Star and structure formation
From first light to the Milky Way
ETH, Zürich, August 2003

Near and Far: The star formation history of disk galaxies

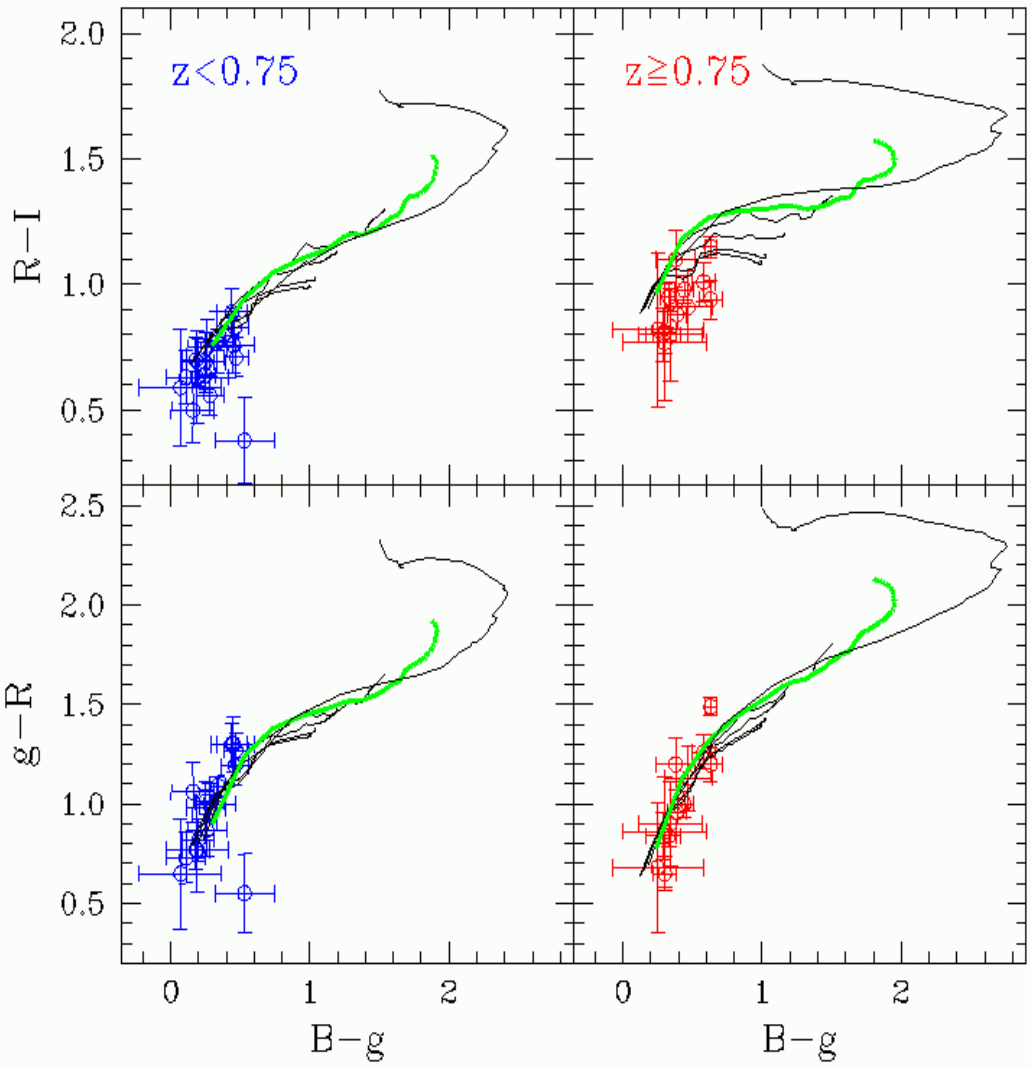
Ignacio Ferreras (Oxford)
Collaborators:
Joseph Silk (Oxford)
Asmus Böhm, Bodo Ziegler (Göttingen)

How do disk galaxies form ?

- The Colour-Magnitude relation in early-type systems (and its redshift evolution) can be used to determine their SFHs.
- We perform a similar analysis on the Tully-Fisher relation to understand the formation process of late-type galaxies.
- A phenomenological approach allows us to search a large volume of parameter space.
- The main goal of this project is to try to establish a possible correlation between global observables and star formation histories.

