Modelling the satellites of the Milky Way

(in a cosmological setting)

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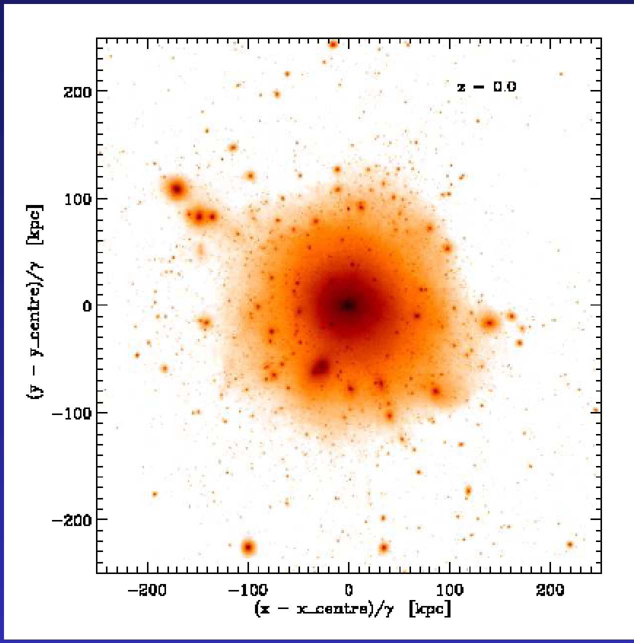
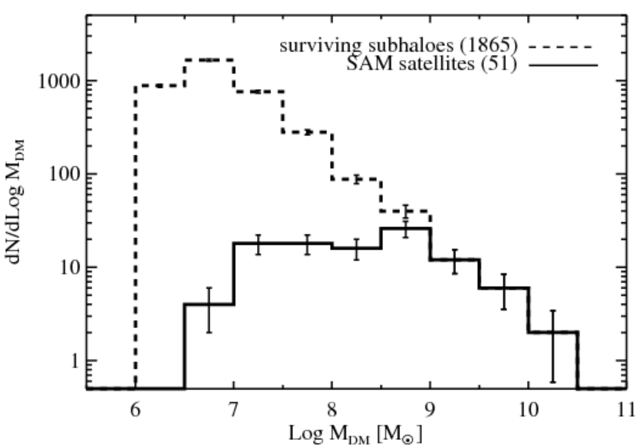
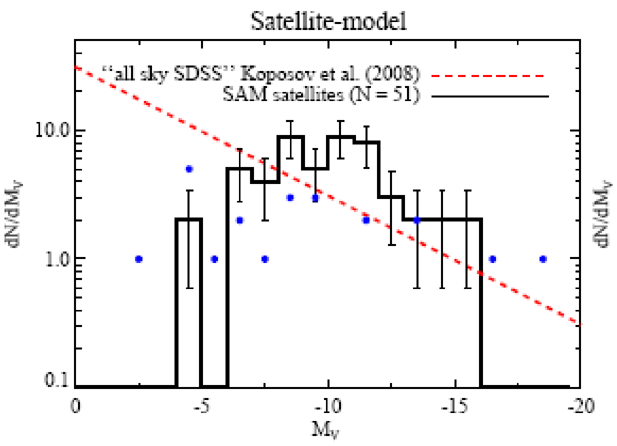
Modeling the satellites in ΛCDM

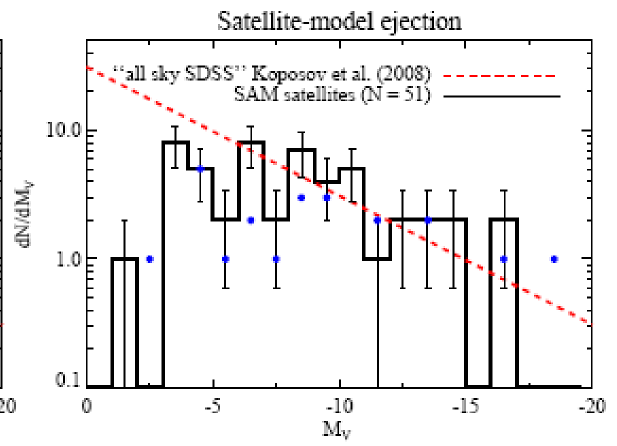
- Subhalos vs satellites:
  - many more subhalos than luminous satellites
  - processes included in SA models to account for this:
    - re-ionization: z_i = 15 to z_f = 11.5 (Gnedin 2000)
    - small halos ($T < 10^4$ K) cannot cool (lack/inefficient coolants)
  - no fine-tuning of parameters
    - improvement: metals are recycled through hot phase (Mac Low & Ferrara 1999)



