Hunting Galaxies with Centaurus A

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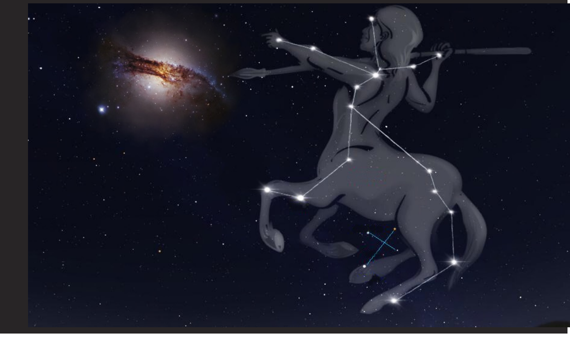

Introduction

Small faint galaxies are known as Dwarf galaxies. They are the building blocks of larger galaxies. Shallow gravity wells makes them sensitive to environmental effects. To understand how dwarf galaxies form and evolve, we must study their formation, evolution and fate in a range of environments. **Recent surveys** (Panoramic Imaging Survey of Centaurus and Sculptor - PISCeS and the Survey of Centaurus A's Baryonic Structures - SCABS) are building the first complete census of the dwarf satellites of Centaurus A. **We model the dwarf satellite populations of Centaurus A** using N-body simulations and the semi-analytic model (SAM) Galacticus (Benson, 2011).

Simulation

We use an existing high resolution gravitational **N-body simulations of Centaurus A analog** run from 100 million years after the Big Bang to the present day using Gadget 2 (Springel, 2005). Isolated Cen A of 10^{13} solar mass is selected within a region 3 Mpc with no massive halos greater than 10^{12}. This galaxy is 10 times more massive than the Milky Way. The simulation was initially analyzed as part of Bovill et al. 2016. Halo properties were analyzed using AMIGA (Knollmann & Knebe 2009) halo finder and merger trees were generated through Consistent trees (Behroozi et al. 2013).

Dwarf galaxies of the Milky Way

We constrain Galacticus to match the properties and evolution of the Milky Way satellites (Weerasooriya et al. in prep).

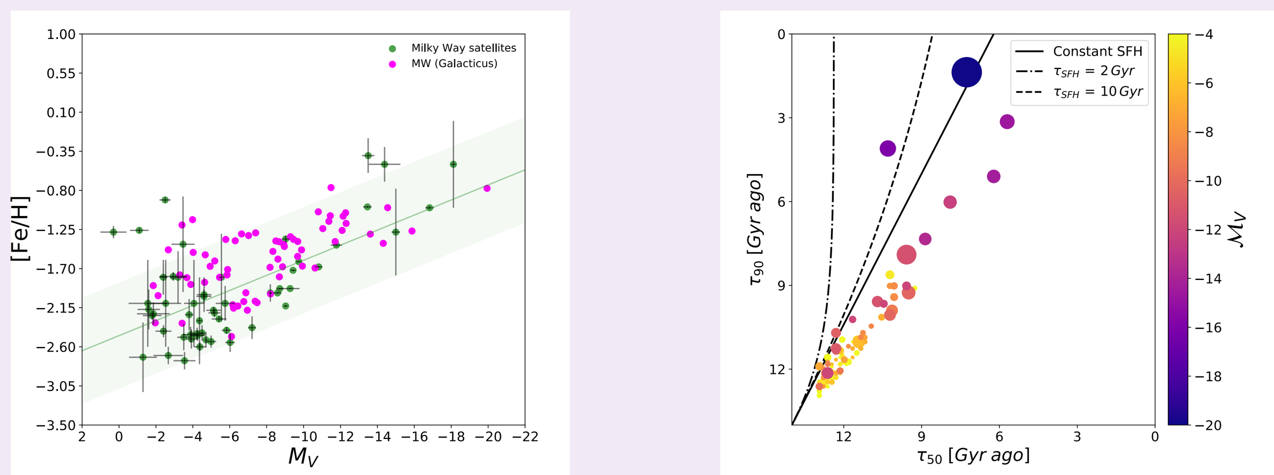

Figure 1: **Cumulative luminosity function of the Milky Way Dwarf satellite galaxies.** M_V denotes the absolute V band magnitude and $\mathcal{N}$ denote the number of galaxies with $\leq M_V$. Green dashed line shows the observed data from McConnachie 2012. Yellow and orange curves show simulated data from Justice League simulations by Akins et al. 2021. Simulated data from SAM are colored by pink solid line. *We match both hydrosimulations and observations well.*. **Metal content of the dwarf satellite galaxies as a function of absolute V band magnitude.** Observed data from McConnachie 2012 are colored in green and simulated data are colored in pink. We calibrate the SAM for the luminosity metallicity relation. Stellar metallicities of the simulated dwarfs match well with observations down to the Ultra-Faint galaxies. *Reproduces observed metal content for dwarfs*