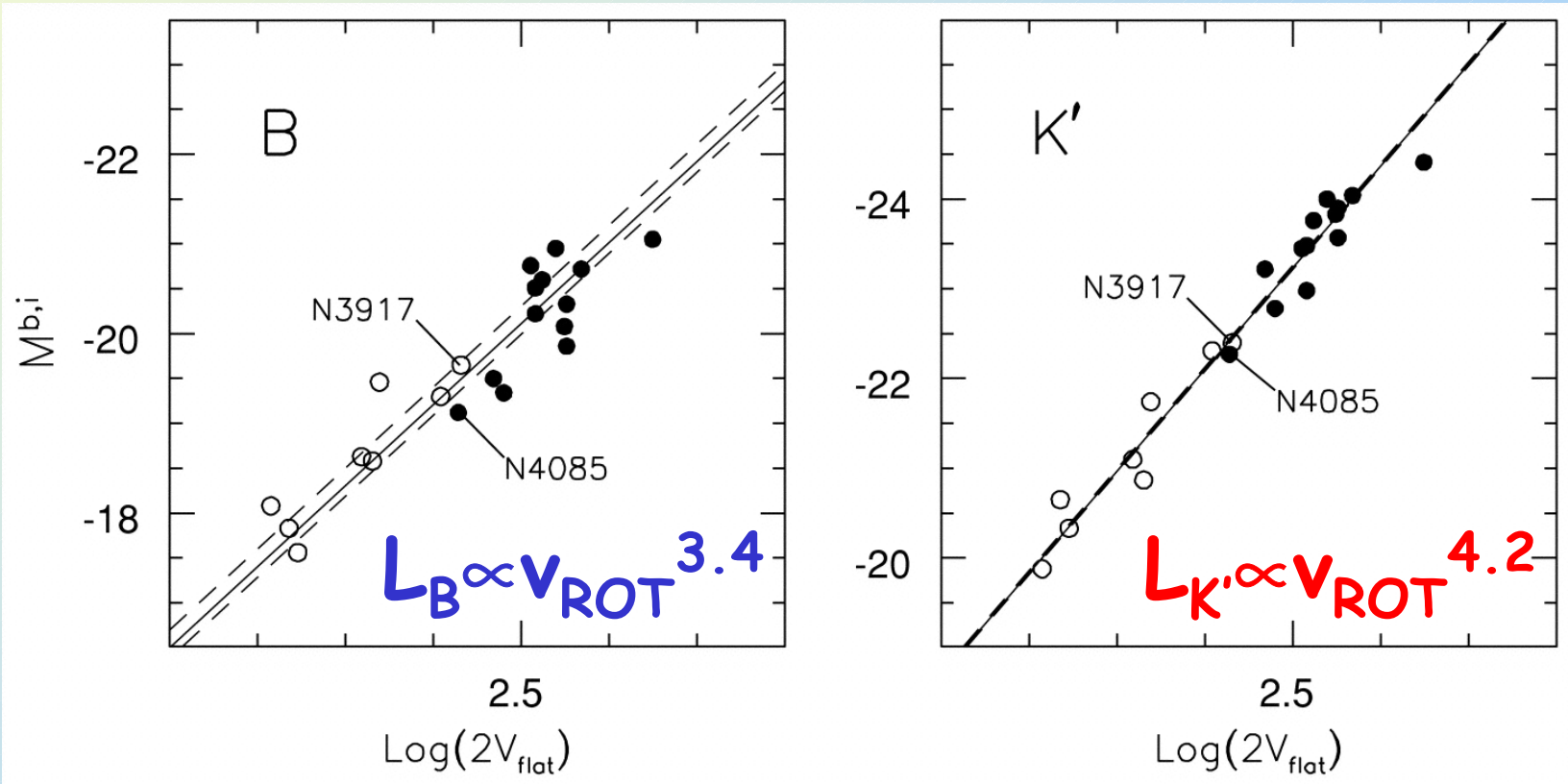
The FORS Deep Field Sample

- Deep UBgRIzJK survey over 6'x6' field (Appenzeller et al. 2000)
- R~1200 spectroscopy @ FORS2 of 79 galaxies (Ziegler et al. 2002) 0.1 < z < 1
- z > 0.5 (30 galaxies) selected
- [OII] λ3727Å$\rightarrow$ v_{MAX}



(z=0) UMa cluster disk sample

- B,R,I,K' photometry (Verheijen 2001)
- Rotation measured from HI
- RC/FD subsample (21 galaxies)

