Forming Stellar Disks: Inside out and upside down

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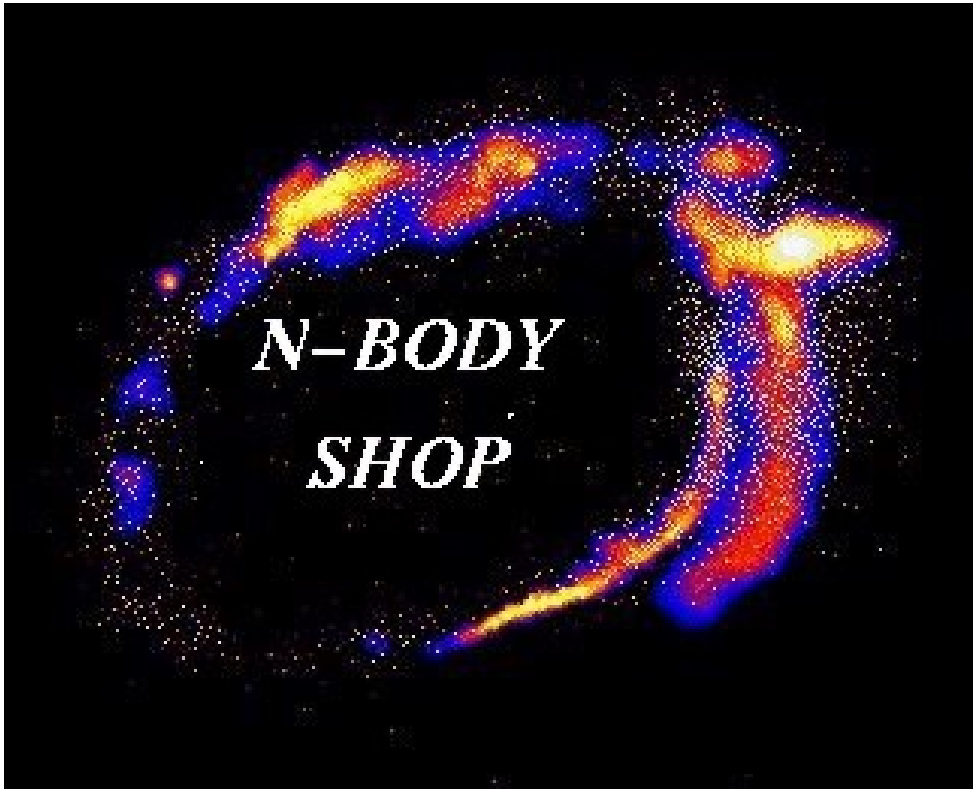
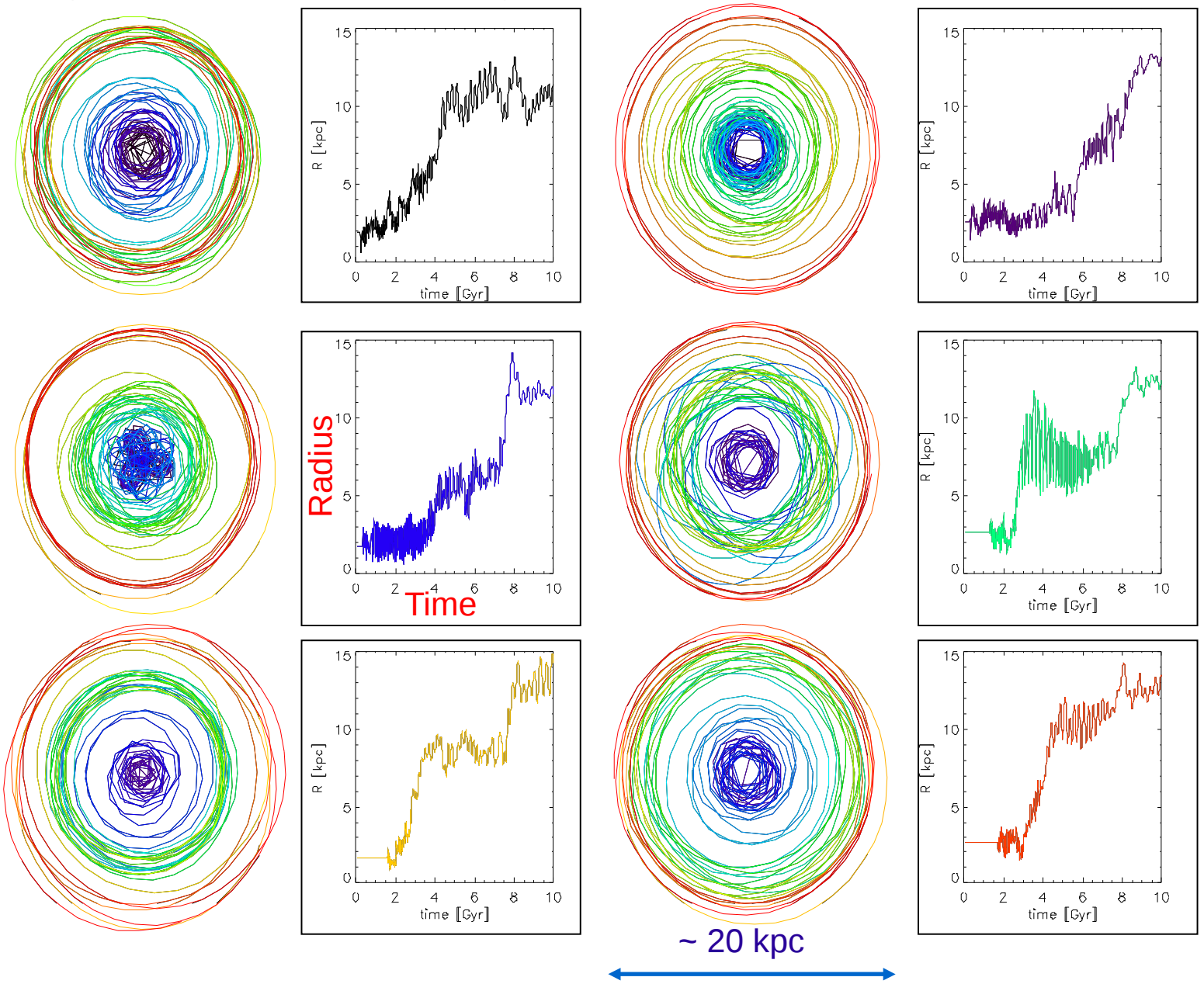


Jonathan Bird, Sarah Loebman, Charlotte Christensen,
Alyson Brooks, Ferah Munshi

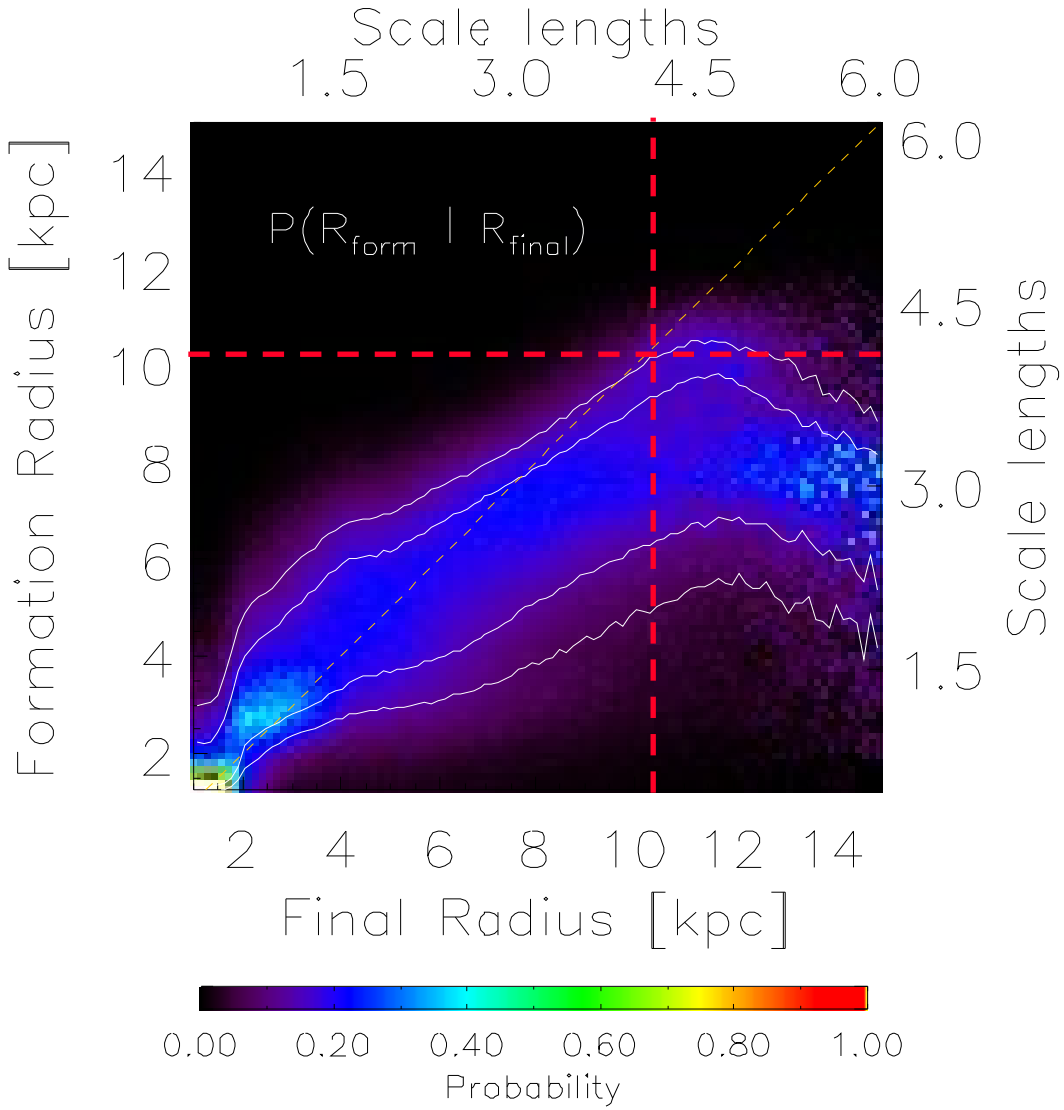
Fabio Governato, James Wadsley

Redistribution by (Transient) Spiral Arms: Large Radial Migrations Without Heating