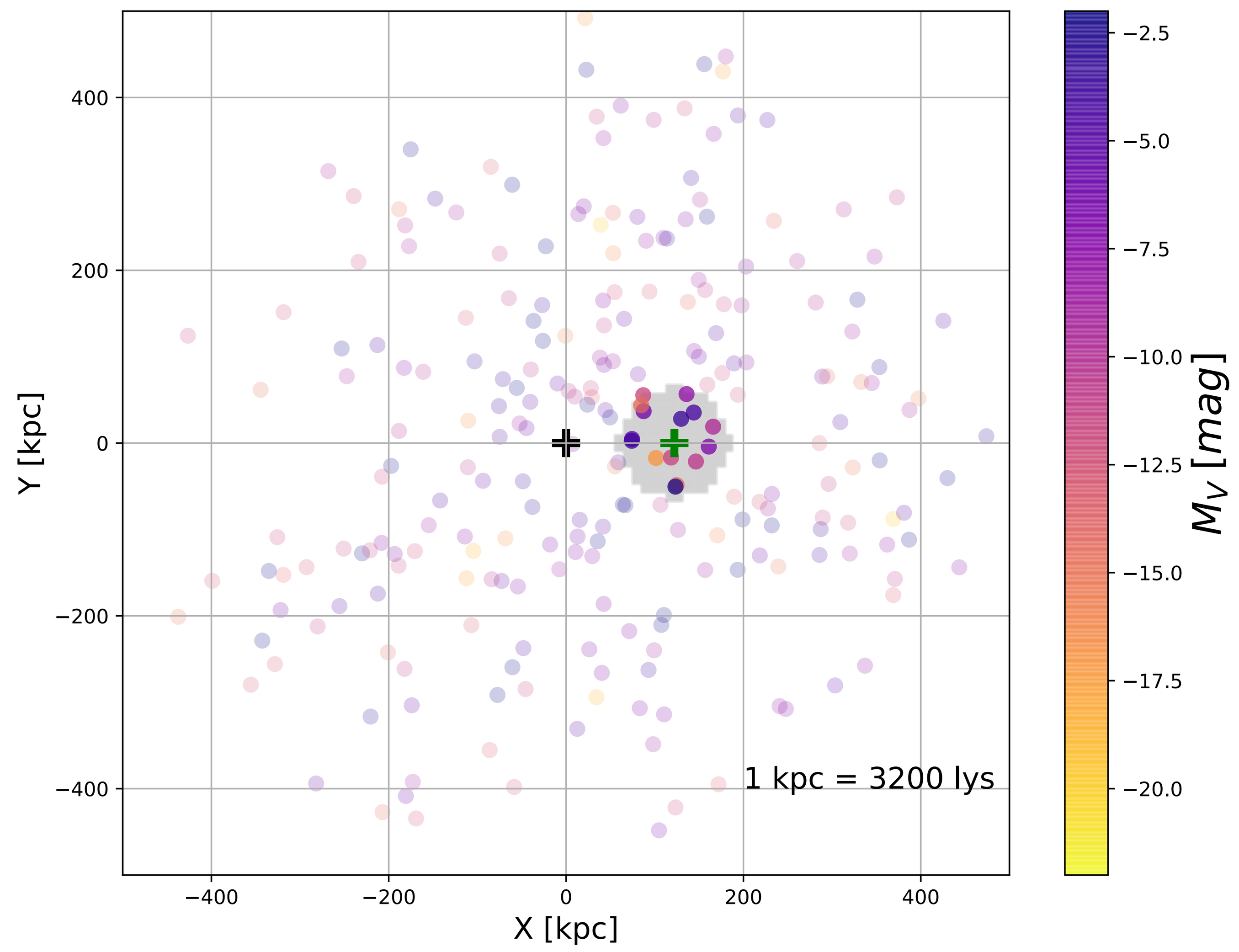

Figure 2: This figure shows **all the satellites around our Cen A analog projected into x-y plane.** All distances are in kpc (1 *kpc* $\sim$ 3200 lyrs).The shaded grey region shows the area of the Dark Energy Survey Camera assuming Cen A is at a distance of 3.5 Mpc. To compare to Taylor et al. 2018 which included dwarfs in only one DECam pointing, only consider dwarfs within this area. Since the direction of x-axis is arbitrary we build our statistics by rotating all the satellites in the counter clockwise direction in 10 increments.