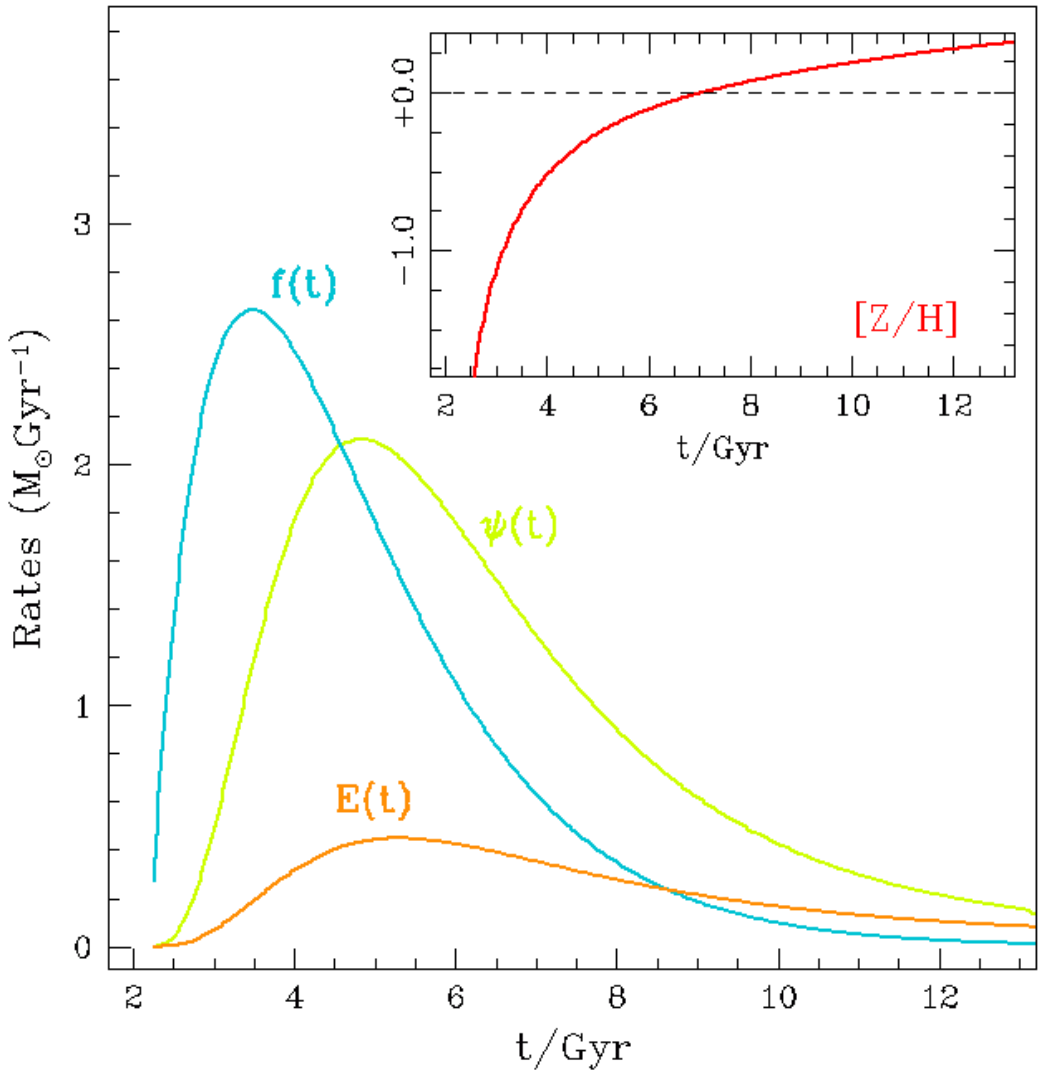


Modelling the SFH

- Infall: Delayed exponential, $\Delta t \equiv t - t(z_F)$:
  $f(t) \propto \Delta t \times \exp[-\Delta t^2 / 2\tau_f^2]$
- Star Formation: $\psi(t) = C_{EFF} \rho_g^{1.5}(t)$
- Standard asumptions for:
  - IMF (Salpeter 0.1 - 60 $M_\odot$)
  - IMS yields (van den Hoek & Groenewegen 1997)
  - SNII yields (Nomoto et al. 1997)
  - SNIa yields (W7; Iwamoto et al. 1999)
  - SNIa rates (Matteucci & Recchi 2001)
- Population Synthesis: Bruzual & Charlot (2002)
- <u>Bottom line:</u> Star Formation history parametrised by:

$$(\tau_f, z_F, C_{EFF}, B_{out})$$

Modelling the SFH



Sample SFH:

$C_{EFF} = 1\ Gyr^{-1}$
$\tau_f = 0.8\ Gyr$
$B_{OUT} = 0.5$
$z_F = 3$
$M_*(z=0) = 10^{10} M_\odot$

Near and Far

z~0
UMa cluster
B,R,I,K'