Cf
Sellwood &
Binney 02

Radial Migration Populates Outer Disk



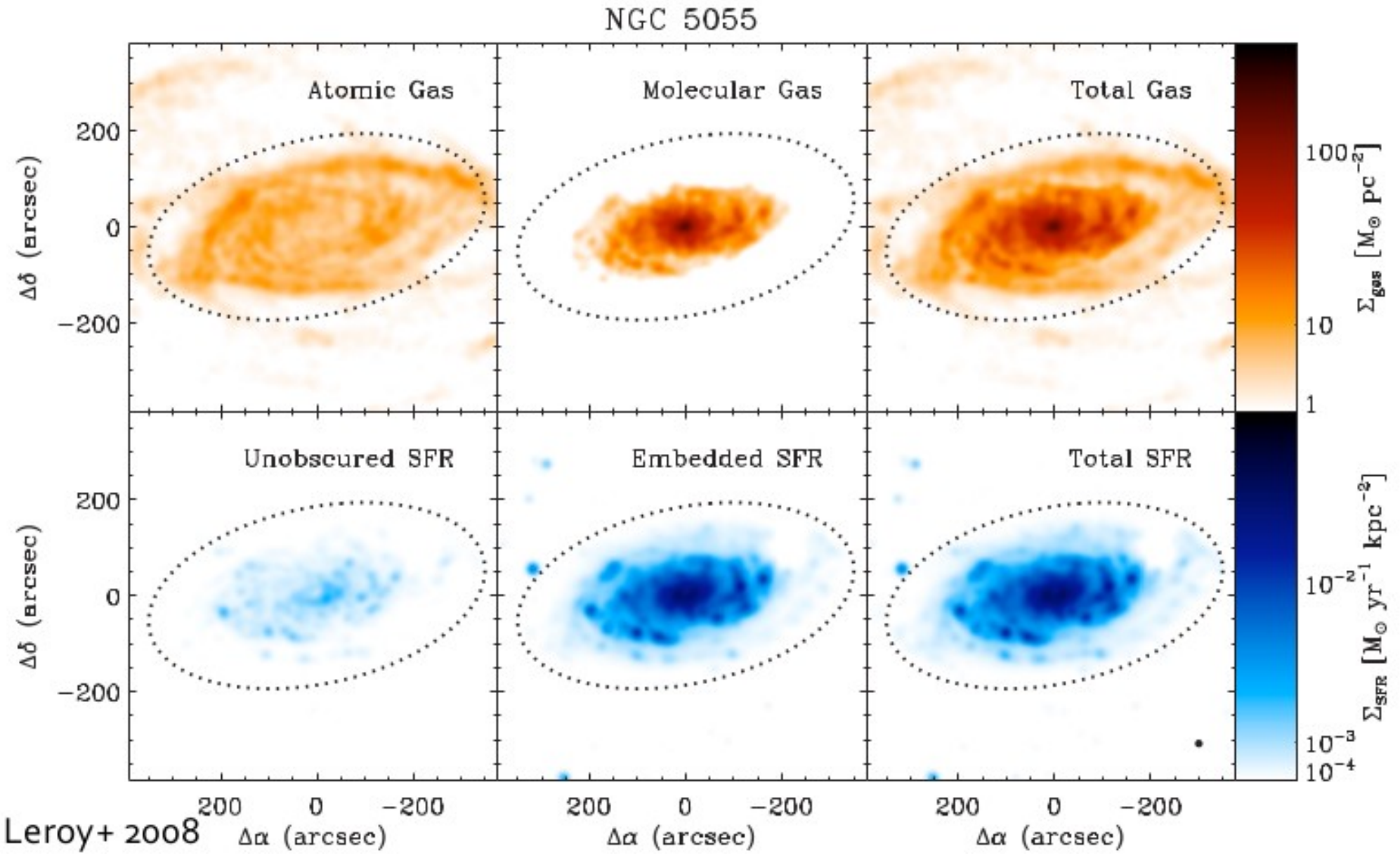
Stars in the outer disk form at smaller Galactocentric radii

(Roškar et al. 2008a)

Modeling Star Formation: it's hard

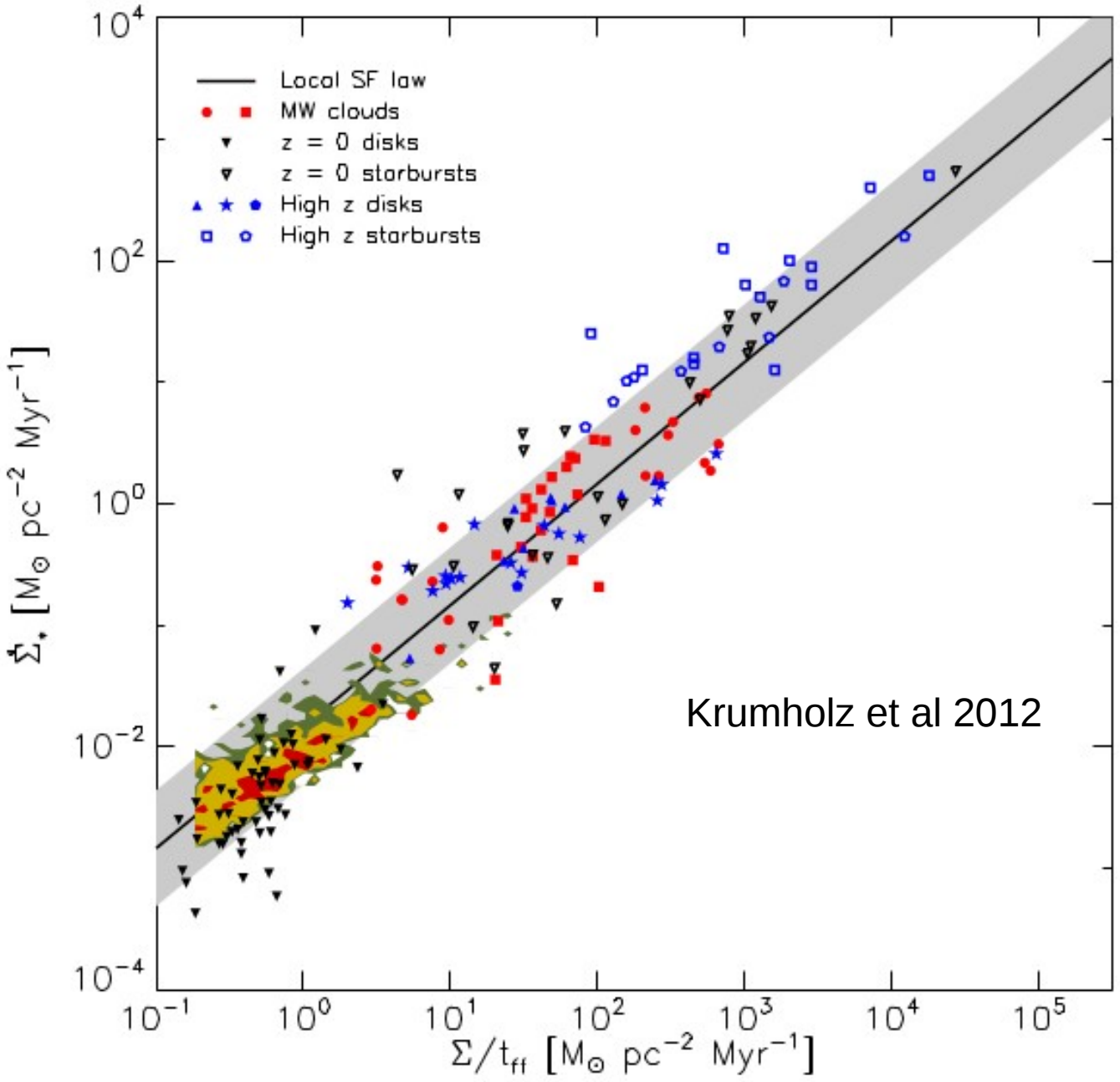
- Gravitational Instabilities
- Magnetic Fields
- Radiative Transfer
- Molecular/Dust Chemistry
- Driven at large scales: differential rotation
- Driven at small scales: Supernovea and Stellar Winds
- Scales unresolvable in cosmological simulations

