Stellar Haloes in CDM

Galaxy Formation 2011
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Stellar Haloes

Belokurov et al 2007, 2008
Not to scale. Thanks to whoever took these pictures! (AAO, ESO)
MW Satellites

Font et al. 2011

Reion. Cooling Feedback

Number < Mv

V-band Magnitude

Not to scale. Thanks to whoever took these pictures! (AAO, ESO)

Tuesday, July 19, 2011
• LF today only a proportion of all satellites that fell into the halo.

• ~30-50% of all companion galaxies have been destroyed (larger fraction at the bright end)
Particle Tagging Model

Tag DM particles in high-resolution N-body simulations of MW-like systems


- Mass and morphology of the accreted stellar halo
- Gradients of density, metallicity, age
- Number and nature of individual satellites that contribute halo stars
- Nature of the stellar halo:
  - In-situ components and thick discs
Density profiles: broken powerlaws, slope consistent with MW (density slightly lower than solar neighbourhood)

Deason et al. 2011 (BHBs, arbitrary normalization!)
Density Profiles

Deason et al. 2011 (BHBs, arbitrary normalization!)

Broken powerlaws, slope consistent with MW (density slightly lower than solar neighbourhood)

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Metal Distribution

Fraction younger than \{\text{age}\}

Enrichment of halo (Z) comparable to bright satellites
Age comparable to faint satellites

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Flat Haloes

All sky projection, galactic coordinates, \( R = 8 \) kpc

Distance to halo stars

Minor axis of dark halo

'Galactic Plane'

kpc
Flat Haloes

All sky projection, galactic coordinates, $R = 8$ kpc
Lumps in the Halo

4d correlation functions of SDSS BHB stars and mocks from model stellar haloes (AC et al. 2011, MNRAS: also Xue et al. 2011)

Too much structure in the models
Some models agree
Most models agree
Lumps in the Halo

4d correlation functions of SDSS BHB stars and mocks from model stellar haloes (AC et al. 2011, MNRAS: also Xue et al. 2011)

Helmi, AC et al. 2011
RMS of MSTO stars/average count, per sq. degree

10-20% extra smooth component

Too much structure in the models
Massive galaxies and groups

$log(M_{\text{sun}}) = 11$

$log(M_{\text{sun}}) = 11.6$

500x500 kpc
Massive galaxies and groups

500x500 kpc

log(M_{\odot}) = 11

log(M_{\odot}) = 11.6
Massive galaxies and groups

500x500 kpc

$r_e = 3 \text{kpc}$

$r_e = 10 \text{kpc}$

$\log (\text{stellar mass})$

$\log (\text{Msol kpc}^{-2})$

$\log (\text{r/kpc})$

$\log (\text{M}_{\odot}) = 11$

$\log (\text{M}_{\odot}) = 11.6$

$\log (\text{M}_{\odot}) = 11.5$

$\log (\text{M}_{\odot}) = 11.0$

$\log (\text{M}_{\odot}) = 10.5$

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Summary

- Differences in the accretion histories of galaxies are reflected in their stellar haloes. CDM galaxy formation models make explicit predictions.

- MW-like haloes are dominated by stars from 1-5 massive progenitors. Halo to halo variations are substantial: models seem consistent with the MW and M31 but larger observational samples required.

- Global metallicity gradients are flat. On average halo stars are older than surviving satellites but just as metal-rich.

- The correlated infall directions of satellites flattens the accreted stellar halo, and may confine most halo stars to low heights above the galactic plane.

- The MW halo is smoother than accretion-only simulations for galactocentric distances less than 30 kpc, suggesting an in situ contribution of at least 10-20%.