Structure of the Star Forming ISM in N-body Galaxy Simulations

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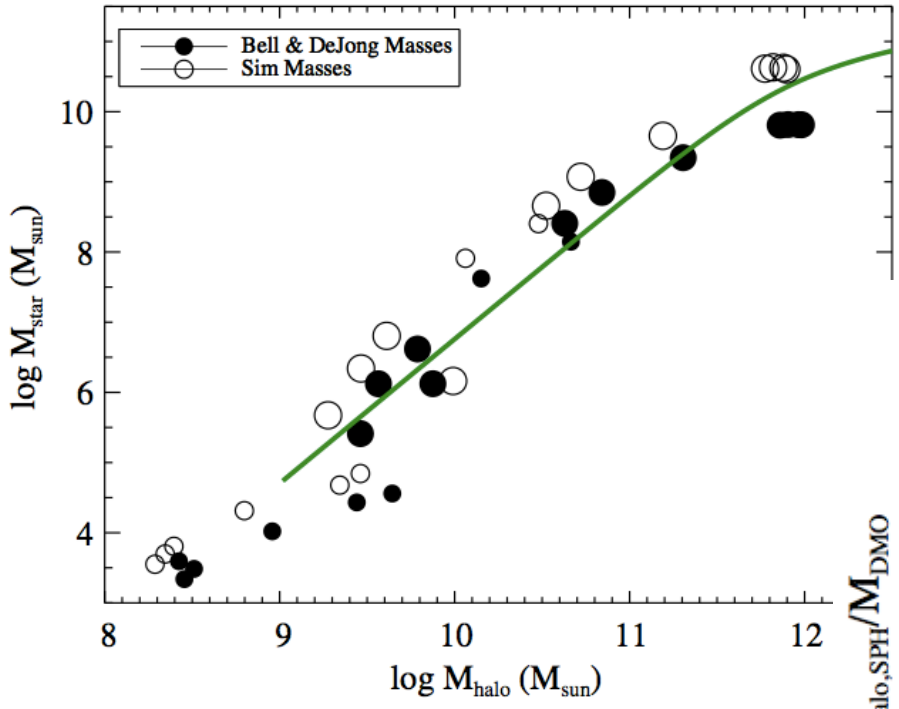
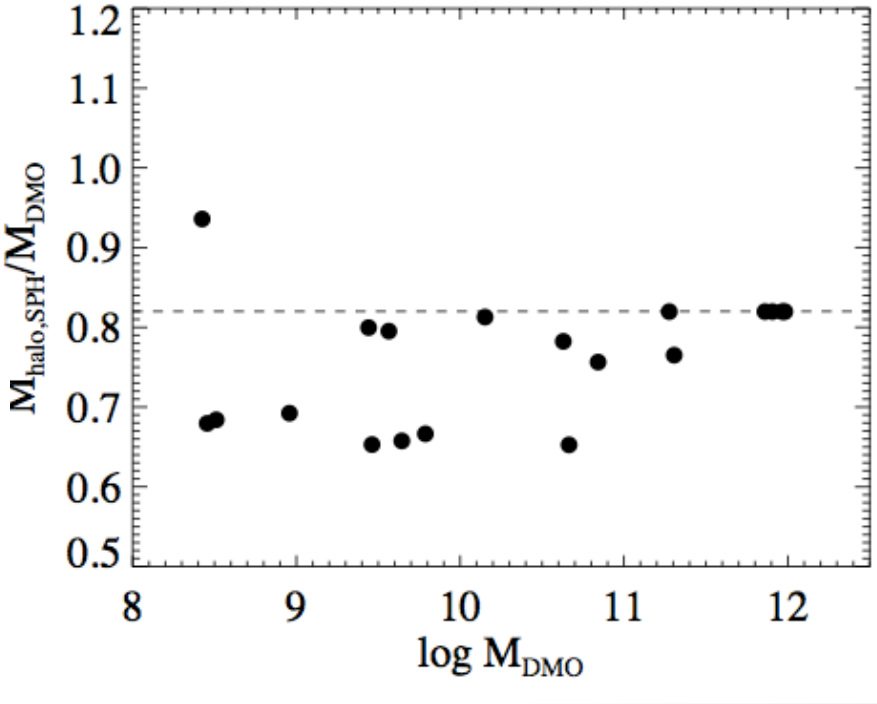
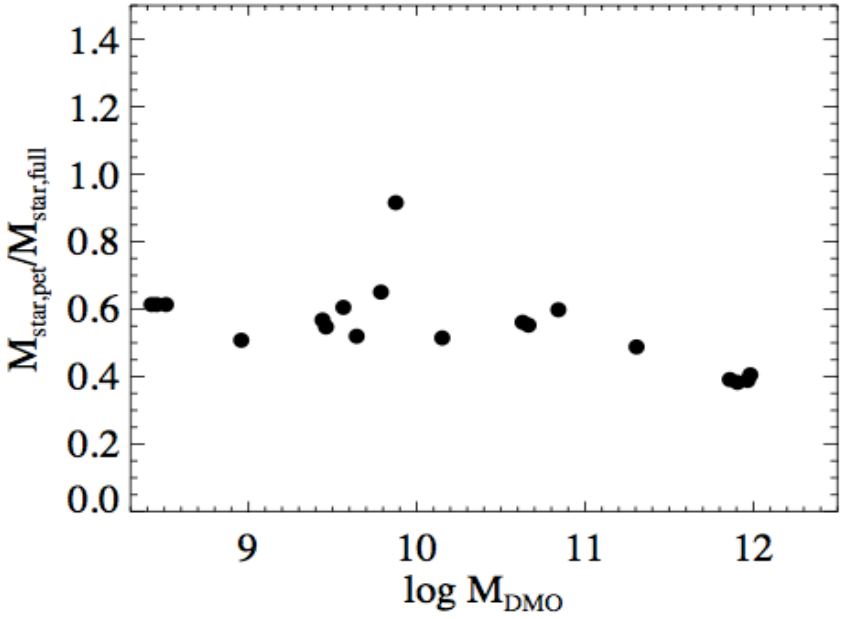

Bell & DeJong Masses
Sim Masses
log M_{star} (M_{sun})
log M_{halo} (M_{sun})


$M_{halo,SPH}/M_{DMO}$
log M_{DMO}


$M_{star,pet}/M_{star,full}$
log M_{DMO}

Munshi+ (2013)

How are star formation and ISM structure related?

