Searching for Globular Clusters in NGC 7332 & NGC 7339

heather.lenz@ucalgary.ca

UNIVERSITY OF CALGARY
FACULTY OF SCIENCE
Rothney Astrophysical Observatory

Heather Lenz, Dr. Phil Langill, Dr. Matthew Taylor
University of Calgary, Rothney Astrophysical Observatory

Research Goals

1. Identify globular clusters (GCs) based on their magnitude in u, i, and K_s filters using a uiK_s colour-colour diagram. With new K_s-band data this method of GC detection is now possible.

2. Determine host galaxy interactions the spatial distribution of GCs can indicate weather these two galaxies are in the early stages of galactic interaction.

3. Study galactic history from the bimodal blue-red colour distribution of GCs.

Why NGC 7332 & NGC 7339?

These galaxies were chosen because they are edge on, close proximity (35.2kpc) to each other, and had catalogue data for the in u, and i filters observed by MegaCam/CFHT but no K_s data.

A proposal was written to CFHT for WIRCam to observe these galaxies in the K_s -band as part of an inaugural undergraduate international learning experience lead by Dr. Langill and Dr. Taylor in May 2024.

WIRCam & MegaCam

MegaPrime/MegaCam

FOV: 1^ox 1^o Plate Scale: $0.187''$/pix
i-filter: 699-854nm u-filter: 311-397nm
i-t_{exp}: 119s (x6) u- t_{exp} : 700s (x7)

WIRCam – Wide-field **I**nfra**R**ed **C**amera

FOV: $21.5''$x $21.5''$ Plate Scale: $0.3''$/pix
K_s-filter: 1983-2308nm K_s- t_{exp} : 20s (x121)

The u, i, and K_s images were stacked and photometrically analyzed using Source-Extractor [2], Scamp [3], SWarp [4], and Mira [5].

References

[1] Muñoz, R. P., Puzia, T. H., Lancon, A., et al. 2014, ApJS,210, 4
[2] Bertin, E., & Arnouts, S. 1996, A&AS, 117, 393
[3] Bertin, E. 2006, in Astronomical Society of the Pacific Conference Series
[4] Bertin, E., Mellier, Y., Radovich, M., et al. 2002, in Astronomical Society of the Pacific Conference Series
[5] Mirametrics. 2025, Mira Pro x64

Methods

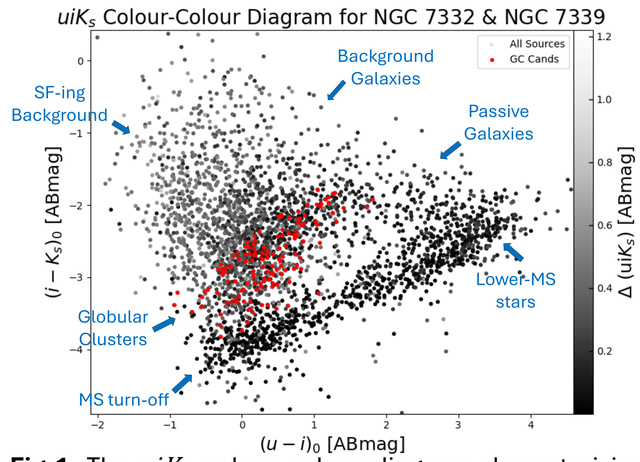


Fig 1. The uiK_s colour-colour diagram characterizing objects using magnitude measurements of sources around NGC 7332 and NGC 7339. Using the normalized colours $(u-i)_0$ and $(i-K_s)_0$ GCs can be separated a method first used in 2014 by Dr. Muñoz [1].

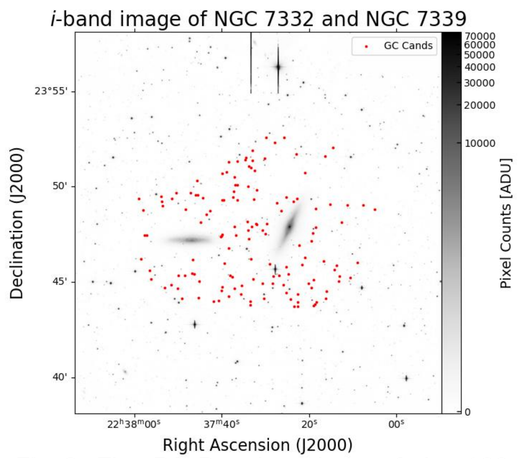


Fig 2. The RA Dec locations of the 139 GC candidates found during this study plotted on the stacked MegaCam i-band image.

