

From October 2015 until December 2015, 1 control pair and 7 sets of program yellow supergiant stars were observed at Missouri State University's Baker Observatory with a 0.36 meter Celestron Schmidt-Cassegrain hybrid telescope equipped with an Apogee Alta U77 CCD detector. Using IRAF, the images obtained were calibrated for differential aperture photometry. The Welch Stetson Index and standard deviations of average nightly delta magnitudes were used to determine candidates for variability. The selected candidates were then analyzed for periodicity. Two classical Cepheid stars were recovered. The rest of the stars were non-variable at the 1% precision level. Discussion of the location of these stars on the Cepheid instability strip is presented.

## Introduction

A Cepheid is a yellow supergiant star that is variable and located within the instability strip of the Hertzsprung-Russell diagram. They are used as distance indicators because of the relationship between their luminosity and period.

Using differential CCD photometry, this project hopes to identify Cepheids. Program stars used in the project are: HD 191010, HD 193205, HD 200805, HD 212312, HD 216105, HD 235518, and HD 240073. HD 200803 was the control.

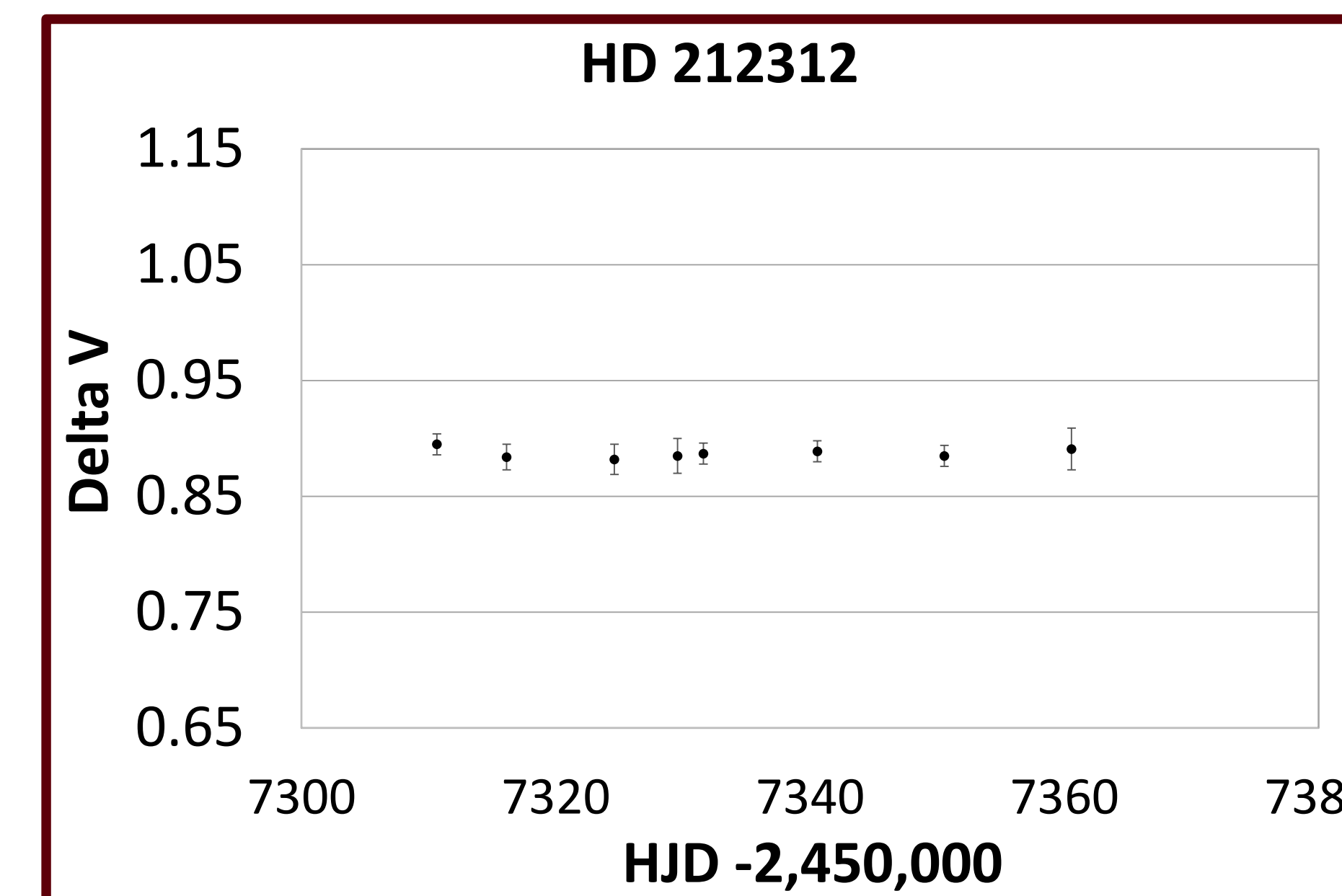
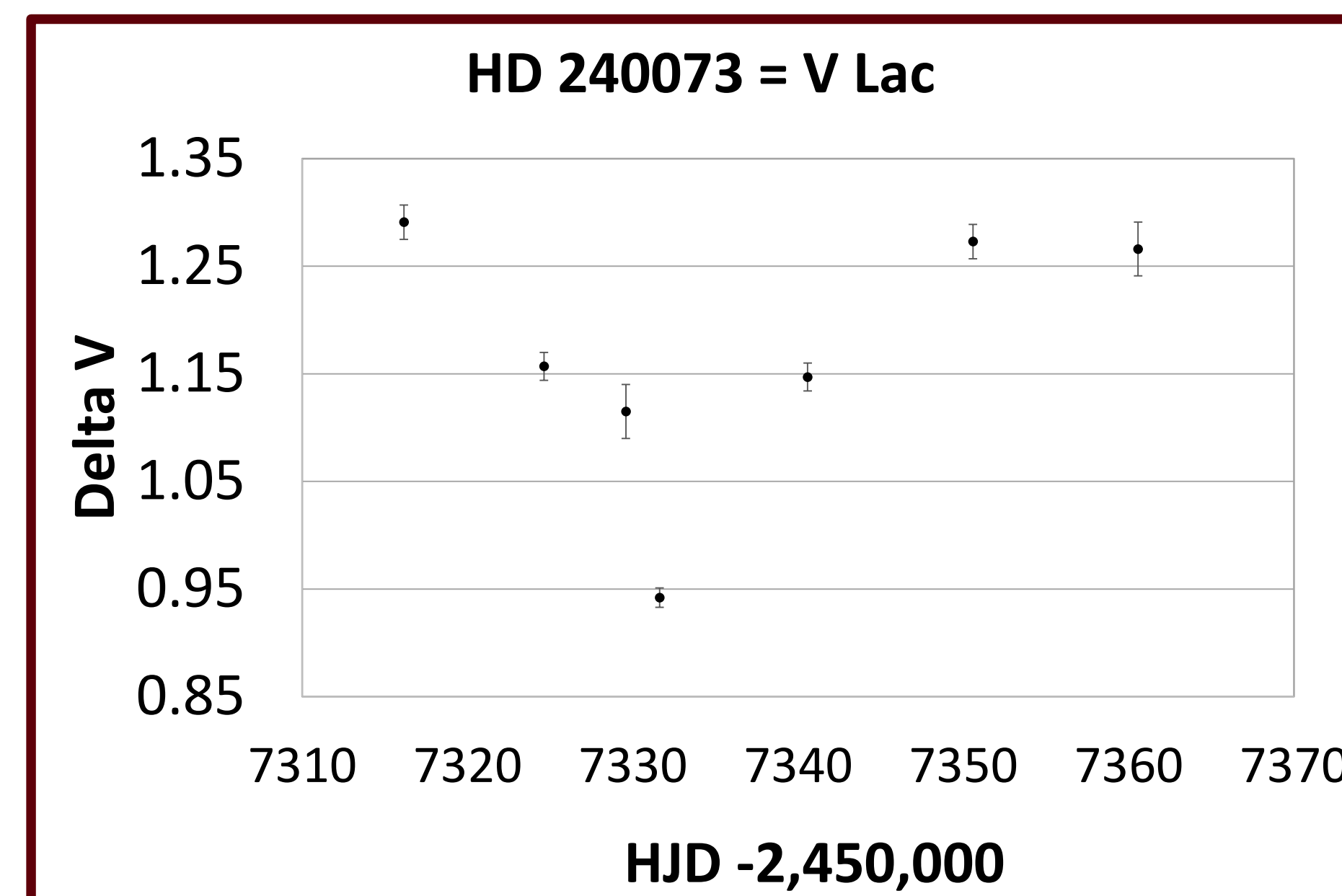
## Observations