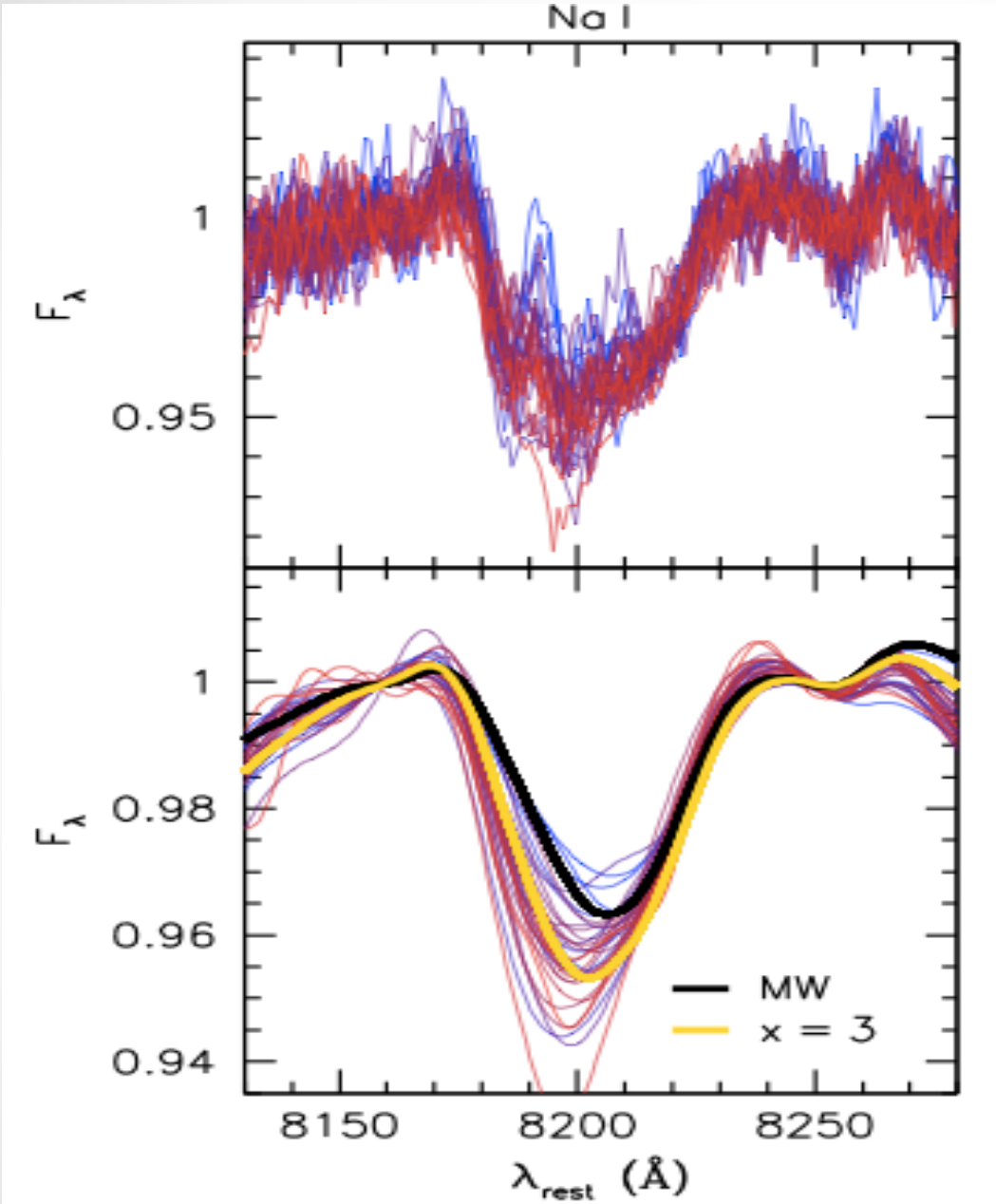
Specifically: Is there a difference in the star forming ISM in bulges vs. disks?

ISM Structure tied to…

galactic properties such as:

