Satellites in Groups and Clusters with IllustrisTNG: The Coevolution of Dwarf Galaxies and Dark Matter Subhaloes

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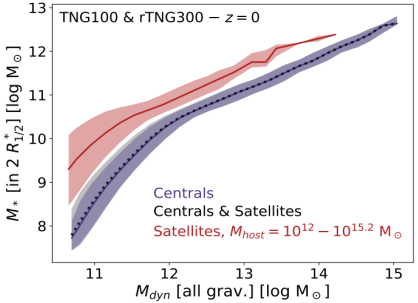
Motivation

The evolution of galaxies and the relation to their underlying dark matter haloes is well established for massive galaxies but remains largely unexplored in the dwarf regime. We study the effects of environment on satellite populations in TNG100 and TNG300 located within the virial radius of group- and cluster-like hosts and analyse the stellar-to-halo mass relation (SHMR) for centrals, satellites in groups and clusters, and subpopulations of satellites as a function of environment. How different is the SHMR for centrals and satellites? How do deviations depend on environmental properties such as host halo mass, the satellites' location inside the host halo, or time of infall?

Stellar-to-Halo Mass Relation



We study the stellar-to-halo mass relation for centrals and satellites in TNG100 and TNG300. To account for resolution effects, stellar masses in TNG300 have been rescaled to TNG100.

When galaxies cannot be separated into centrals and satellites, satellites contribute to the perceived galaxy-to-galaxy variation.

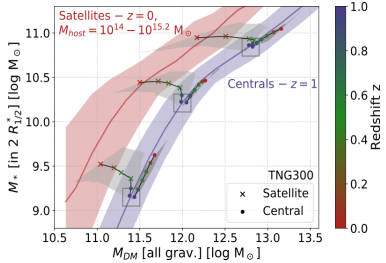
However, at fixed stellar mass, the SHMR of satellites is shifted systematically to lower total dynamical mass.
Satellites form their own SHMR due to the impact of their environment.

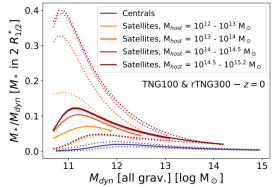
Tidal Stripping vs Quenching

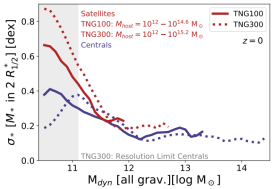
Select centrals at z=1 and follow dark matter and stellar mass to z=0 – depending on whether they stay centrals or become satellites.

Centrals
Evolution along their original SHMR: growth in dark matter and stellar mass.

Satellites
Ongoing star formation followed by quenching and a significant degree of tidal stripping of their dark matter subhaloes after infall into the new host potential.







The shift of satellite and central SHMR increases in more massive host environments:

$M_{host} = 10^{12} - 10^{13}$ M$_\odot$: **0.55 dex**

$M_{host} = 10^{14.5} - 10^{15.2}$ M$_\odot$: **0.78 dex**

The SHMR scatter also increases with host mass.

The scatter in stellar mass as a function of dynamical subhalo mass increases significantly towards the low mass end, but becomes constant for more massive subhaloes with $M_{dyn} > 10^{12}$ M$_\odot$

Environment

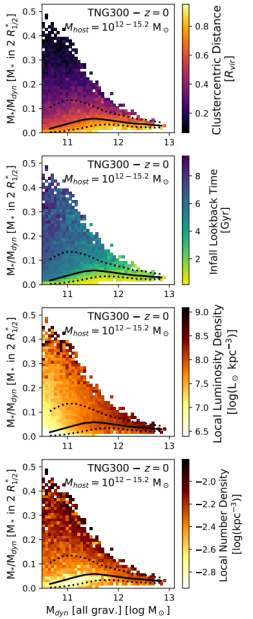
We classify environment using various parameters:

Clustercentric Distance
Distance to the host halo's central galaxy

Infall time
Infall through the virial radius R_{200c} of the satellites' present-day host

Local Luminosity Density
r-band luminosities of surrounding galaxies within a sphere with a radius of 10% of the host halo's R_{200c}

Local Number Density
Distance to the 10th nearest neighbour as radius of the sphere of influence



The SHMR shift to higher stellar fractions is larger for satellites at smaller clustercentric distance, with earlier infall, and in regions of overall higher local density.

TNG100 and TNG300 are publicly available on:
http://www.tng-project.org/

Marinacci+2018, MNRAS, 480, 5113
Naiman+ 2018, MNRAS, 477, 1206
Nelson+ 2018, MNRAS, 475, 624
Pillepich+ 2018a, MNRAS, 475, 648
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