Li, de Lucia & Helmi in prep



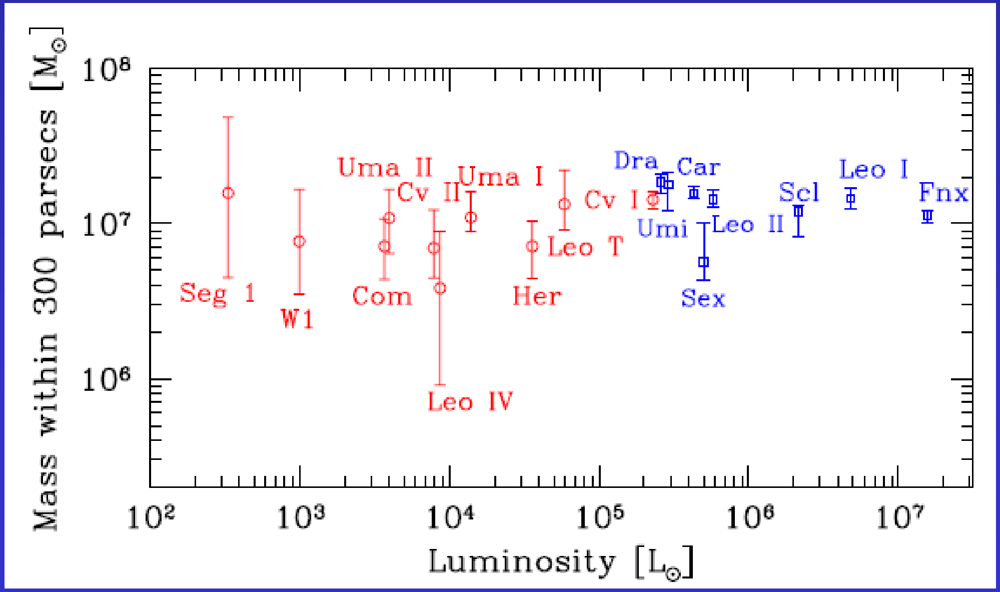




The common mass scale of the dSph

- dSph have similar masses in innermost region: M(r<300 pc) ~ 10^7 Msun
  - Also 600 pc if the classical dwarfs are considered
  - 5 orders of magnitude in luminosity vs 1 order of magnitude scatter in mass

- Possible explanations:
  - Dark matter does not cluster with M < 10^7 Msun (not cold?)
  - Astrophysical mechanism preventing the formation of stars in small objects



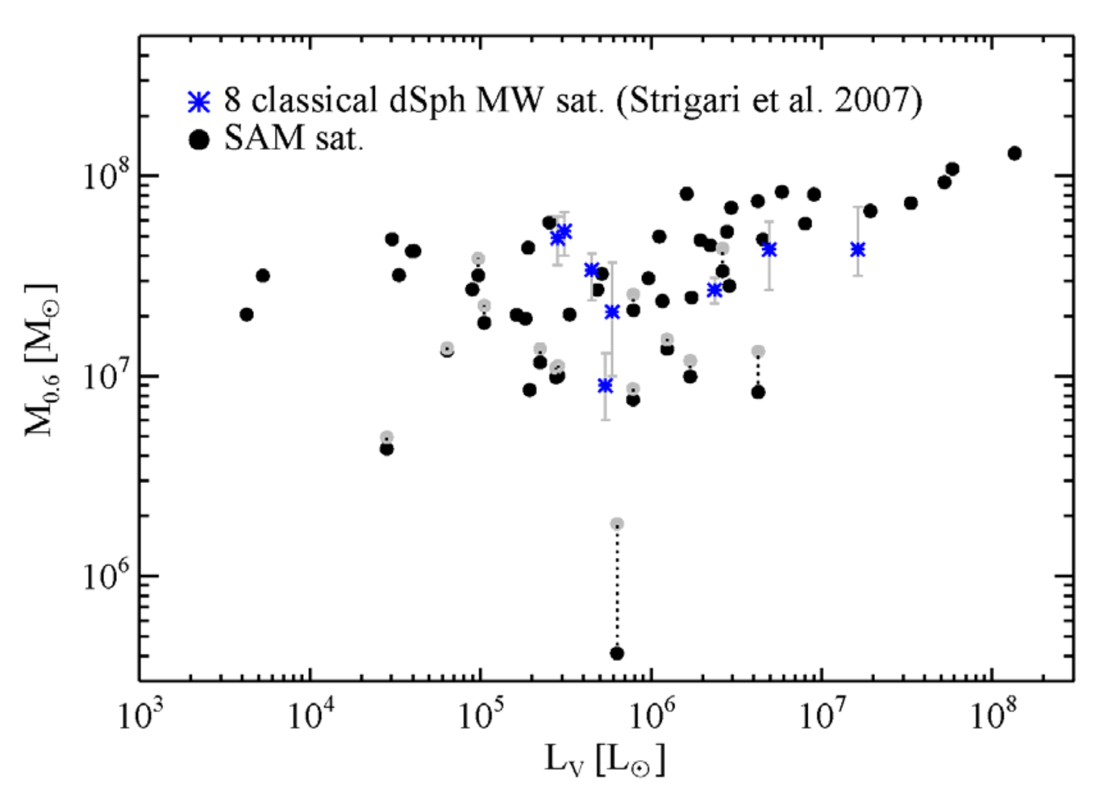
Strigari et al 2008

Does LCDM predict a common mass scale?