Images of the program stars were taken at Baker Observatory on: October 15, 20, and 29; November 3, 5, 11, 13, 20, and 24; and December 4 of 2015. Images were taken in the V filter, and between 10 and 30 bias, dark, and flat images were taken each night to use to correct the program star images.

## Data Processing

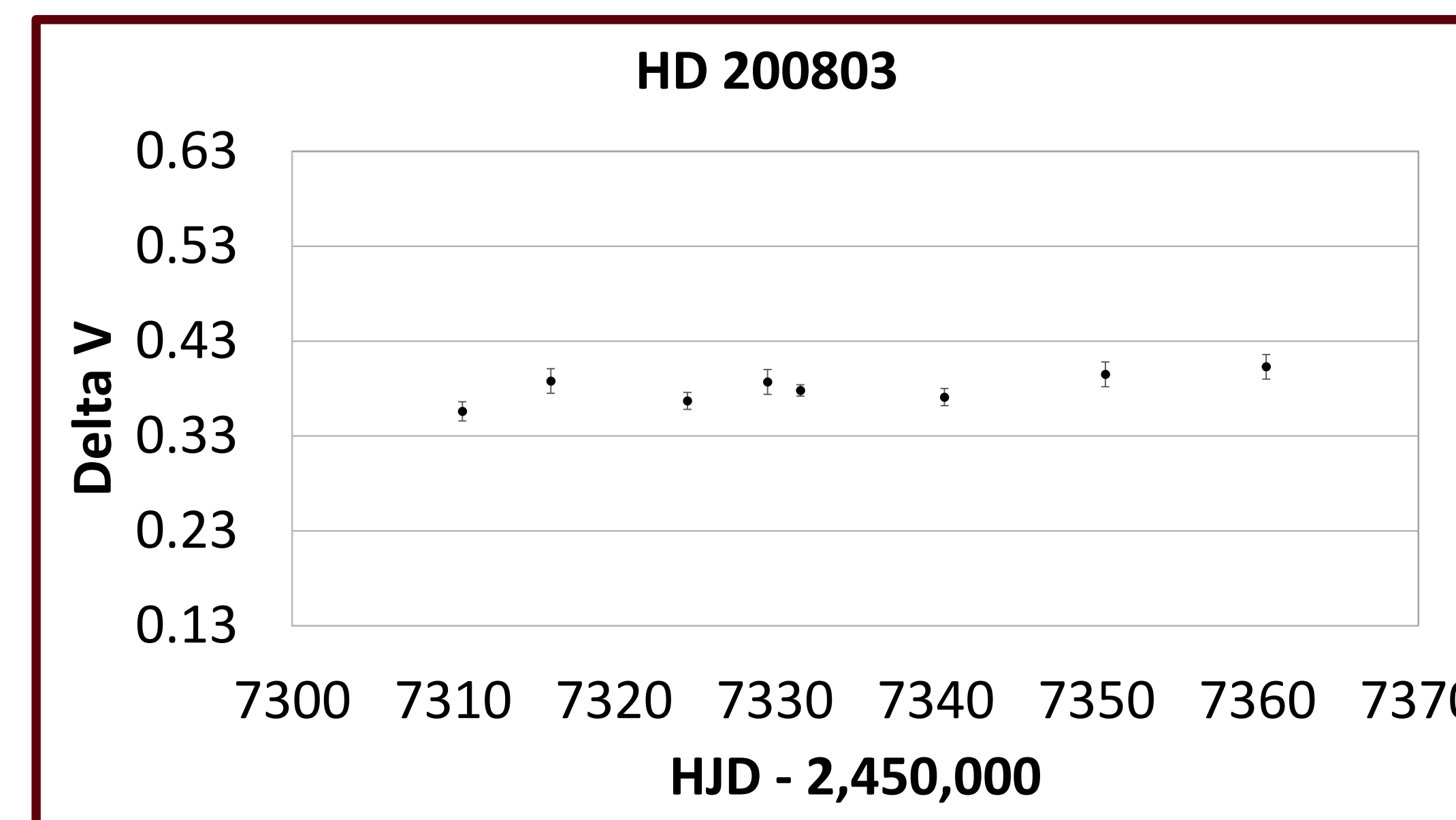
To calibrate images in IRAF, first the bias, dark, and flat images were combined into masters of their type. Then the images were trimmed and had the master bias subtracted. The master dark was scaled to the exposure time of each program star and then subtracted. Finally, the master flat was divided into each image on a pixel-by-pixel basis and re-normalized to complete image calibration.

For photometry, *daofind* and *editcoo* were used in IRAF to select the program, comparison, and check stars. Next, *phot* was run and the resulting .mag files were used to find the nightly average delta magnitude for the program star with respect to the comparison and check stars.



Above are examples of a variable and non-variable star

Below is the Control star



## Conclusion

Two classical Cepheids, HD 240073 (=V Lac) and HD 216105 (=X Lac), were recovered. While no clear period was obtained for HD 216105, that can be attributed to the small number of data points. Even though a period was found with *pdm* for HD 193205, the standard deviation and relatively low Welch Stetson Index value compared to the confirmed Cepheids, does not point to it being variable. All other program stars were non-variable within the precision of the measurements. In the future, more work will be done on identifying the nature of the control pair, since it was on the higher end of the Welch Stetson Index values obtained.

## References

Hirshfeld, A., Sinnott, R. 1985, Sky Catalogue 2000.0 Volume 2 (Cambridge, MA: Sky Publishing Corporation)

Perryman, M., Lindegren, L., Kovalevsky, J., et al. 1997, The HIPPARCOS Catalogue

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## Results

The delta magnitudes were used to calculate the Welch Stetson Index for each star. The values for these are below. The four stars with the highest index value had the standard deviation of their average nightly delta magnitude calculated as well.

HD	avg. delta-mag	WSI	$\sigma$ (avg. nightly delta-mag)
240073	1.18	1371	0.11
216105	1.48	632	0.15
200803	0.38	13.7	0.015
193205	2.07	8.1	0.009
200805	1.99	1.8	--
191010	2.00	1.7	--
212312	0.89	1.4	--
235518	1.93	0.9	--

The phase dispersion minimization task in IRAF was also used on the four stars with the highest index value. The goal was to find the stars' periods. The results can be seen next to the periods for some of the stars obtained from the HIPPARCOS Catalogue and Sky Catalogue

HD	pdm period	HIPPARCOS/Sky Catalogue period
240073	5.5	4.98
216105	--	5.44
200803	1.155	--
193205	1.58	--