Star formation and Molecules



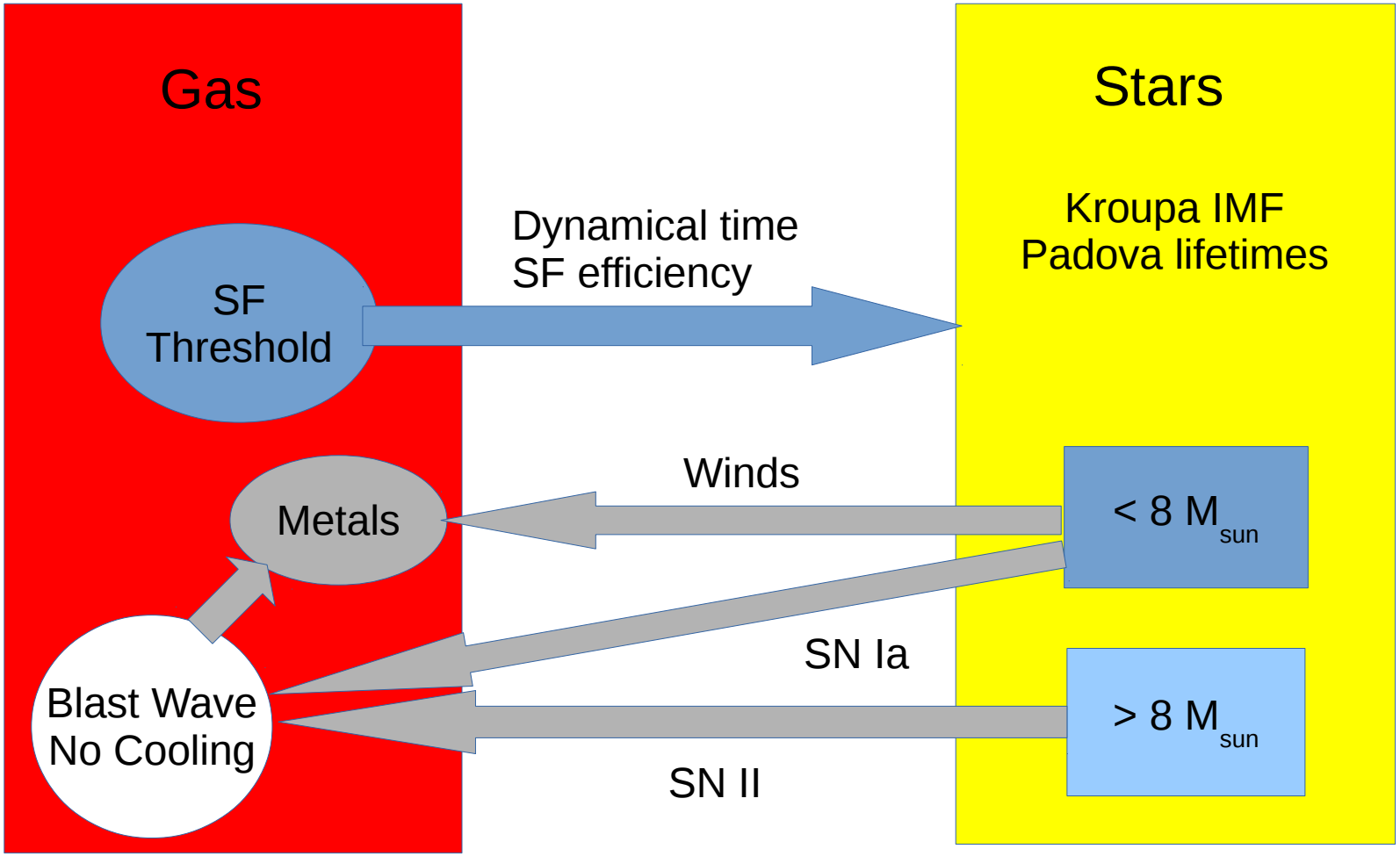
Leroy+ 2008

Star Formation Efficiency ~ 0.01



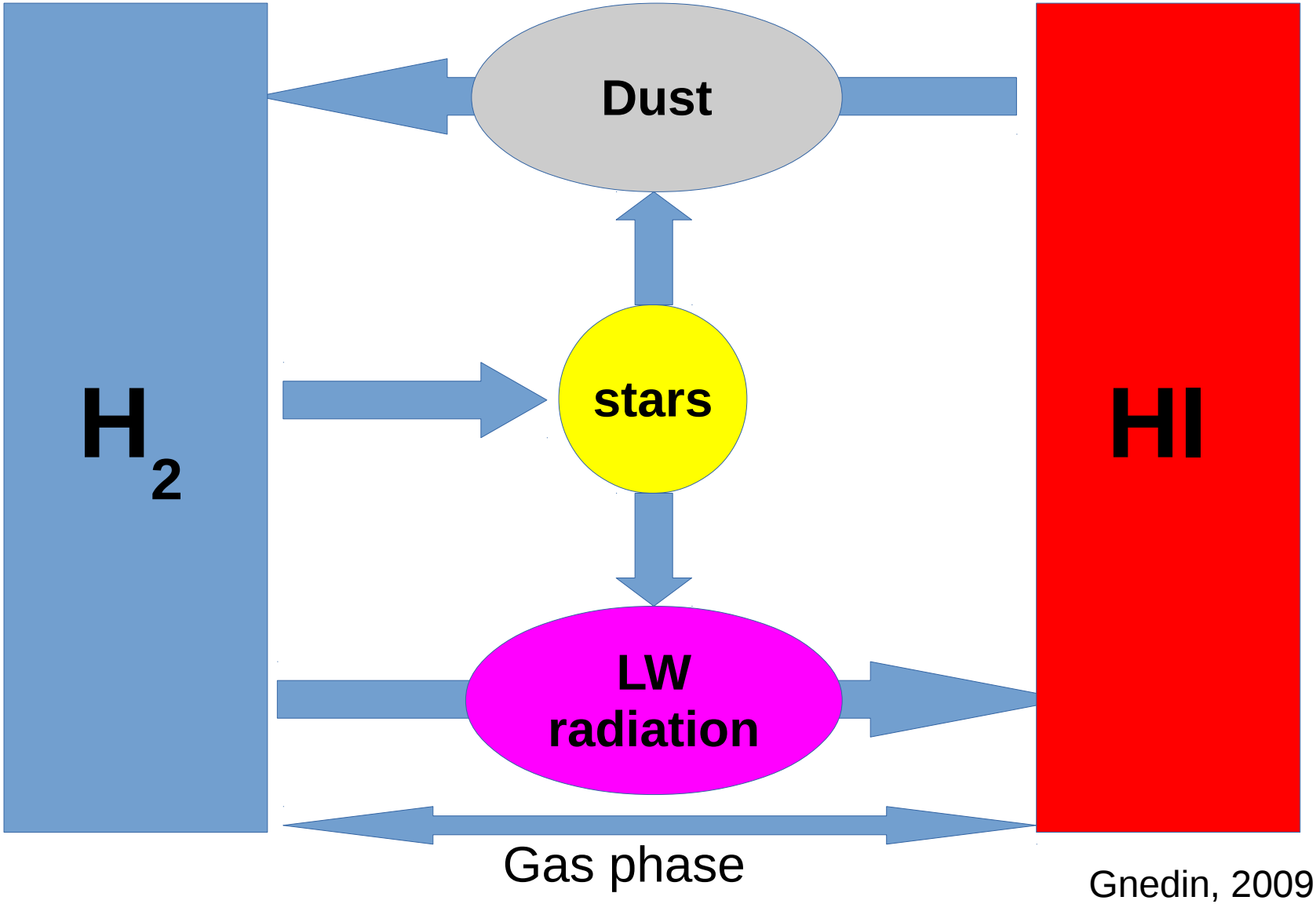
Krumholz et al 2012

Star Formation/Feedback



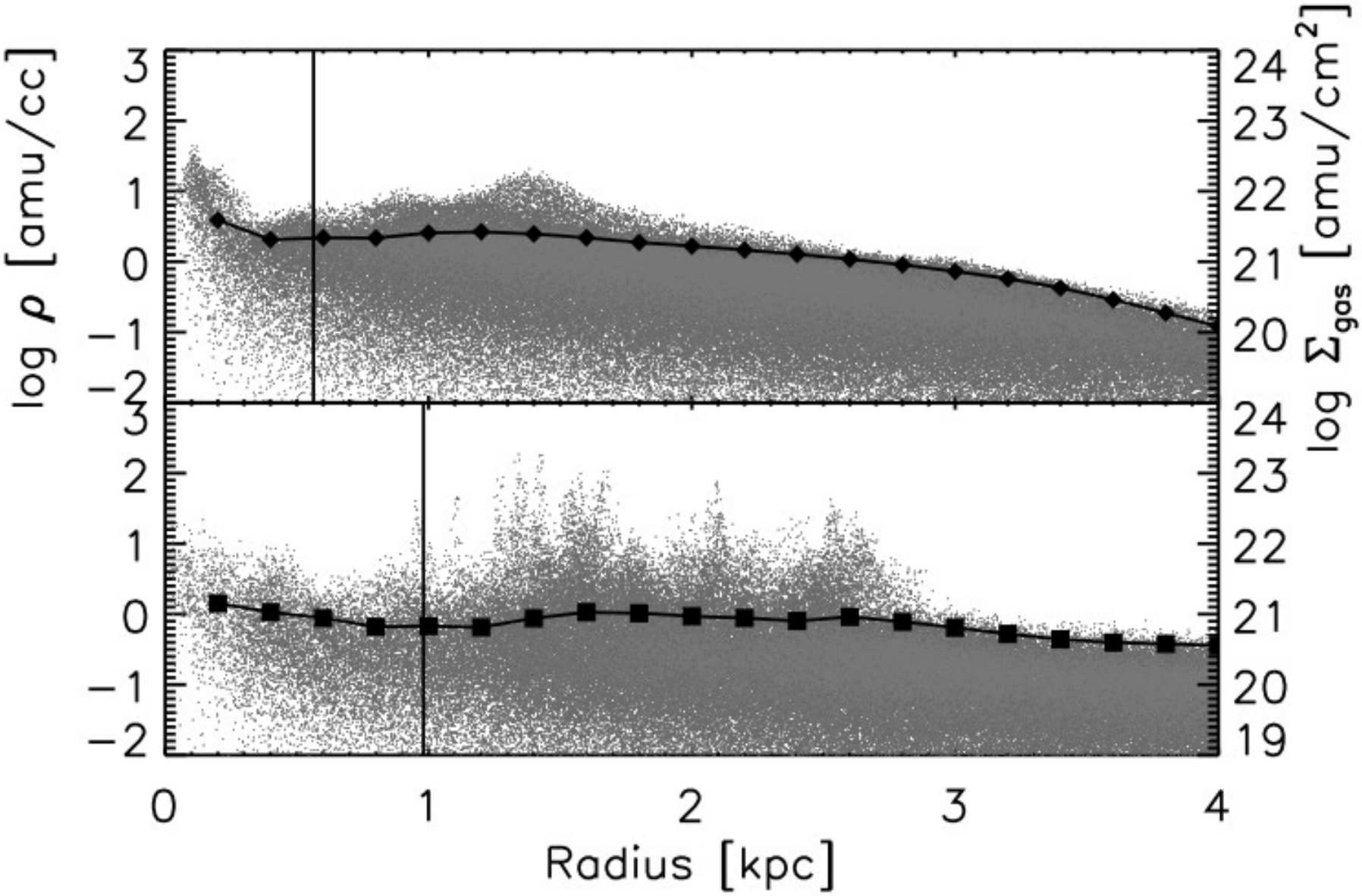
Stinson et al 2006

Molecular Hydrogen and Stars



Gnedin, 2009
Christensen, 2012

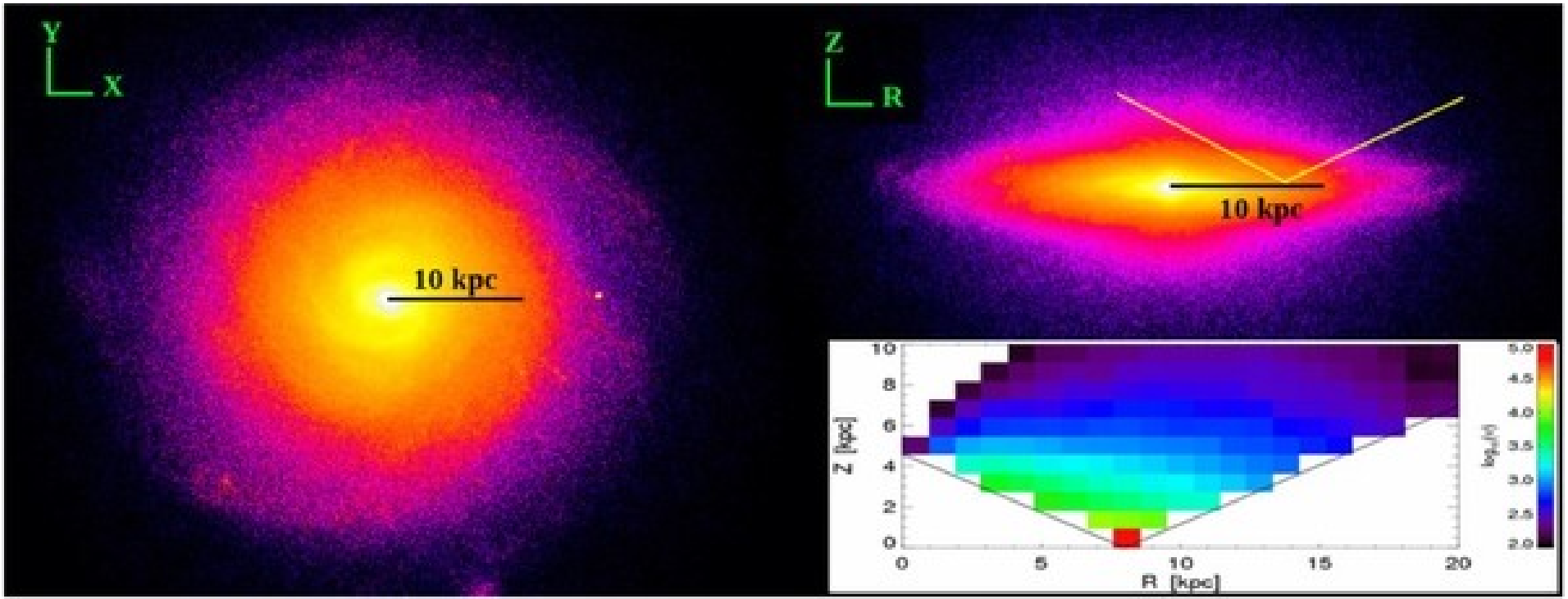
H_2 and Star formation



H277 Simulation

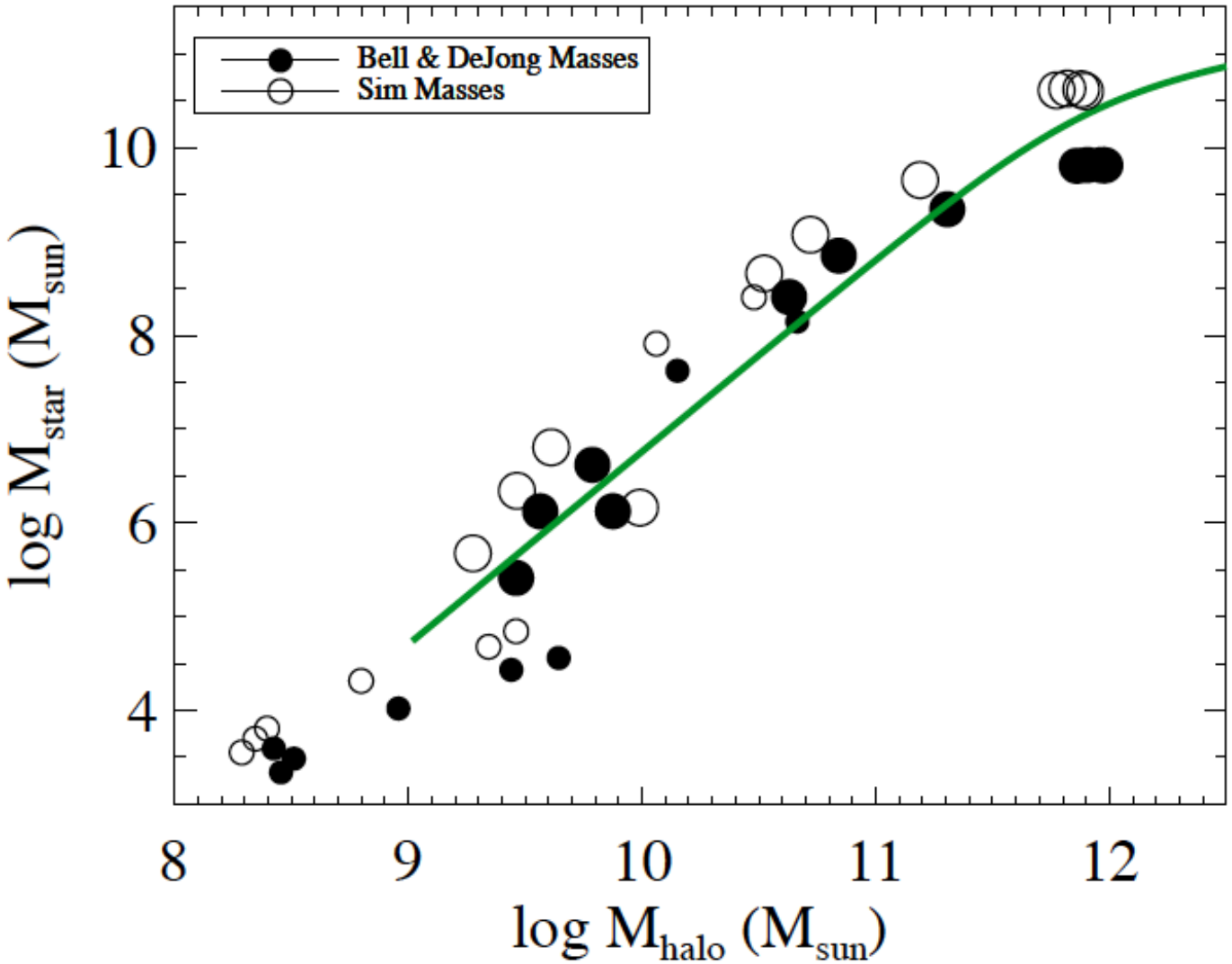
- Non-equilibrium H_2 based star formation
- 173 pc (spline) gravity resolution (17 pc gas)
- 1.3e5, 2.7e4, 8e3 Msun in dark, gas, stars
- Virial Mass 6.8e11 Msun
- Disk scale length 3.1 kpc (Loebman 2014)
- On the SMHM relation (Munshi 2013)
- Satellite LF matches MW (Zolotov 2012)

Stellar distribution



Loebman et al 2014

Simulated Observations match Observed



Green: Moster et al (2013) abundance matching result (z=0)

