The Impact of Baryons on Dark Matter: Observable Consequences

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with C. Christensen, F. Governato, A. Pontzen, A. Zolotov, & the N-Body Shop collaboration

Outline of This Talk

The creation of DM cores:
How high resolution and a realistic treatment of SF affect simulation results

Observational Consequences:
tests of DM core creation in galaxies

Data Wanted:
DM mass distributions as a function of mass

Gasoline

Gasoline:

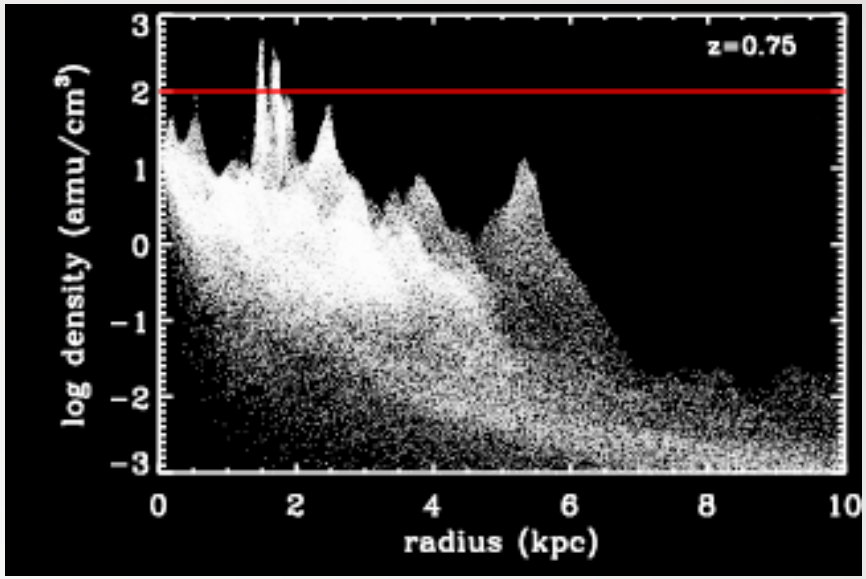
- N-Body + Smoothed Particle Hydrodynamics (SPH)
- Uniform UV background (mimics reionization)
- Star particles born with Kroupa IMF
- "Blastwave" feedback model
- SN energy coupled to gas *as thermal energy* only
- Cooling shutoff in neighbor gas particles (adiabatic phase) for few Myr

Latest "zoomed-in" runs:

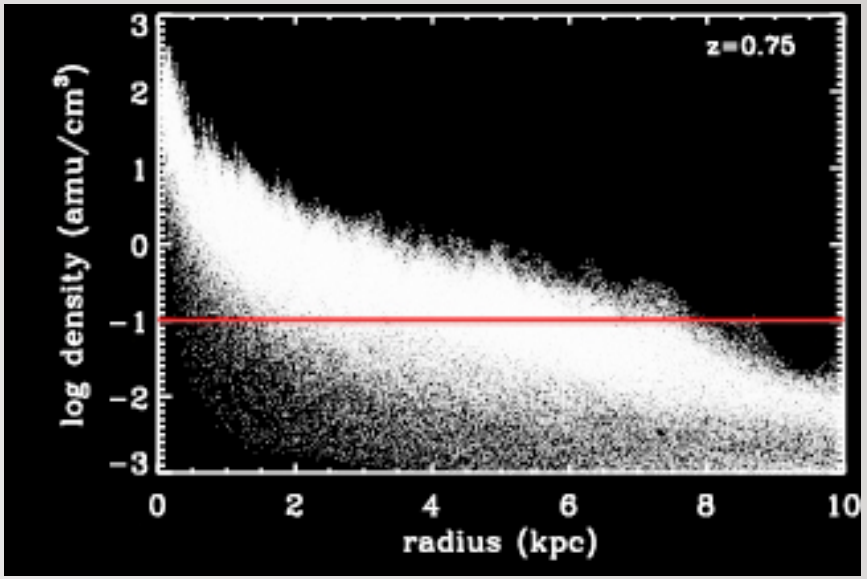
- Resolution 50-160pc ~ 'resolved' SF regions
- Star particles ~ 1000-10000 M_{sun}
- Radiative cooling (with metal lines) down to 200K
- H2 cooling and H2 based SF
- Several million particles per (main) galaxy at z=0.

Wadsley et al. (2004), Stinson et al. (2006), Shen et al. (2010), Christensen et al. (2011, submitted)