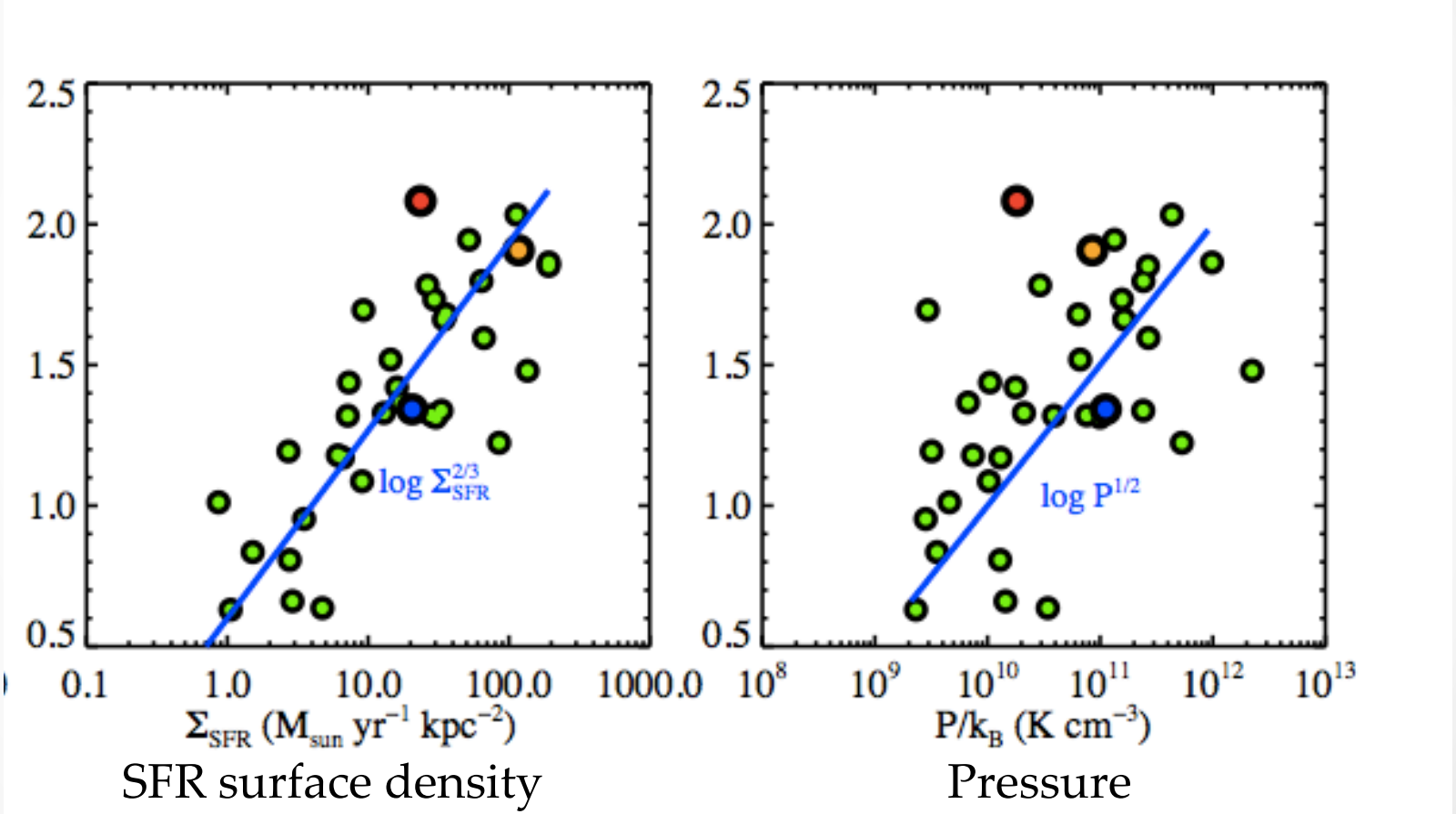
1. Metal enrichment history
2. SFRs, stellar masses of galaxies, assembly history
3. **IMF**

http://ircamera.as.arizona.edu/NatSci102/NatSci102/images/m42_hst.jpg



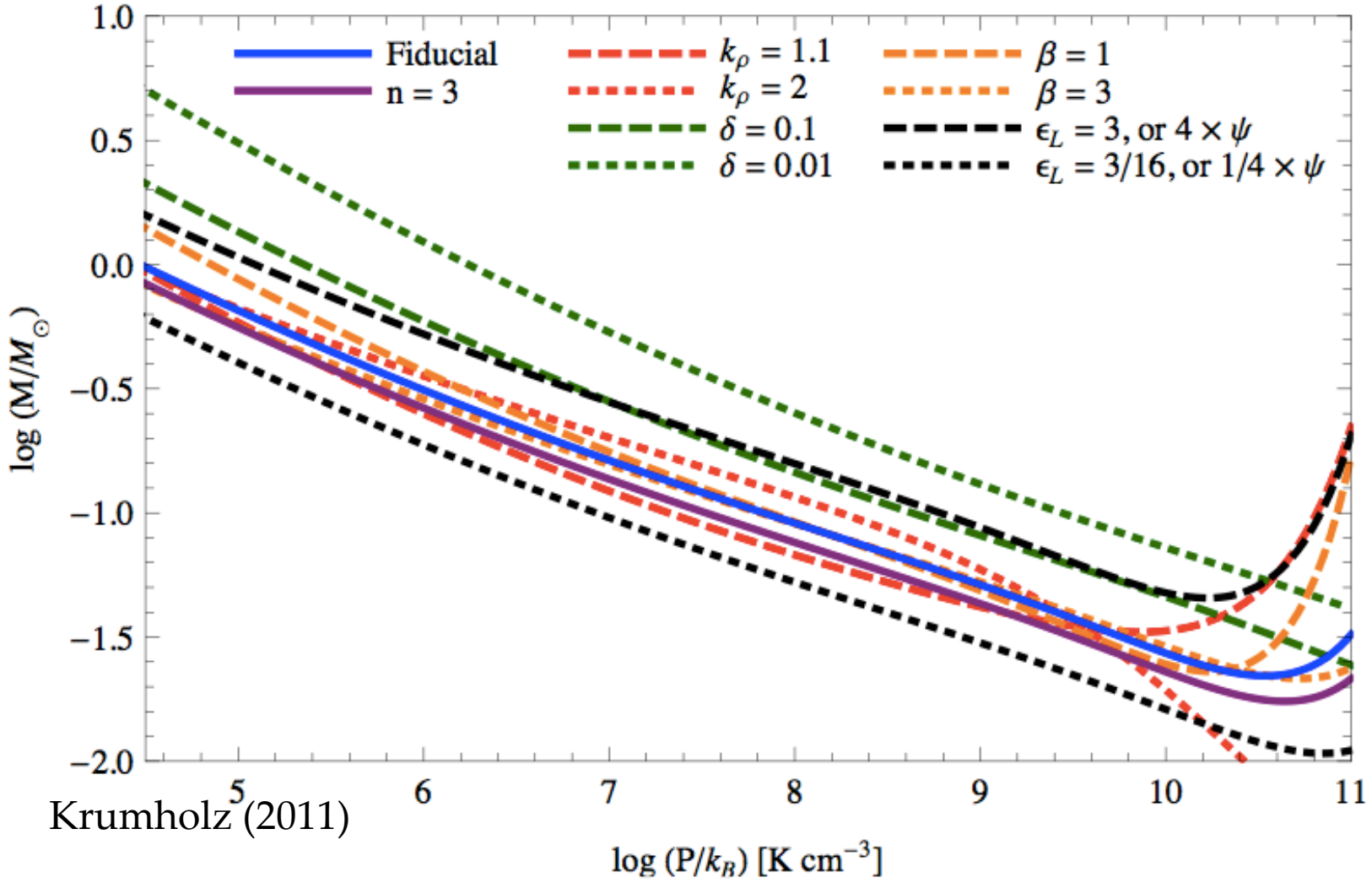
Gravity sensitive stellar absorption lines in giant elliptical systems: bottom heavy IMF? (van Dokkum & Conroy (2011), Spinelli (2012))

