The LCID Project: a Comparative Analysis of the Star Formation History of Isolated Local Group Galaxies

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Driving Questions – *) Does any nearby dwarf galaxy show an important delay in onset of the dominant event of star formation?
*) How well did these small galaxies could retain the gas? How important was the SNe feedback?
*) How strong are the environmental effects on dwarf galaxies evolution?

Summary – The Star Formation History (SFH) of nearby Local Group galaxies is a powerful tool for studying the role of reionization in galaxy formation and evolution. In particular, isolated dwarfs are ideal laboratories since their evolution has not been signicantly influenced by the vicinity of giant galaxies. During Cycle 14 a total of 111 HST orbits were secured to observe five isolated dwarf galaxies, namely Tucana, LGS3, IC1613, LeoA and Cetus. The aim of the project is a full characterization of the stellar content of these galaxies, in term of their SFH, radial distributions, halo populations and variable stars. Deep (V~29) F475W, F814W images allowed us to fully sample all the evolutionary phases from the tip of the red giant branch to well below the old Main Sequence Turn Off (MSTO). To complete the sample, we also include WFPC2 data for the Phoenix dwarf galaxy.
We present here a brief summary of the method and results we derived.

The galaxy sample

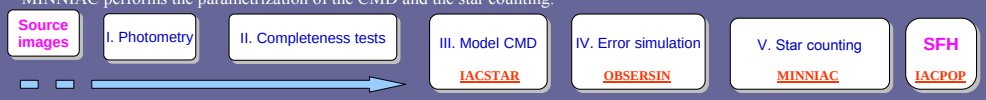
Galaxy	Type	$(m-M)_0$	D(kpc) MW / M31	# Orbits
IC1613	dIrr	24.41	769 / 520	24
Leo A	dIrr	24.50	794 / 1180	16
LGS3	dIrr/dSph	23.98	625 / 270	12
Phoenix	dIrr/dSph	23.30	457 / 610	22_{wfpc2}
Cetus	dSph	24.39	755 / 680	25
Tucana	dSph	24.77	899 / 1340	32

The table reports the galaxies in our sample, their morphological type, distance modulus, distance in Kpc from the Galaxy and M31, and the number of orbits.
Galaxies of different morphological type were selected to have a complete sample. We adopted the F475W and F814W filters, because it was the optimal combination to trace age differences at old ages.
We optimized the large number of orbits assigen to each galaxy for variable stars detection and period estimates (see talk by E. Bernard).

Our method to derive the SFH

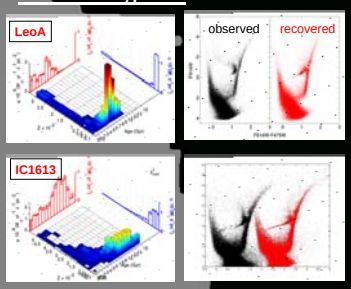
Our method is based on the IACPOP code (*http://www.iac.es/galeria/aaj/iac-pop.htm*). The main points of the software are:
- any SFH can be expressed as a function of two independent variables: age and metallicity
- IACPOP compares the distribution of stars of an observed and a model CMD, therefore the observable is the *number* of stars
- it uses a genethic algorithm for a χ^2 minimization

However, the full process of recovering the SFH of a resolved stellar systems involves many different steps. We developed our own different *independent* packages to cope with the most relevant (see the talk by S. Hidalgo for more details).
IACSTAR is used to create a model CMD, using a variety of different input: stellar evolution library, SFR, binary fraction, IMF…
OBSERSIN uses the information from the completeness tests to reproduce the observational error in the model CMD.
MINNIAC performs the parametrization of the CMD and the star counting.



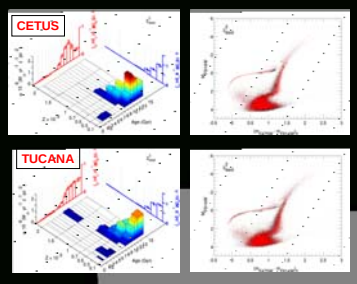
Results

Dwarf Irregulars



Leo A discloses the most interesting SFH in our sample: there is a clear delay in the onset of the main event of SFH: there is evidence of the presence of a small old population (RR Lyrae candidates, Dolphin et al 2003), but the majority of the stars were formed between ~8 and ~6 Gyr ago.
• See Cole et al, 2007, ApJ, 659L, 17
IC1613 could form star at basically all epochs. However, we find evidence for low SFH at very old epoch, with a strong increase and a peak delayed by ~3-4 Gyr. Is this a similar, but much less strong, effect observed in LeoA?

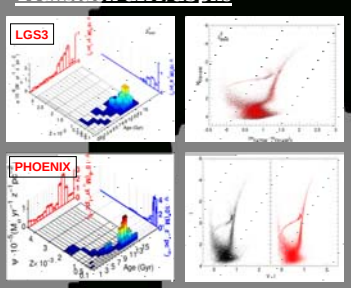
Dwarf Spheroidals



Cetus and Tucana are old and metal poor galaxies. SFH is confined in the first few Gys of life of these dSph.

The figures show the derived SFH (left), represented as a 3-D histogram as a function of age and metallicity, and a comparison (right) between the observed CMD (in black) and the CMD corresponding to our solution SFH (in red). Note the excellent agreement in all the main evolutionary phases.

Transition dIrr/dSphs



Phoenix and LGS3 present a very similar overall SFH: the most important episode of SH occurred at old epochs (>10 Gyr), characterized by a strong event that lasted for ~3Gyr. Both galaxies present a steep decline after the main event, but both systems were able to form star until present epoch

Conclusions

- IACPOP is a flexible code devoted to derive quantitative star formation histories of resolved stellar system
- LeoA is the only galaxy in our sample showing a clear delay in the dominant SFH event