Extragalactic Star Clusters and Dwarf Galaxies with *Roman*

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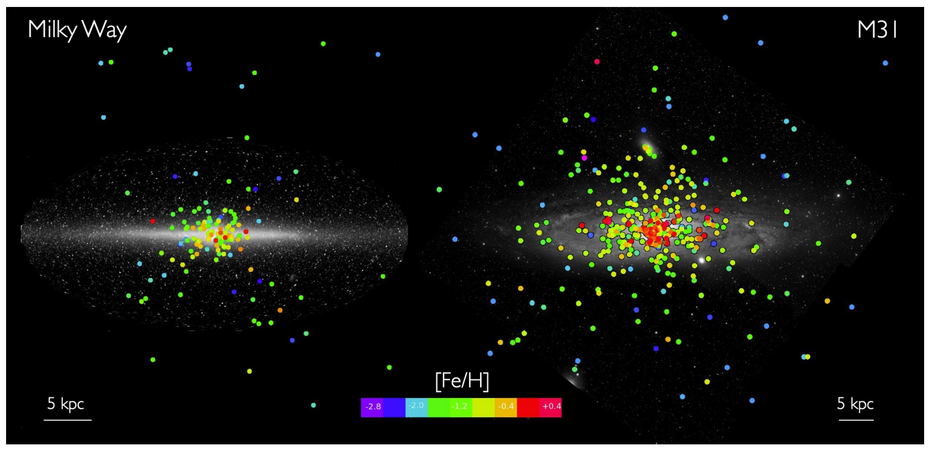
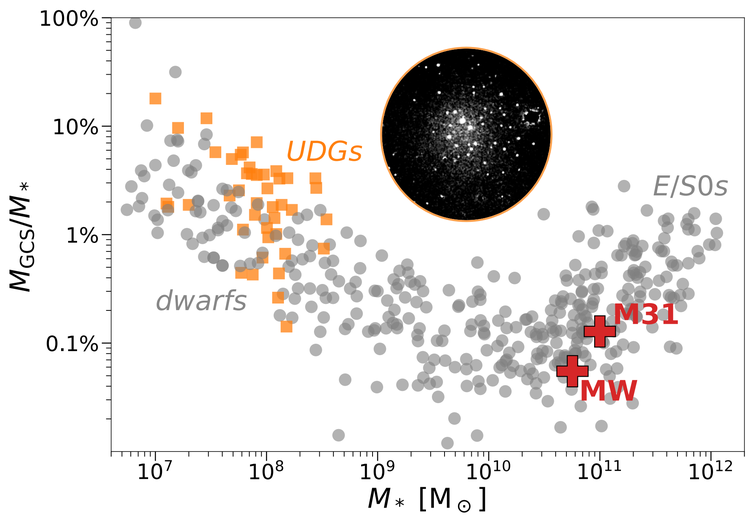
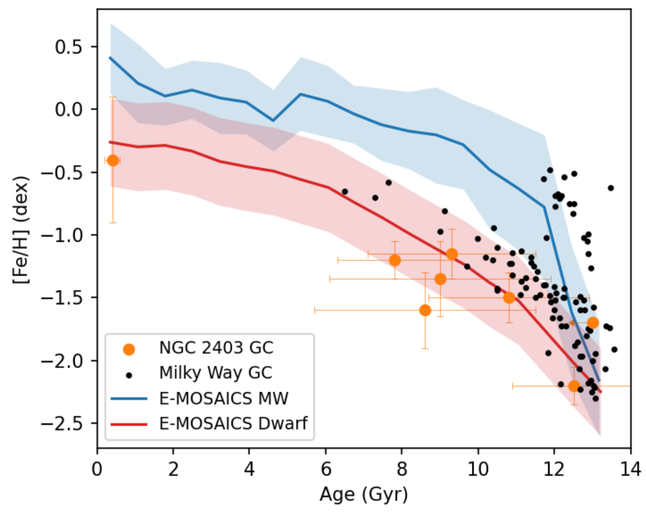
The smallest and faintest stellar systems – star clusters and dwarf galaxies – provide unique constraints on star and galaxy formation and on the nature of dark matter itself. The depth, resolution, field of view, and near-infrared wavelengths of *Roman* promise to open up transformative studies of these objects in the nearby Universe, through discovery and modeling of stellar populations. We present plans for a systematic survey of thousands of low-redshift globular clusters in the core surveys, in synergy with other surveys such as Rubin/LSST, and interpreted though models for galaxy formation. We also showcase results from *Euclid* on nearby star clusters and dwarfs as a preview of the potential of *Roman*.