ISM structure tied to pressure, SF



Conroy & VanDokkum (2011)

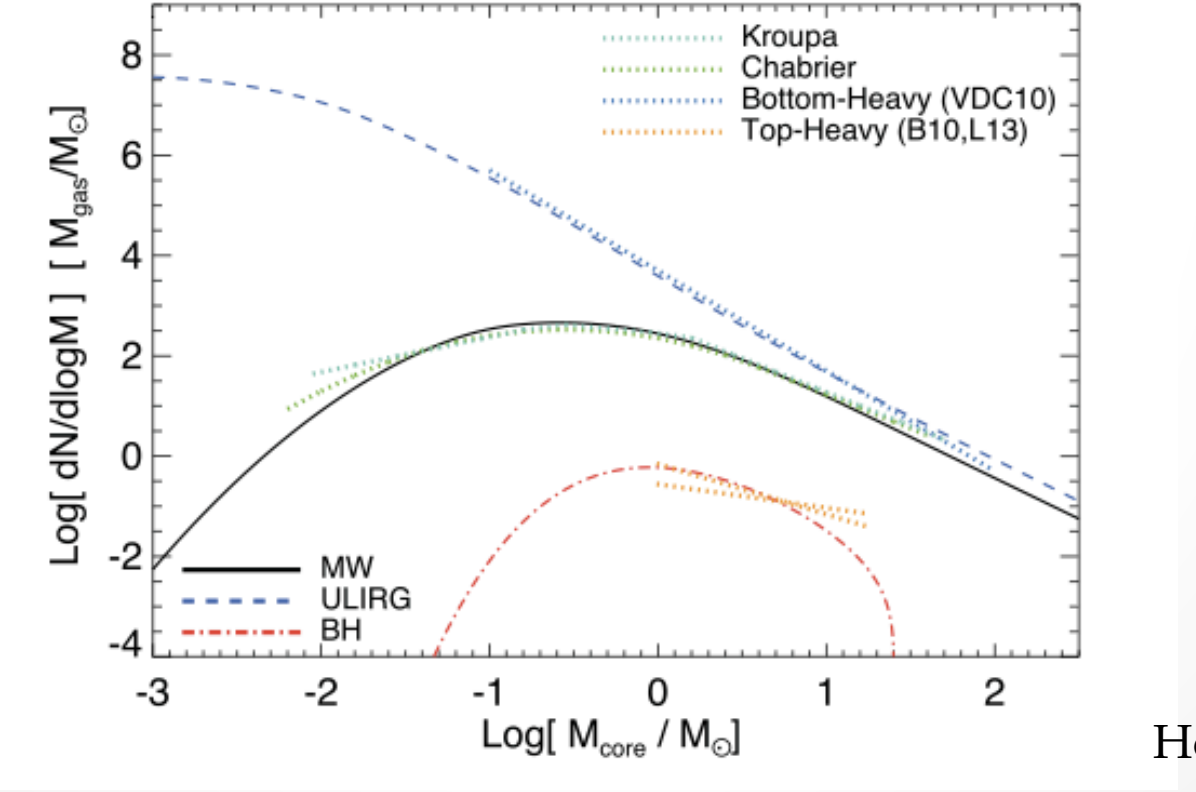
ISM structure tied to pressure



Krumholz (2011)

IMF: universal or not?

- Is this due to varying physical conditions in the star-forming molecular ISM? (Krumholz (2011), Hopkins + (2013))



Hopkins + (2013)

"Give up on that sissy lighter fluid and use…"

Gasoline

Gasoline:

- N-Body + Smoothed Particle Hydrodynamics (SPH)
- Uniform UV background (mimics reionization)
- Star particles born with Kroupa IMF
- "Blastwave" feedback model
- SN energy coupled to gas *as thermal energy* only
- Cooling shutoff in neighbor gas particles (adiabatic phase) for few Myr

Latest "zoomed-in" runs:

- Resolution 50-160pc ~ 'resolved' SF regions
- Star particles ~ 1000-10000 M_{sun}
- Radiative cooling (with metal lines)down to 200K
- H2 cooling and H2 based SF
- Several million particles per (main)galaxy at z=0.

The Simulations

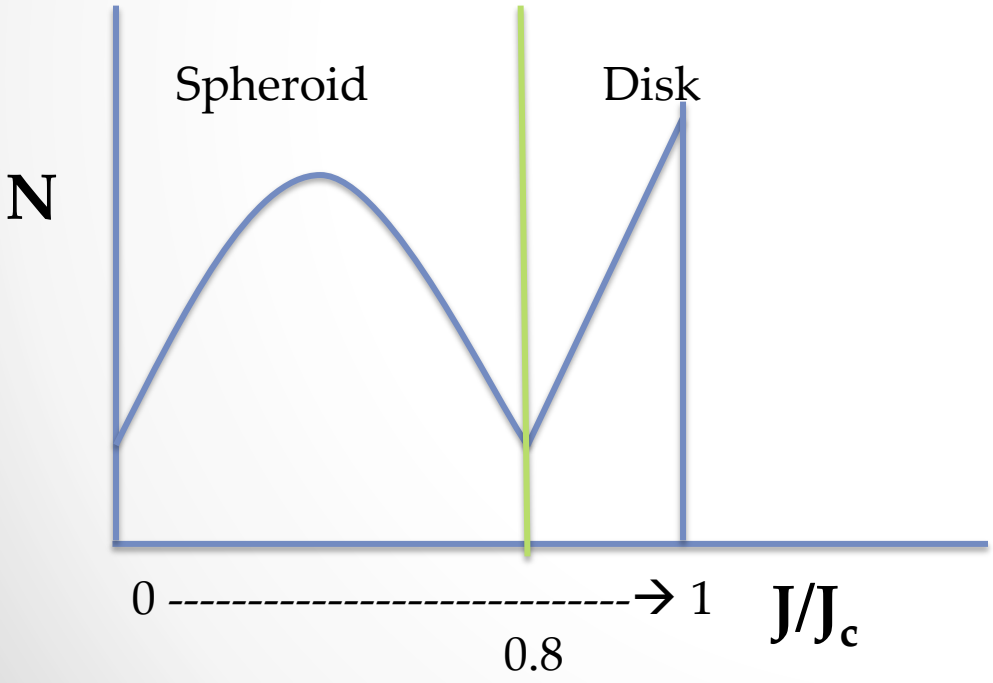
- 5 Milky-Way sized, cosmological spiral galaxies (halo mass ~10^{12} M_{sun}, stellar mass ~10^{10} M_{sun})

