Image Analysis on NGC 6171 and NGC 6553: Looking for Long Period Variable Stars

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Introduction

Long-period variable stars are typically supergiant or giant class stars, near the end of their lives. The variables we are interested in are generally pulsating variables with a period of a month to years. These stars tend to vary in luminosity due to changes in the interior of the star, which cause variations in the radius and surface temperature. Variable stars with regular periods usually have well-defined relations between their period and luminosity. This means that they can be used to determine distances to the star clusters in which they reside. Variable stars also useful in the study of stellar structure and can help to determine the age of their clusters as well.

Clusters

NGC6171 is located in the southern sky in the constellation Ophiuchus at RA: 16h 32m 32s Dec: -13 03' 13". All of the images analyzed were taken in 2009 and 2010 using the .5m BGSU telescope and CCD.

NGC6553 is located in the southern sky in the constellation Sagittarius at RA: 18h 09m 17.60s Dec: -25 54' 31.3". All of the images analyzed were taken in 2010 and 2011 using the PROMPT .4m telescopes at the Cerro Tololo Inter-American Observatory (CTIO), Chile.

Images for both clusters were taken in the *V* and *I* band-passes with two separate *I* exposures, *I* short and *I* long.
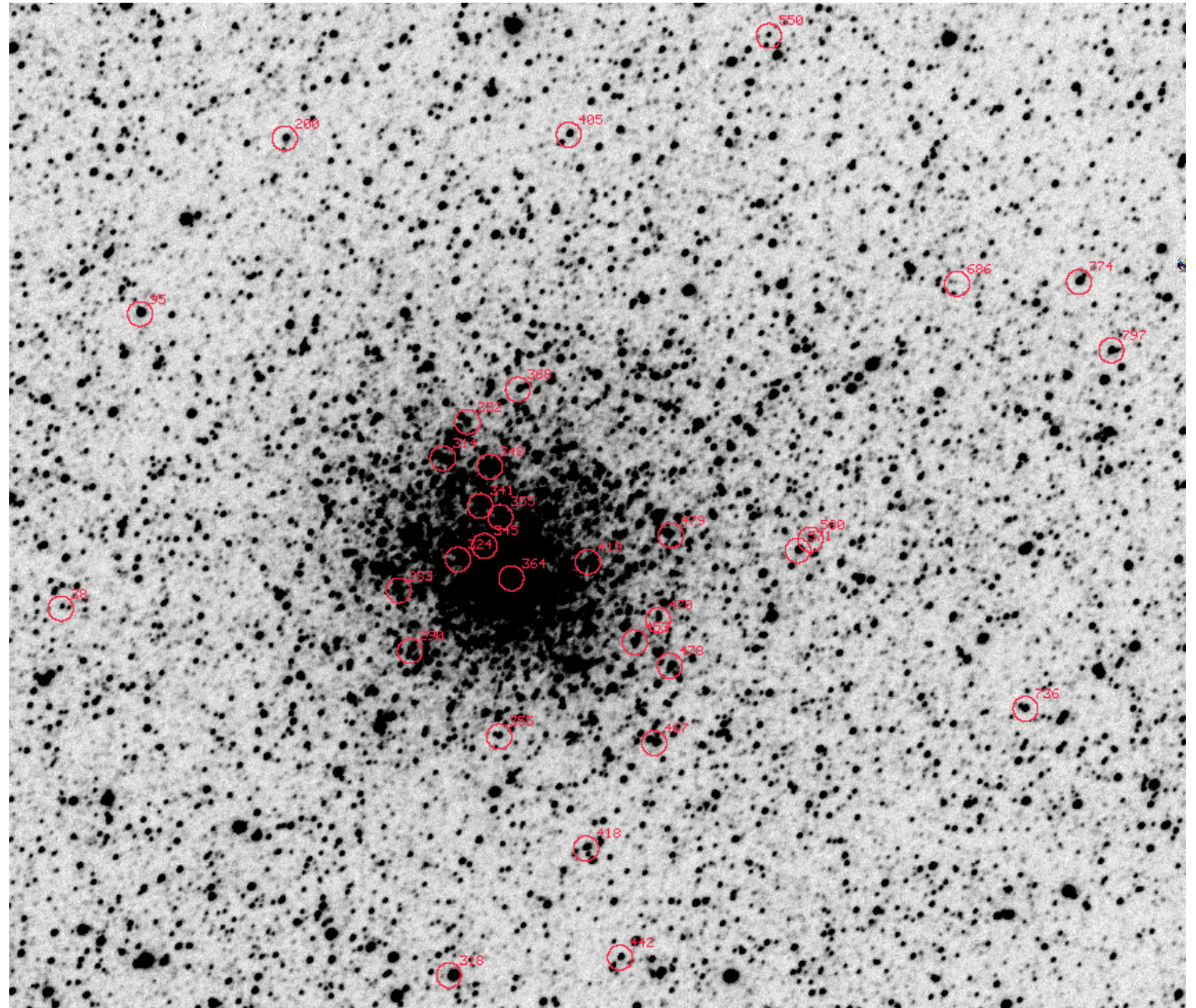
NGC6171

