Star formation quenching mechanisms in nearest dwarf spheroidal galaxies: ram pressure and tidal stripping vs. gas depletion

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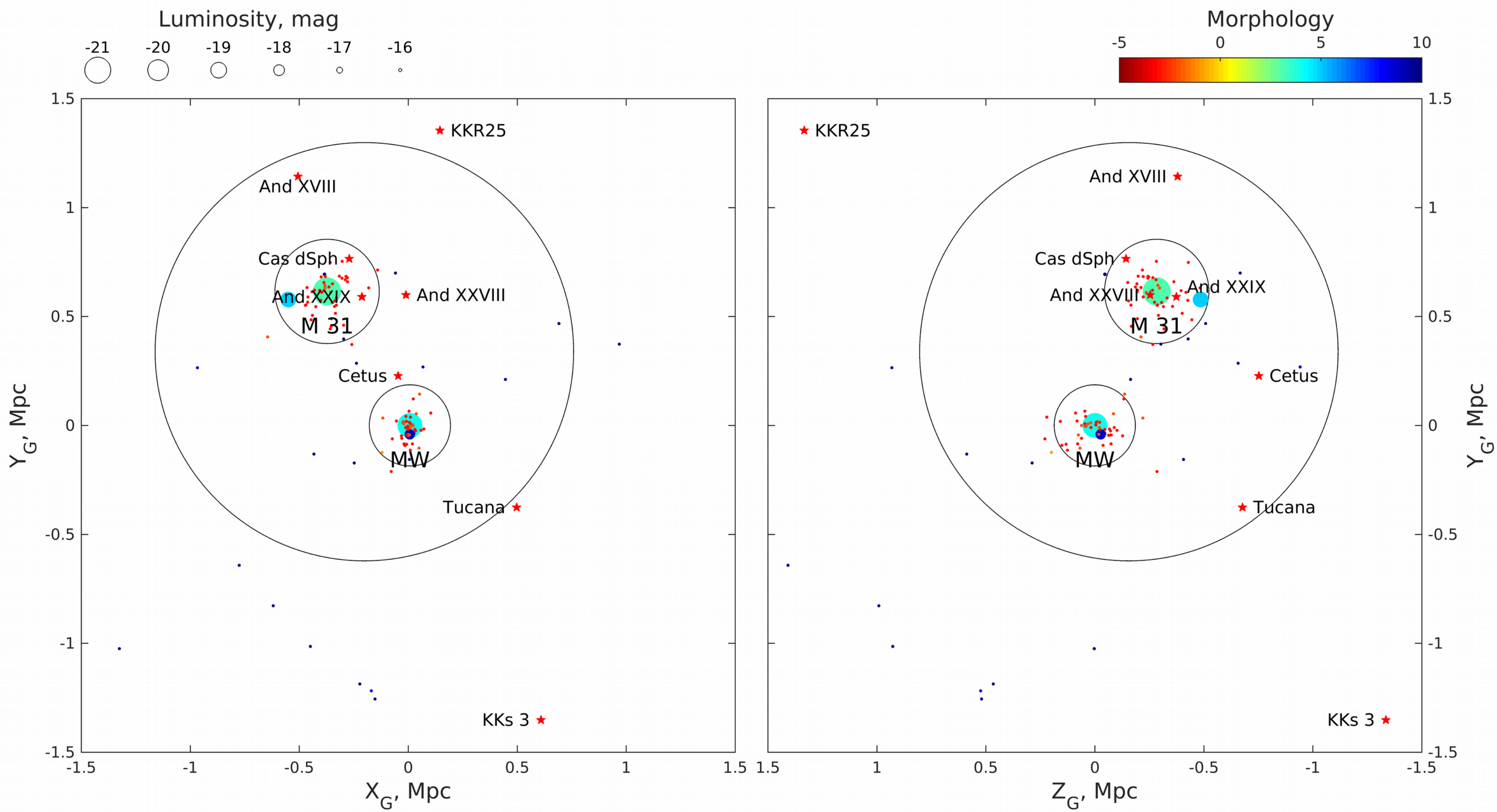
Outline