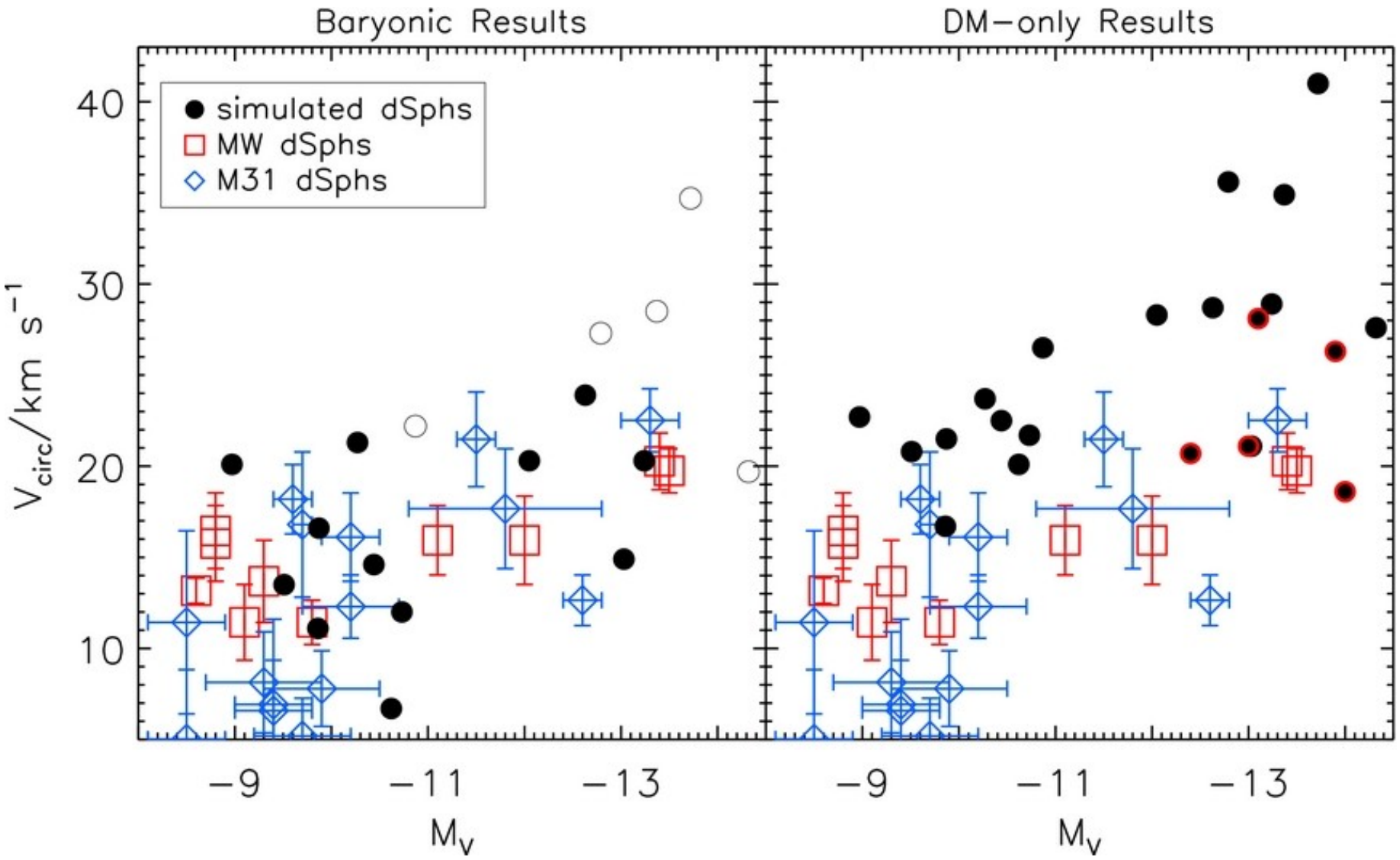
Open circles: Values taken directly from simulations

Filled circles: Values estimated from photometric properties as an "observer"

[B-V color, Bell & DeJong (2001) M/L ratio]

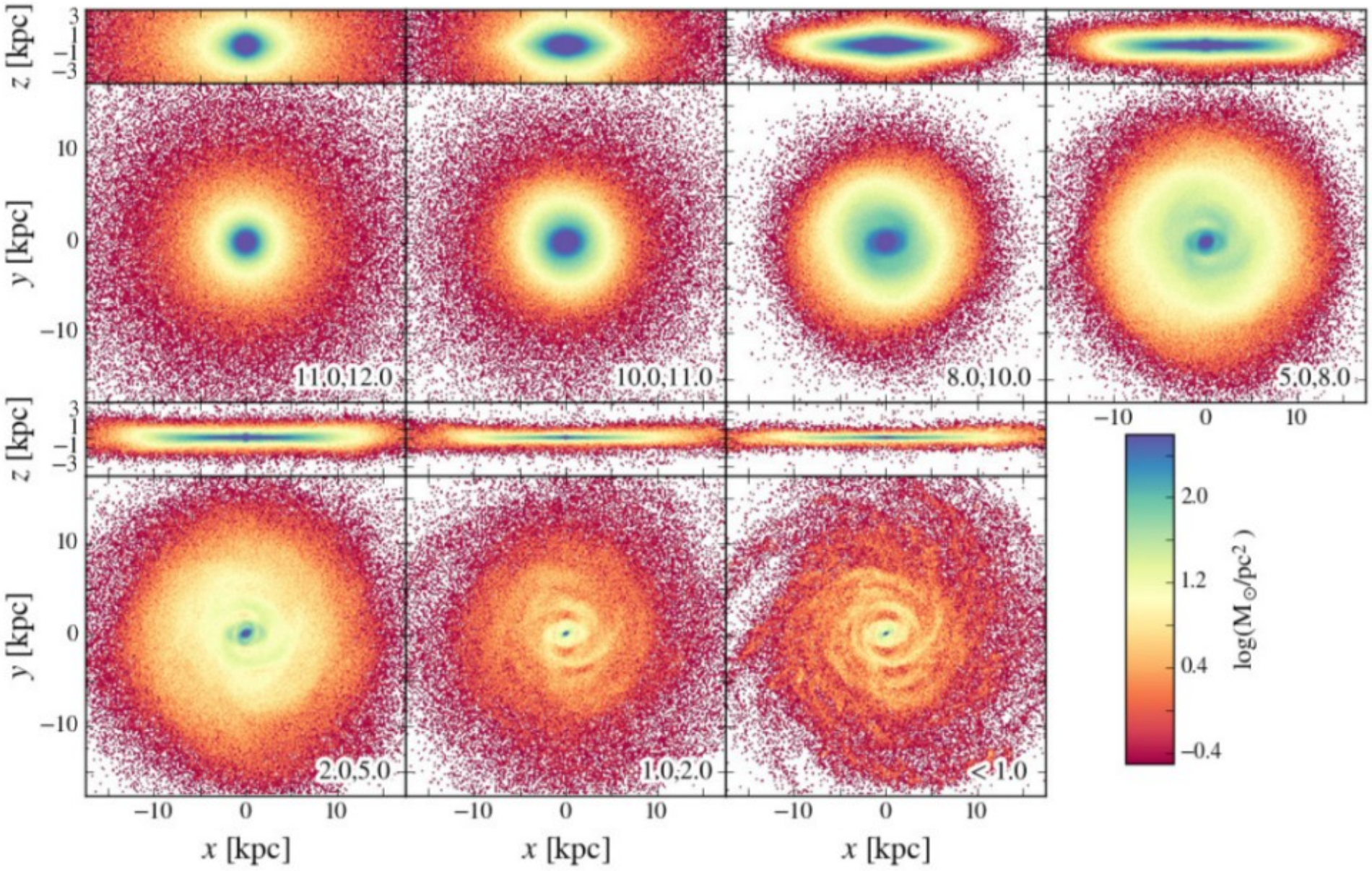
Munshi et al. (2013)

