Photometry of Satellite Galaxies of Milky Way

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Abstract

The color magnitude diagram of a number of Milky Way Satellite Galaxies have been derived using Gemini Deep Data. These objects have been discovered using Dark Energy Survey telescope. Photometry studies of these objects can lead into a more accurate determination of their sizes, age, luminosities, and distances. This ultimately results in a better understanding of these dark matter-dominated dwarf galaxies and of the formation mechanisms of the Milky Way galaxy.

Introduction

The Dark Energy Survey (DES) has discovered many new Milky Way satellites over the past few years.
We have obtained deep imaging data with the gemini multi-object spectrographs (GMOS) on the Gemini South 8.1m telescope. The Gemini Observatory consists of twin 8.1-meter diameter optical/infrared telescopes located on two of the best observing sites on the planet.
Using GMOS data, we have been constructing color magnitude diagrams to better understand these satellite candidates that can ultimately help us in better understanding of Dark Matter distribution in Milky Way.

Figure 1. Gemini South with star-trails of the South Celestial Pole overhead.

A satellite galaxy is a galaxy that orbits a larger galaxy due to gravitational attraction. In a pair of orbiting galaxies, if one is considerably larger than the other, then the larger is the "primary" and the smaller is the satellite.

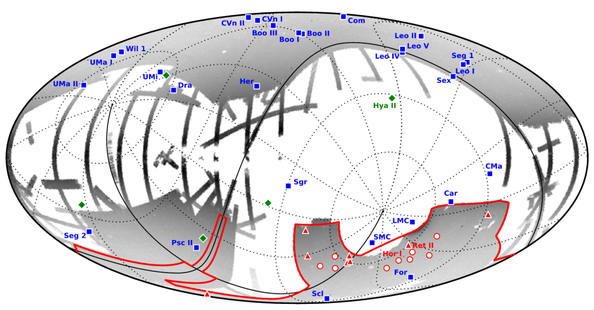

Figure 2. Milky Way Galaxy and some of its satellite galaxies

A color magnitude diagram is a variant of the Hertzsprung-Russell diagram. While the Hertzsprung-Russell (H-R) diagram is a summary of temperatures and magnitudes of individual stars, a color magnitude diagram (CMD) is dedicated to the study of star clusters.
The two most common star clusters are globular and open. A globular cluster contains thousands of stars and is considered old in comparison to other clusters. They also tend to organize outside the main disk of a galaxy.
Open clusters on the other hand are considered young, and exist within the main disk of a galaxy.
The galaxy color–magnitude diagram shows the relationship between absolute magnitude (a measure of luminosity) and mass of galaxies.
There are three main classifications for galaxies based on their CMD: Red Sequence, Blue Cloud, and Green Valley.
The red sequence includes most red galaxies which are generally elliptical galaxies.
The blue cloud includes most blue galaxies which are generally spirals.
In between the two distributions is an underpopulated space known as the green valley which includes a number of red spirals.
Deeper data similar to ones from Gemini South is the key to understanding these objects better.

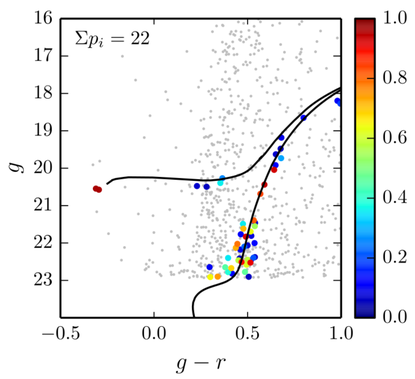

Figure 3. Color-magnitude diagram for the Reticulum III using Dark Energy Survey Data. Drlica-Wagner et al 2015.

Data

Data from Gemini facility instruments are stored as Multi-Extension FITS (MEF) files. Each MEF file consists of one Primary Header Unit (PHU) and one or more extensions that contain pixel data. We have been using data from January 14th of 2016 for both r and g band.

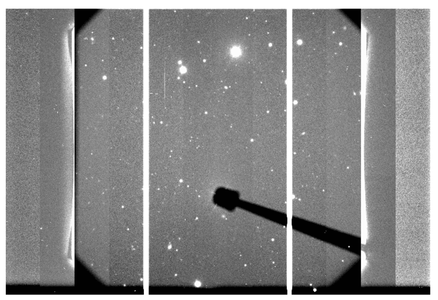

Figure 4. Raw GMOS South Data

Data Reduction

For reducing the data we had, we used the Gemini Pipeline designed specifically to match GMOS MEF.

Using Gemini Package, these are the steps we followed:

1- Creating a bias frame
2- Creating a normalized flat
3- Trimming the images
4- Co-adding the images

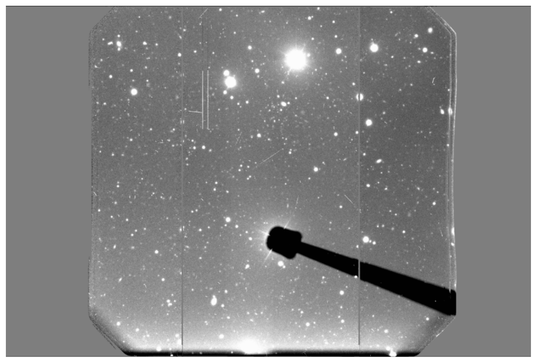

Figure 5. Reduced data using Gemini Package

We used Source Extractor on our reduced data to identify the sources. Source Extractor is a software helping us detecting the brightest objects in the image by comparing the value of each pixel with the ones surrounding it. Then it generates a catalog containing information such as the position of the sources and their magnitudes. Using this information, we constructed our CMD for different bands.

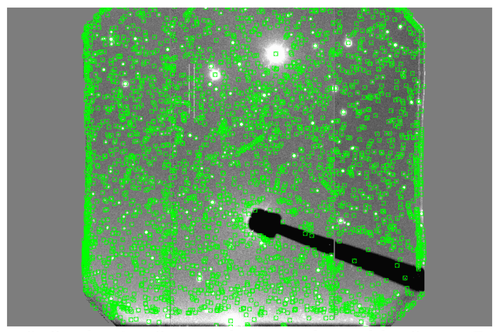

Figure 6. Overlapping Sources that were detected by Source Extractor with reduced Gemini Data

Results

Plotting magnitude of the sources we found in Ret3 vs their color, we make a CMD as shown below. This is a preliminary results as magnitudes of the sources need to be calibrated with respect to the zero point of our data. Once the zero point is obtained, values will be shifted accordingly.
Next, further analyses are required to better understand the characteristic of these stars based on their position in this plot.

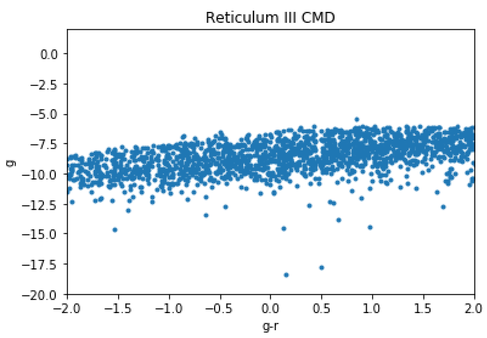

Figure 7. CMD for Reticulum III using GMOS data

References

Bertin, E. & Arnouts, S. 1996: SExtractor: Software for source extraction, Astronomy & Astrophysics Supplement 317, 393
processed using the Gemini IRAF package
Drlica-Wagner, A. et al. 2015, 813, 109

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