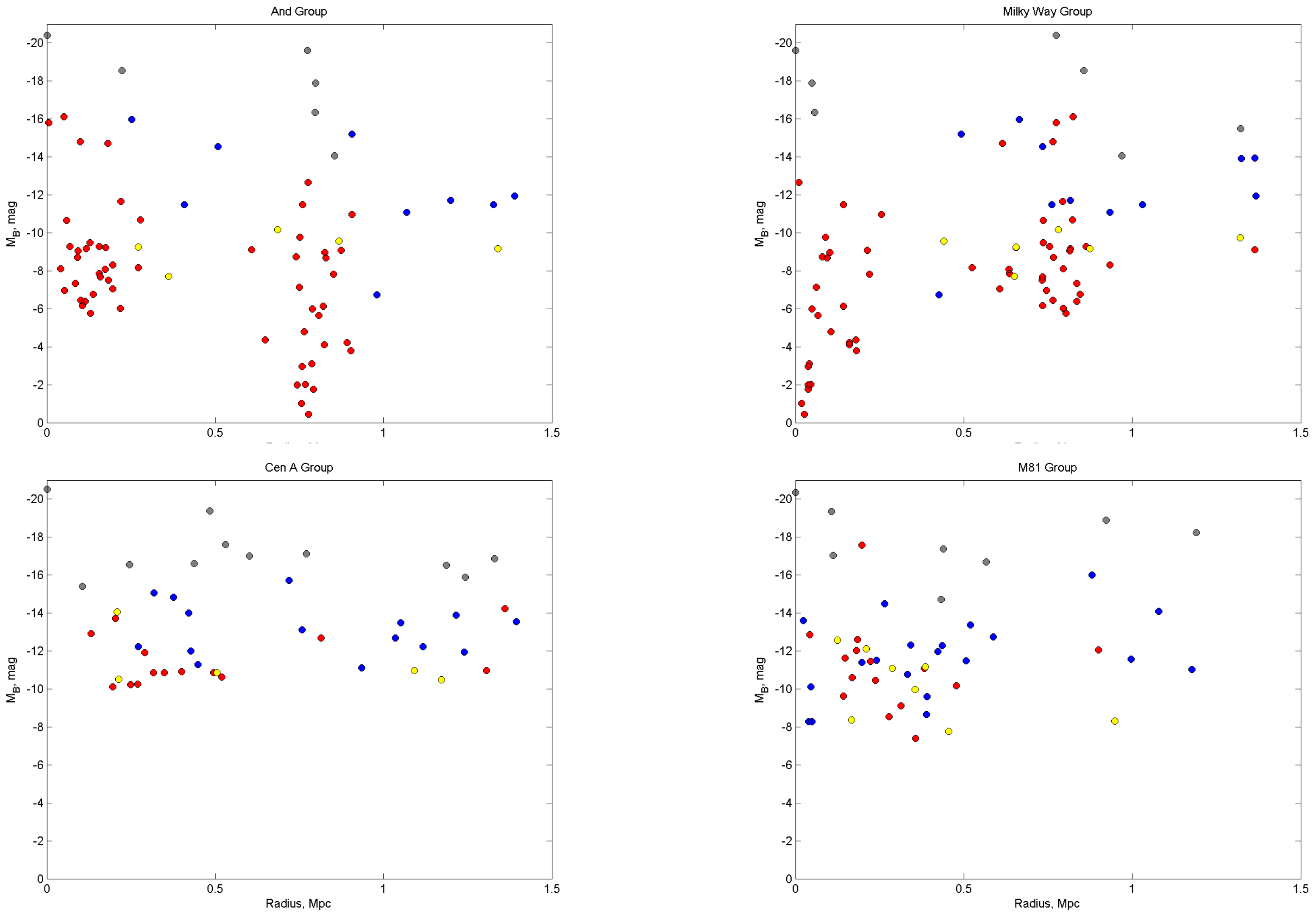
- Dwarf galaxies in our Local Group: morphological types and spatial segregation
- Resolving nearby galaxies into stars: color-magnitude diagram and star formation histories
- Dwarf galaxy sample selection: homogeneous observations and reduction
- Star formation histories of the dwarf galaxies: star formation rate dependence from ages and metallicities of the resolved stellar populations
- Star formation quenching mechanisms in the studied dwarf galaxies: gas depletion, ram pressure and tidal stripping

The Local Group

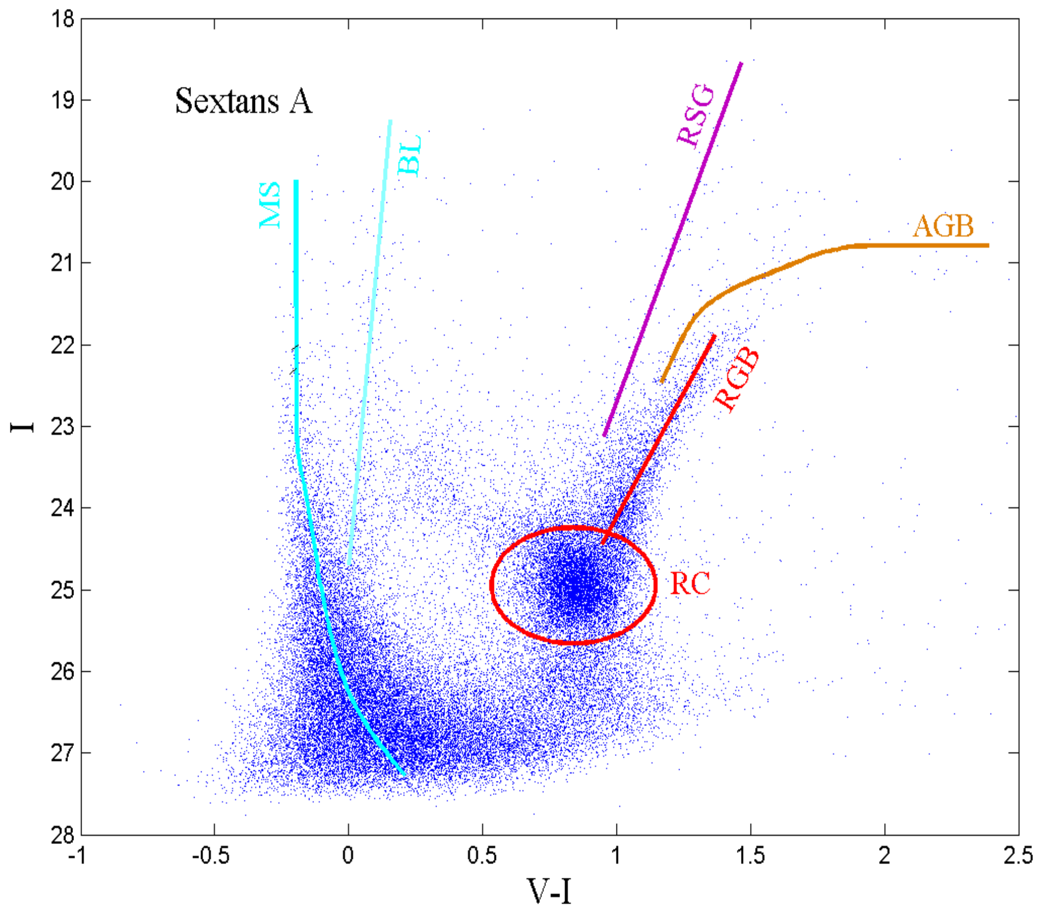


A panorama of the Local Group in the galactic coordinates. The color of a dot represents the morphology of the galaxy according to the colour bar. The size of a galaxy corresponds to its luminosity as shown in the legend panel. The big circle encloses the Local Group shows the sphere of zero-velocity with Ro = 0.96 Mpc (Karachentsev et al. 2009). The small circles around Milky Way and M 31 are virial radii, R_200 , that correspond to masses 0.8×10^{12} and 1.7×10^{12} M⊙ respectively (Diaz et al. 2014).

