

Detection of a High Globular Cluster to Host Galaxy Luminosity Ratio Galaxy in the NGC 1407 Group

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The NGC 1407 group includes many dwarf galaxies including ultra diffuse galaxies (UDG). We are studying a UDG with a high globular cluster (GC) to host galaxy luminosity ratio, which may indicate the presence of a high mass dark matter halo. We compare the Legacy survey magnitudes and colors of these GC candidates to those of other objects in the NGC 1407 group including known GCs and contaminant stars from the SLUGGS survey, to help classify the candidates. We find a preliminary ratio of 13% of the UDG luminosity is in its GCs which is one of the highest values observed yet and comes close to the percentage of the record holding galaxy. We are pursuing follow-up spectroscopy of the GC candidates to measure their radial velocities.

Ultra Diffuse Galaxies

Ultra diffuse galaxies (UDG) contain very little star forming gas and are therefore populated by old stars. These objects have a low luminosity but can be as large as the Milky Way galaxy. This may indicate the presence of a large amount of dark matter.



NGC 5846-UDG1, a UDG with 13% of its luminosity coming from its GCs (Danieli et al. 2022). Image source: Legacy Survey

Since globular clusters formed very early in the history of the universe there may be a correlation between the number of GCs a galaxy has to the mass content of its dark matter halo.

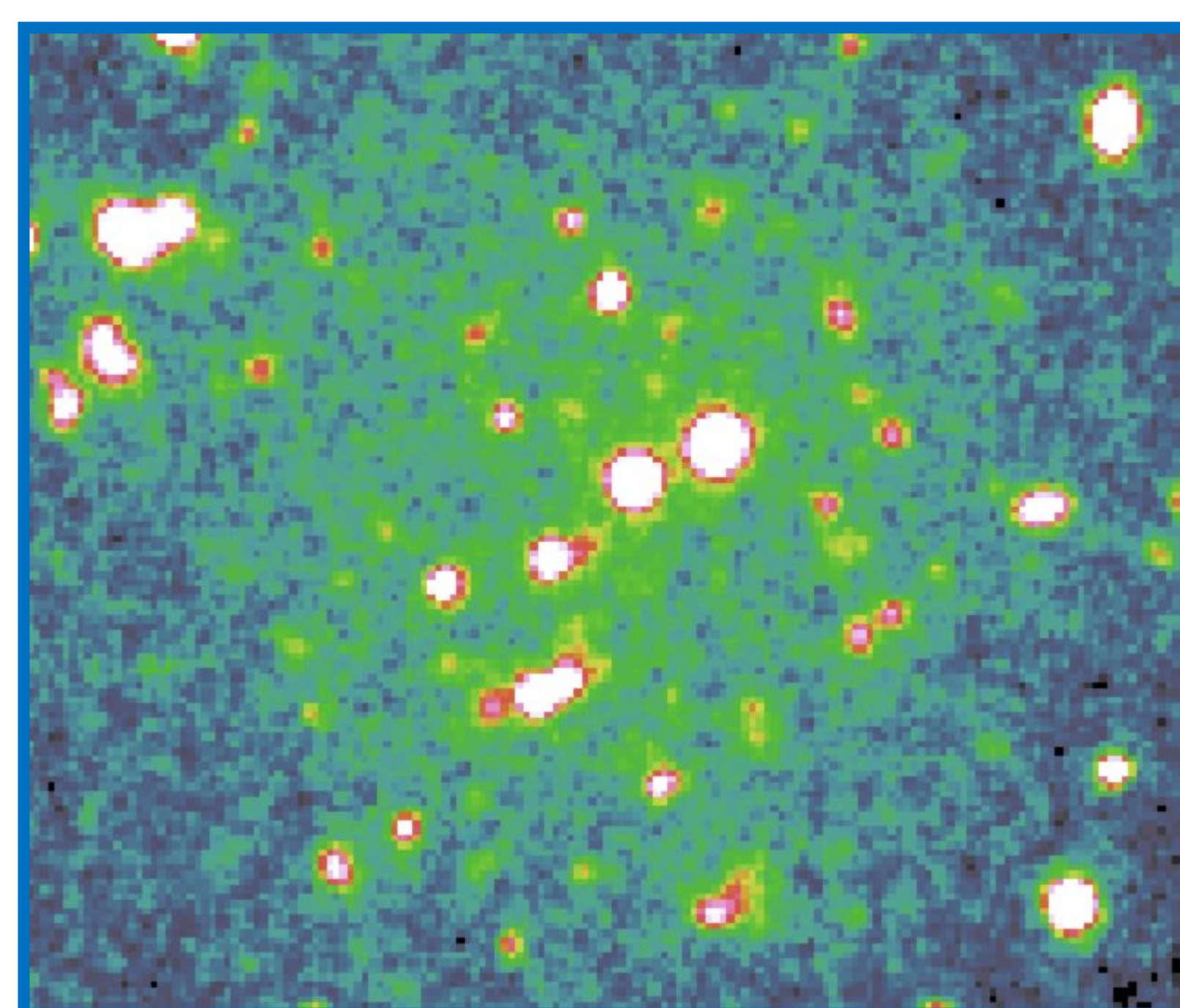
One way we are trying to use this correlation is by finding the ratio of the luminosity of a galaxy's GCs to the total luminosity of the galaxy. A higher ratio indicates that a significant amount of the galaxy's luminosity comes from its GCs and thus the galaxy contains a higher amount of dark matter.