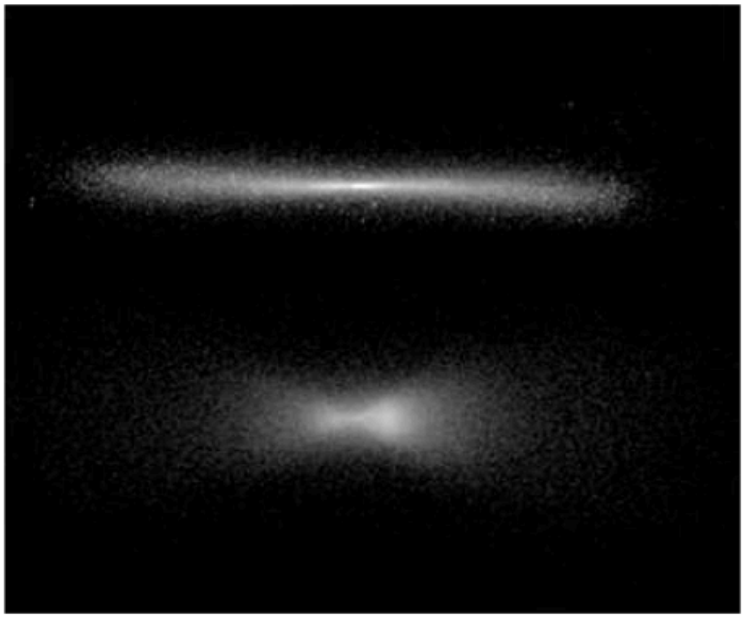
The Simulations

- The SFR set by the local gas density and H2 fraction (Christensen et al. 2012)
- Do **not** have to resort to simplified approaches based on a fixed local gas density/temp threshold (Governato et al. 2010; Kuhlen et al. 2011)

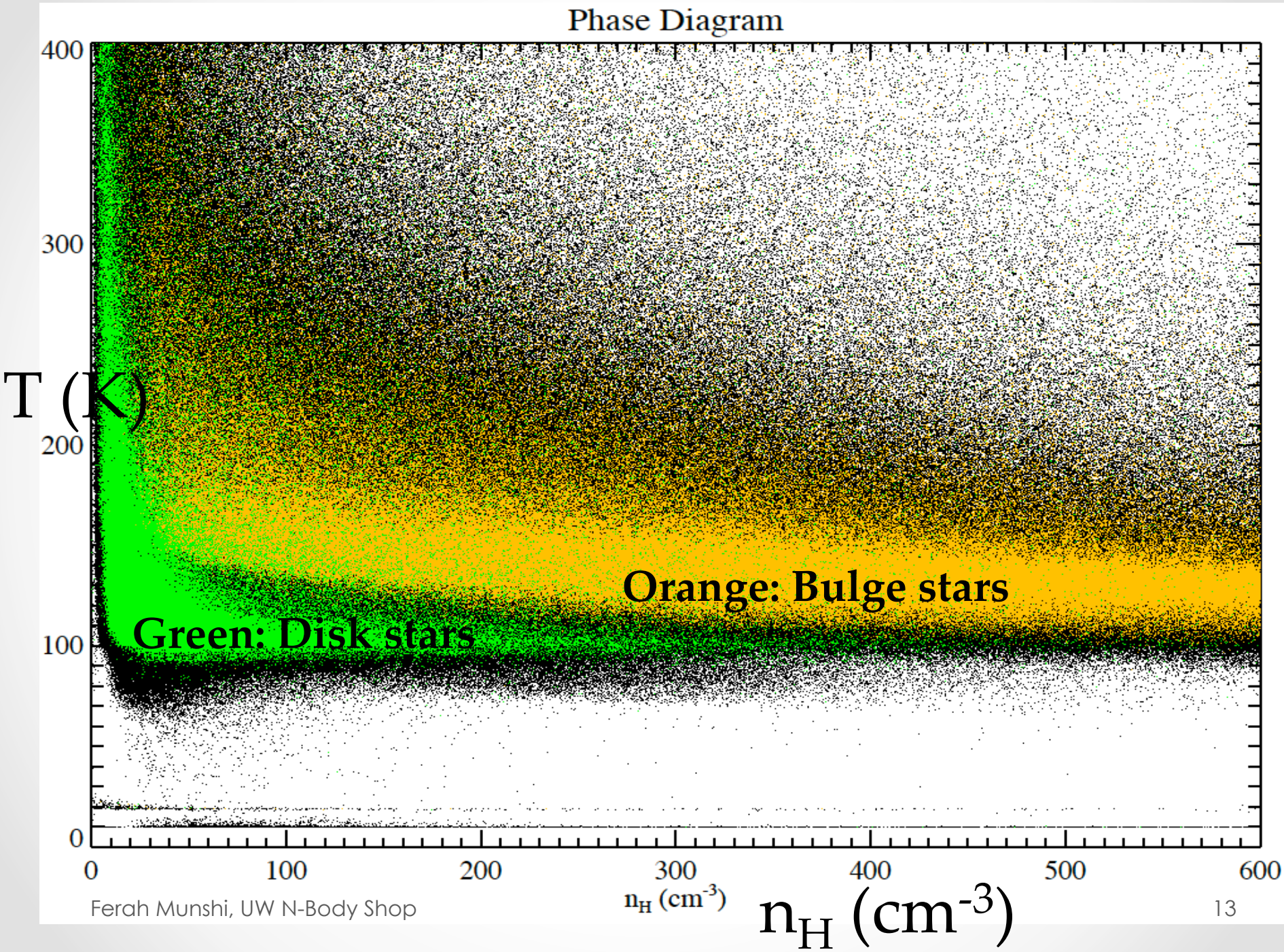
Decomp: dynamical decomposition of spiral galaxies