“Resolving” Star Formation Regions



High Threshold



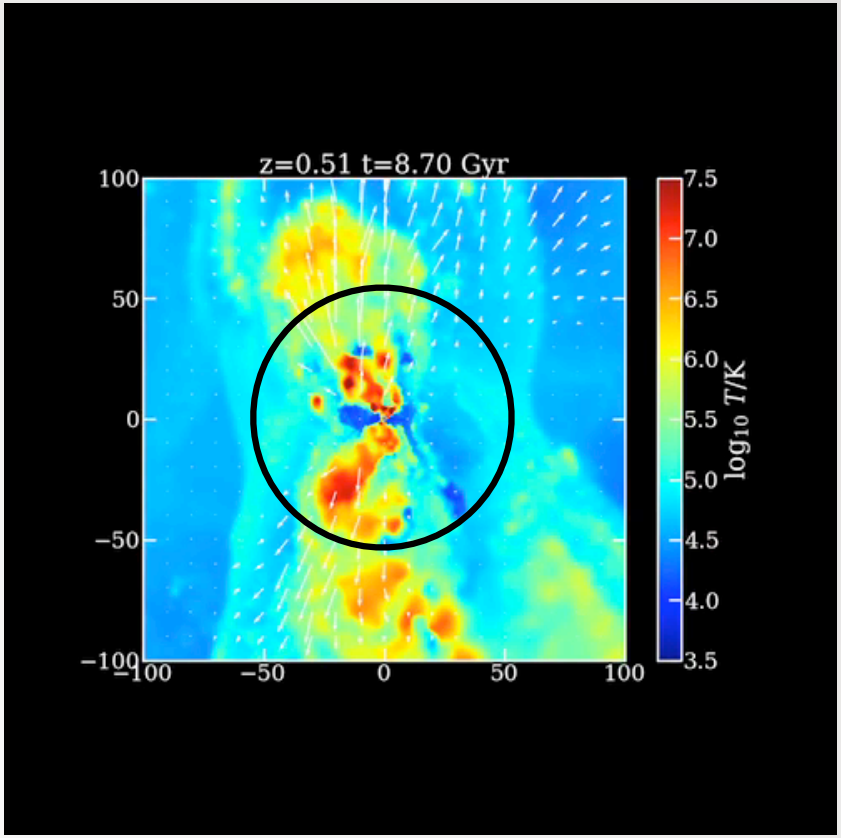
Low Threshold

Feedback becomes more efficient

(more outflows per unit mass of stars formed)

see also: Ceverino & Klypin (2008), Robertson & Kravtsov (2008), Tasker & Bryan (2008)

Outflows!

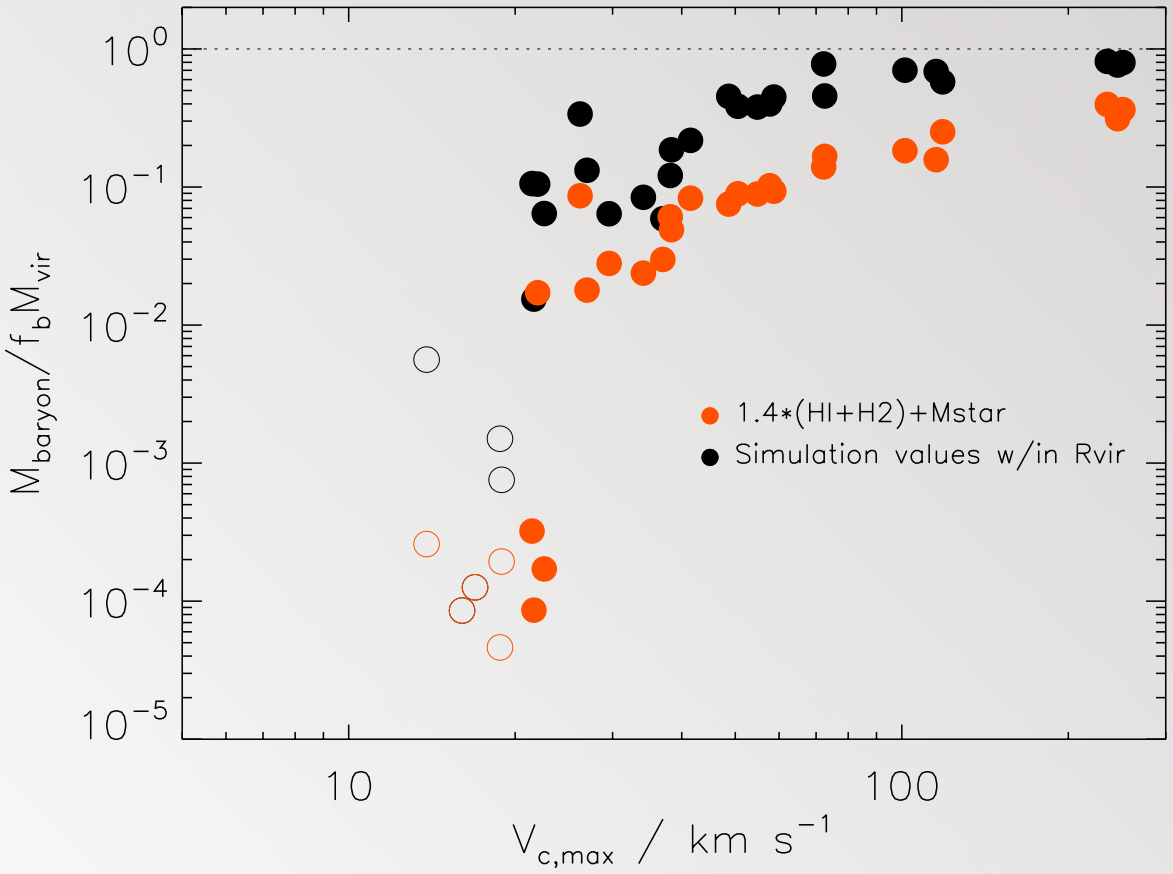


Edge-on disk orientation

(arrows are velocity vectors)

Brook et al. (2011)

