SJSU Undergraduate Research Grants

Optical Image Analysis of Gas-Rich Ultra-Diffuse Galaxies

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1. Abstract

Ultra-diffuse galaxies (UDGs) were identified as a population with large sizes and low surface brightness in high-density environments. Galaxies with similar characteristics in low density environments were found through their HI emission in the ALFALFA survey, after matching with optical imaging from the Sloan Digital Sky Survey. Here we carry out a follow-up optical study of these gas-rich UDGs, using deeper and higher-resolution archival imaging from the Hubble Space Telescope and CFHT/MegaCam. These high-quality data enable us to characterize the gas-rich UDG morphologies, star-forming regions, and star cluster populations.

2. Methods

1.) Archival Imaging

- Extract Right Ascension and Declination data from the HUDS subsample in the ALFALFA HI emission ALFALFA survey. Use optical image sources such as Hubble Legacy Archive (HLA) for *HST*, Legacy Survey DR8 for DECaLS, and MegaCam graphical search tool for CFHT.

2.) Morphology Characterization

- Use color images provided by archive for HST and DECaLS. For CFHT, use DS9 and Python code to make color images from FITS datasets. Using colored images are also useful for identifying star-forming regions and star cluster candidates.

3.) Star Cluster Candidates

- Use Hubble Source Catalog for photometry. Extract concentration index, and combine with visual inspection of the interactive image to identify point-like objects. Create a color–magnitude diagram for potential star cluster candidates: use F606W and F814W magnitudes.

3. Example Images

AGC 201993: SDSS, DECaLS, HST (spiral arms?)
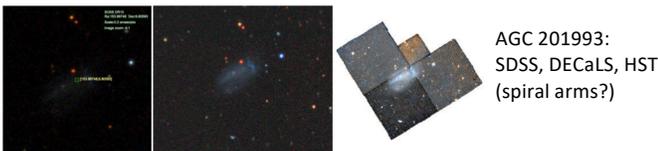
AGC 223471: SDSS, DECaLS, CFHT

AGC 748816: SDSS, DECaLS, CFHT (barred spiral)
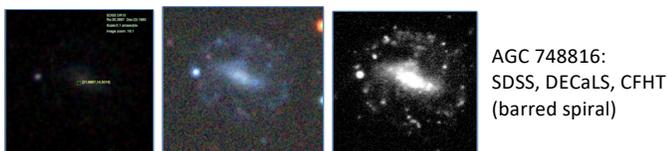
4. Star Clusters in KKH 60

KKH 60 (AGC 201993): *HST / WFPC2* image

The *HST* data for KKH 60 included filters F606W and F814W (similar to *V* and *I*). This allowed us to create a color–magnitude diagram, after using the concentration index to select the point-like sources. The orange box below shows the region expected for old globular clusters.
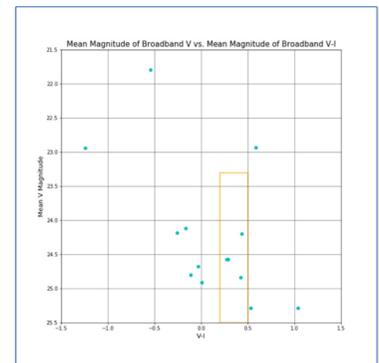
5. Conclusion

With archival optimal imaging from DECaLS and CFHT, the HUDS properties (such as size and morphology) are much clearer than in SDSS.

For KKH 60, *HST* imaging is available, with a quality that surpasses both SDSS and DECaLS (CFHT imaging was not available for this galaxy). Relatively few globular cluster candidates were identified, which will be compared quantitatively with other UDGs from the literature.

Citations
- Leisman et al. 2017, ApJ, 842, 133
- van Dokkum et al. 2015, ApJL, 798, L45
- van Dokkum et al. 2017, ApJL, 844, L1