GC Sorting

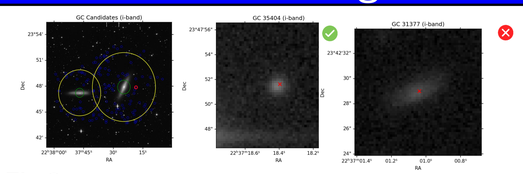


Fig 3. GC proximity plot and image cutouts of GC candidates.

GCs were selected from the central region of the uiK_s diagram seen in Fig 4. Candidates were then filtered using photometric measurements made by Source Extractor such as, magnitude, flux radius, and ellipticity. Image cutouts of the GCs were made to confirm GC-like appearance and proximity to its host galaxy (within 5 effective radii) Fig 3. This process identified 139 GC candidates.

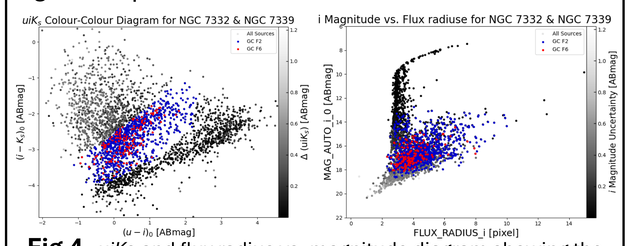


Fig 4. *uiKs* and flux radius vs. magnitude diagram showing the region selected for GC candidates (blue) and the sorted GC (red).

GC Distribution

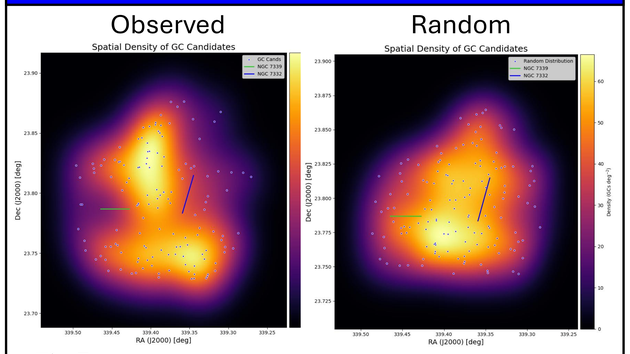


Fig 5. Density plot of GC candidates per square degree (left) observed distribution of GC (right) random distribution of GCs.

To test whether the observed GC distribution is the results from overlap or gravitational interaction, random GC distributions were generated based on observed distances of GCs. Fig 5 shows that the random distributions produce a relatively even GC density, while the observed data shows a central concentration. A Kolmogorov-Smirnov test (Fig. 6) confirms a statistically significant difference between the distributions, supporting the case for non-random structure and possible interaction.

Results

Using a uiK_s colour–colour diagram (Fig 1), I have identified 139 GC candidates surrounding NGC 7332 and NGC 7339 (Fig 2). This method combines near-UV (u), optical (i), and near-infrared (K_s) photometry to effectively isolate GCs in colour space. Although the candidates match expected photometric and structural properties of GCs, spectroscopic confirmation is needed to verify their identities and association with their host galaxies.

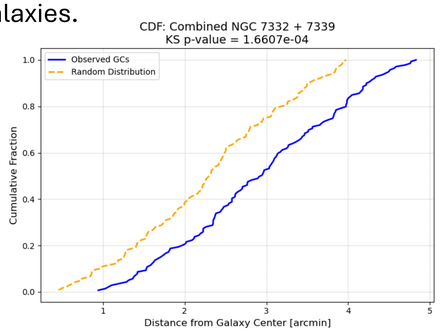
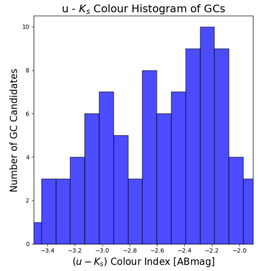


Fig 6. A Kolmogorov-Smirnov (KS) test comparing the cumulative radial distributions of observed and randomly generated GC positions. The resulting p-value ($p = 1.7 \times 10^{-4}$) indicates a statistically significant difference, this rejects the null hypothesis that the observed distribution is random. This supports the presence of a non-random spatial structure, which is consistent with gravitational interaction between NGC 7332 and NGC 7339.

Fig 7. $u - K_s$ histogram reveals a blue-red GC bimodality, with more red GCs, suggesting these galaxies formed through mergers with fewer, larger galaxies.



About Me

I'm an undergraduate student passionate about Astrophysics, especially galaxies and cosmology. I'm currently an intern at the RAO, graduating in 2026 and actively looking for a master's supervisor.