Morphological segregation of galaxies within the nearest groups



Colour-magnitude diagram



MS – main sequence stars (H burning in core), 10-300 Myr
BL – blue loop stars (He burning out of core), 10-300 Myr
RSG – red supergiants (He burning in core), 10-300 Myr
AGB – asymptotic giant branch, > 1 Gyr
RGB – red giant branch (He burning in envelope), > 1 Gyr
RC – red clump stars

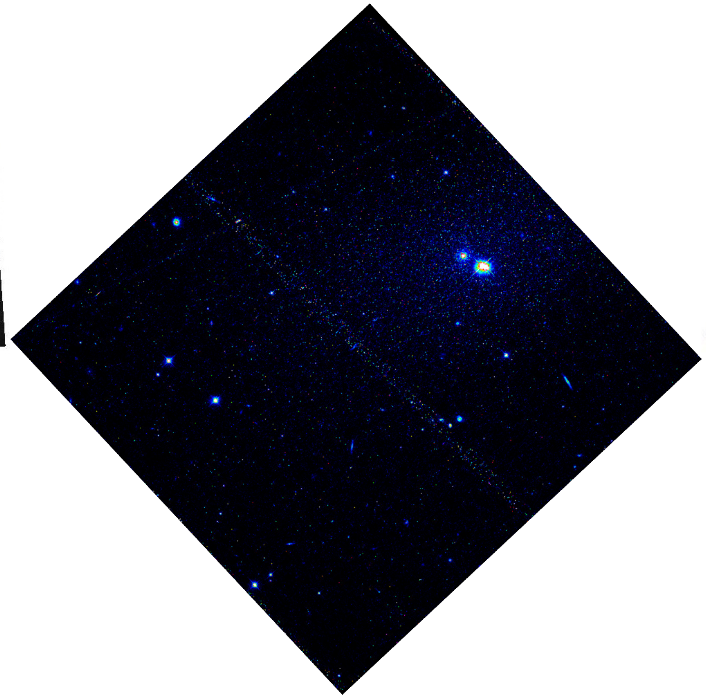
The method

- Quantitative approach to SFH determination: Tosi et al. 1989, Aparicio et al. 1997, Dolphin 2000
- We have created a program StarProbe to analyze our large and homogeneous sample of nearby galaxies (Makarov and Makarova 2004).
- We construct synthetic color-magnitude diagrams from theoretical stellar isochrones taking into account the initial mass function, galaxy distance, external extinction and photometric errors. We use the Padova stellar isochrones set.
- Photometric uncertainties and completeness values were added using results of artificial star tests, that are the accurate way to solve the problems of photometric errors, blending and incompleteness
- A linear combination of synthetic CMDs of different ages and metallicities forms a model CMD
- For SFH determination we have to find a best linear combination of partial model CMDs to match the observed data. We construct a maximum-likelihood function for this task.