Master Image for this data set.

Red circles indicate detected variables. Circles labeled with a "V" indicate known variables detected by Samus (2005). Otherwise they are new detections.
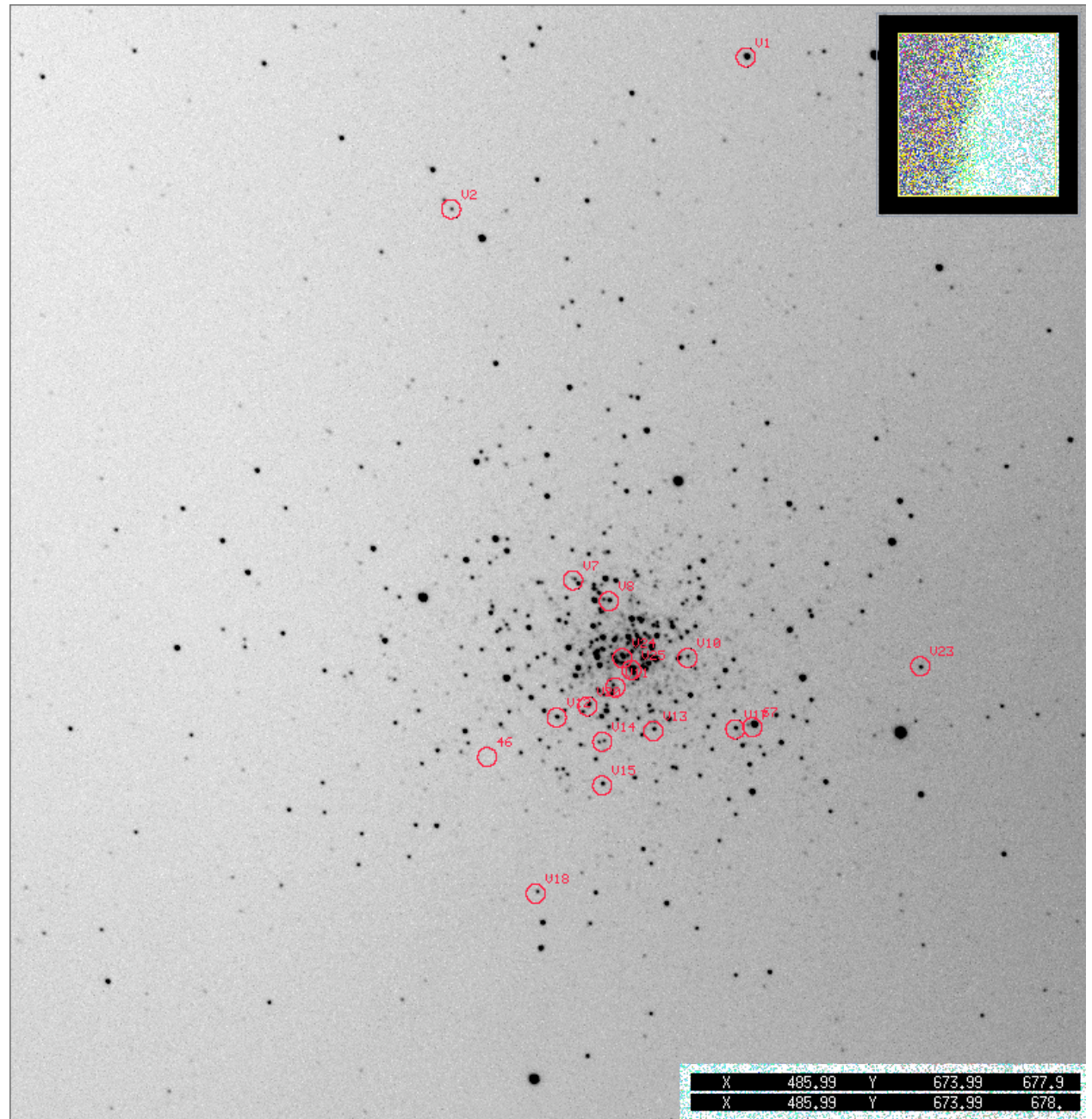
NGC6553