GC and Host Galaxy Luminosity Ratios

We originally began working with multiple catalogs of galaxies from the NGC 1407. We were attempting to find UDGs with GCs and then we would count the number of GCs in each galaxy. We should be able to find a correlation between the number of GCs in a UDG to that UDG's dark matter halo mass. When looking through one of the catalogs, we came across an incredibly dim galaxy with two bright points. These bright points are assumed to be GCs and we have worked to verify their status as GCs or contaminate objects such as stars. Under the assumption that they are GCs, we have also done a preliminary analysis to determine the GC to host galaxy luminosity ratio.



The UDG in NGC 1407 that we are studying. The galaxy itself is almost impossible to see. The two bright spots in the center are the candidate GCs. Image Source: Legacy Survey

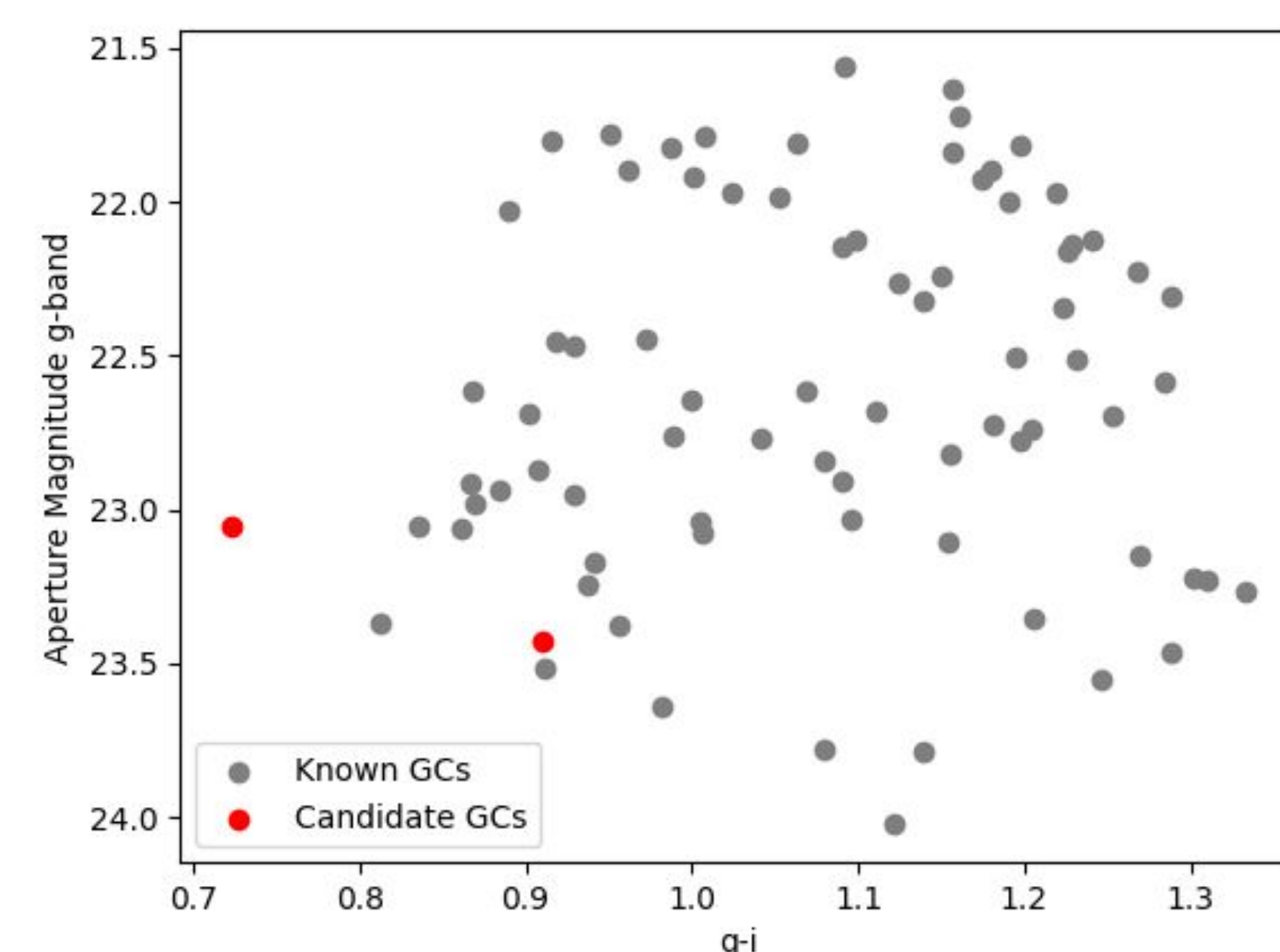


The same UDG with Subaru Suprime-Cam from the SLUGGS survey (Romanowsky et al. 2009).

Are These Objects Globular Clusters?

The aperture curves of the GCs match well with two reference stars which indicates that they are indeed point sources and not extended objects.