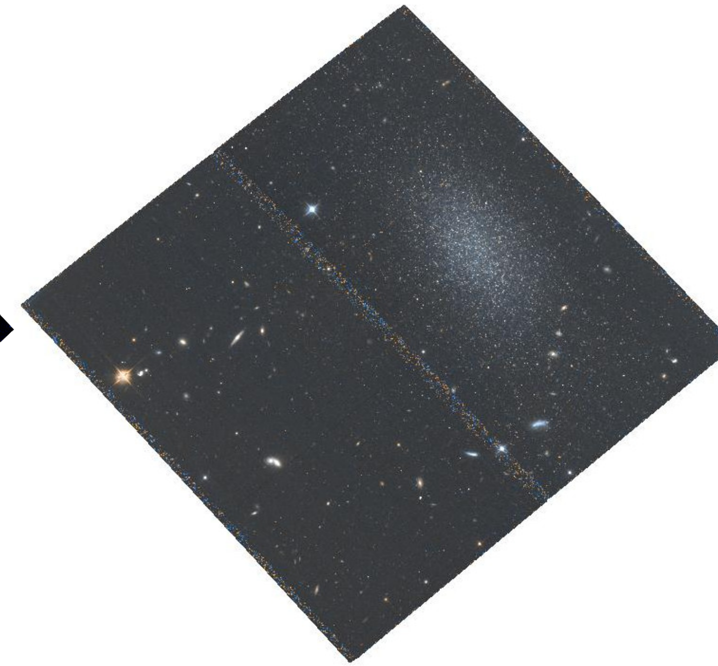
The test sample selection

KKR 25

KKs 03



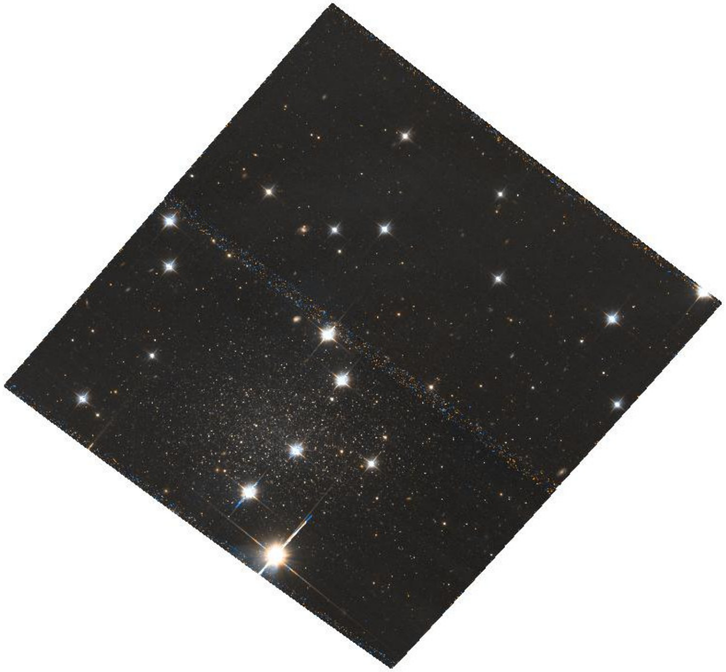
KK 258



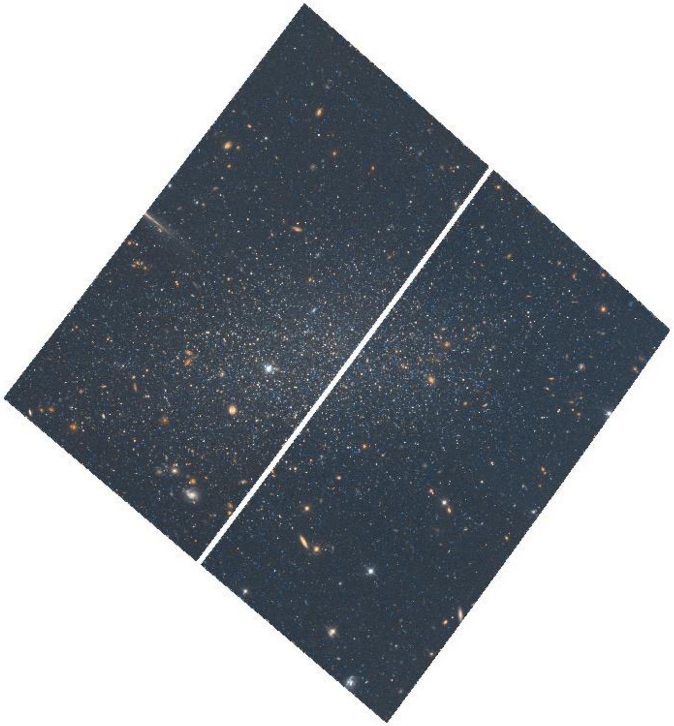
Highly isolated objects studied by us in the framework of our HST/ACS projects + HST/WFPC2 archival data. The selected objects sizes are preferably less than 3 arcmin to fit HST/ACS field of view.

The test sample selection

And XVIII



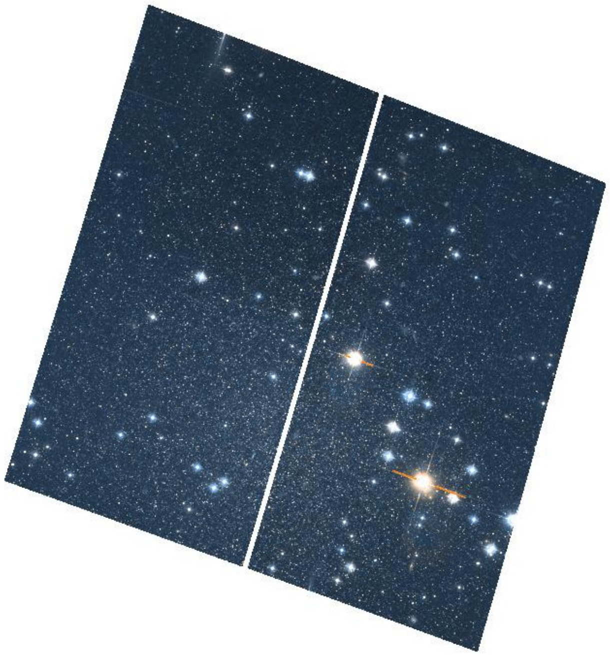
Tucana dSph



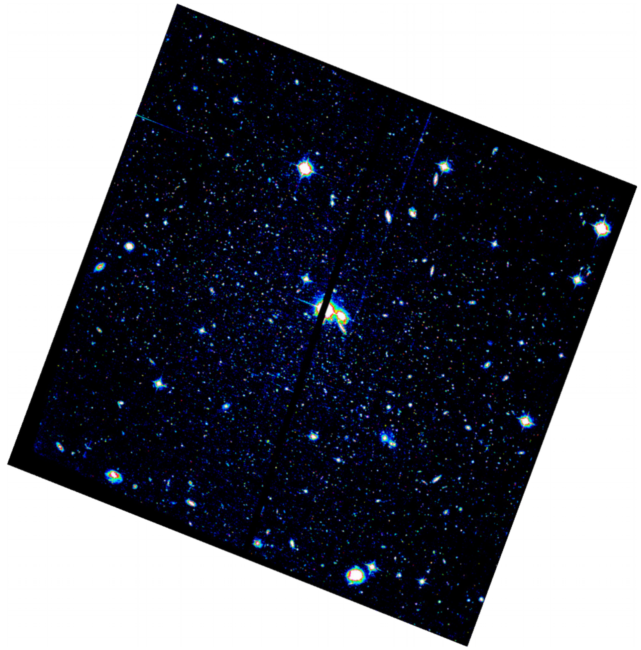
Objects within the Local Group zero-velocity sphere studied by us in the framework of our HST/ACS projects + HST/ACS archival data.