z~0.5-1
FDF
B,g,R,I,J,K

v_{ROT}

$(\tau_f, z_F, C_{EFF}, B_{out})$
as fcn of v_{ROT}

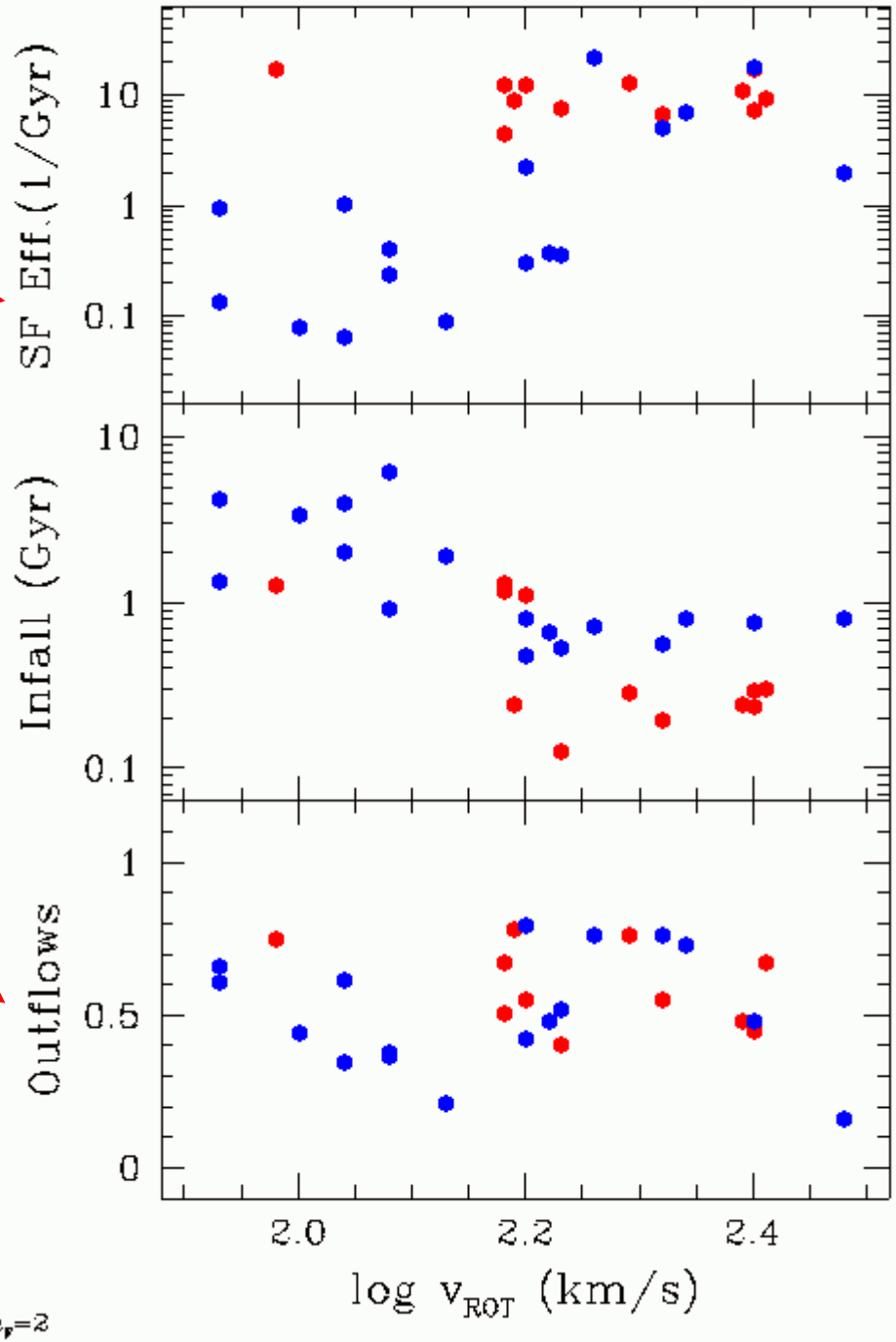
$z_F=2$

Star Formation Efficiency (C_{EFF})

Infall Timescale (τ_f)

Outflow fraction (B_{OUT})