Nick vs Stacy: my promised plot



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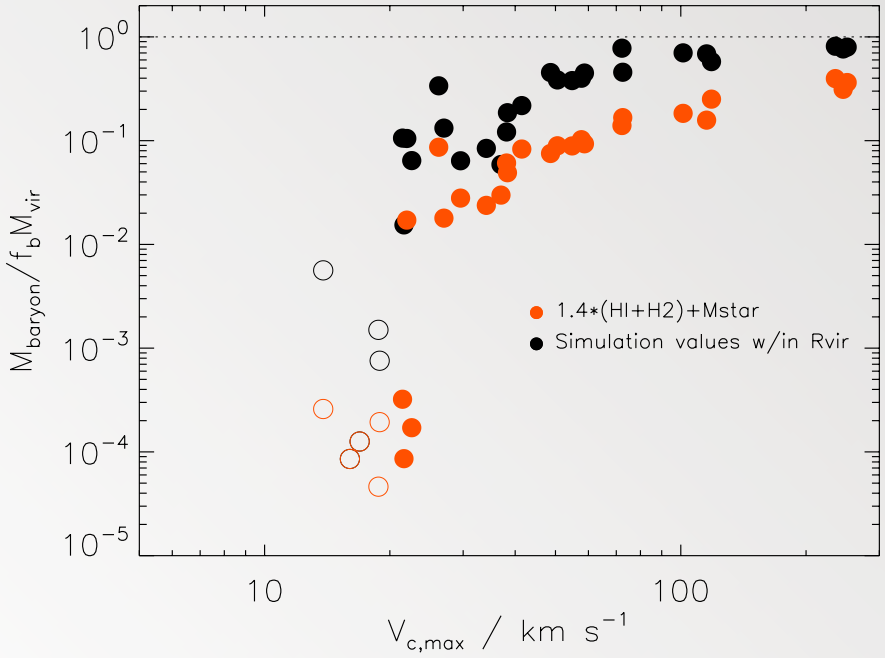
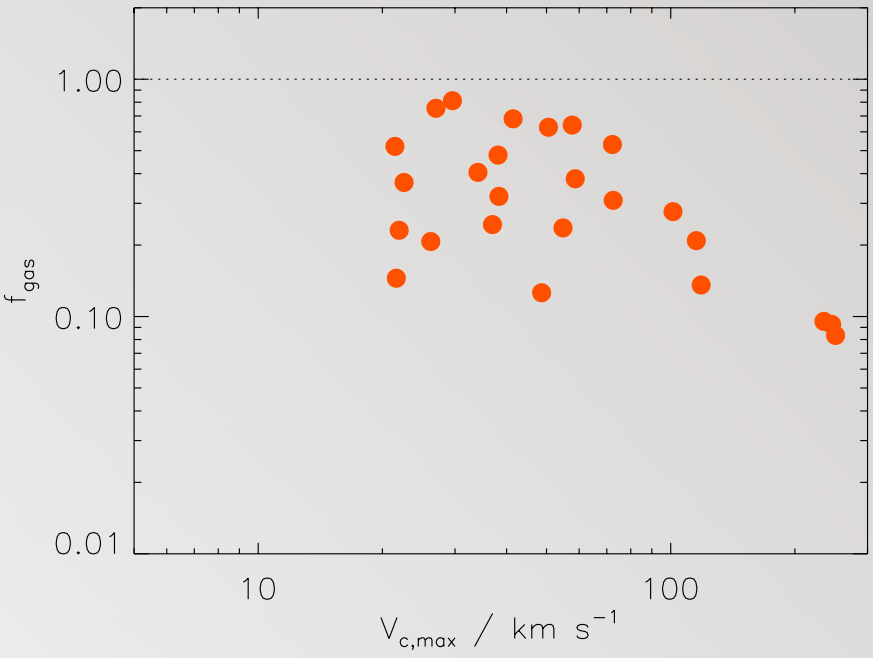
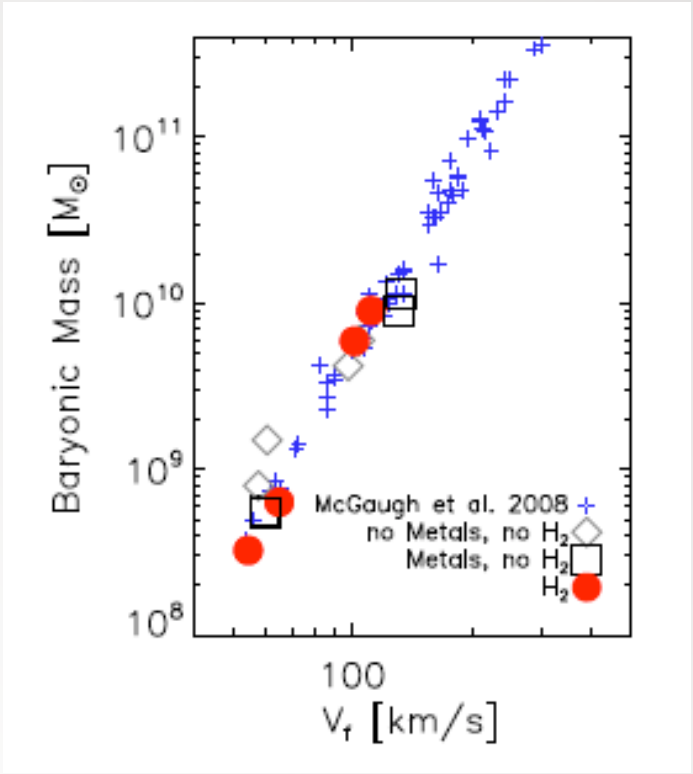
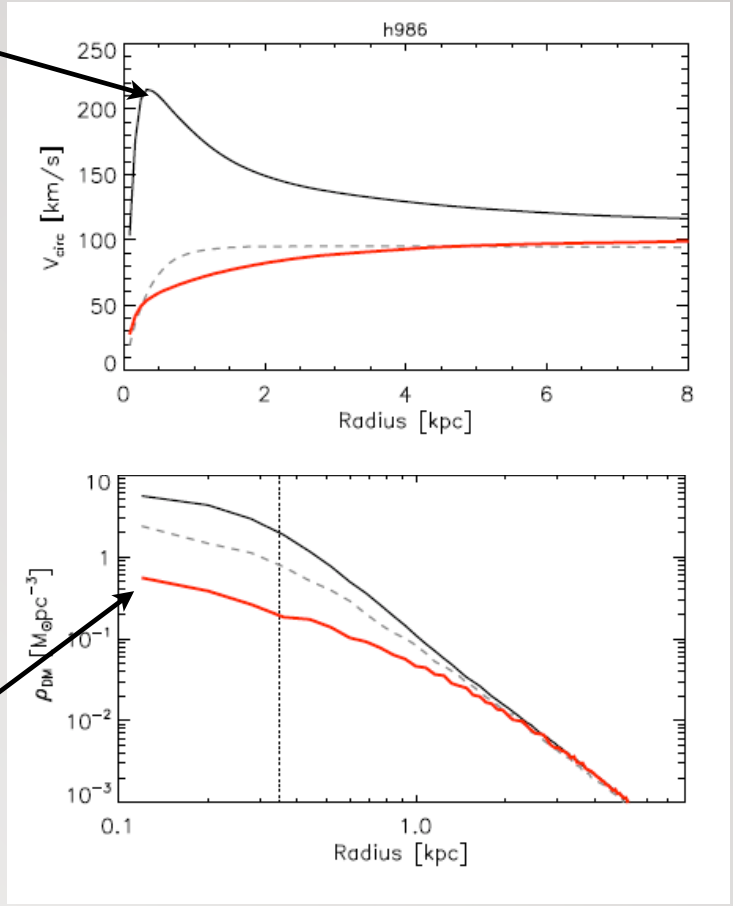






