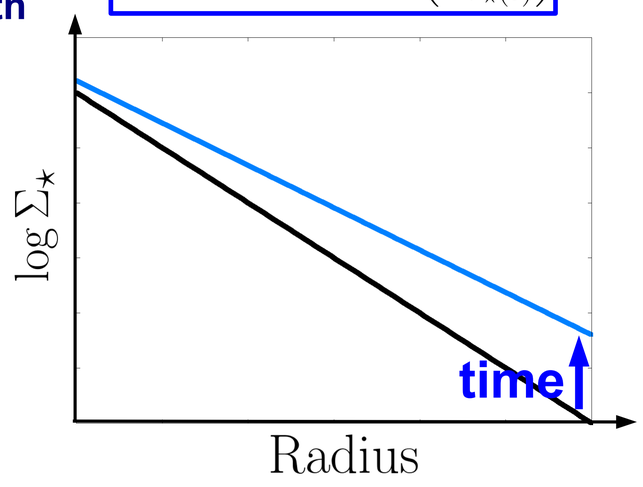
THEORY

IF stellar discs are exponential with a time-growing scale-length

$$\Sigma_\star(t,r) = \Sigma_{\star,0}(t)\exp\left(-\frac{r}{r_\star(t)}\right)$$



THEN the star formation rate should have a universal profile

2 parameters:

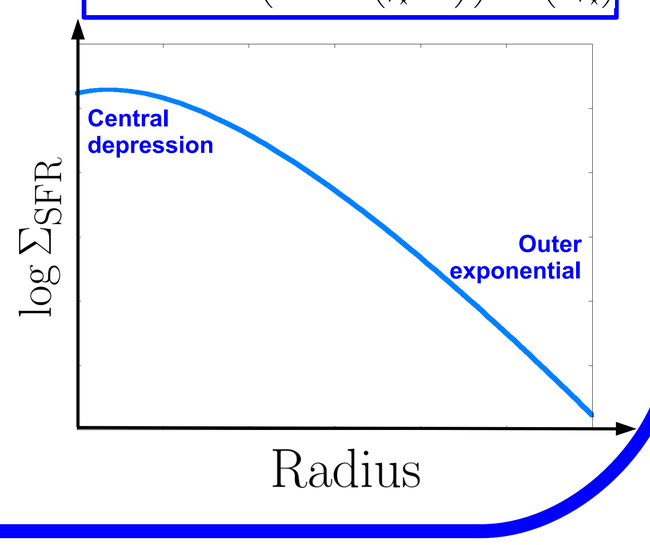
- mass growth rate:

$$\nu_M \equiv \frac{\dot{M}_\star}{M_\star}$$

- radial growth rate:

$$\nu_r \equiv \frac{\dot{r}_\star}{r_\star}$$

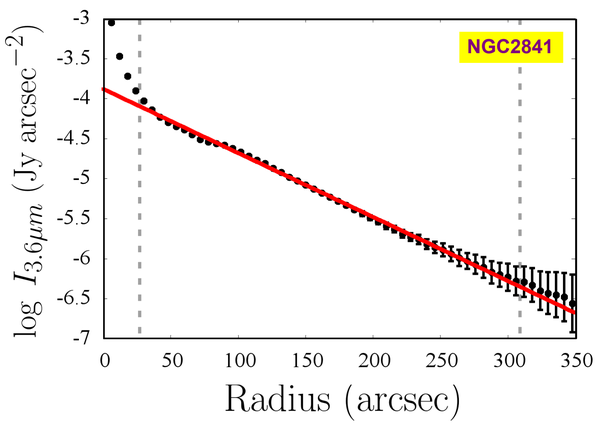
$$\Sigma_{\rm SFR}(r) = \Sigma_{\star,0}\left(\nu_M + \nu_r\left(\frac{r}{r_\star} - 2\right)\right)\exp\left(-\frac{r}{r_\star}\right)$$



OBSERVATIONS

SAMPLE: 35 nearby spiral galaxies, with available NIR and (extinction-corrected) FUV profiles (Muñoz-Mateos et al. 2009 [1], data from the SINGS survey)

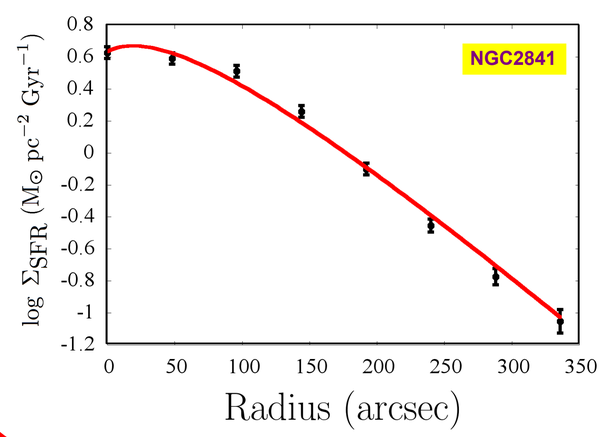
1) Stellar mass surface density (Spitzer IRAC 3.6 μm)