1. State of the field for extragalactic globular clusters

Globular clusters (GCs) are unique probes of star formation and galaxy assembly, serving both as fossil probes of early epochs and as tracers of later accretion of satellite galaxies. The GC system of the Milky Way (MW) is well studied, but it is likely not representative of GCs around galaxies in general. For example, **on the left** are diagrams of the GC systems of the MW and M31, color-coded by metallicities (Caldwell & Romanowsky 2016). The GC numbers and metallicity distributions are starkly different, suggesting these galaxies represent the extremes of recent merger activity. Relatively little is known about spiral galaxy GC systems beyond the Local Group. **Below center:** fraction of stellar mass in GCs vs. galaxy mass, from dwarfs to massive ellipticals. The variations in this plot are not well understood, including the ultra-diffuse galaxies (UDGs) with high GC mass fractions (see inset *HST* image). However, an unbiased, homogeneous data set is not yet available. **Below right:** metallicity vs. age for GCs around the MW and low-mass spiral NGC 2403. Cures show theoretical predictions, which are generally untested but show some tension with MW observations.





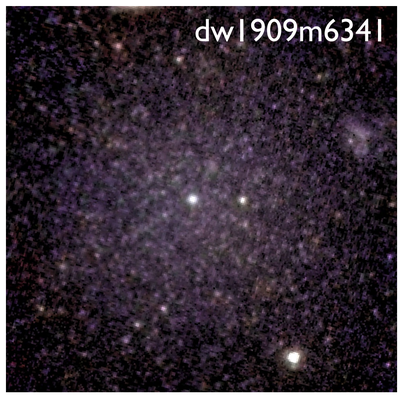
2. New opportunities from space surveys

Euclid and *Roman* will provide transformative gains for studying extragalactic GCs. We will use the *Roman* core surveys (HLWAS and HLTDS) to study thousands of GCs around hundreds of giant and dwarf galaxies in the nearby Universe (Cycle 1 Program ID 19111). Examples of science applications using *Euclid* data (ERO and Q1) are given below – while *Roman* will provided even deeper and higher resolution imaging.

3. Dwarf galaxies in the Local Volume

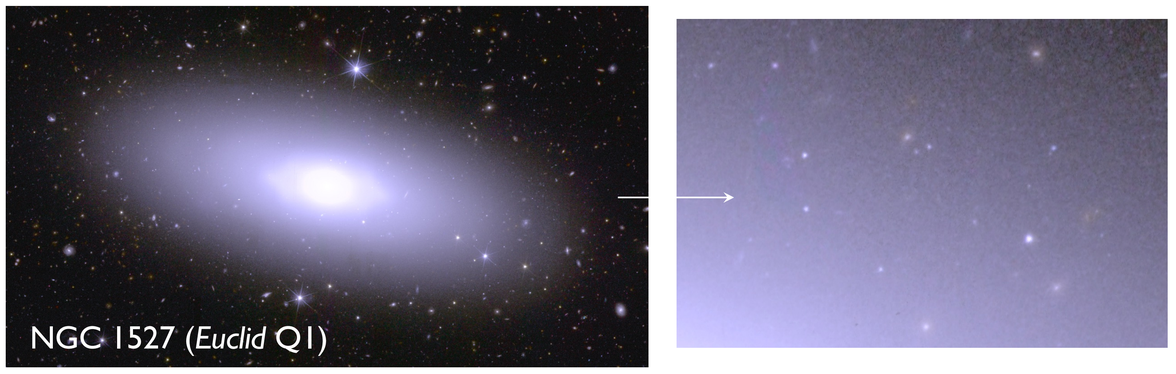
Left: NGC 6822 is a dwarf irregular ($M_\star \sim 10^8$ $M_\odot$) at 0.5 Mpc imaged in *Euclid* ERO (Hunt et al. 2025; Howell et al. 2026). It hosts both classical GCs and mysterious extended star clusters (see thumbnail examples). We are analyzing the stellar populations (ages and metallicities) of the star clusters using SED fitting (optical+NIR) and are checking those against spectroscopic results from the Keck Cosmic Web Imager.

Right: Dwarf galaxy with $M_\star \sim 10^7$ $M_\odot$ newly confirmed around the giant spiral NGC 6744 at 9 Mpc (Hunt et al. 2025) in *Euclid* ERO. Galaxies are clearly resolved into stars at this distance, and both *Euclid* and *Roman* will provide an unparalleled census of faint dwarfs in the Local Universe, with solid distances from TRGB and SBF.