Using Metal Dependent Cooling increases the amount of stars formed at high-z (in bulges)

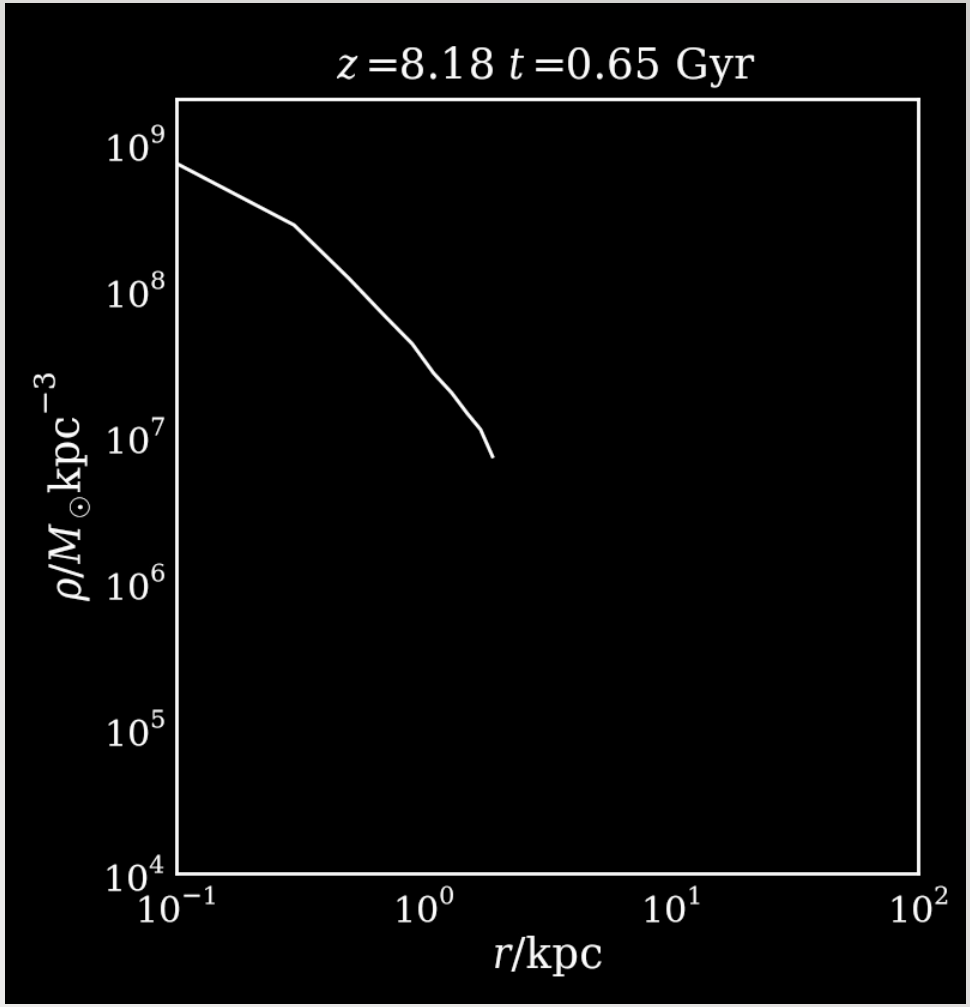


Lower Dark Matter and stellar densities due to enhanced outflows

Christensen et al., in prep (2012)

