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Satellites of dwarf galaxies with the DELVE+ MADCASH surveys :

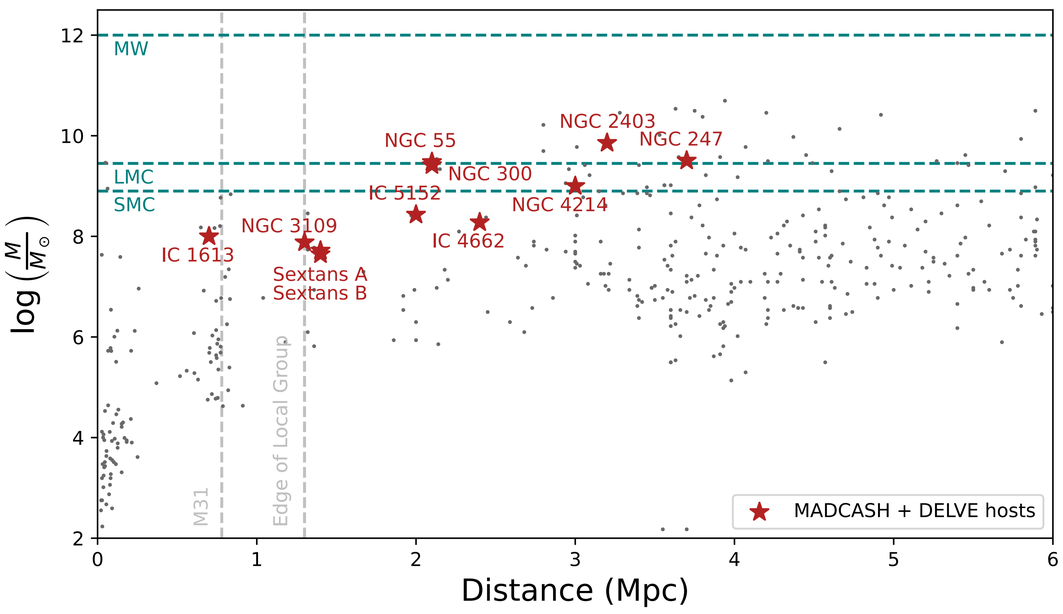
NGC 3109 satellite system

Dwarf galaxies are old, dark matter-dominated objects with low stellar mass. As a result, they are a great test bed for cosmology.

In this work, we are interested in the satellites of dwarf galaxies. Indeed, these sub-MW mass hosts provide a unique opportunity to explore the environments between high-mass hosts and isolated dwarf galaxies. Clear predictions on the properties of satellite systems of LMC-SMC type hosts have been made by ΛCDM (*Dooley et al. 2016, Santos-Santos et al. 2022*), our surveys are designed to test these predictions.

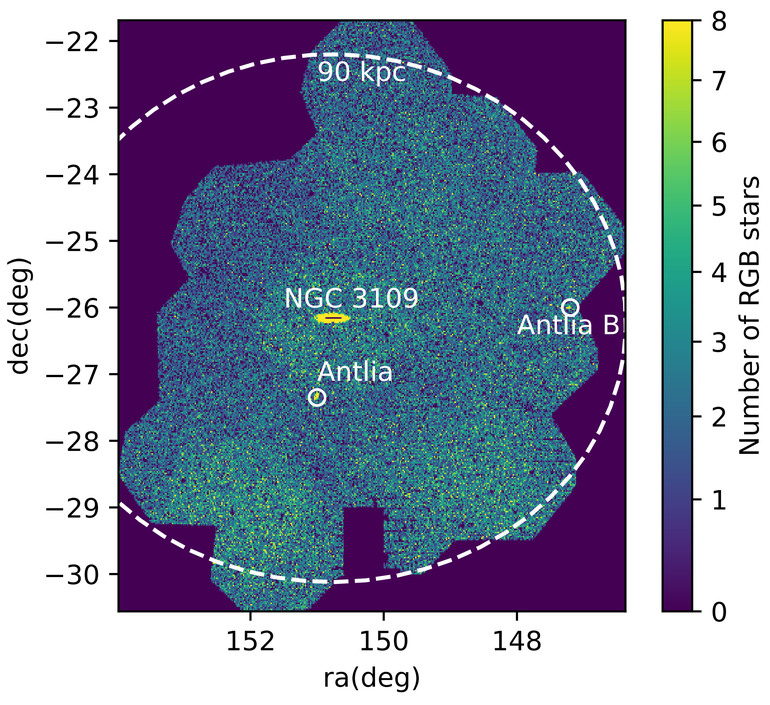
DELVE + MADCASH

The Magellanic Analog Dwarf Companions and Stellar Halos (**MADCASH;** *Carlin et al. 2016*) and the DEEP component of the DECam Local Volume Exploration Survey (**DELVE;** *Drlica-Wagner et al. 2022*) are deep, homogeneous, wide-field photometric surveys that **probe the halos of Local Volume LMC-SMC mass galaxies up to their virial radii**. Using the Blanco 4-meter telescope and the Subaru 8.2-meter telescope, **11 hosts** have been observed, selected to be relatively isolated, within 4 Mpc, and with masses ranging from 1/3 M_{*SMC} to 3 M_{*LMC}. The main goal is to derive the global properties (number of dwarfs and luminosity function) of their satellite system and to explore the implications for galaxy formation & evolution and the CDM framework.