Master Image for this data set.

Red circles indicate detected variables. Labels were determined by the X location of the star detected using ISIS.

Methods

<u>NGC 6171</u> The images first had to be combined to remove dead pixels and other blemishes as much as possible, as well as to increase the signal to noise for each image. The combined images were then run through ISIS, which puts out a list of potential variables.

<u>NGC 6553</u> The images were first retrieved from the Skynet database. After this I obtained information on each image individually for use with DAOPHOT. Select images from 2009-10 were then run through ISIS as an independent test of our results.

Programs

ISIS – Combined images were given a common dimension. The master image was then subtracted from each image. The absolute value of the difference was then used to make a master variable image. This was checked for variables and the detections were then checked again to remove false positives from blemishes, background noise, etc.

DAOPHOT – It first checks the image for stars well above the standard deviation and Gaussian in their profiles in their in order to remove faint galaxies, blemishes, etc. It then finds a point-spread function (PSF) in order to check other stars. Once the PSF is built for the best stars ALLSTAR is run to find faint stars hidden by brighter neighbors. After running these cycles several times, a list of stars (8000-18000 for NGC 6553) with position, magnitude, and a variability index is given. This is then used to determine which are potential variables.
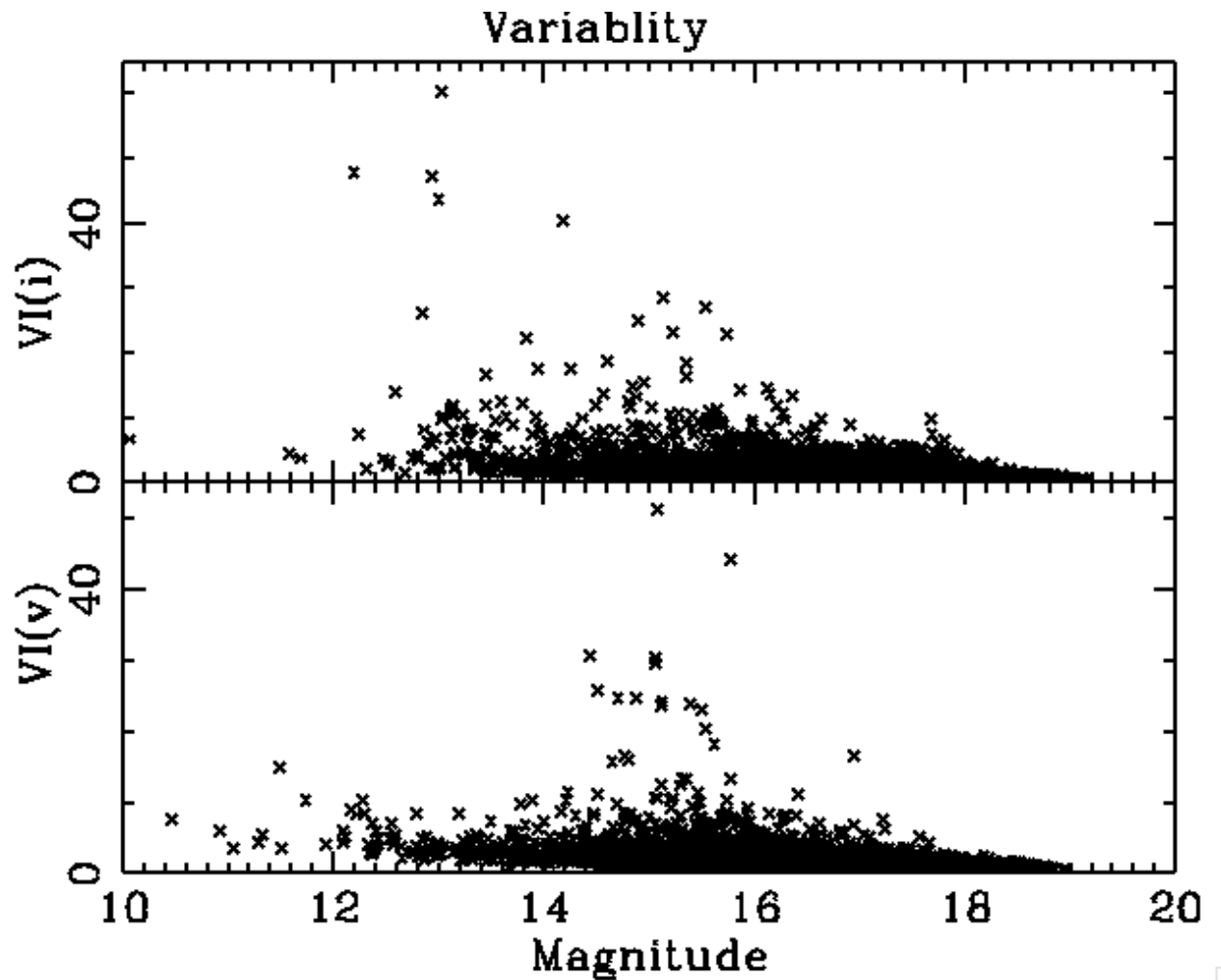
ISIS

This is the image, after removing several bad images, that the ISIS process produced for NGC6171.