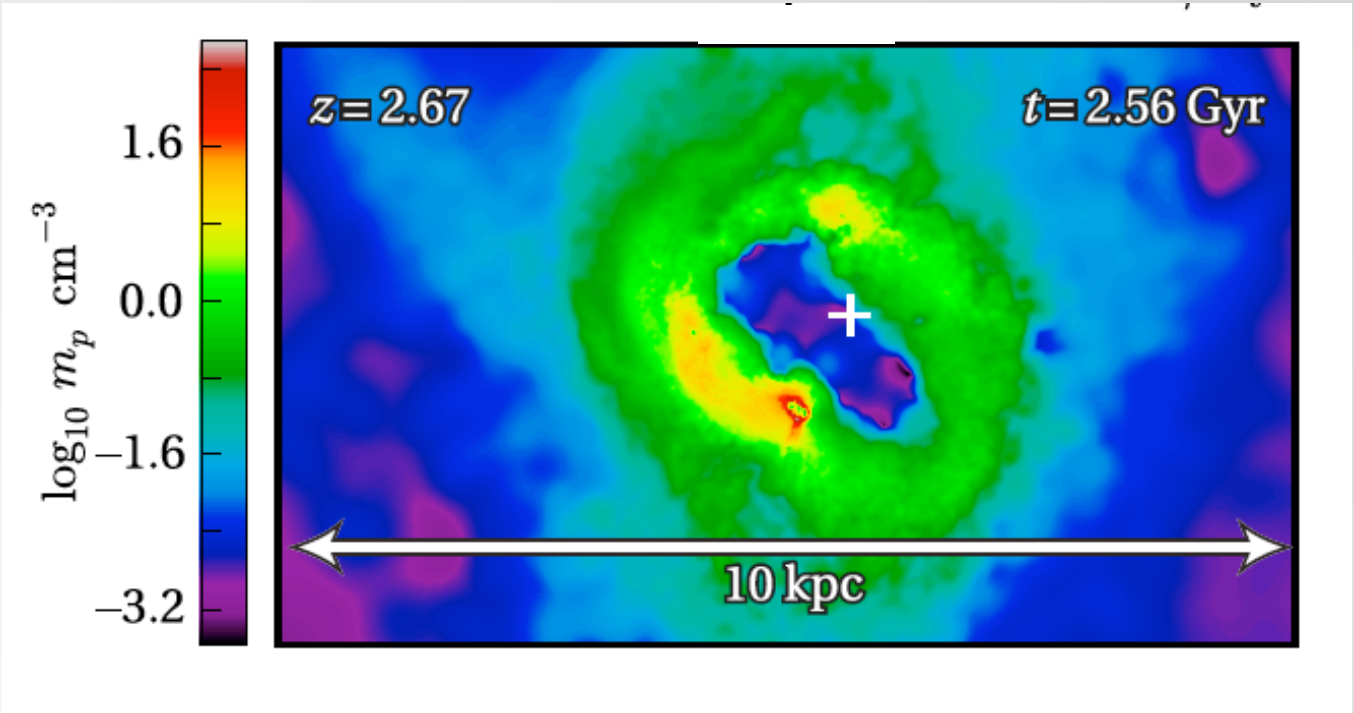
Outflows Flatten the DM Density Profile

Core Creation!



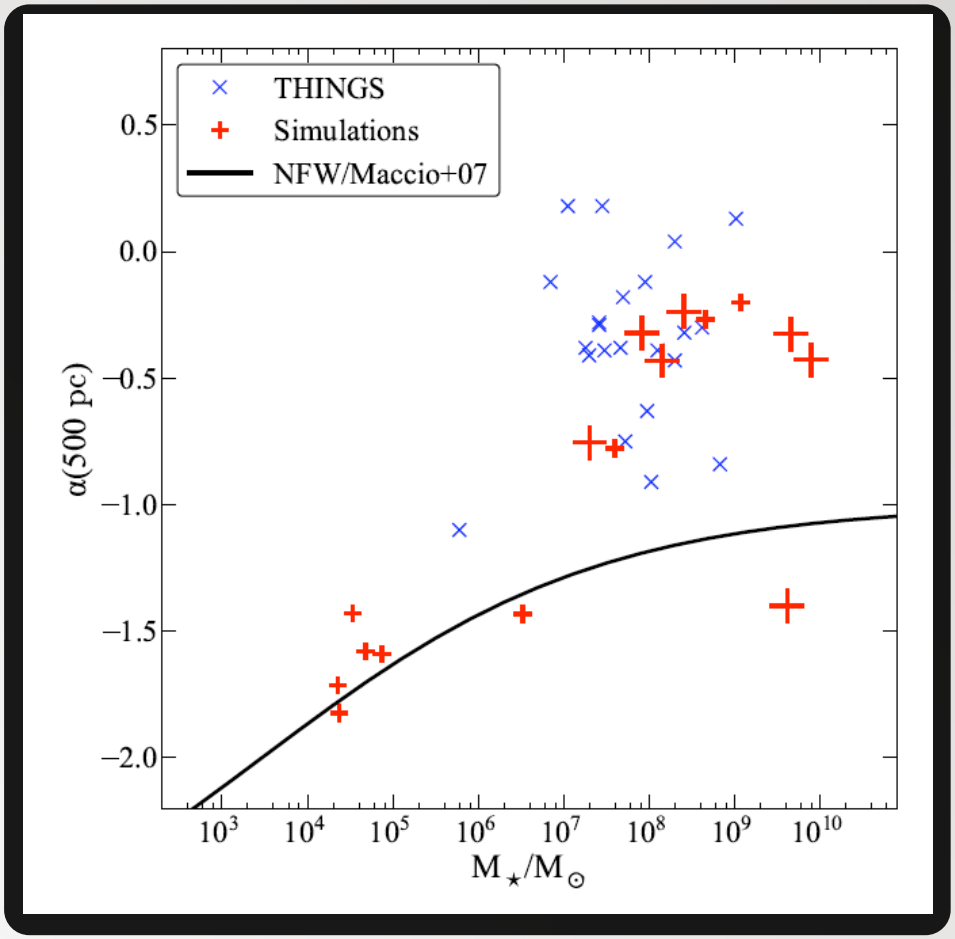
see also: Mashchenko et al. (2007, 2008); El-Zant et al. (2004); Navarro et al. (1996); Mo & Mao (2004); Tonini et al. (2006)

How Are Cores Created?
Bursty SF!



Pontzen & Governato (2012)

Core Creation varies with Mass!