- Divide a simulated spiral galaxy into it's components based on **angular momentum** and **energy** of star particle



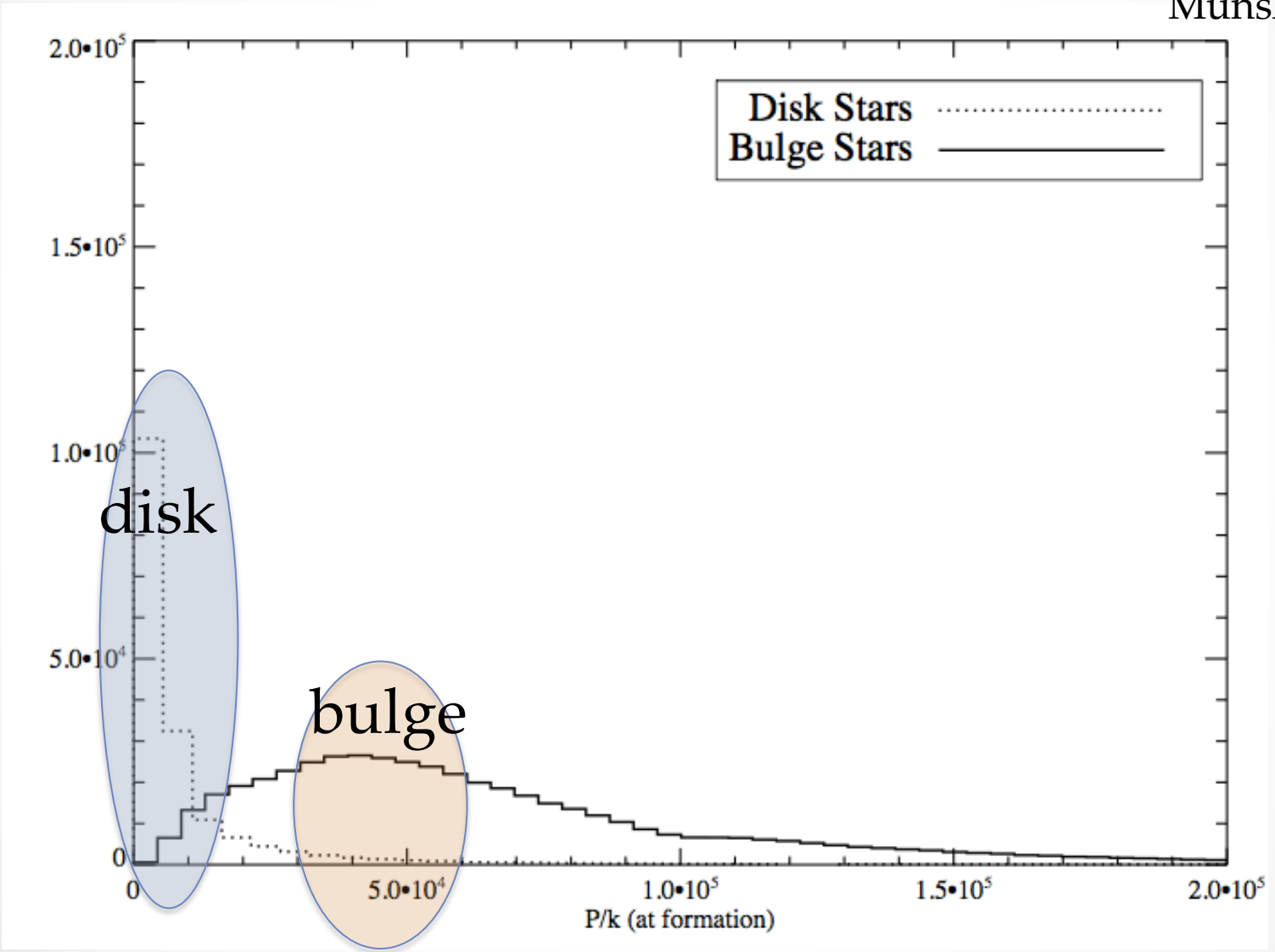


Scannapieco+ 2012
Chris Brook
Governato+ 2009


Phase Diagram
400
300
200
100
0
T (K)
0
100
200
300
400
500
600
n_H (cm^{-3})
Orange: Bulge stars
Green: Disk stars
n_H (cm^{-3})