Detections that did not have a roughly Gaussian full width at half maximum (FWHM) were removed from the list of variables. Some can be seen as the squares left in the image.
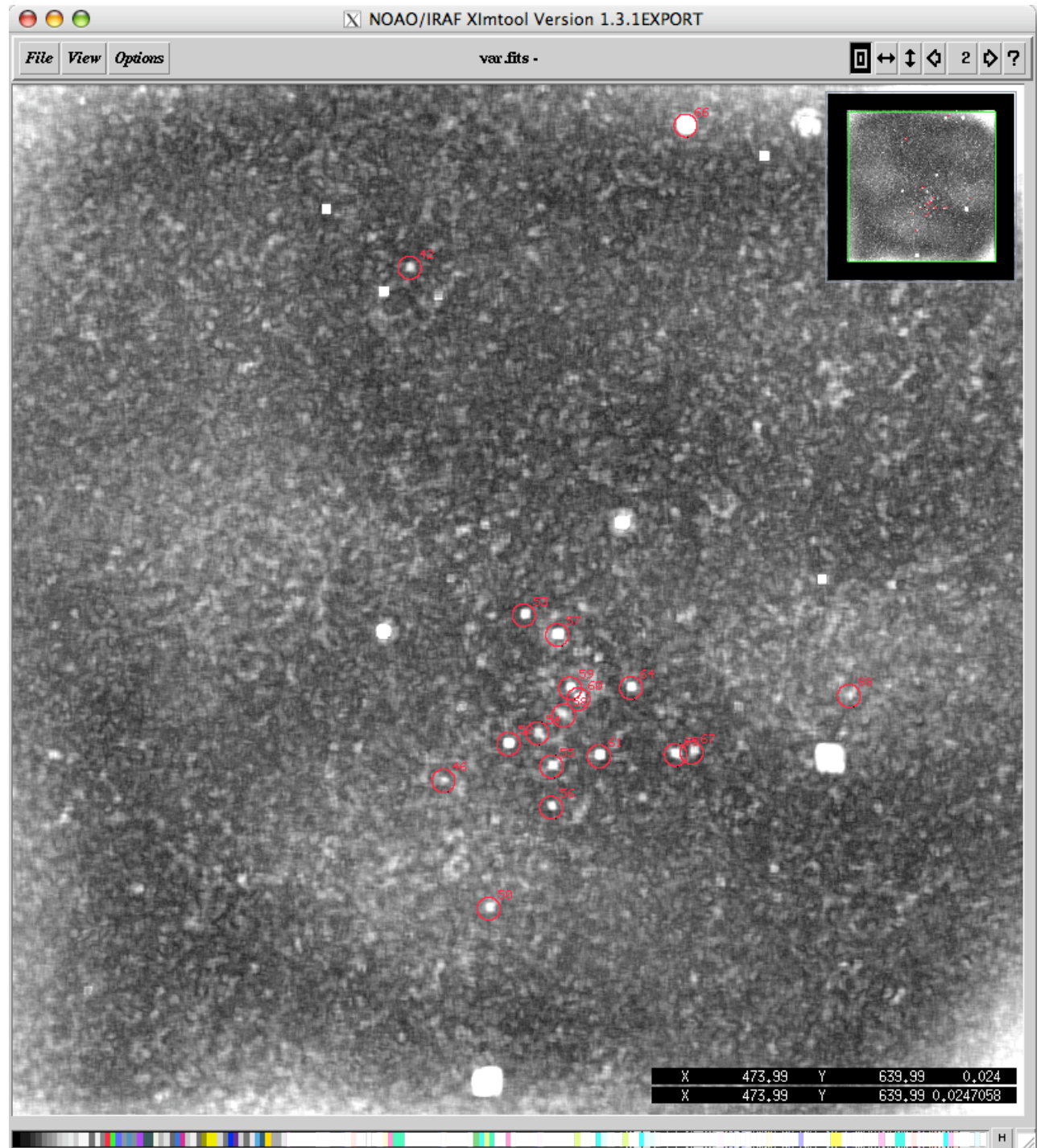
DAOPHOT

This is the Variability Index for each star in NGC6553 plotted against its apparent magnitude. Results are shown for the *V* and *I* short images.