- $z < 0.75$
- $z \geq 0.75$



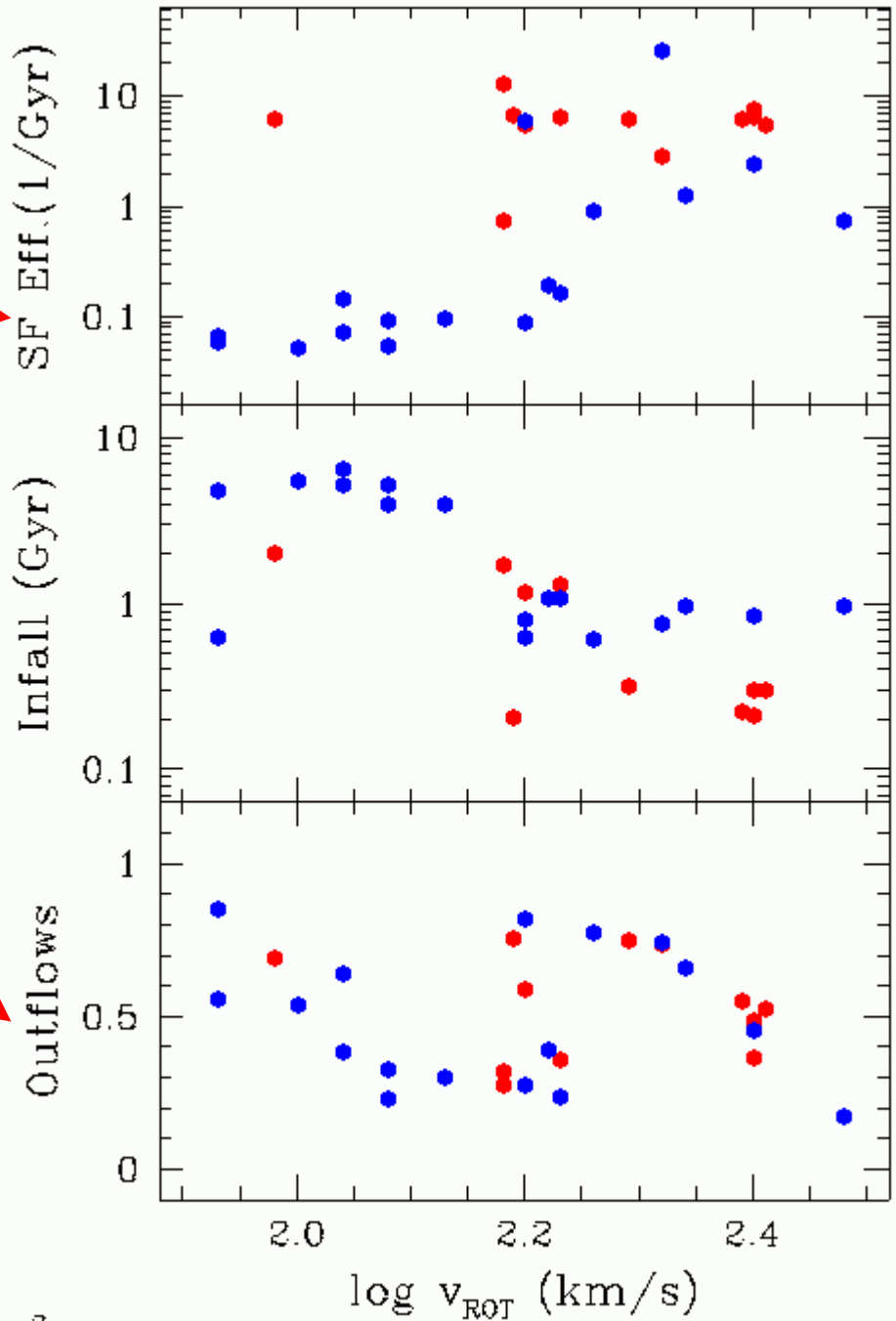
$z_F=3$

Star Formation Efficiency (C_{EFF})

Infall Timescale (τ_f)

Outflow fraction (B_{OUT})

- $z < 0.75$
- $z \geq 0.75$



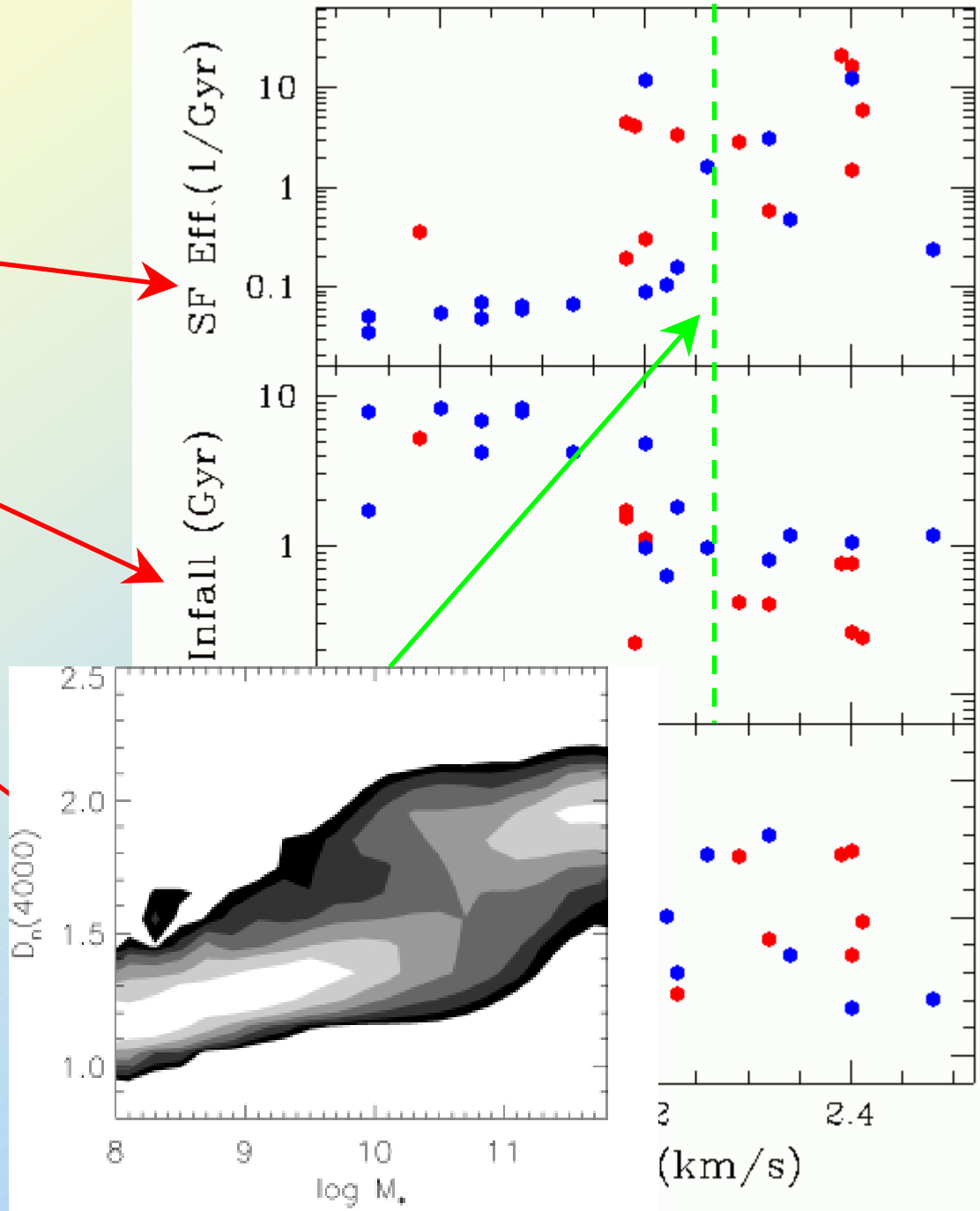
$z_F=5$

Star Formation Efficiency (C_{EFF})