The test sample selection

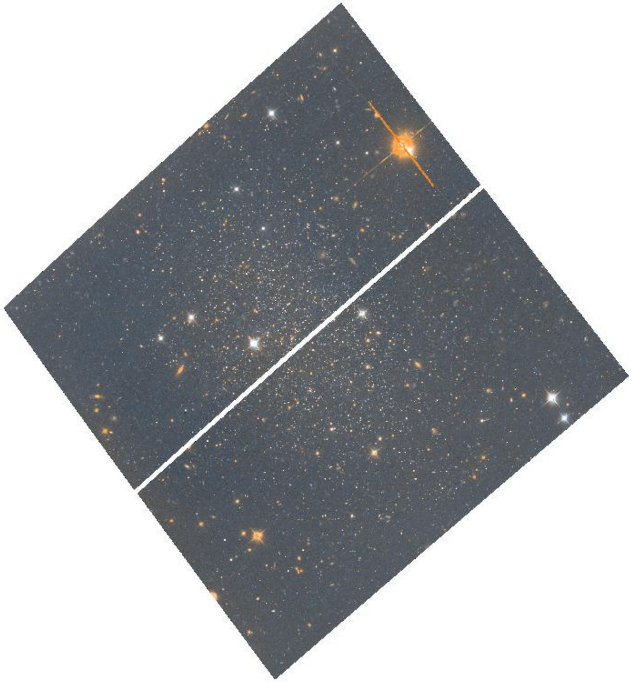
Cas dSph



And XXIX



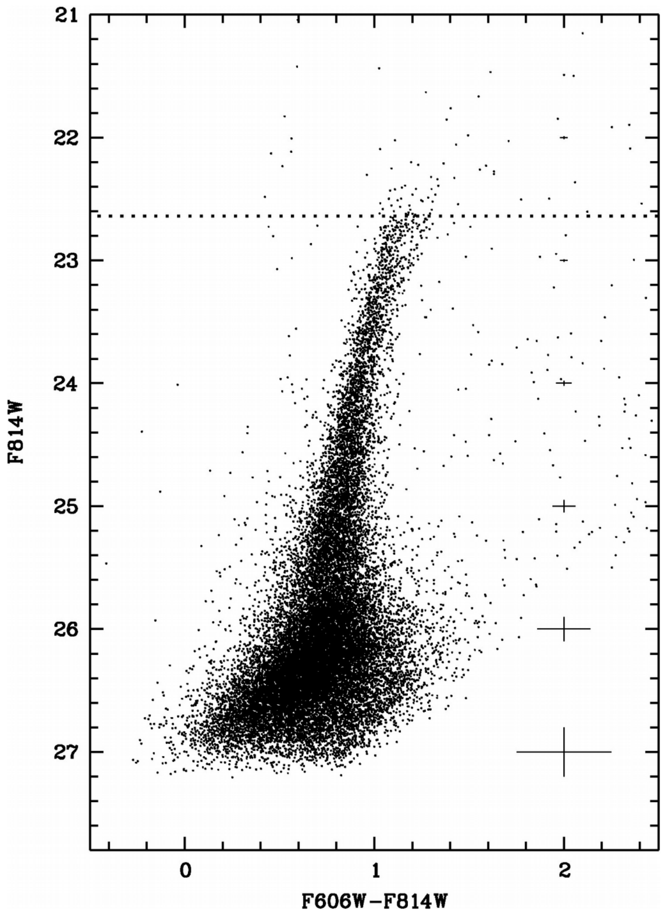
And XXVIII

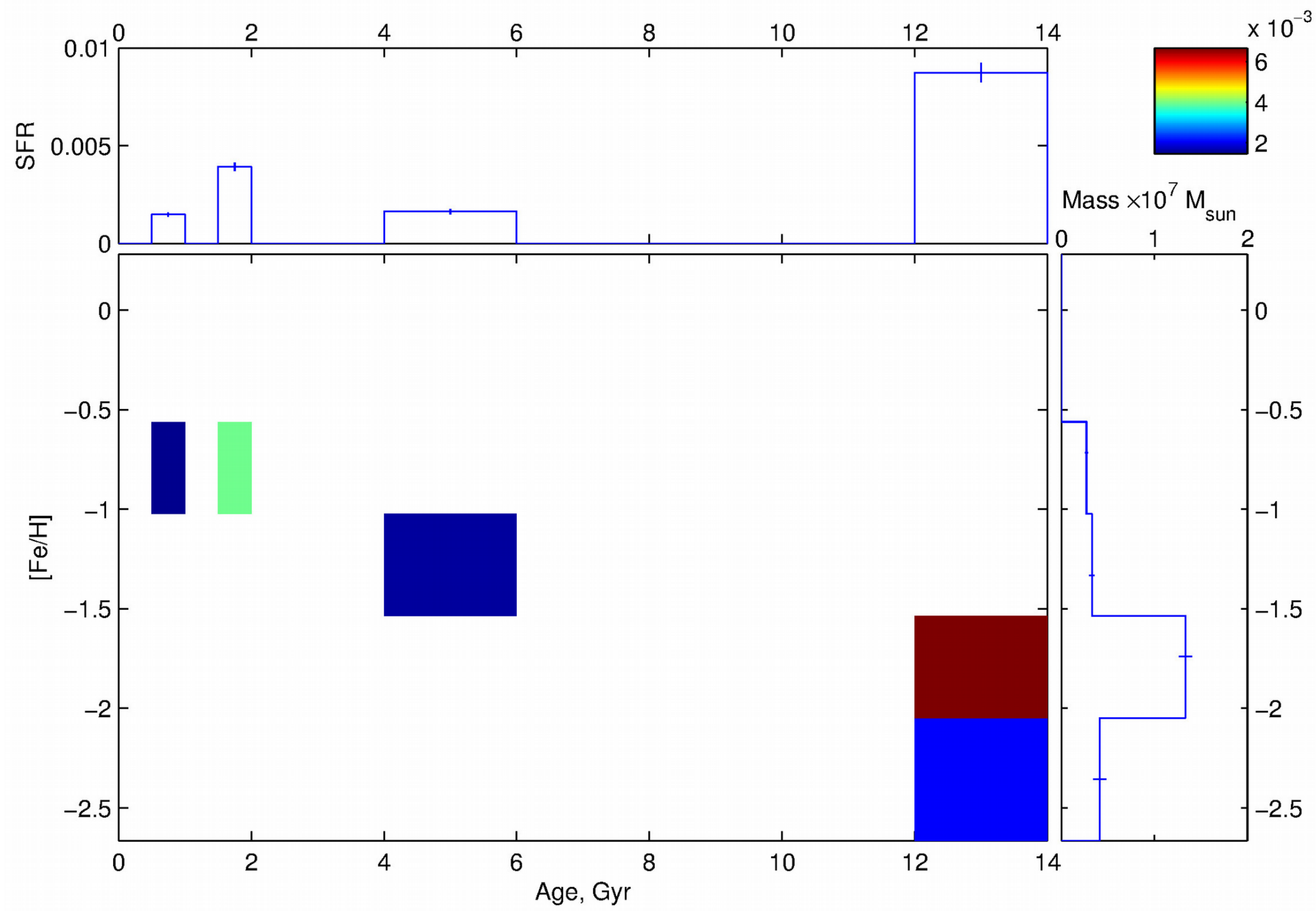


Objects within (or nearly within) the Andromeda virial radius studied by us,
HST/ACS archival data.