NGC 3109

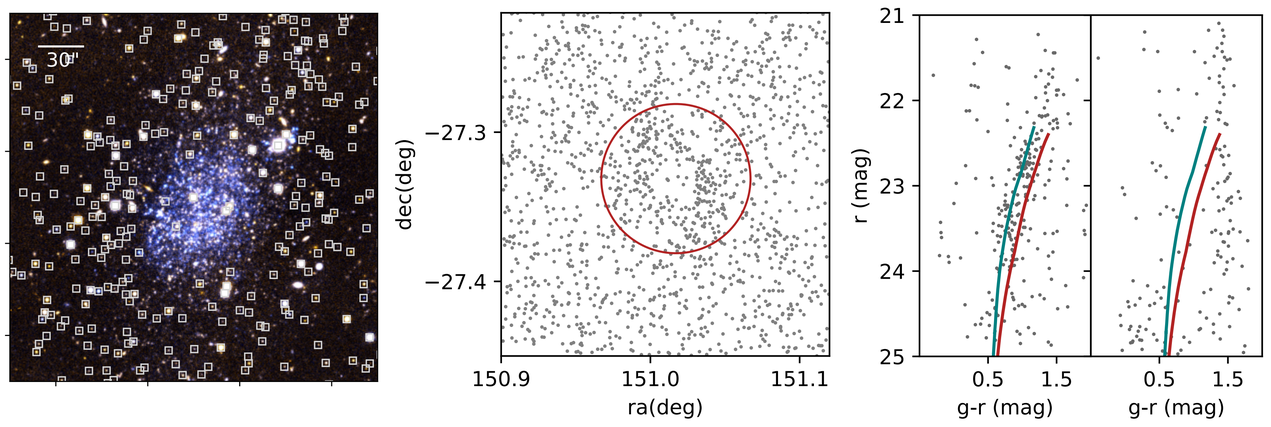
NGC 3109 is a SMC-type host at a distance of 1.3 Mpc. It was observed with the Dark Energy Camera (DECam) on the Blanco 4-meter telescope.
The following figure shows the Red Giant Branch (RGB) star map obtained for the footprint of NGC 3109. Antlia (*Whiting et al. 1997*) and Antlia B (*Sand et al. 2015*), **the two already known satellites of NGC 3109, appear as overdensities**. There are no other obvious stellar structures in the halo.



NGC 3109 dwarf galaxies search

Looking at the first panel of the figure below, which shows the image of Antlia from MADCASH+DELVE, it is interesting to note that the system appears to be **semi-resolved (i.e. a few resolved stars on top of unresolved light).** Since we cannot recover stars in the crowded central regions, and considering the higher photometric uncertainties, the overdensity of RGB stars in the color-magnitude diagram (CMD) and in the sky is weaker. This effect has led to the use of both **resolved (match filter) and unresolved (Sextractor parameter cuts)** searches for dwarf galaxies to achieve maximum efficiency.
These searches recovered both known dwarf galaxies with high confidence, but no other obvious satellites were found.

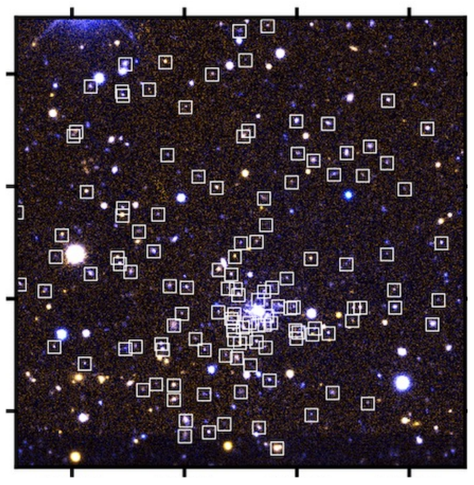
Antlia in DELVE+MADCASH



From left to right : Image, Spatial Distribution, and CMD for the known dwarf Antlia. The resolved stars are marked by white squares in the image. The CMD stars are selected inside the red circle in the spatial distribution. We overlayed Padua isochrones on the CMD (age=10 Gyr and [Fe/H]=-2 -1.4 from left to right; Bressan et al. 2012).

Dwarf galaxies detection limits

To compare the properties of this satellite system to simulations, we must have a great understanding of the **detection limits**. We therefore inject thousands of simulated dwarf galaxies into the images (see image below) and test their detection by the resolved and unresolved search algorithm.



First glance at the simulations

The expectation from the ΛCDM simulation presented in Dooley predicts between 1-5 satellites with $M^*>10^5$ $M_\odot$ ($M_V<-7.5$) around NGC 3109, depending on the stellar-halo-mass relation (or in other words, on the level of feedback included in the physics of galaxy formation and evolution). Considering that our survey is almost complete up to this magnitude, we can confirm that **the number of satellites observed is compatible with the number expected from ΛCDM**.

The DELVE+MADCASH survey provides the first opportunity to robustly characterize the satellite systems of LMC/SMC-type hosts. Resolve and unresolve searches for dwarf galaxies, along with the determination of completeness for 11 hosts, will allow us to use the observations to constrain ΛCDM.

STAY TUNED FOR DELVE+MADCASH RESULTS !

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