because SF varies with mass

Galaxies in the THINGS survey have average α~-0.3

Lower mass galaxies do not undergo repeated bursts of SF; retain cusps

Governato, et al., MNRAS, in press

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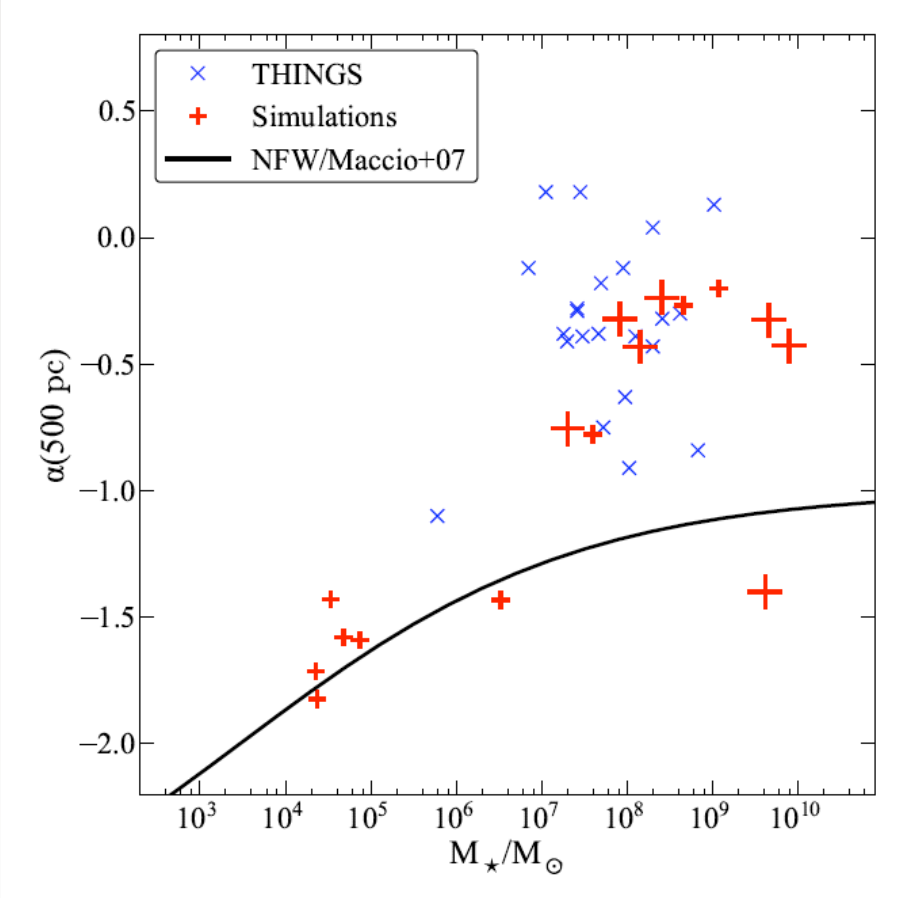
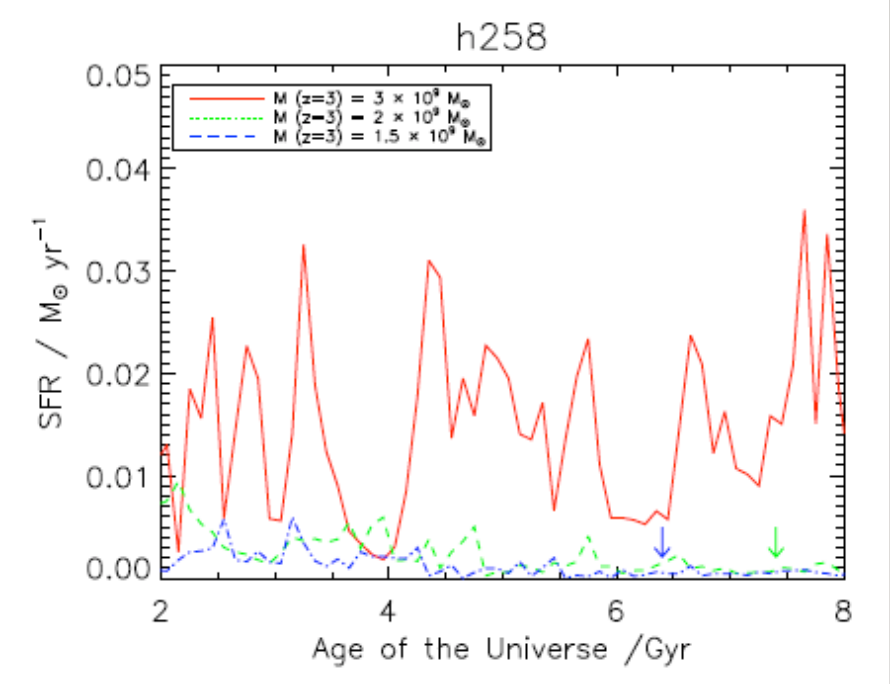
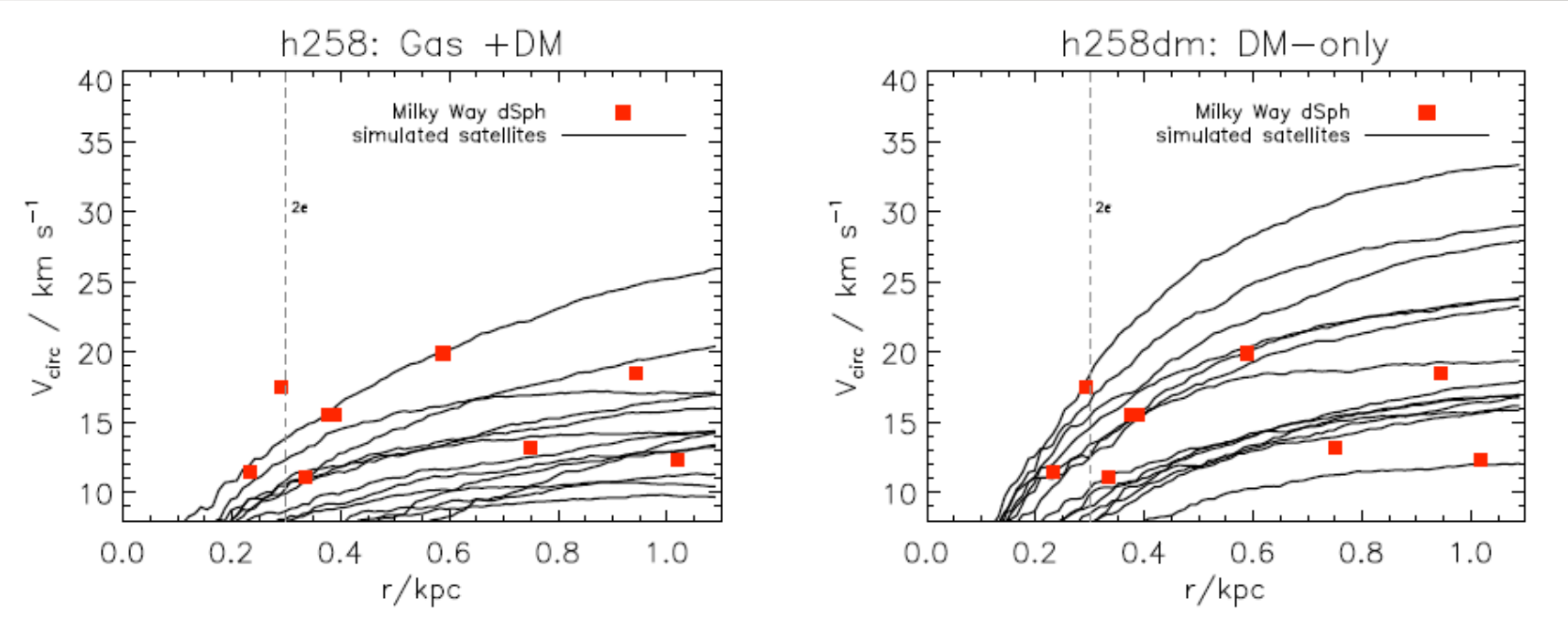
because SF varies with mass