SFH reconstruction results: highly isolated objects

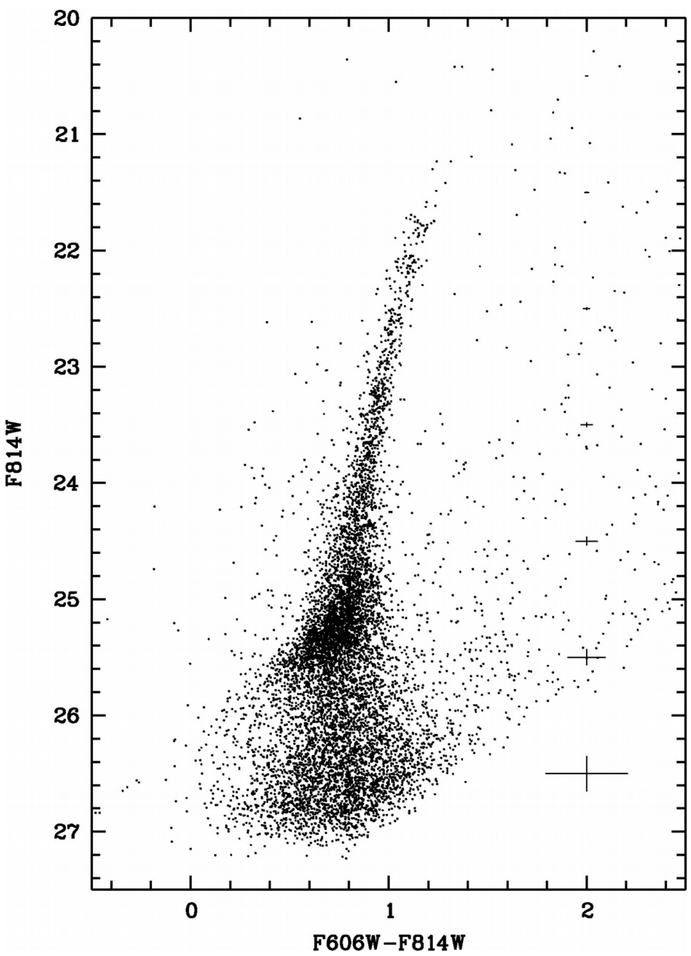
KKs 03

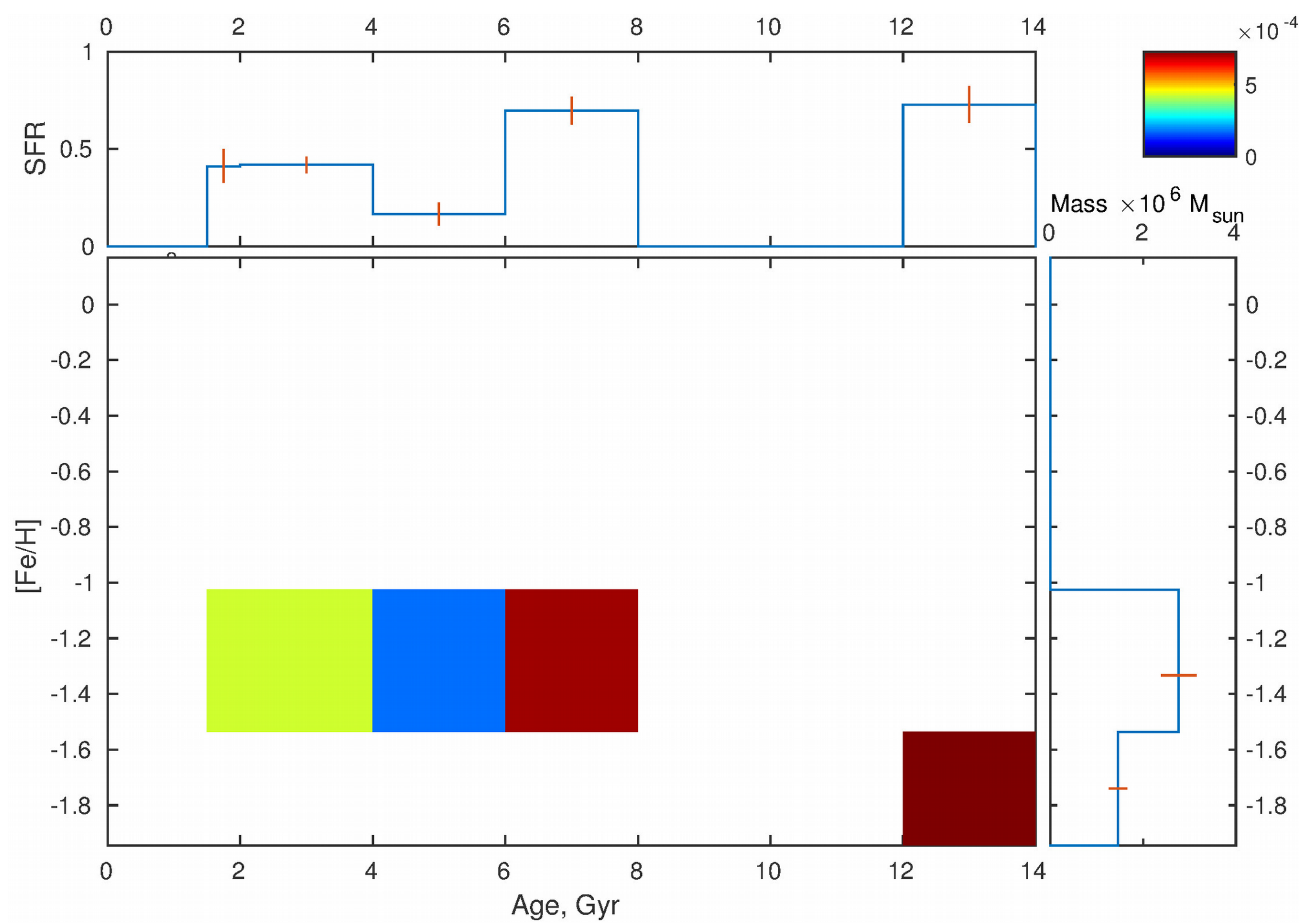




SFH reconstruction results: objects within the LG

Andromeda XVIII

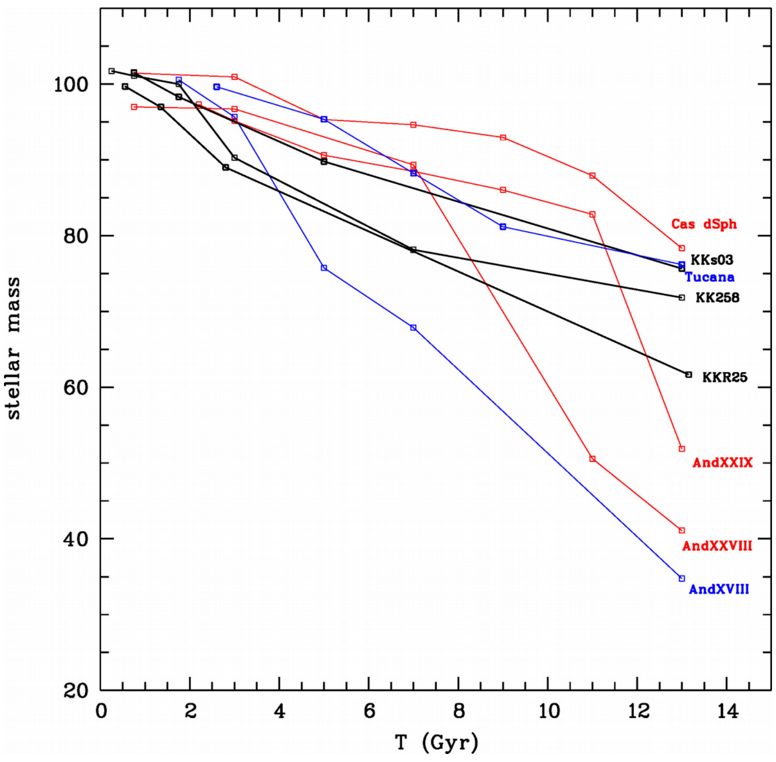


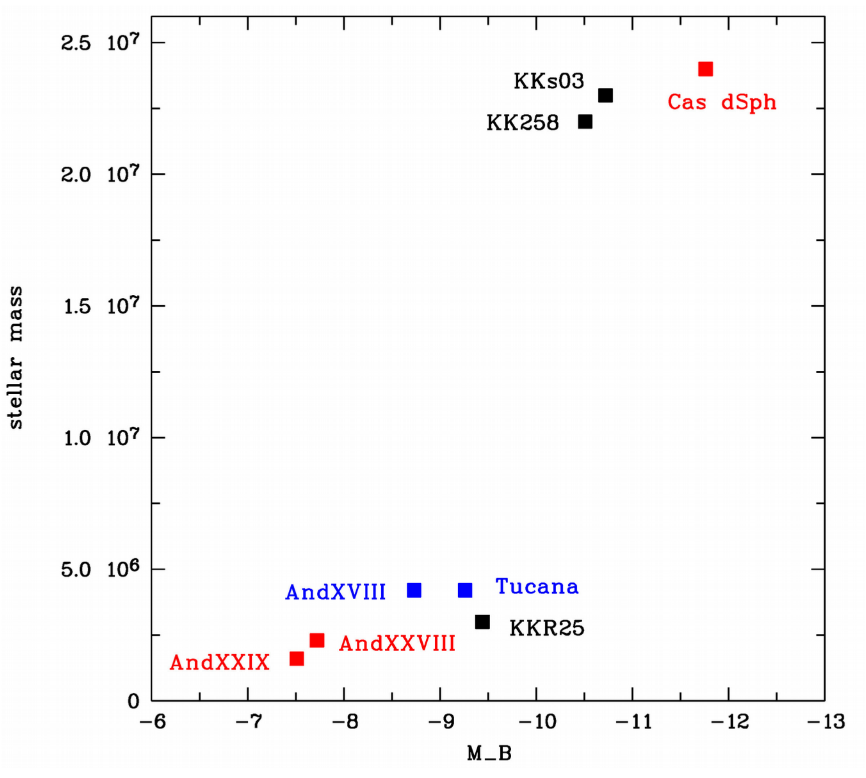


Star formation parameters of the studied galaxies

Name	Type	Distance Mpc	$M^*_{\leq 2\ Gyr}$ %	$M^*_{\geq 8\ Gyr}$ %	M^*_{Total} Msun	SFR≥12Gyr M_{sun}/yr	Source
KKR25	dSph	1.93±0.07	11	62	$3.0*10^6$	$1.7±0.2*10^{-3}$	Makarov et al. (2012)
KK258	dTr	0.84±0.09	11	70	$2.2*10^7$	$7.9±4.0*10^{-3}$	Karachentsev et al. (2014)
KKs03	dSph	2.12±0.07	12	74	$2.3*10^7$	$8.7±0.4*10^{-3}$	Karachentsev et al. (2015)
Tucana dSph	dTr	0.92±0.02	0	81	$4.2*10^6$	$1.6±0.2*10^{-3}$	This work
AndXVIII	dSph	0.58±0.09	5	34	$4.2*10^6$	$7.3±0.9*10^{-4}$	Makarova et al. (2017)
And XXVIII	dTr	0.38±0.09	0	50	$2.3*10^6$	$4.7±1.2*10^{-4}$	This work
Cas dSph	dSph	0.23±0.03	0.5	93	$2.4*10^7$	$9.4±0.8*10^{-3}$	This work
AndXXIX	dSph	0.20±0.02	0	86	$1.6*10^6$	$4.2±1.3*10^{-4}$	This work