Not so Big and Failing

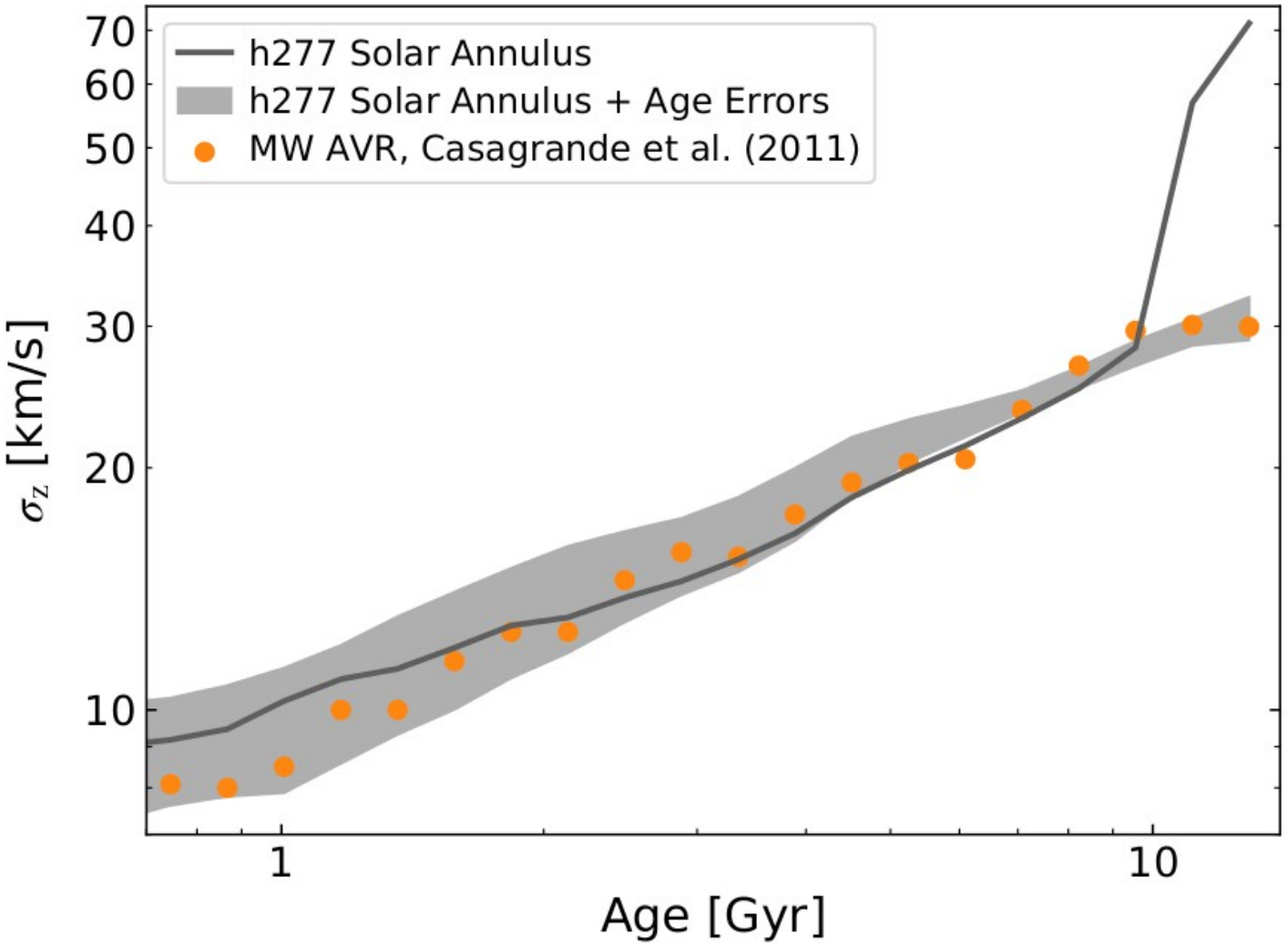


Brooks & Zolotov 2014

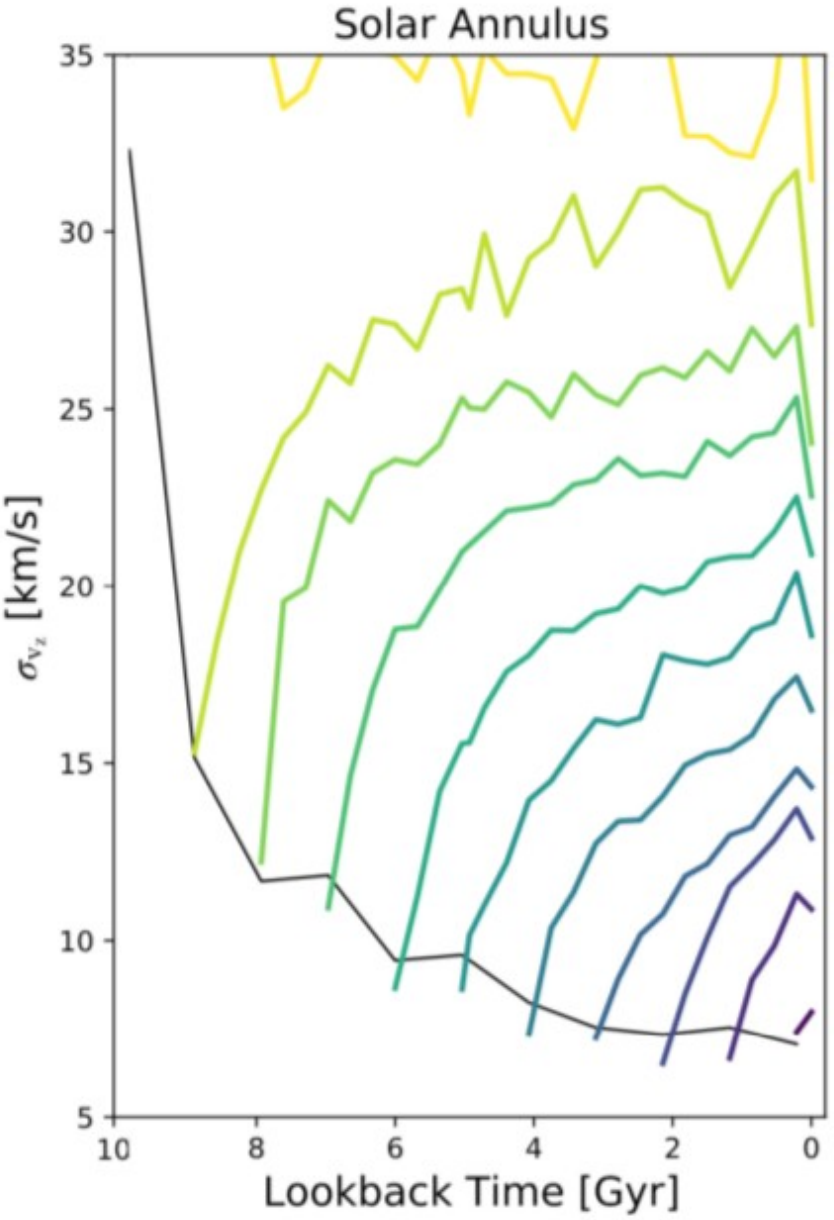
Stellar surface density



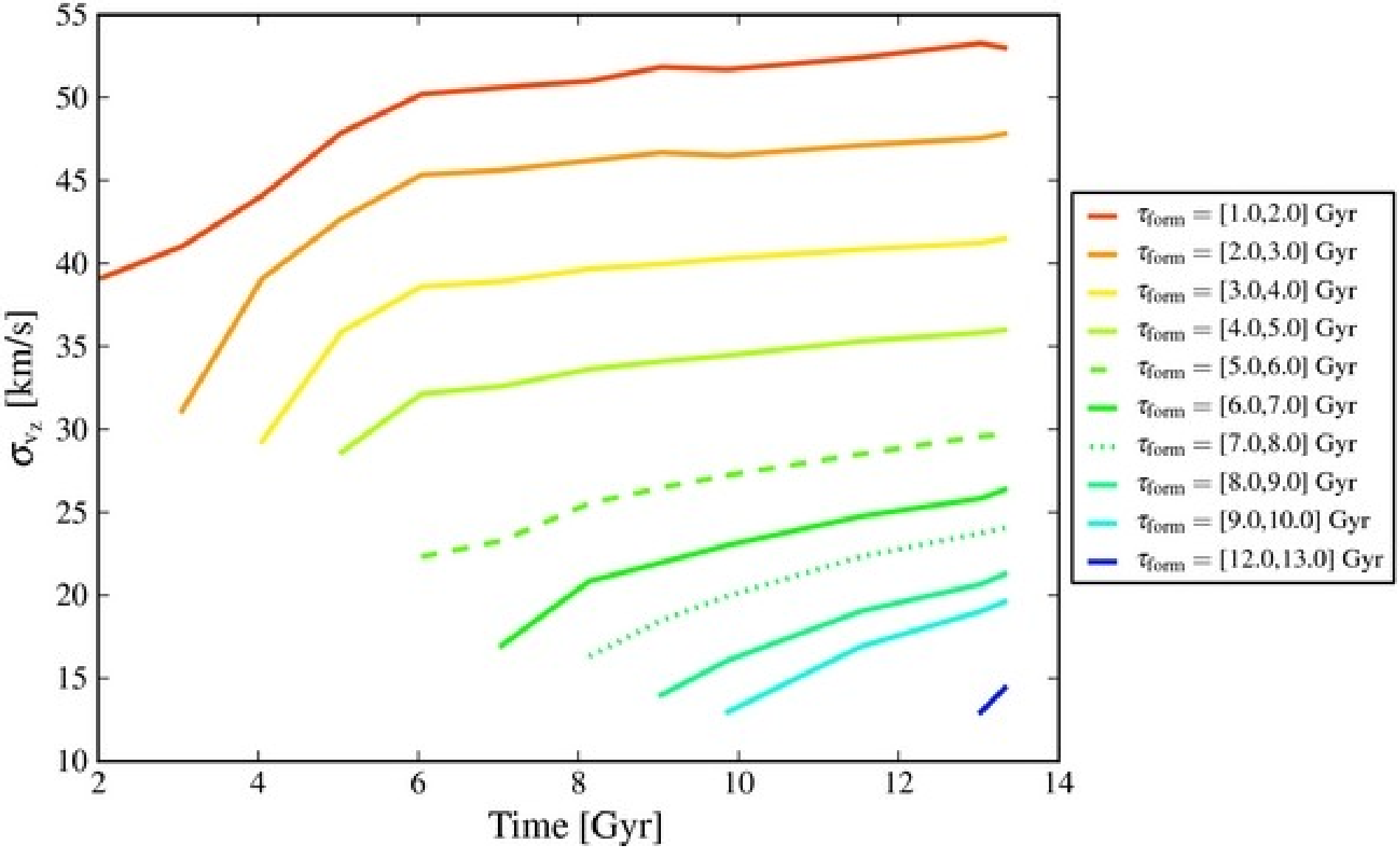
“Solar” Age-Velocity Relation



Stellar Population Evolution

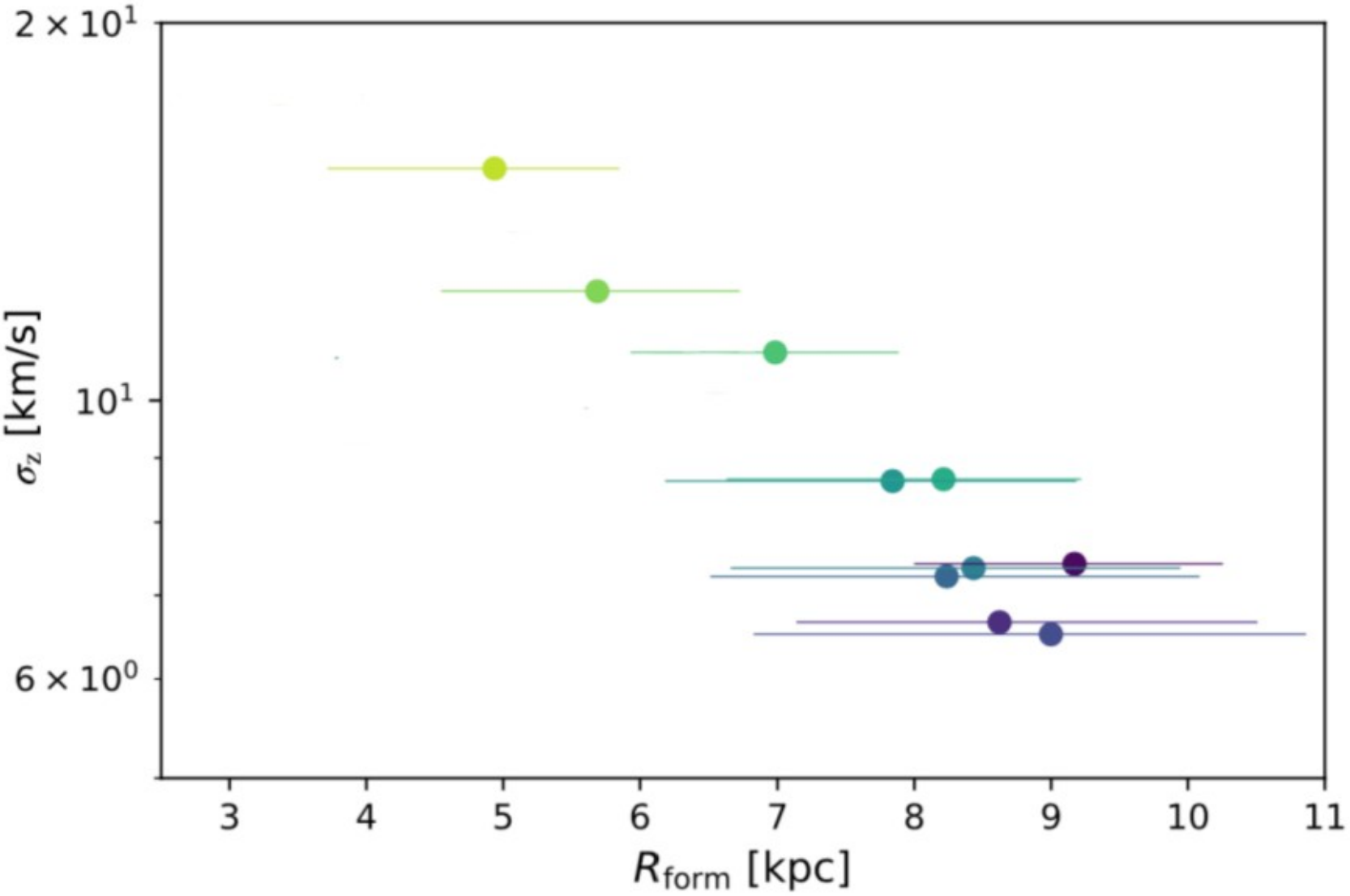


Compare Eris (no H2)

