

Seeking footprints of the primeval Universe in dwarf galaxies

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Abstract. We present the star formation histories (SFHs) of four isolated dwarf galaxies, Cetus, Tucana, LGS-3, and Phoenix, as a function of galactocentric radius. Our results suggest that beyond some distance from the center, there are no significant differences in fundamental properties of these galaxies, such as the star formation rate (SFR) or age-metallicity relation (AMR). The stellar content of this region would be composed of old ($\gtrsim 10.5$ Gyr) metal-poor stars only. In the innermost regions, dwarf galaxies appear to have formed stars during time intervals which duration varies from galaxy to galaxy. This extended star formation produces the dichotomy between dwarf spheroidal (dSph) and dwarf Transition (dTr) galaxy types.

Keywords. galaxies: dwarf, galaxies: evolution, Local Group.

We present the SFHs of four isolated dwarf galaxies, Cetus, Tucana, LGS-3, and Phoenix, as a function of galactocentric radius. The results are based on the observations of the LCID project (Local Cosmology from the Isolated Dwarfs). The aim of this project is to obtain the full SFHs of six isolated dwarf galaxies of the Local Group: Leo-A, Phoenix, Cetus, Tucana, LGS-3, and IC1613. The global SFHs of these galaxies has been already described in Cole, Skillman, Tolstoy, *et al.* (2007), Hidalgo, Aparicio, Martínez-Delgado, *et al.* (2009), Monelli, Hidalgo, Stetson, *et al.* (2010a), Monelli, Gallart, Hidalgo, *et al.* (2010b), Hidalgo, Aparicio, Skillman, *et al.* (2011), and Skillman *et al.* (2013), respectively. We have selected a subsample of the dwarf galaxies of the LCID project to obtain the SFH as a function of the galactocentric radius: two dSph galaxies, Cetus and Tucana, and two transition (dTr) galaxies, LGS-3 and Phoenix.

For a clearer and more consistent comparison of the results, four of the regions (R1 to R4) were selected in each galaxy. The three innermost ones are such that their equivalent radii approximately correspond to α_ψ (R_1), $1.5\alpha_\psi$ (R_2), and $2\alpha_\psi$ (R_3) where α_ψ is the scale length or the stellar mass distribution of each galaxy. R_4 corresponds to the area outer of $2\alpha_\psi$. This fourth area has not been used in Phoenix due to the low number of stars observed in it (less than 3% of the total).

We have used a CMD fitting technique (IAC-star/IAC-pop/MinnIAC) to obtain the SFHs as described in Aparicio & Hidalgo (2009) and Hidalgo, Aparicio, Skillman, *et al.* (2011). Figure 1 (left panel) shows the SFR as a function of time, $\psi(t)$, of Cetus, Tucana, LGS-3, and Phoenix obtained for the four regions defined above. The SFR has been normalized to its time integral for each region. There is star formation activity in all galaxies for ages $\gtrsim 10$ Gyr, regardless of distance to the center. Interestingly, in the outermost area (R_4) the three normalized SFRs are almost indistinguishable within error bars. However, $\psi(t)$ gradually decreases outwards for ages $\lesssim 9$ Gyr. Few stars younger than this age exist in the R_4 regions, though some stars can still be observed at ~ 3.5 Gyr

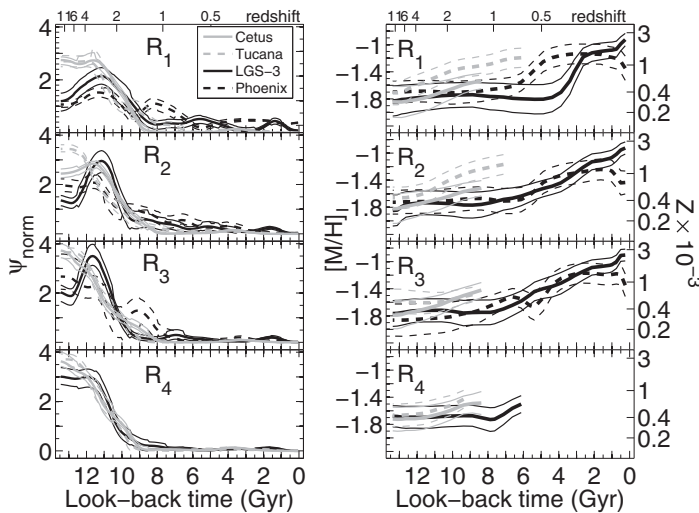


Figure 1. SFHs (left panel) and age-metallicity relations (right panel) as a function of galactocentric radius of four isolated dwarf galaxies of the Local Group.

for Cetus and Tucana and at ~ 1.5 Gyr for LGS-3. These stars have been identified as a population of Blue-straggler stars (BSS) in Cetus and Tucana by Monelli, Cassis, Mapelli, *et al.* (2012). In the case of LGS-3, the expected BSSs may be mixed with some young and intermediate age stellar population, which produces the bump at 1.5 Gyr in $\psi(t)$.

Figure 1 (right panel) shows the AMR for the four regions in all the galaxies (three in the case of Phoenix). The overall trend is that metallicity increases with time. However, in the case of LGS-3 and Phoenix, the metallicity remains almost unchanged for most (LGS3) or half (Phoenix) of the lifetime of the galaxy in the central region. For these galaxies, the AMR relation can be separated into two distinct time periods: a first period involving the older stars where metallicity does not change significantly with time, and a final period where the metallicity increases steeply. The duration of the first period seems a function of radius, decreasing with increasing radius. In contrast, the metallicity of Cetus and Tucana increases steadily with time, showing no trend with radius. As a result, stars between 6 – 10 Gyr old are on average more metal poor in LGS-3 and Phoenix than in Cetus and Tucana.

References

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