Obtaining Images

Once the clusters that we are studying have been selected, the 2MASS website and database (located at http://irsa.ipac.caltech.edu/applications/2MASSQL/interactive.html) has images in the fits format, which we can compare to images compiled from our telescope here at Bowling Green. However, the images often do not share the same viewing area, and multiple pictures must be used from the 2MASS site. For example, the image on the top left is a compilation from our telescope, and the image just below it is the relevant segment for one of the four pictures from the database. This image matches the top left corner of our image. Missing sections of data are not an issue, since the 2MASS images overlap each other.

Acquiring coordinates

With the 2MASS images, we can find the right ascension ($\alpha$) and declination ($\delta$) of variables we have marked in the cluster using the World Coordinate System values displayed by DS9. By finding the marked stars in the 2MASS image by comparing with our image, this will give us approximate coordinates when selected. The $x$-value and $y$-value coordinate values of the stars in the 2MASS images were also recorded. For isolated stars, finding the correct coordinates is easy, while for stars near the center of a dense cluster identifying the variable star is difficult. This can cause issues when drawing magnitudes from the 2MASS databases.

2MASS IR Photometry Data

Now that we have the coordinates for the stars that we are interested in, we can supplement our data with more data from 2MASS. Using the Gator portion of the 2MASS site (http://irsa.ipac.caltech.edu/applications/Gator/), we can obtain the J and K-magnitudes recorded by 2MASS along with other data such as error, proximity to the nearest star, and quality of data. Inputting the approximate $\alpha$ and $\delta$ will give us a screen similar to the examples in the middle left, and various viewing ranges can be chosen. Beneath this image is a list of data, ordered with respect to the numbers in the image. The data given for our listed variables is transferred to our network. Along with the specific data for the speculated variable stars, we also transferred to the data for the entire cluster, out to 5 to 10 arc minutes. An example of the data strings collected is on the bottom left.

K and J-K comparison

The final step is to graph the relation between the K magnitudes and the J-K values for each possible variable we have found. Graphing these values gives us a form of magnitude and color diagram, akin to the HR diagram. Supermogo is the main program used during this process. We use both sets of data collected, with each star in the cluster shown in blue, and the variables shown larger and in red. Also added to the graph are the error bars for the variables found, linked to their respective points of data. Variables near the top right of the graph indicate Long Period Variable stars at the top of the Red Giant Branch. The other variables may be eclipsing binary systems or other pulsating variables on which light curve analysis is ongoing.