Stars with a Variability Index >=10 were chosen for further inspection

Variablity

Results

NGC 6171

23 variables were detected, with 16 confirmations of past data, and 7 potential new variables.
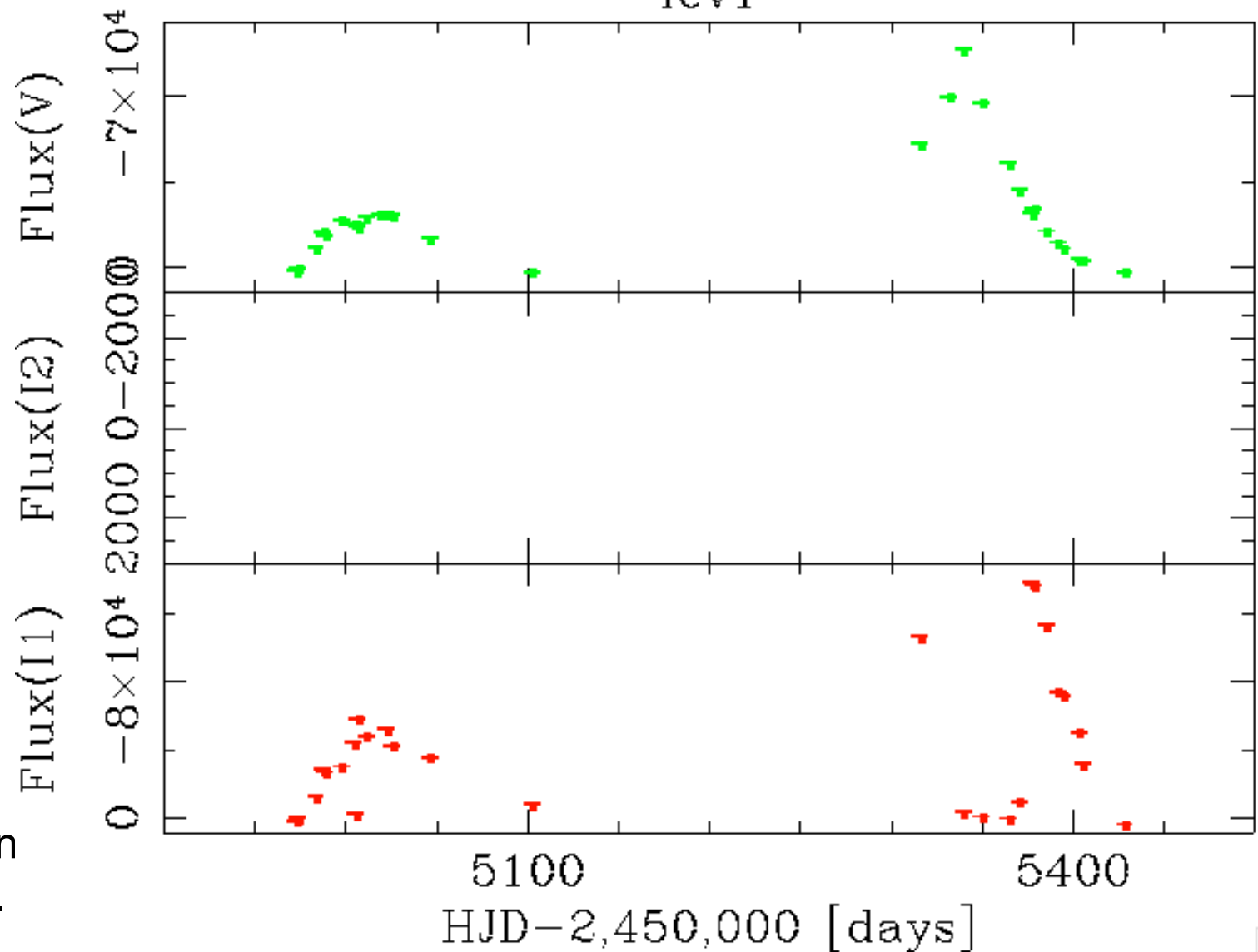
NGC 6553

38 potential variables were detected with DAOPHOT, while 35 were detected with ISIS.