Pressure Distribution

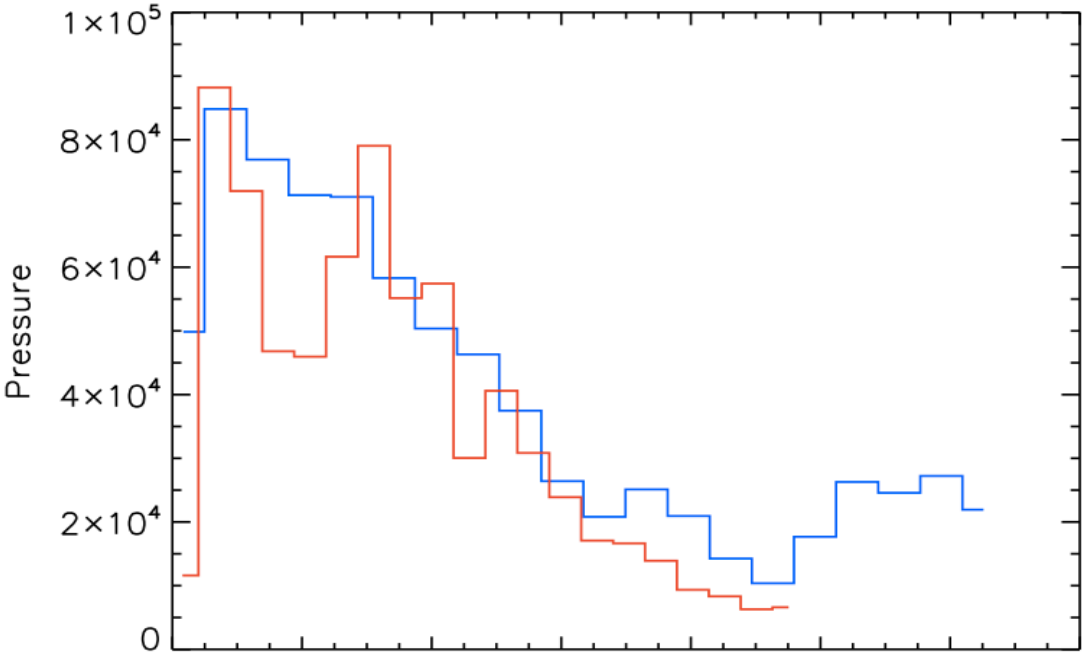
Munshi+, in prep



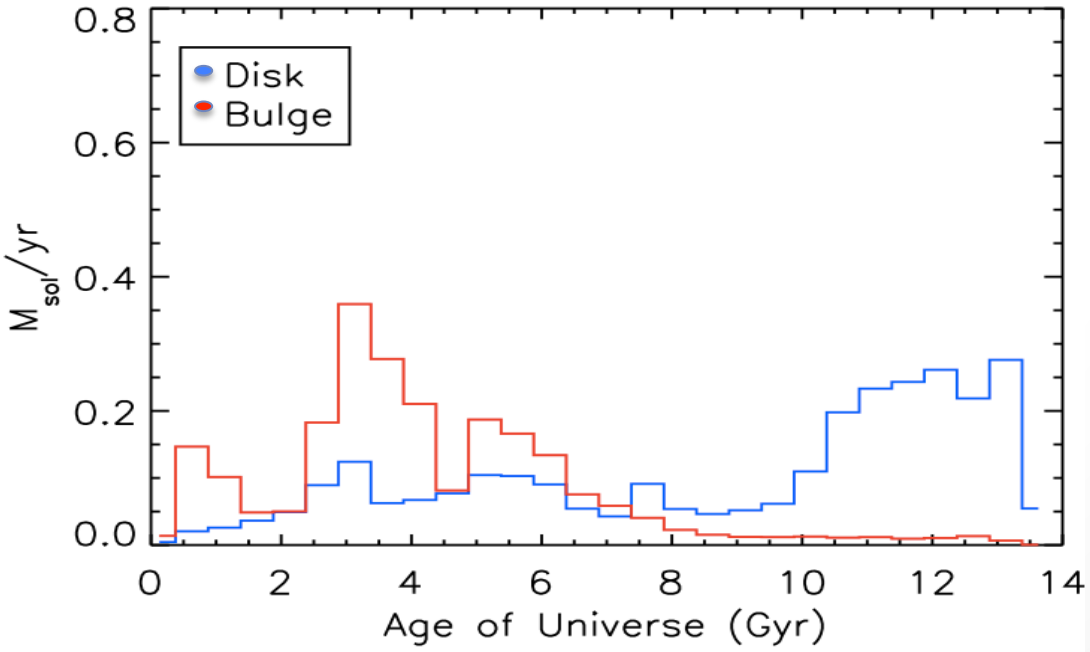
Number of stars

Pressure (at formation)