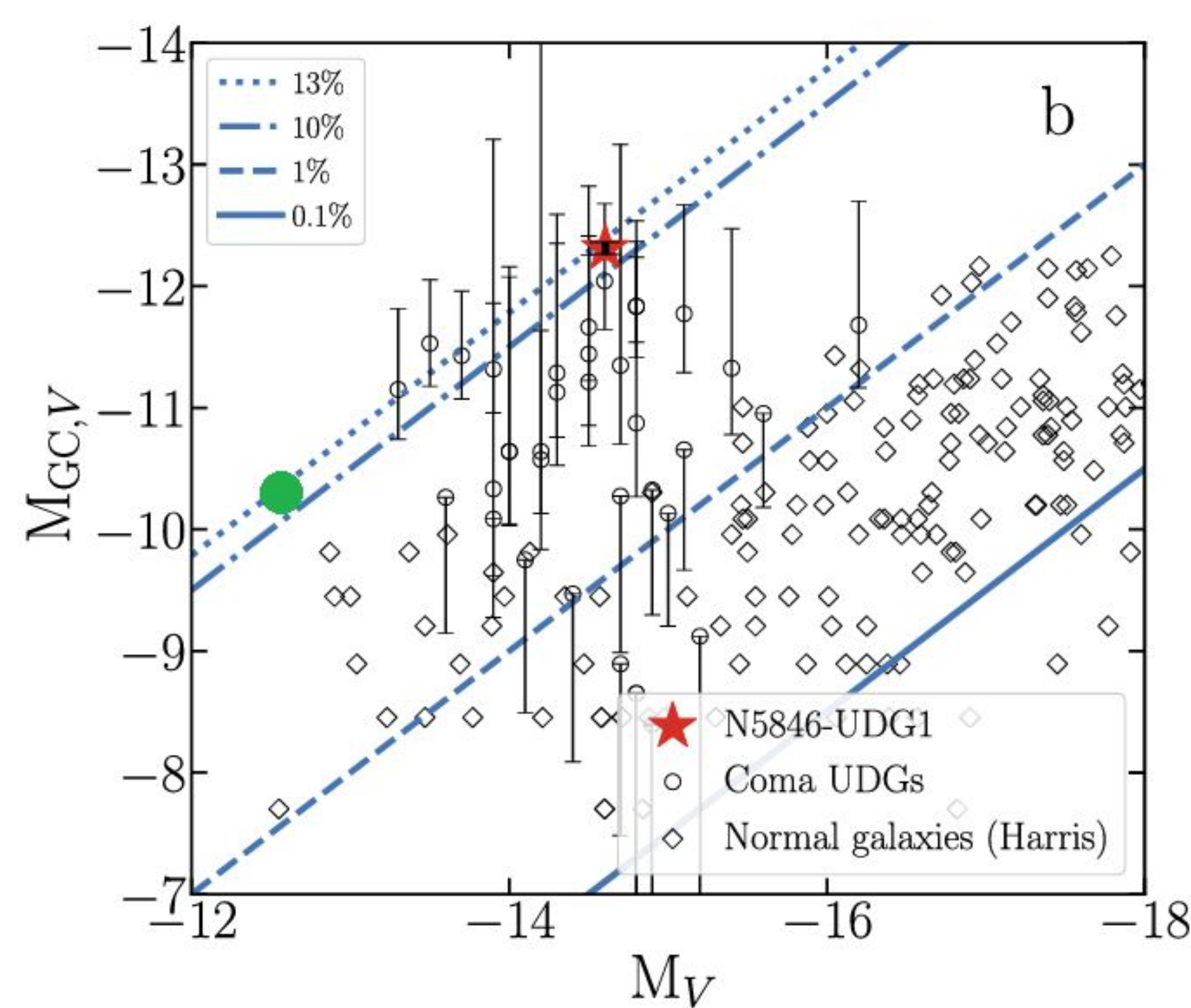
We also compared the magnitude vs $g-i$ color diagrams of the candidate GCs to those of spectroscopically confirmed GCs in the NGC 1407 group (Forbes et al. 2017). From this we can see that the color and magnitude of one of the candidates are similar to those of known GCs while the other GC is on the edge.



$g-i$ color diagram of known GCs in the 1407 group in grey and the two candidate GCs in red. The y-axis is the aperture magnitude in the g -band and the x-axis is the $g-i$ color.

GC to Stellar Mass Fraction

From a similar analysis of UDGs in the Coma Cluster by Danieli et al, we can see how our UDG fits into established data.



Mass fraction plot of UDGs in the Coma Cluster with absolute magnitude of the GCs on the y-axis and absolute magnitude of the host galaxy on the x-axis (Danieli et al. 2022). Our galaxy is placed here in green.

Future Work

We plan to obtain further observational data in order to confirm their distances and luminosities so that we can be sure they are GCs and associated with the galaxy. More GCs could also be present in the UDG that could further increase the luminosity ratio percentage. There are also other similar promising galaxies in this group that may have high percentages of GC to host galaxy luminosities. It would be prudent to study those UDGs as well.

References

- Aaron J. Romanowsky et al 2009 AJ 137 495
- Duncan A. Forbes et al 2017 AJ 153 114
- Shany Danieli et al 2022 ApJL 927 L28