Light curves, measures of the changing flux/magnitude over the time of observation, were produced for most potential variables in each cluster.
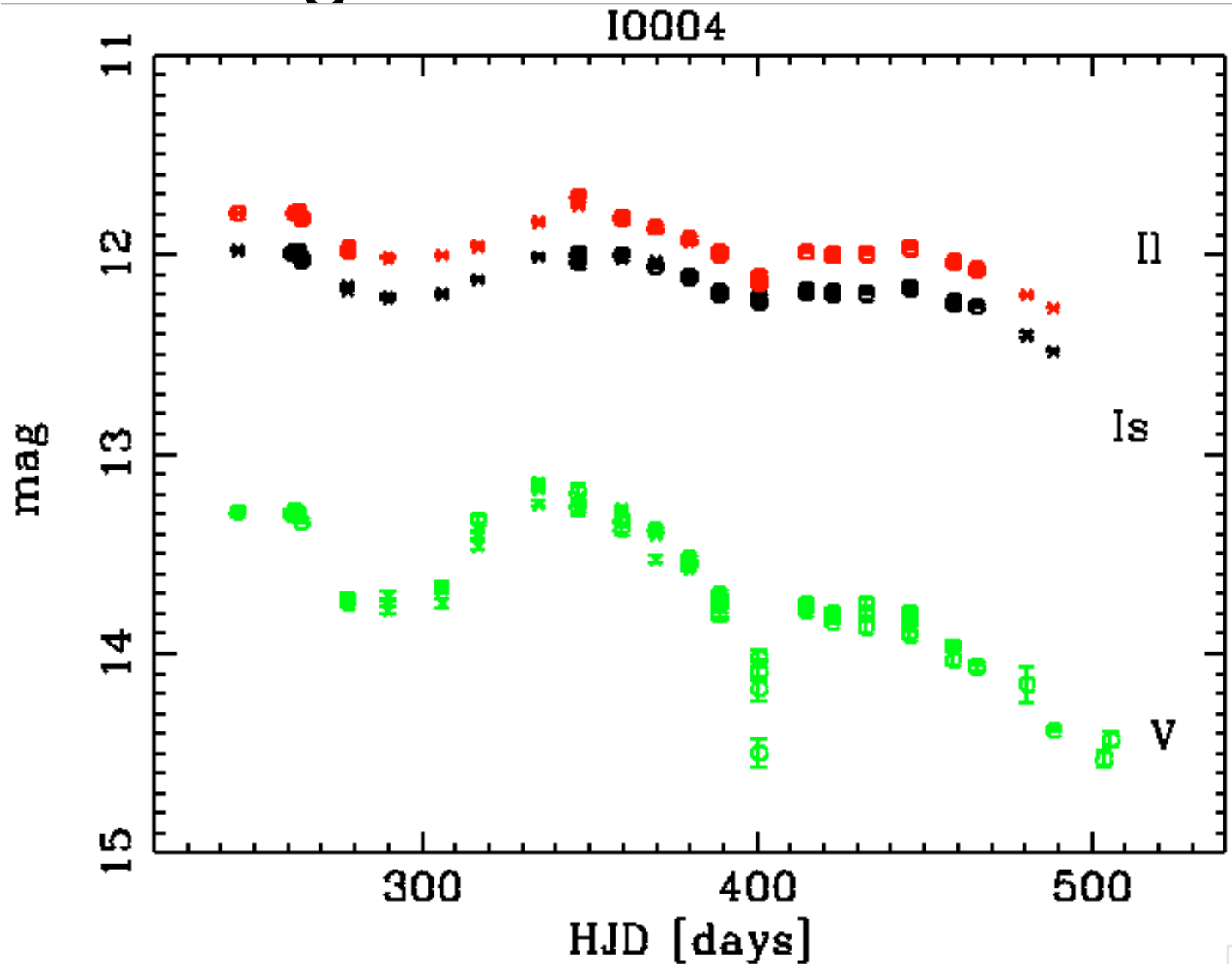
NGC 6171 Star V1 Lightcurve

Flux is given in arbitrary units.