Governato, et al., MNRAS, in press

Core Creation with Mass: The Impact on Satellites



Zolotov & Brooks, 2012, in prep

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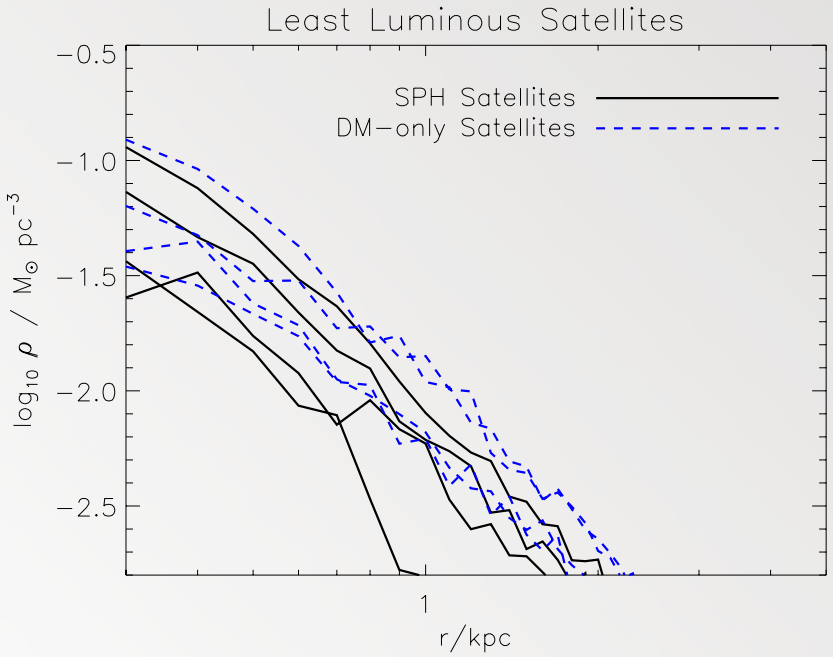

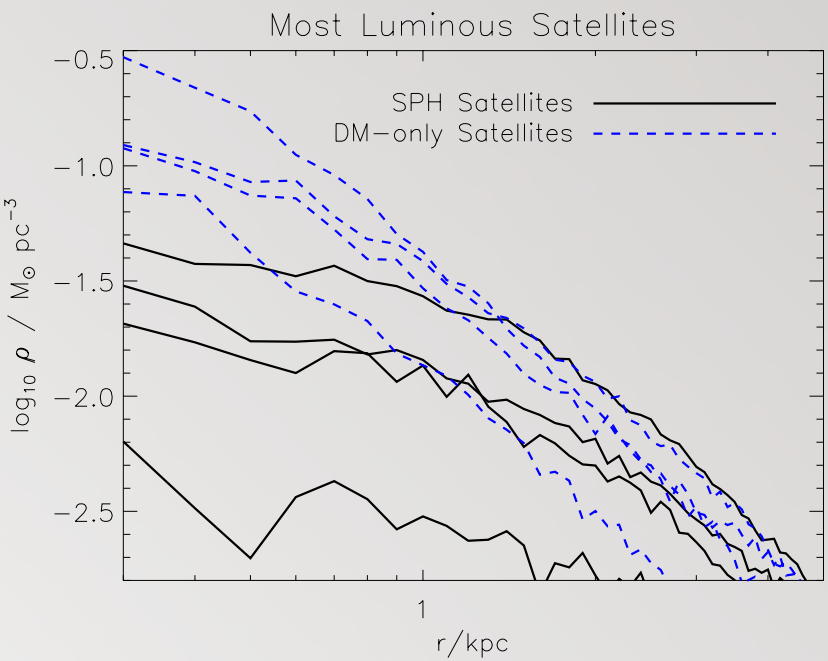

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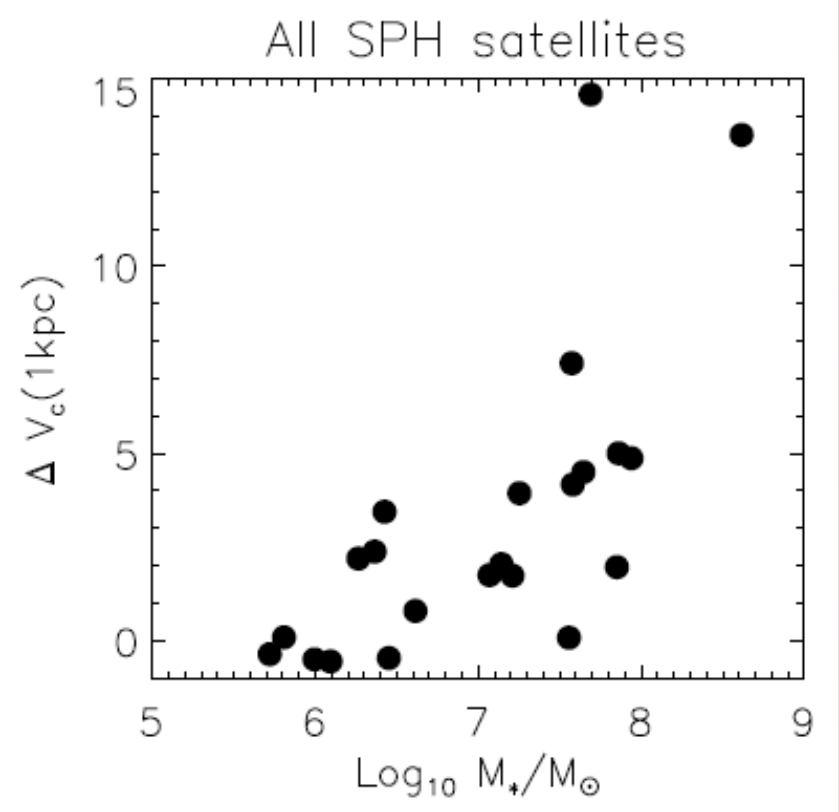