4. Globular clusters around a massive galaxy

The spatial and metallicity distributions of GCs around giant galaxies trace both the accretion histories and the dark matter profiles. **Right:** NGC 1527 (S0 at 17 Mpc) in *Euclid* Q1 imaging, with a zoom-in showing many point sources that are likely GCs. This galaxy will become a benchmark system as it resides in deep fields from *Euclid*, LSST, and *Roman*. Spectroscopic follow-up of its GCs is currently underway with Gemini/GMOS (Chies-Santos et al.).



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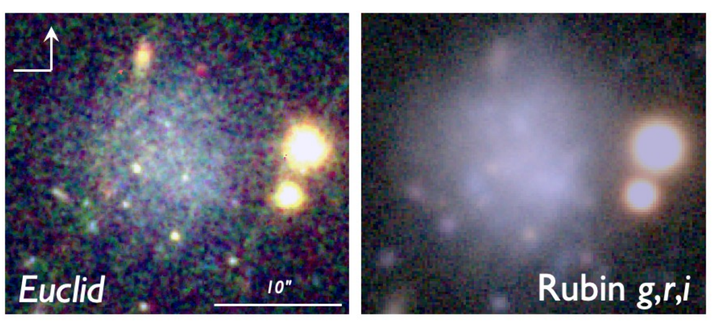

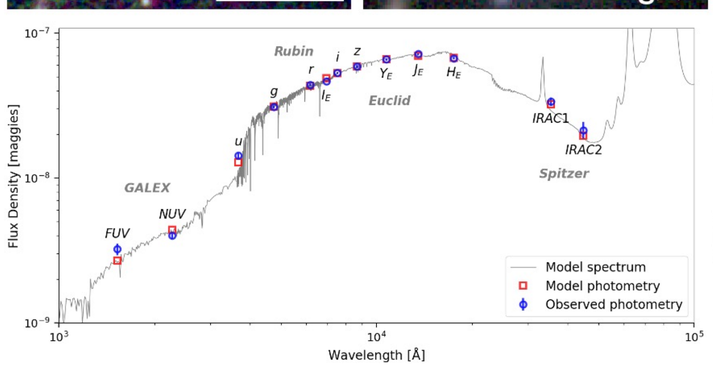

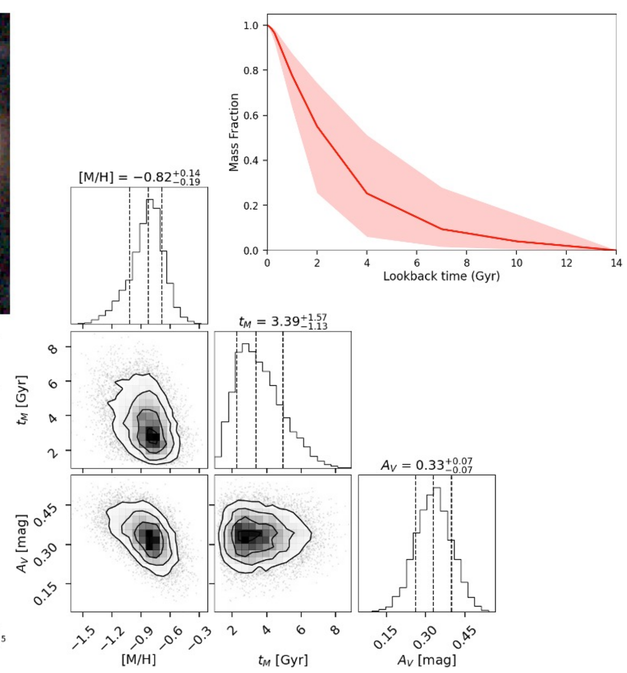

5. GCs and stellar populations in a distant ultra-diffuse galaxy

On the left is a UDG imaged with both *Euclid* Q1 and Rubin DP1 (EDFF/ECDFS field; Romanowsky et al. 2025). GC candidates are visible as point sources, and suggest a distance of ~55 Mpc. SED fitting with Prospector (Johnson et al. 2021), yields a metallicity of [M/H] ~ −0.8 dex and a mass-weighted age of ~3 Gyr (*see corner plot of posteriors, and plot of cumulative stellar mass*). A recent peak of star formation may have led to expansion of the dwarf.

References and Acknowledgements

- Caldwell & Romanowsky 2016, ApJ, 824, 42
- Howell et al. 2026, *A&A*, 706, A185
- Hunt et al. 2025, *A&A*, 697, A9
- Johnson et al. 2021, *ApJS*, 254, 22
- Romanowsky et al. 2025, *RNAAS*, 9, 181

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