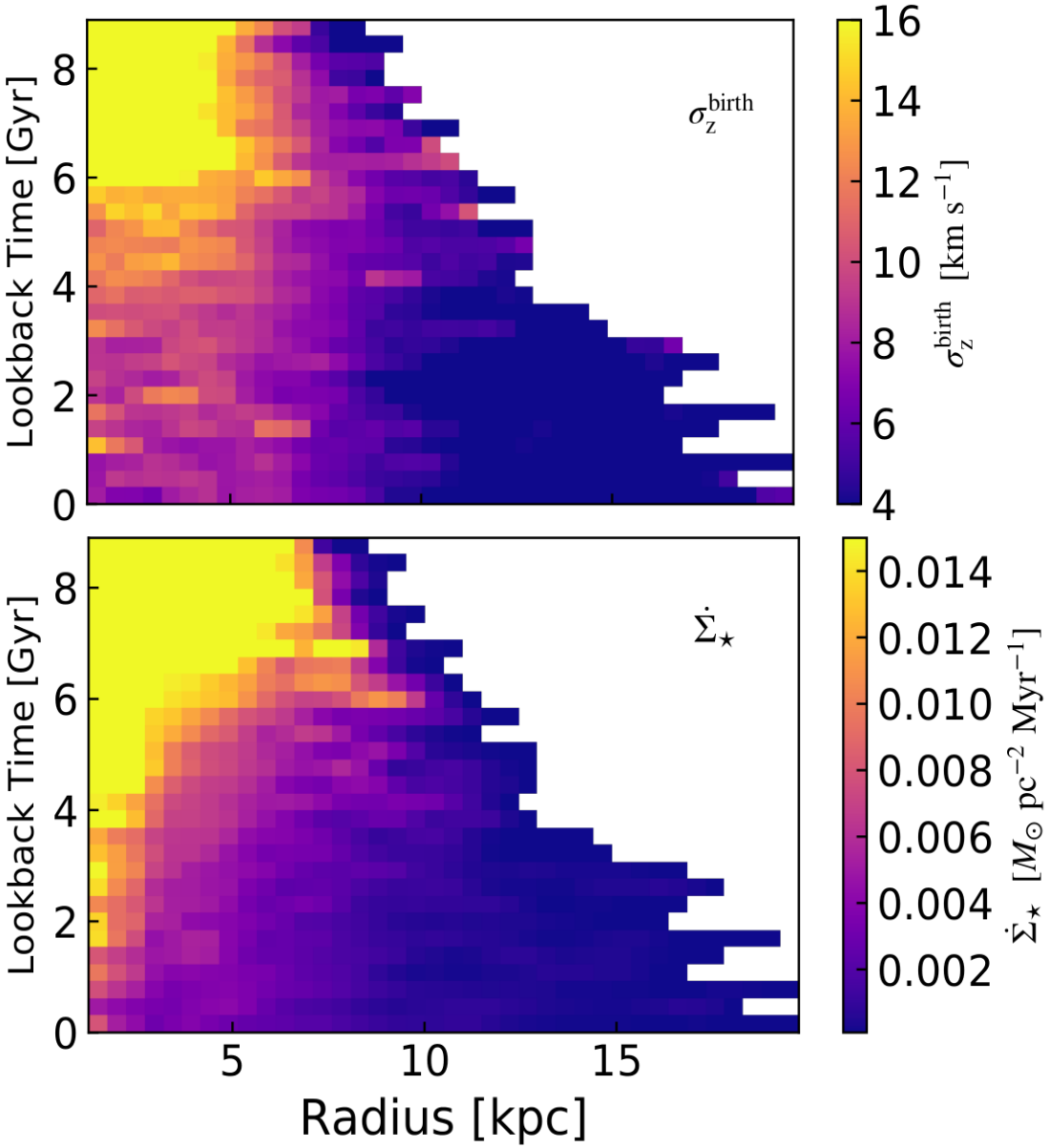


Bird et al 2013

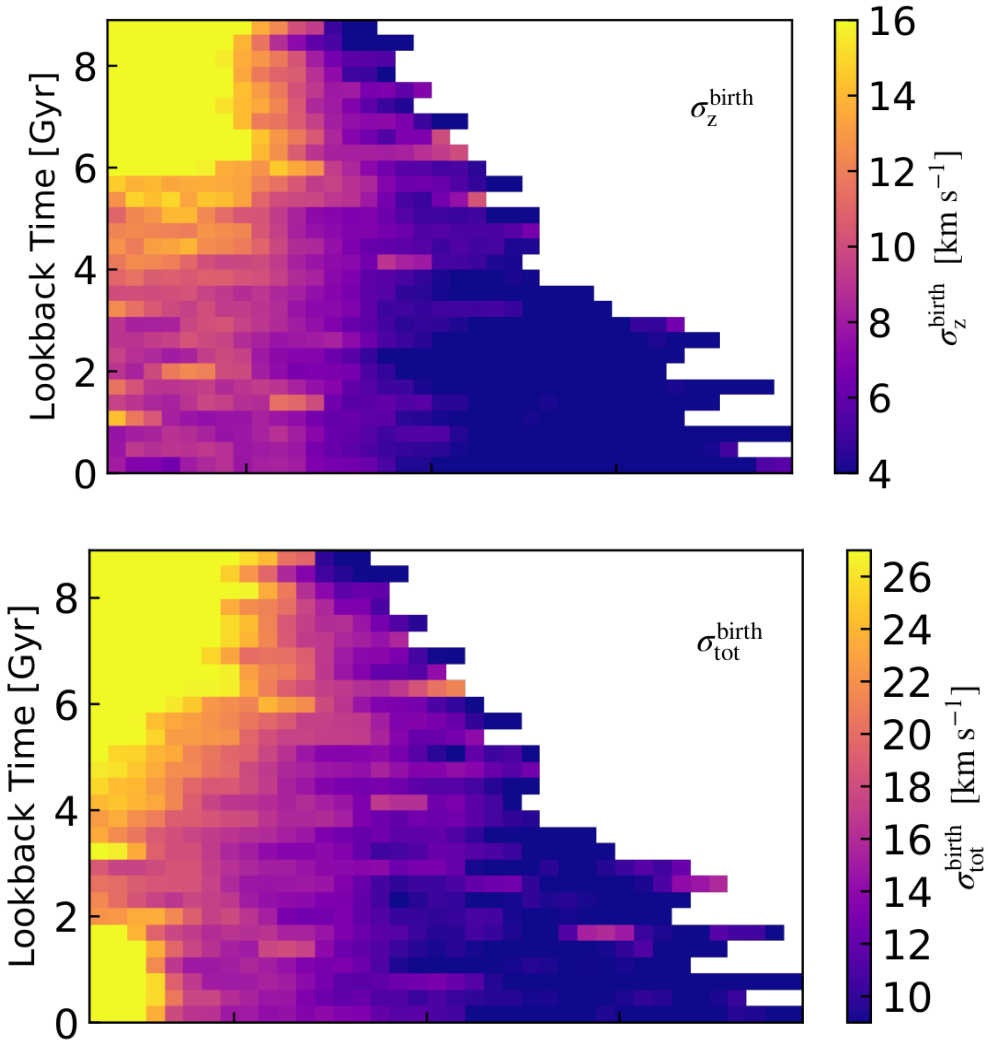
Dispersion vs Formation Radius



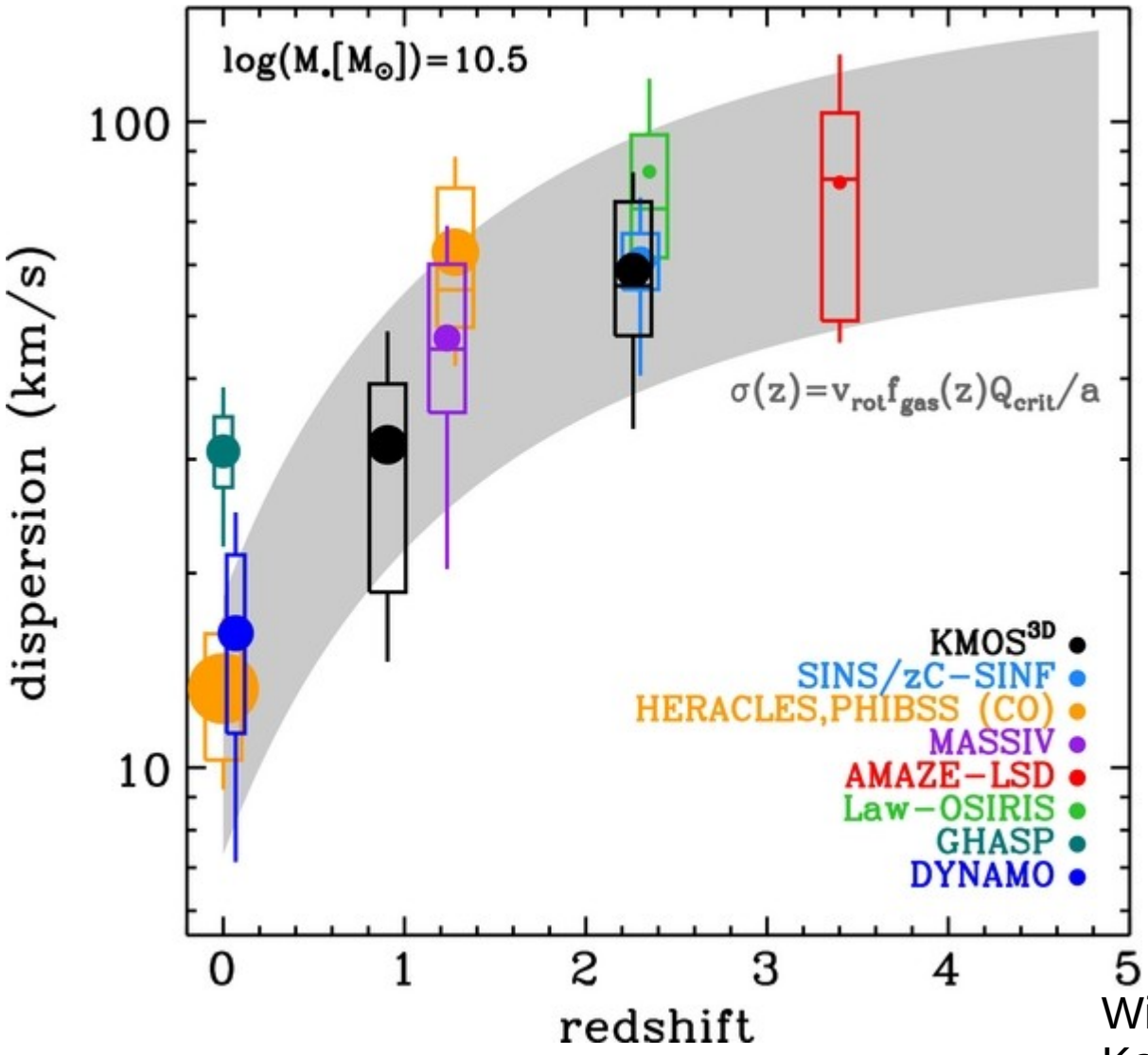
Birth dispersion and SFR density



Vertical and Radial birth dispersion

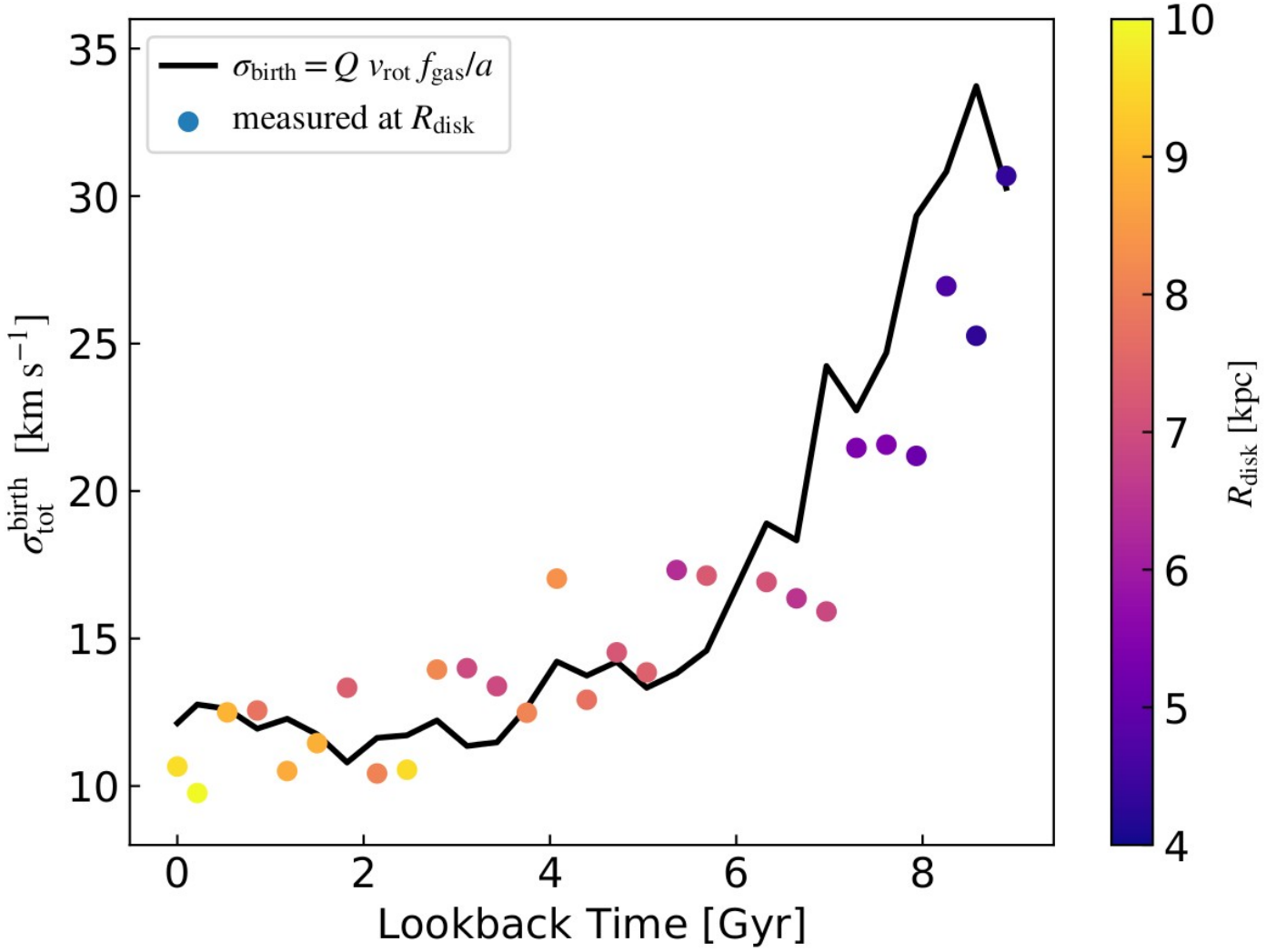


Observed dispersion evolution



Wisnioski et al 2015
Kassin et al 2012

Time Evolution



Summary

- We are able to reproduce the stellar disk Age-Velocity in a cosmological simulation
- Two effects:
  - Populations heat with age
  - Older populations born hotter
- Older populations currently in the Solar annulus were born significantly closer to the Galactic center.
- Are we converged?
  - Higher resolution simulations; better subgrid models

Acknowledgments

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