STEP 1: Exponential fit of the disc mass surface density

Measure $\Sigma_{\star,0}, r_\star$

2) Star formation rate surface density (GALEX FUV + Spitzer MIPS bands)



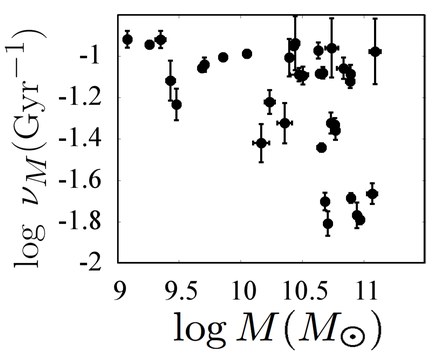
STEP 2: Fit of the theoretical SFR density

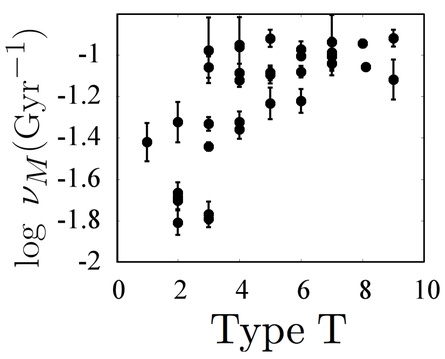
Measure ν_M, ν_r

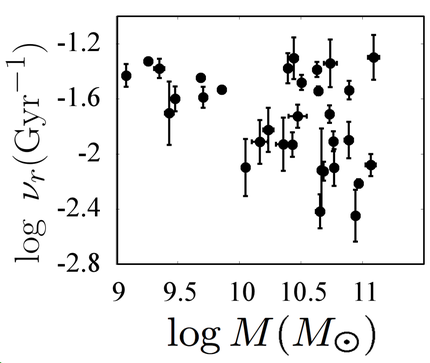
RESULTS

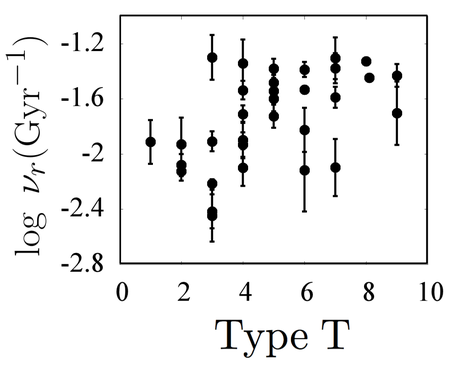
- 32/35 galaxies show positive radial growth $(\nu_r > 0)$

- Mass and radial growth rates (ν_M, ν_r) **show only mild trends with mass and morphological type...**

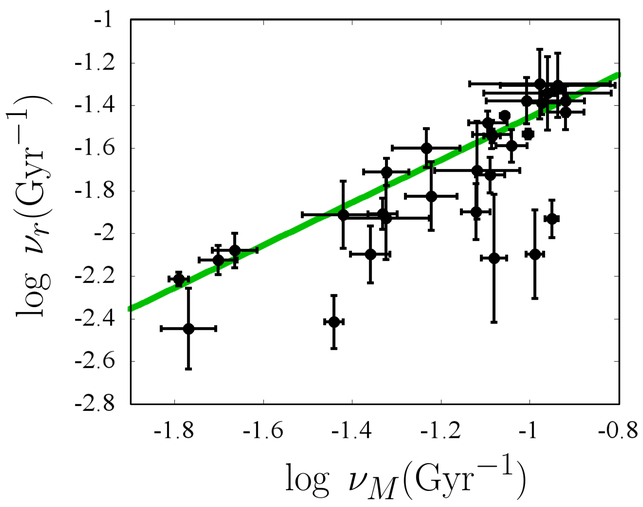








... but they are quite strongly correlated with each other!



The solid line (NOT fitted to the data) is the expectation if:

- the Tully-Fisher relation [2] $V_c \propto M^{0.25}$

- and the Fall relation [3] $V_c\, r_\star \propto M^{0.6}$

were not evolving with time

CONCLUSIONS

- **SFR density profiles of spiral galaxies can be used to measure the growth rate of their exponential discs**
- **The typical radial growth rate of a spiral galaxy is ~0.35 times its mass growth rate**
- **Results are consistent with known scaling relations being universal (not evolving with time)**

References:
[1] Muñoz-Mateos, J.C. et al. 2009, ApJ, 701, 1965M
[2] McGaugh, S. 2012, AJ, 143, 40M
[3] Romanowsky, A.J. & Fall, S.M. 2012, ApJS, 203, 17R