Infall Timescale (τ_f)

Outflow fraction (B_{OUT})

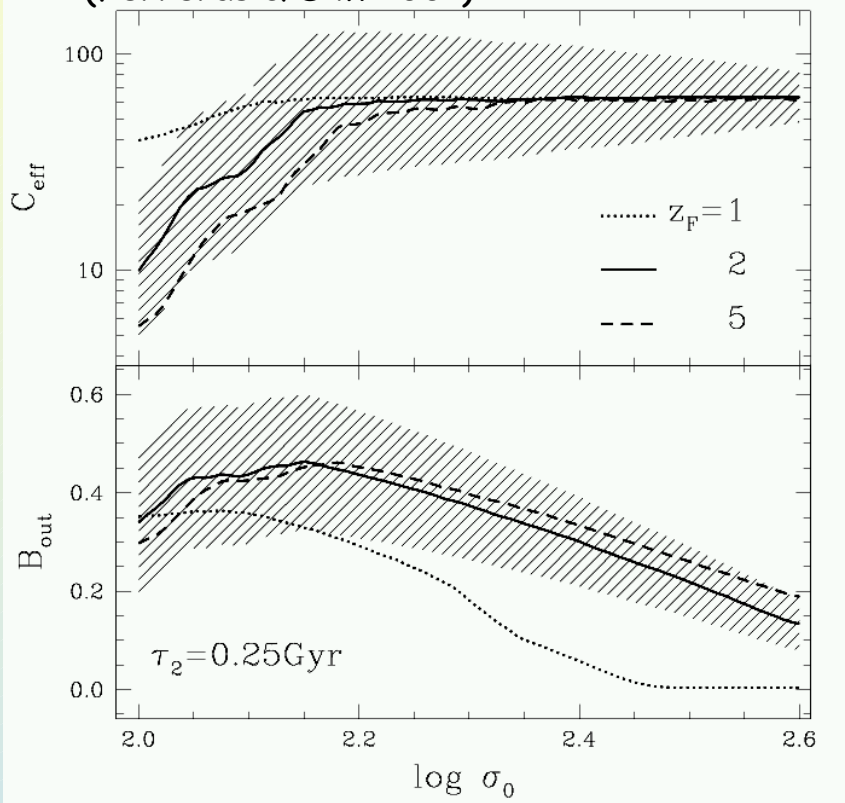
- z < 0.75
- z ≥ 0.75

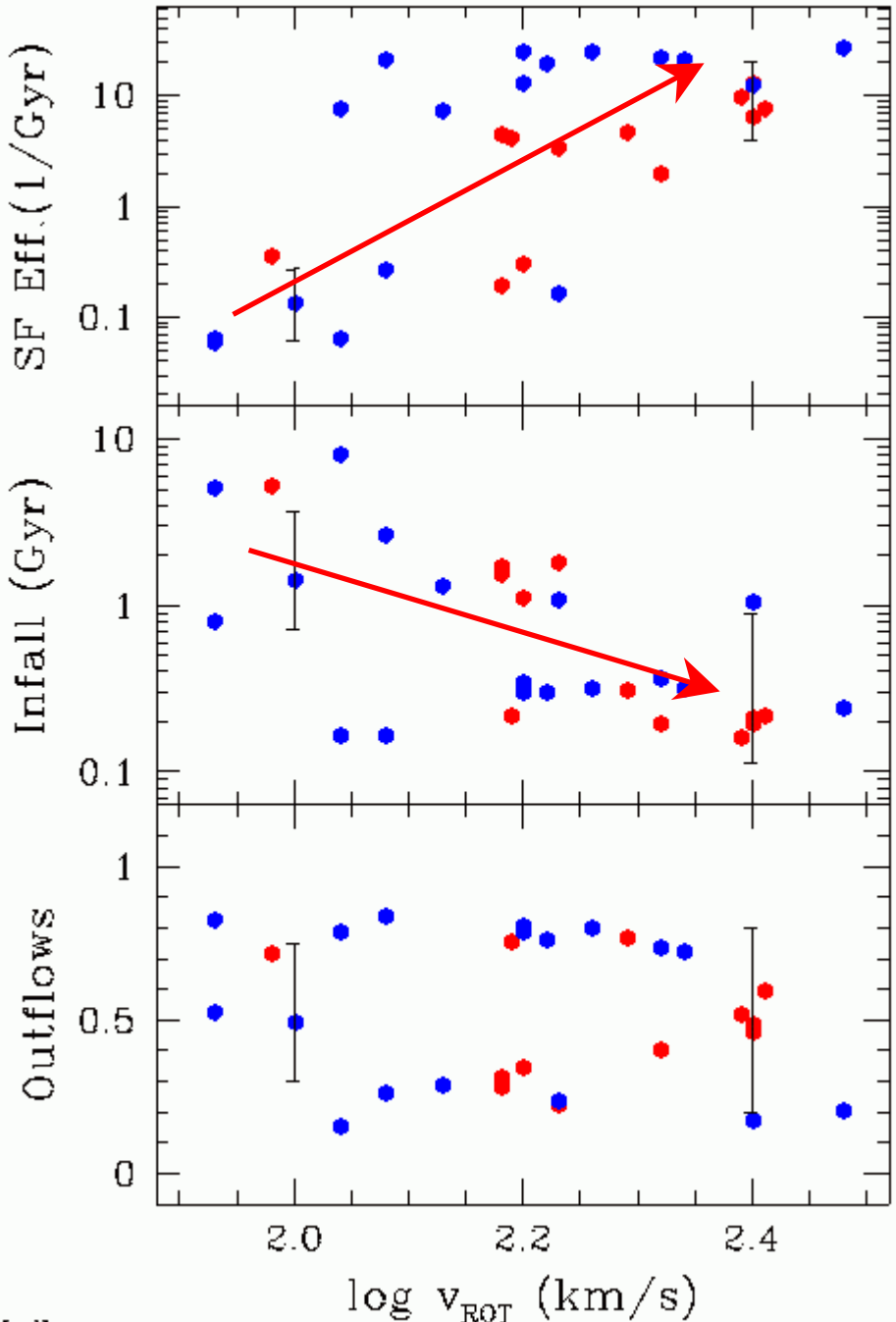