NGC 6553 DAOPHOT Variable I4 Lightcurve

Apparent magnitude is not necessarily the "night sky" value, but is good relative to other points in the same color.
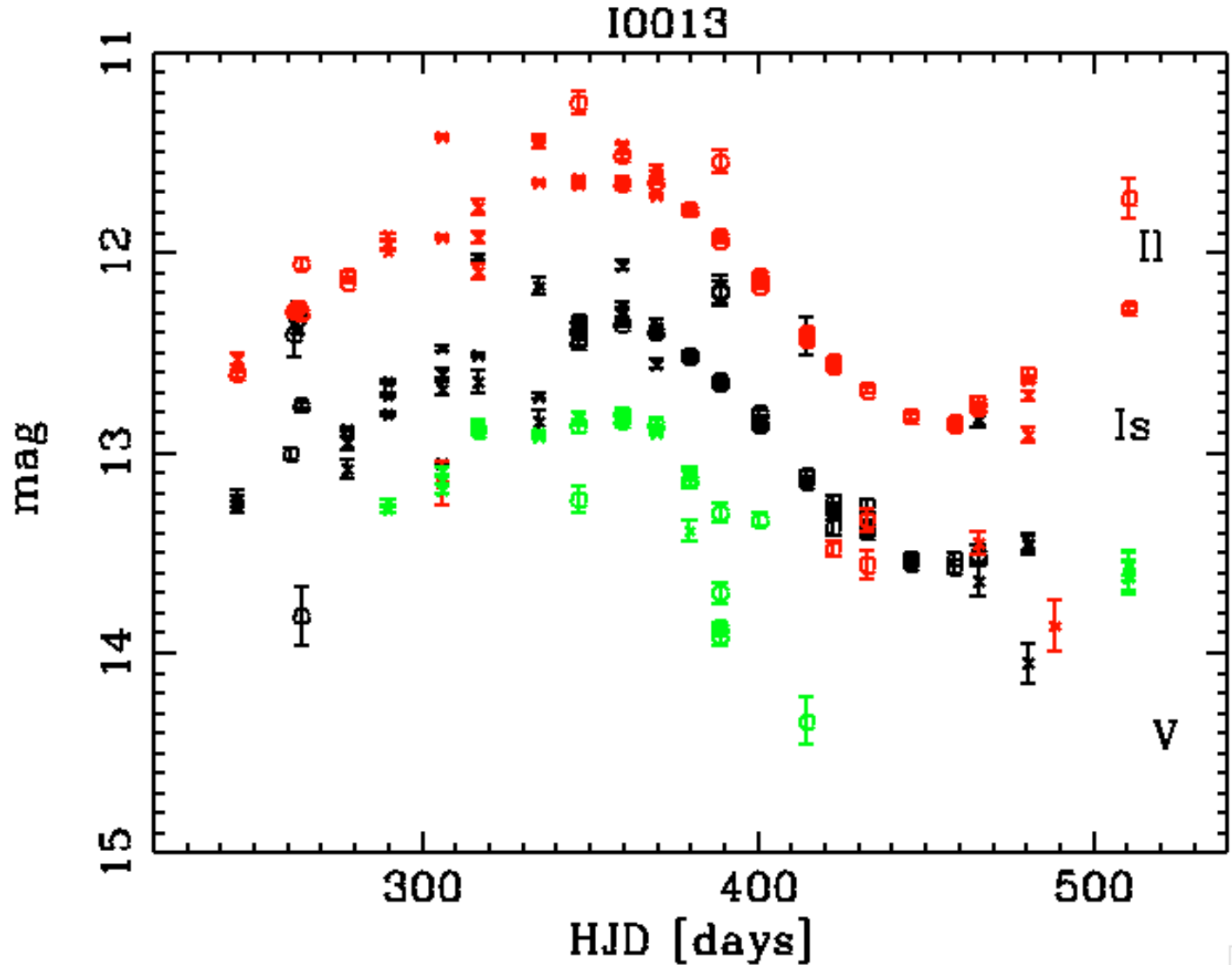
Curves have been shifted for ease of viewing.

NGC 6553 DAOPHOT Variable I13 Lightcurve

Apparent magnitude is not necessarily the "night sky" value, but is good relative to other points in the same color.

Curves have been shifted for ease of viewing.

Conclusions

NGC 6171

While we were able to verify some known and potentially detect some new variables, we cannot suggest a period from our data. This is because, although we have data over two years, it does not encompass enough nights to give a good measure of the period of pulsation, especially since we would like to see three full periods in our data before we make a conclusive statement.

NGC 6553

While we detected several variables between both ISIS and DAOPHOT, we did not have sufficient time in order to run the rest of the 2011 data through DAOPHOT. The 2010 data alone gave us several stars for which we could give periods, though we would like to check against our past 2009 data, and run the 2010 and 2011 data through DAOPHOT together for greater certainty.

Future Work

NGC 6171

More data over a longer portion of the year would assist in further studies. Placing this cluster on our PROMPT observation list should give the data we need.

* Previous work done on 2009 data by BGSU Master's student Elisabeth Kager. Her thesis has helped immensely in my own work.

NGC 6553

Once DAOPHOT is run on the 2010-11 data together, we will be able to compare to past data* and potentially give estimates of periods for our variables. Additional data is being taken for 2012 with PROMPT as well.

Acknowledgements

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