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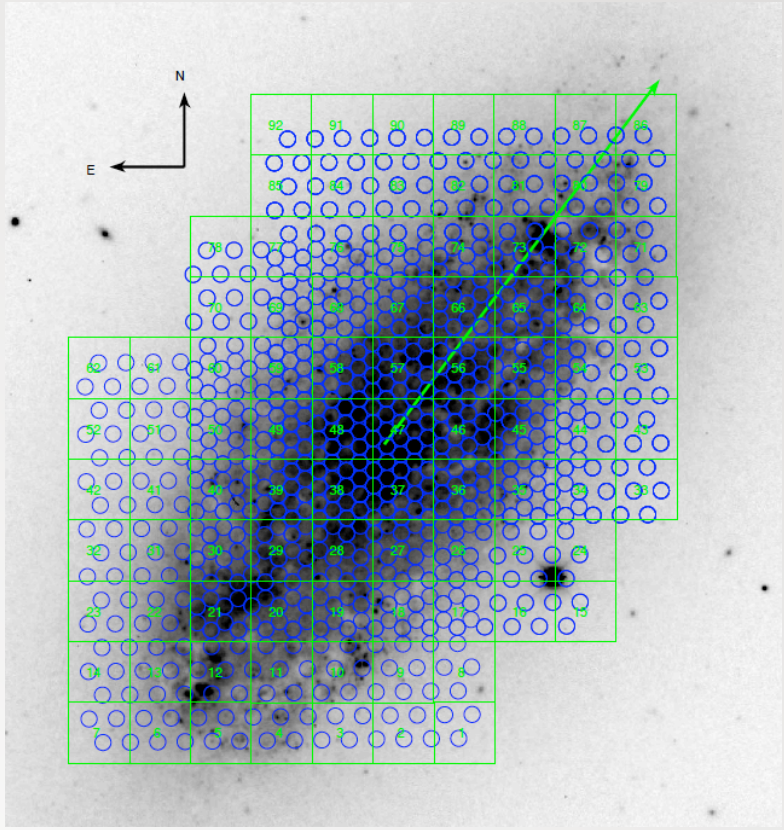
Do Cores Exist? Stellar vs Gas Kinematics



Adams et al. (2011)
VIRUS-P
NGC 2976

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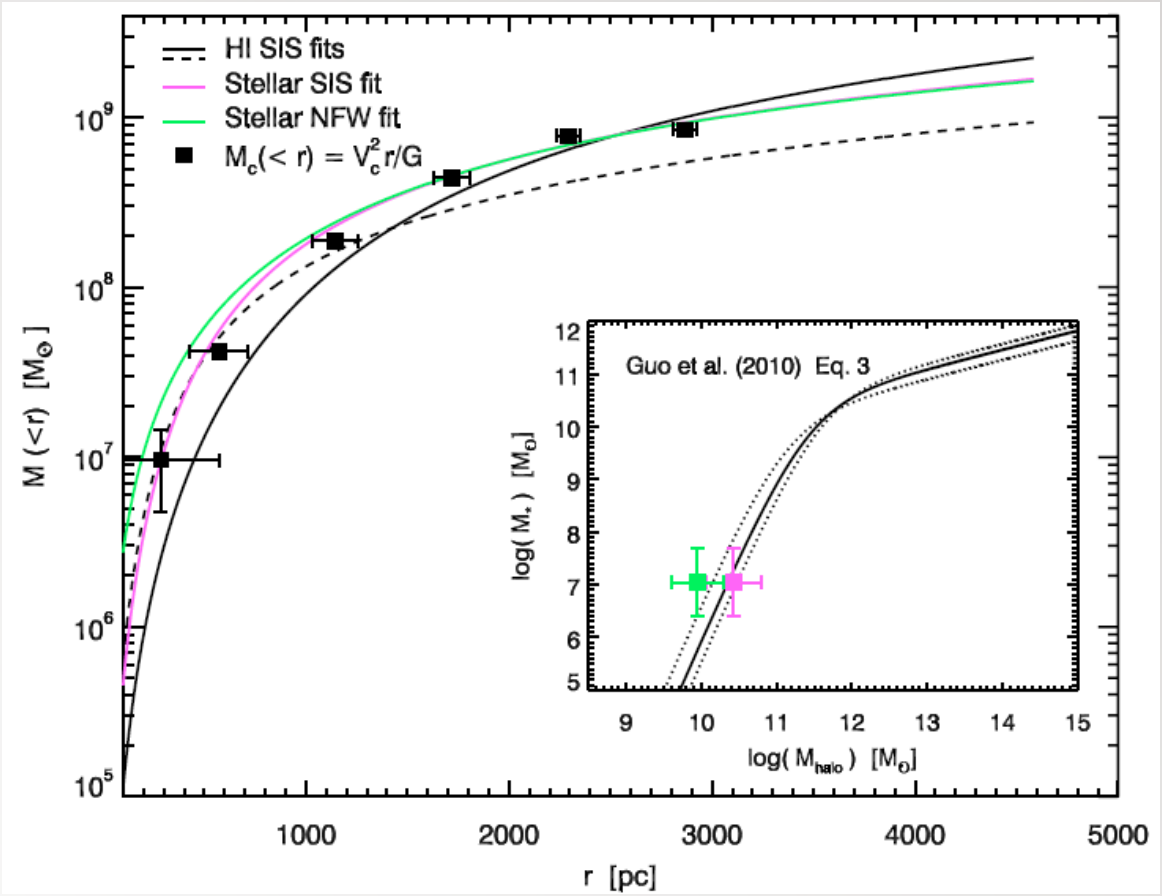

Leaman et al. (2012)