Pressure



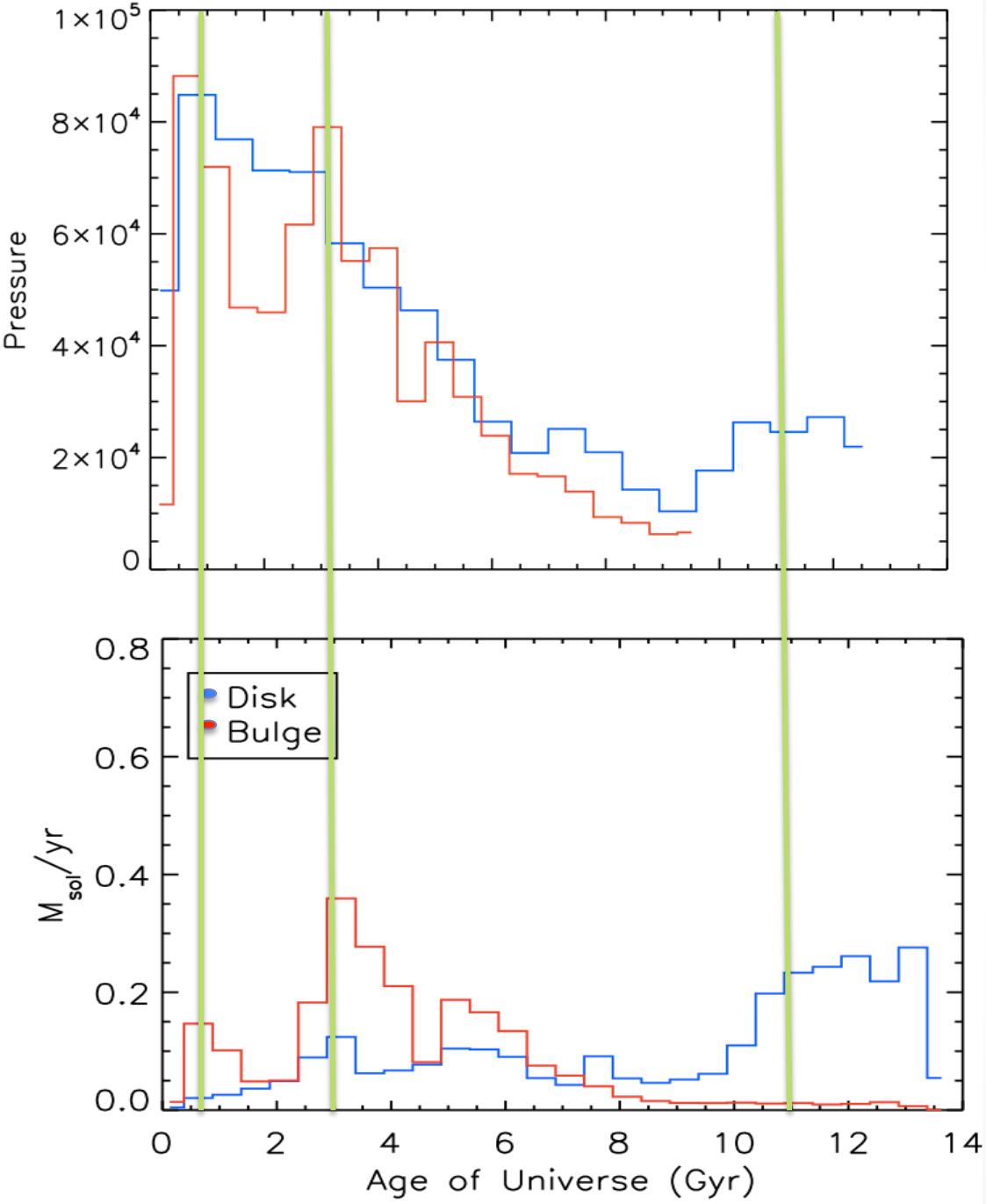
SFR



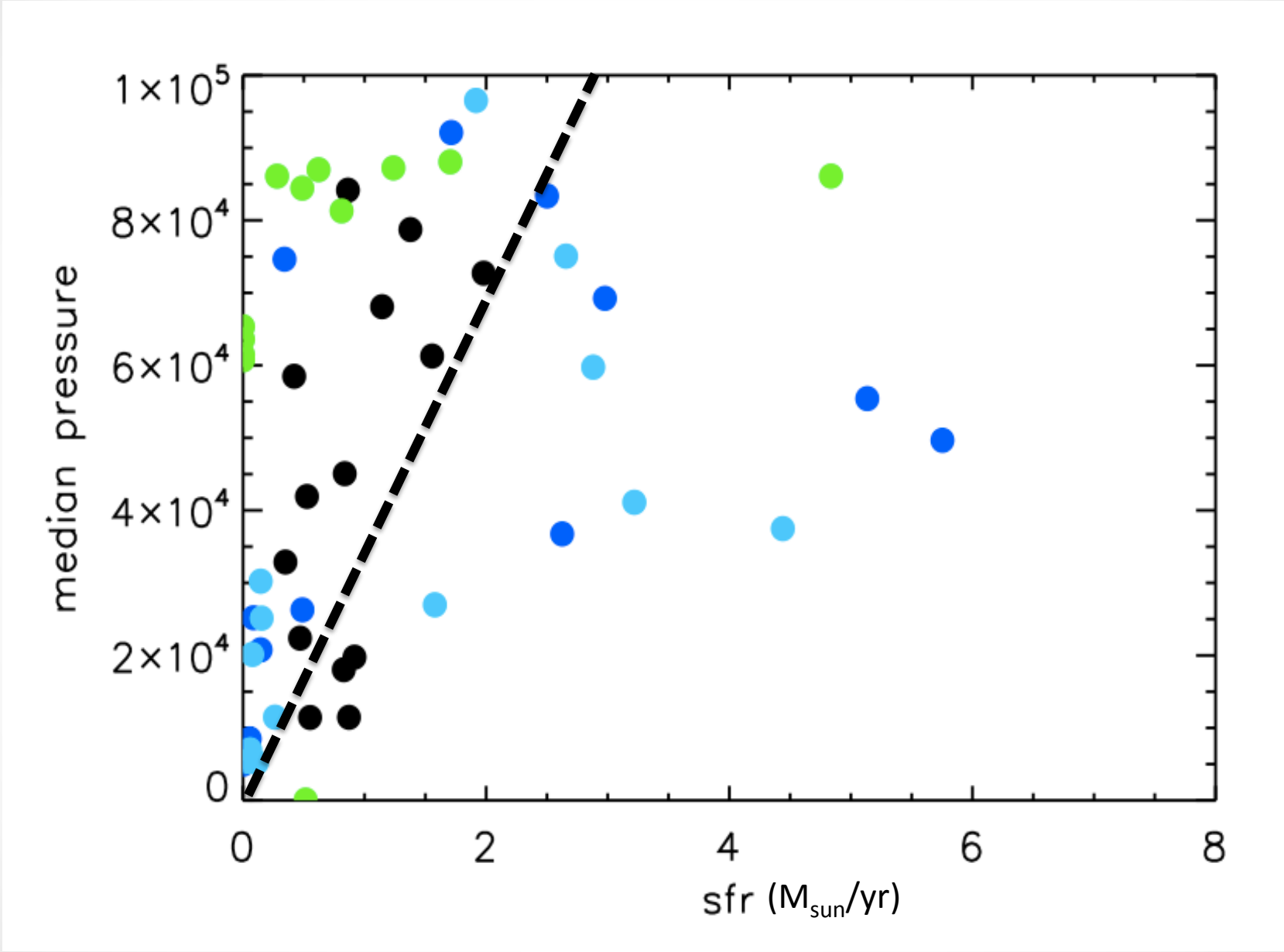
Munshi+, in prep

Pressure

SFR



Munshi+, in prep



Munshi+, in prep

Conclusions

- The star-forming ISM in the bulge and in the disk is different
- Higher P < -- > higher SFR
- Stars formed earlier in a galaxy's history tend to form at higher Ps

How are star formation and ISM structure related?

Specifically: Is there a difference in the star forming ISM in bulges vs. disks?

YES!