Best z_F

18 values chosen in $0.9 \leq z_F \leq 5$ range

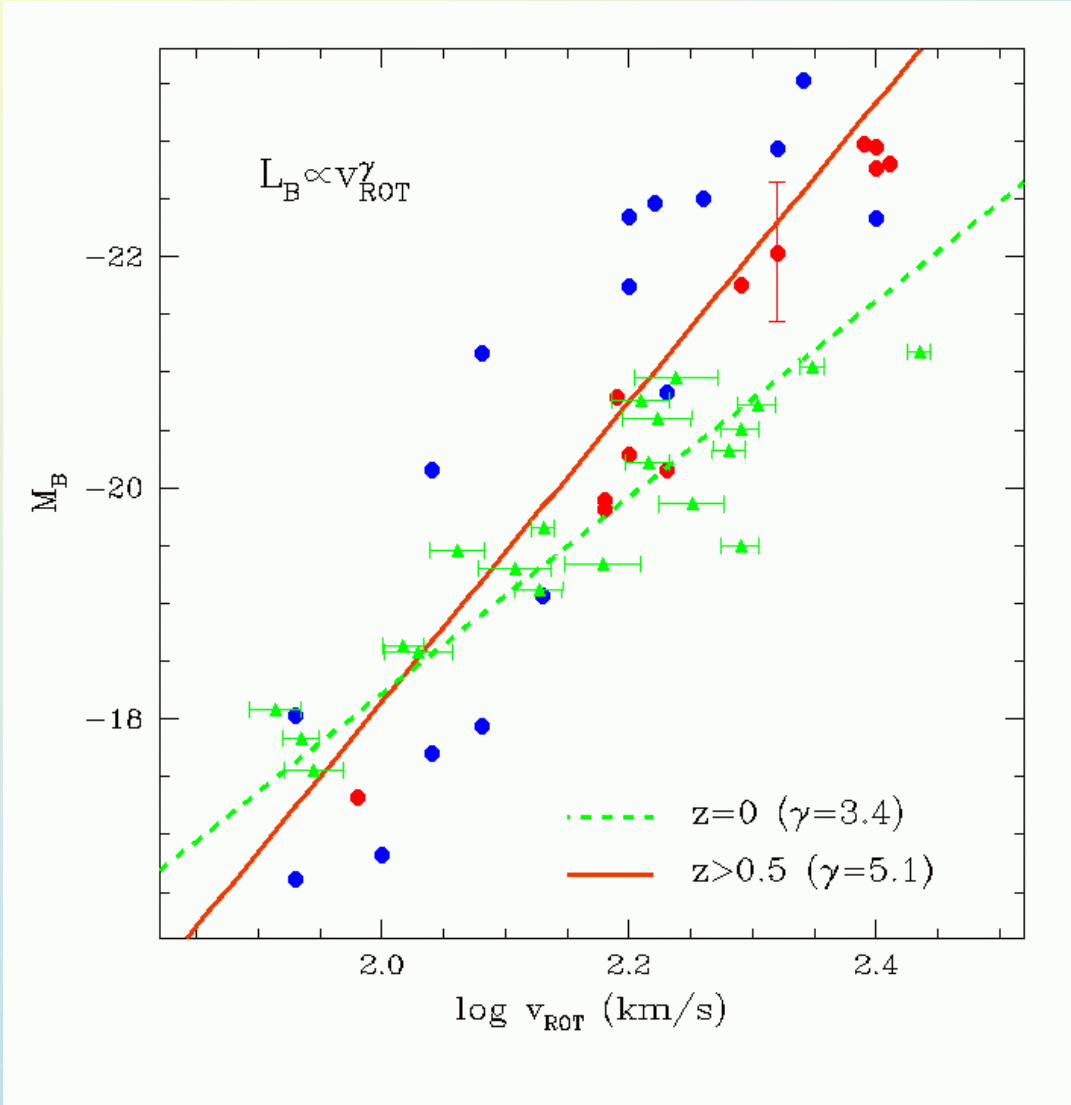
Early-types
(Ferreras & Silk 2001)