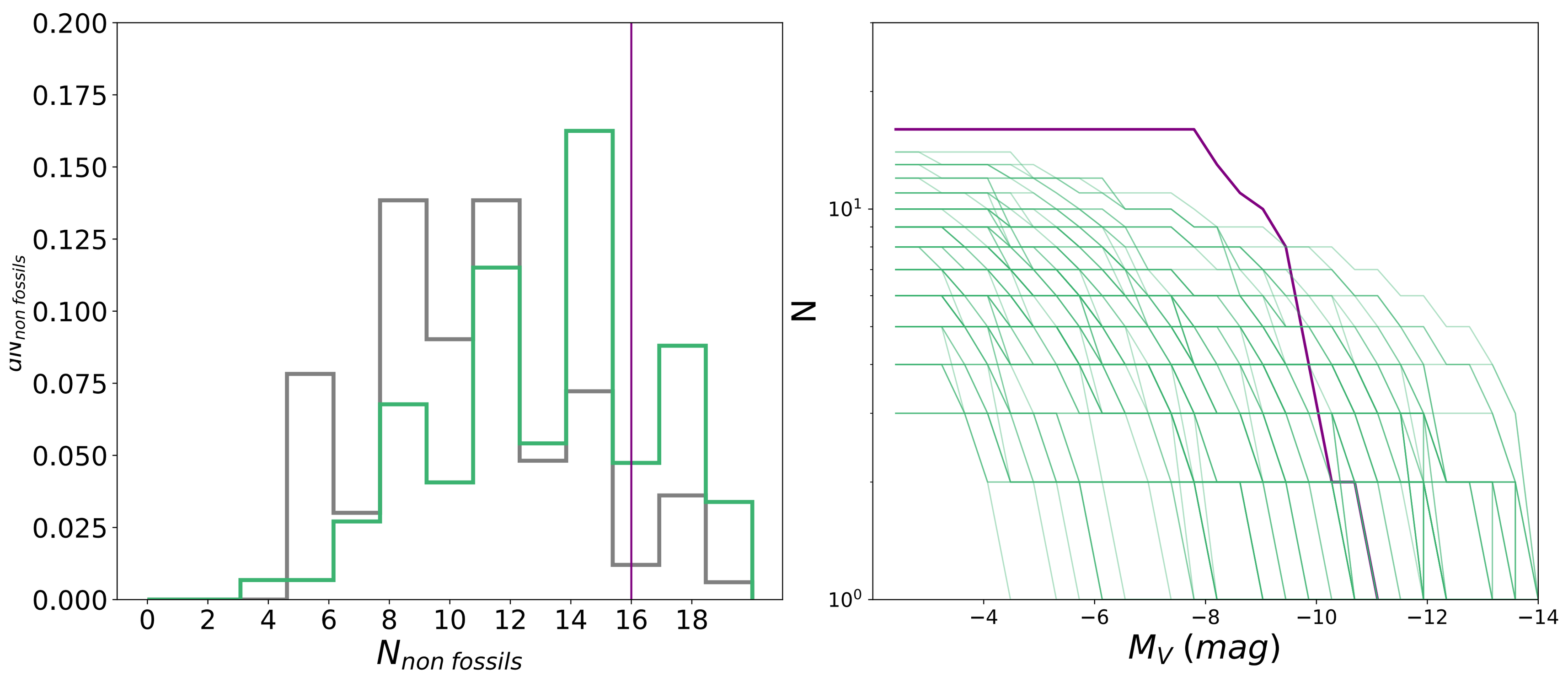

Figure 3: **Left panel: The number of dwarf satellites in a DECam pointing.** The green histogram shows the distribution of the number of luminous dwarf satellites in a single DECam pointing. The grey histogram shows the distribution of the number of more massive dark matter subhalos within the same DECam pointings. We expect all of these massive subhalos to be luminous. Purple vertical line shows the number of luminous satellites observed by Taylor et al. 2018 along tile 4 of SCABS survey. **Right panel: This figure shows luminosity function of dwarf satellites in a single DECam pointing.** The green curves shows the distribution of luminosities for various orientations of our Cen A analog. The purple curve shows the distribution of luminosities for dwarfs in Taylor et al. 2018. Note that while the match between our simulated dwarfs and the observations is reasonable, we do systematically over produce dwarfs at higher luminosities while under producing dwarfs $M_V \geq -10$. *To increase the statistics for both of these curves we have repeated the process from Figure 1 in both x-z and y-z planes.*