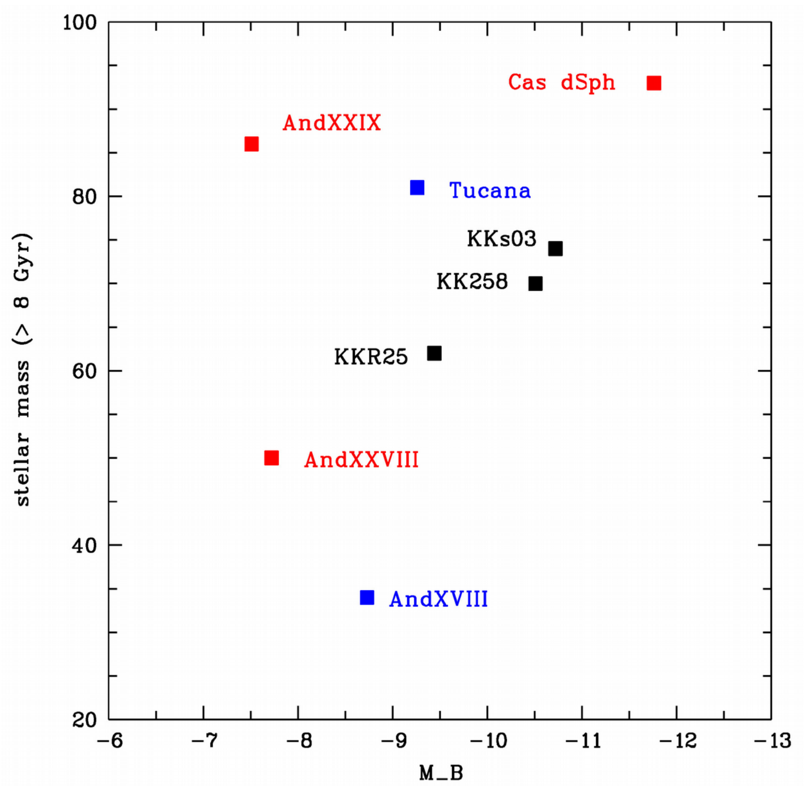
Star formation and evolution of dwarf galaxies

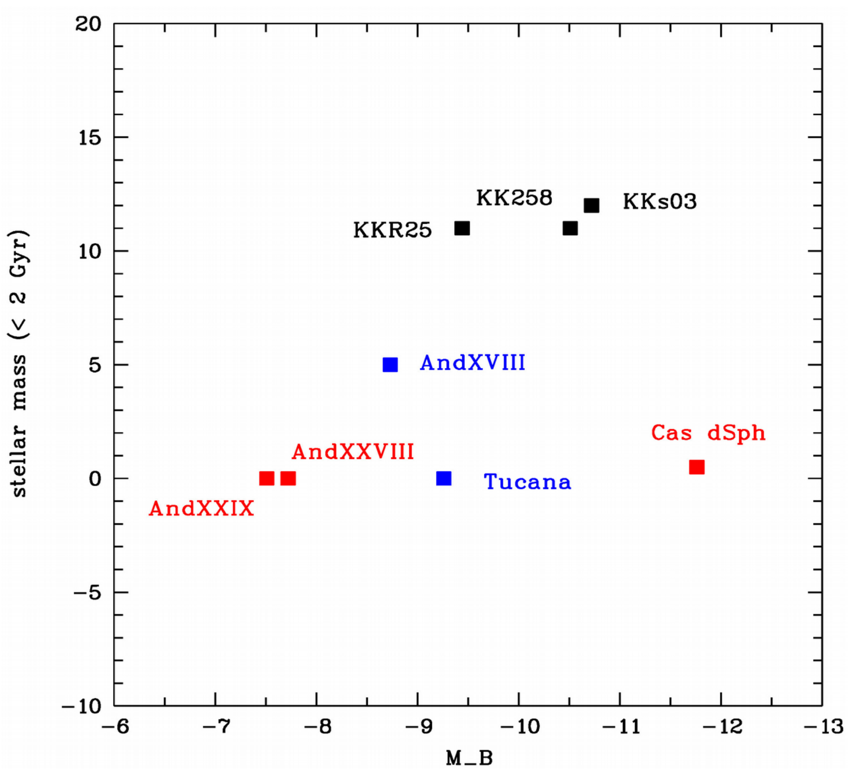




1. The DG with higher stellar mass form bulk of their stars early (intensive star formation)
2. Interactions within the galaxy group can quench SF faster

Star formation and evolution of dwarf galaxies





1. Strong interaction in the past could alter star formation intensity, and galaxy could loss its gas due to ram pressure and tidal stripping effects
2. Highly isolated objects show residual recent star formation clearly

Summary remarks

- We studied an observationally homogeneous sample of dwarf spheroidal galaxies situated within and nearby the Local group
- Highly isolated dwarf spheroidal galaxies were found when its accurate photometric distances were measured
- Quantitative star formation histories were measured using resolved stellar populations of the dSph galaxies with our StarProbe software
- Possible signs of different evolutionary scenario were found in the star formation of the nearby dwarf spheroidal galaxies:

1. The DG with higher stellar mass form bulk of their stars more intensively
2. Interactions within the galaxy group in the past could alter star formation intensity
3. Galaxy could loss its gas due to ram pressure and tidal stripping effects
4. Highly isolated objects show residual recent star formation clearly