- We measure M(r<600pc) for our satellites
  - 600 pc ~ 4 * Softening
  - Typically > 400 particles in this region (so generally well-resolved)

- Most of the satellites have M(r < 600 pc) in the range observed

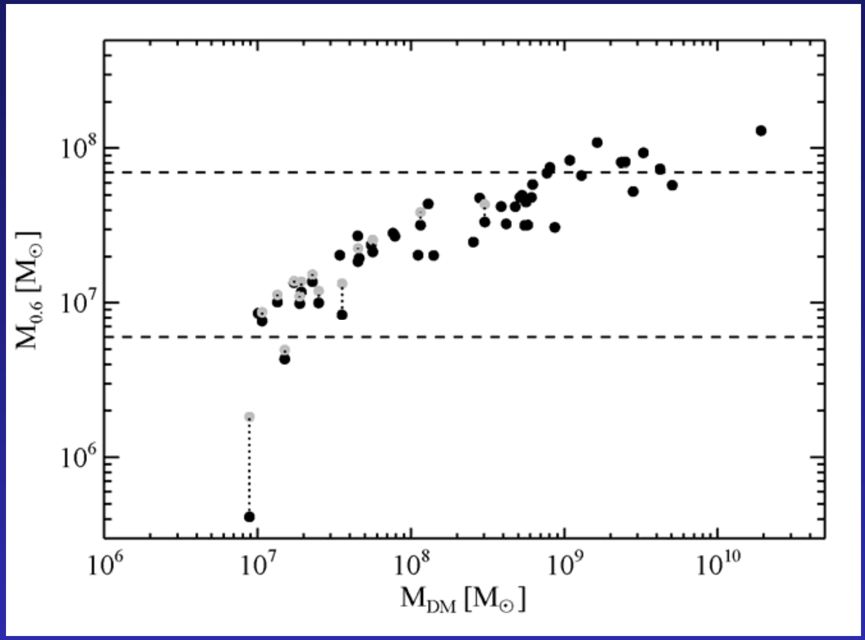
- Factor 10 spread in innermost mass, a factor 10^5 in luminosity!

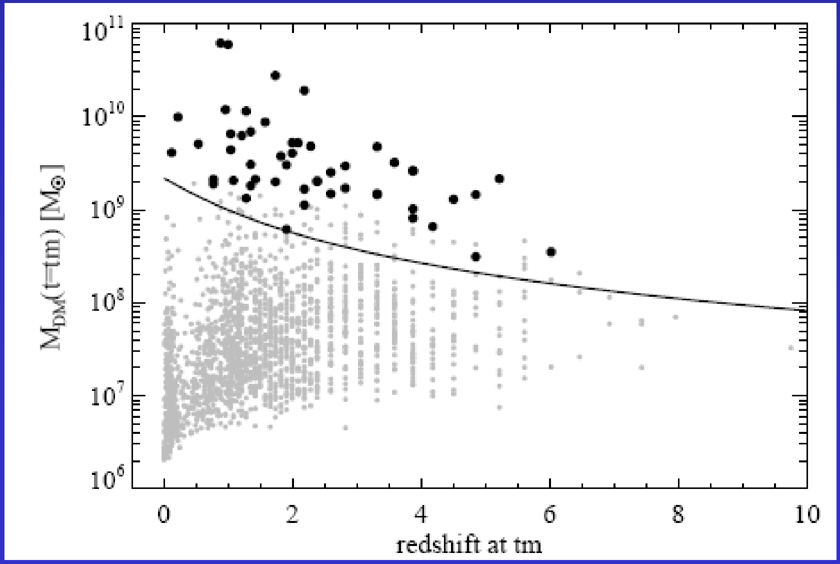


Li, AH et al. 2008

Do satellites have the same total mass?

- Large range in present-day total dark matter mass
  - factor 5 x 10^3
- Weak correlation: lightest have also the smallest innermost mass
- There is a minimum mass scale at time of accretion
- Large range in peak mass (or mass at the time of accretion)
  - factor 5 x 10^2
- Large range of accretion redshifts





Li, AH et al 2008

Satellites in LCDM

- Satellites do not live in a common mass-halo but there is a minimum scale below which no stars form
    - stars only form in halos with $T > 10^4$ K (at $z = 10 \rightarrow M > 10^8 M_\odot$)

- The large range in luminosities:
    - range of total masses at the time of accretion (factor 10 - 50)
    - range in times of accretion (at fixed mass, satellites accreted early will on average form fewer stars)

If we assume $L \propto M_{max}(z) = M_{max}\, e^{-2\alpha z}$

Then the range of luminosities

$$L_{min}/L_{max} = M_{max}^{low}(z_{acc})/M_{max}^{up}(z_{acc})\, e^{-2\alpha(\Delta z)}$$

- first term: range of masses at fixed accretion epoch
- Δz denotes the range of accretion redshifts.

For the values above, and for $\Delta z = 6$,

$$L_{min}/L_{max} = 0.02 - 0.1 \times 0.01 \sim 0.0002 - 0.001$$