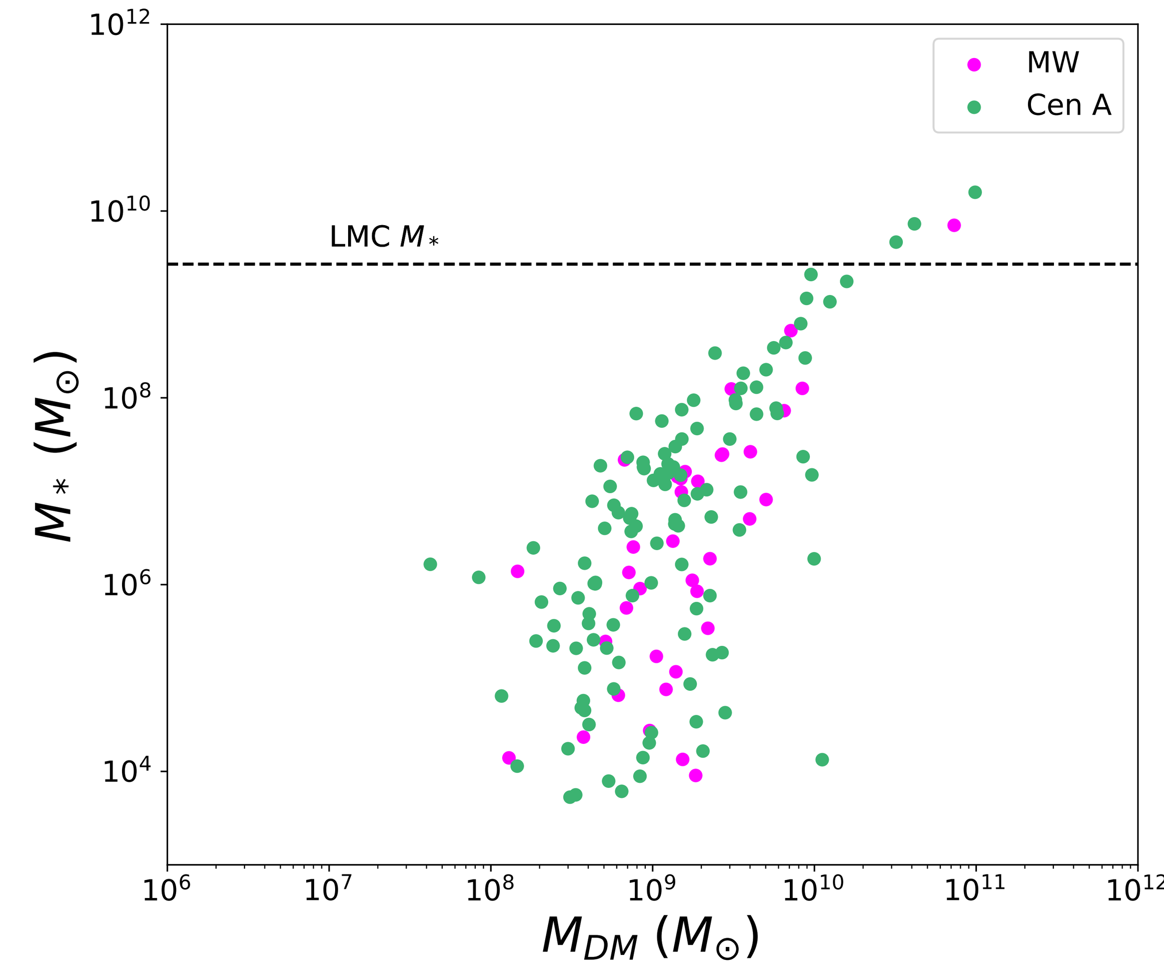

Figure 4: This plot compares the **stellar mass vs dark matter mass of dwarf galaxies in the Milky Way and Centaurus A**. Pink dots shows the Milky Way satellites while green dots shows the Centaurus A satellites. Notice that distributions of both systems are similar indicating that star formation physics are not that different.

Conclusions & Future Work

Our results suggests 2 possibilities.

1.) The simulation does not have enough subhalos.
2.) The specific DECam pointing analyzed in Taylor et al. 2018 may have higher number of dwarf galaxies than the average.

If the DECam pointing in Talor et al. 2018 is typical of the entire Cen A system, then our simulation is not producing enough dark matter subhalos to account for the observed number of dwarfs. Then, the mass of the Cen A halo maybe 2-3 times greater than currently considered. To determine if the second option is true we will compare to other surveys such as PISCeS (, and the dwarf satellites in additional DECam pointings from SCABS (Taylor et al. 2016) as they become available

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Dwarf galaxies are the most abundant type of galaxies in the universe, their sensitivity to local feedback and neighboring galaxies makes them excellent probes of their environments. We model dwarf galaxies around a galaxy far away towards Cenataurus constellation. This work will show us how their star formation physics are similar or different from that of the Milky Way and predict their properties.