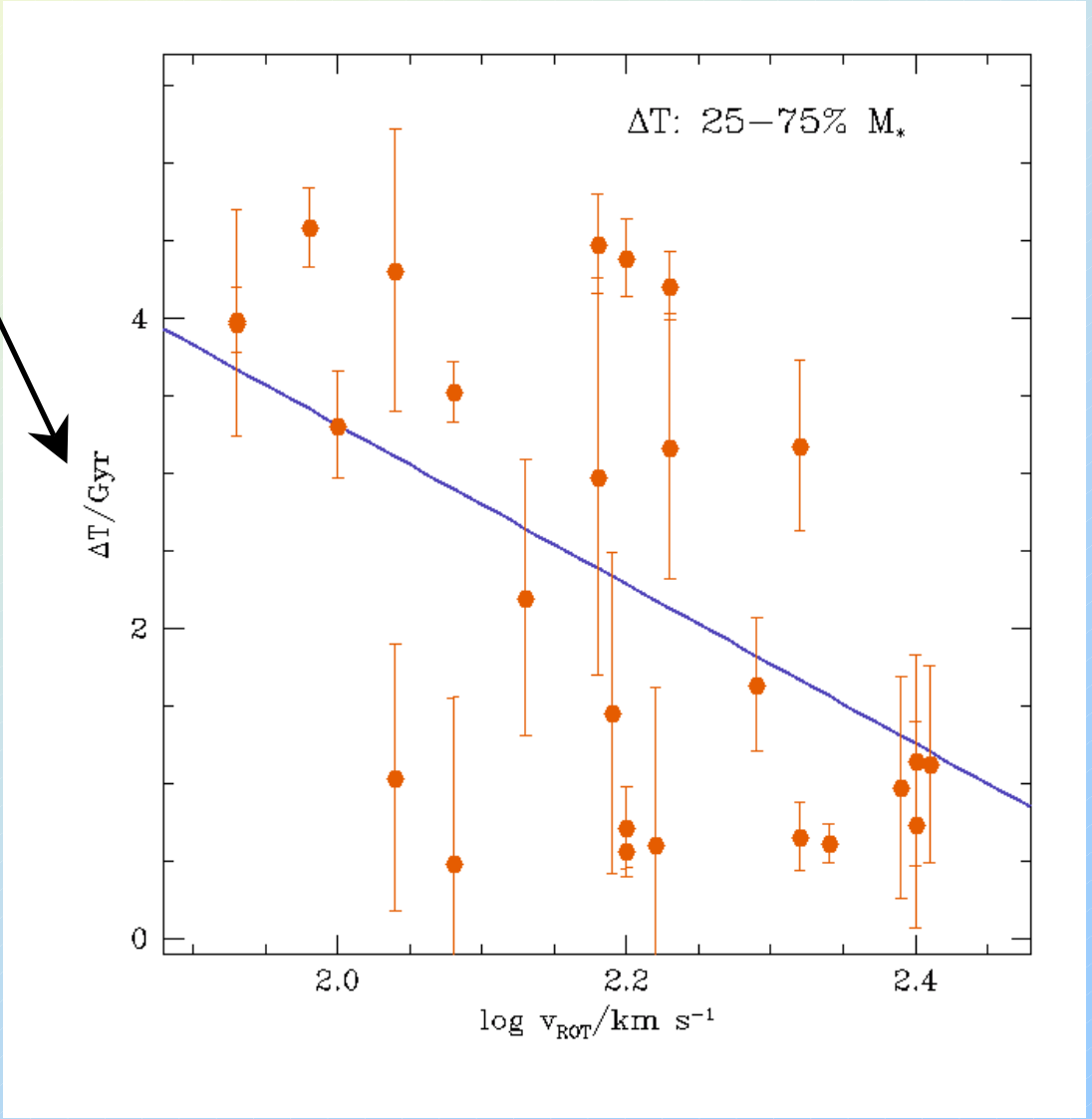
Zf all

The z-evolution of the Tully-Fisher relation



The duration of star formation

ΔT is the time needed to assemble 50% of (z=0) stellar mass content.



Massive disks assemble in ΔT~1 Gyr

Low-mass disks take ΔT~4 Gyr to grow

Conclusions

- Phenomenological model used to compare low-z and hi-z disk galaxies, constraining SFHs at a given v_{ROT}.
- C_{EFF} correlates with v_{ROT}, with a possible break at around *log* v_{ROT}*=2.25*, which corresponds to M_B=-20.4, i.e. M_*~2.5x$10^{10}M_\odot$ (cf. SDSS analysis of Kauffmann et al. 2003)
- τ_f (infall) correlates with v_{ROT} as well, being shorter in massive disks
- No trend of gas outflows with v_{ROT}
- Overall behaviour suggests massive disks form their stellar component in ΔT~1 Gyr whereas low-mass disks take longer (ΔT~4 Gyr) to form.