

# Color Magnitude of M103

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By Dylan De La Pena and Justin Perea

# Why Color Magnitude Diagram?

We wanted to make an attempt at some real Astronomy

To gain more experience with photometry

One night of observing

# What is a color magnitude diagram?

Plot of Color vs Magnitude

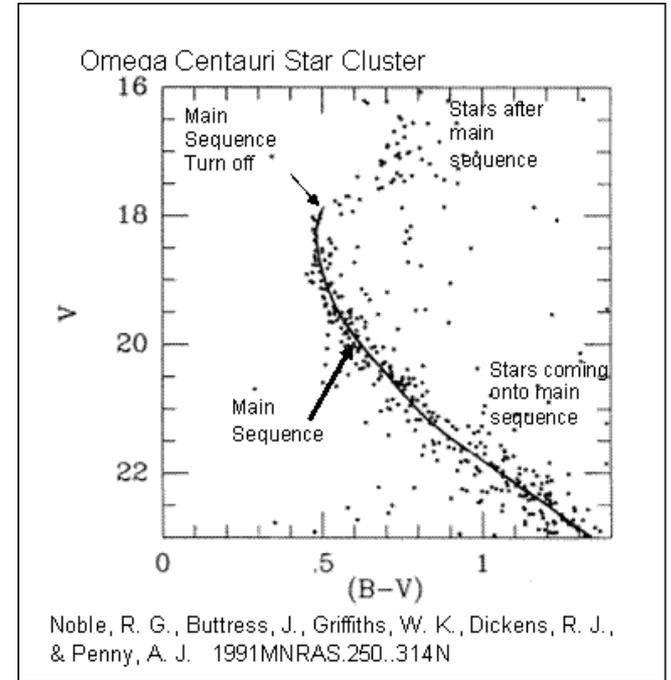
Color indicates temperature

Capable of finding-

Age of cluster

Mass of stars at main sequence turn off

Distance of star cluster



# Why M103?

Open cluster (less stars)

Viewing time and position was  
optimal

Well catalogued stars



Freestarcharts.com. "Messier 103 - M103 - Open Cluster | Free Star Charts."  
*Messier 103 - M103 - Open Cluster | Free Star Charts.* N.p., n.d. Web. 04 Dec.  
2016. <<http://freestarcharts.com/messier-103>>.

# M103

Open cluster

RA: 01h 33.2m

Dec: +60 42'

Constellation- Cassiopeia

Around 172 stars

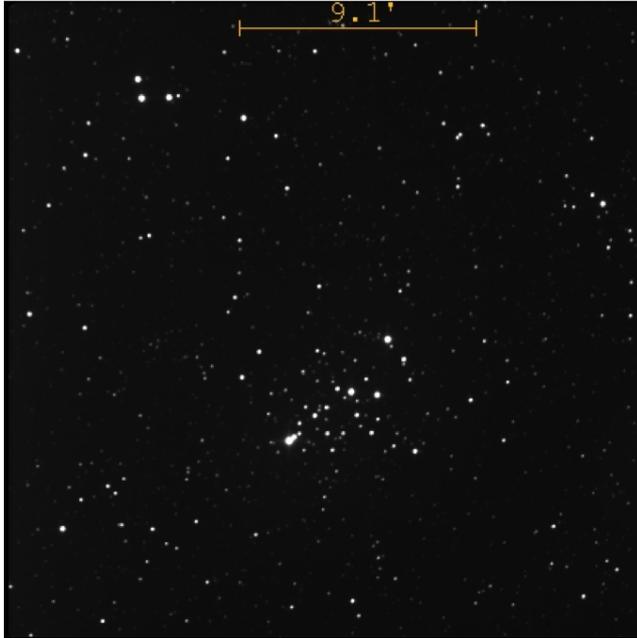
10,000 light years away

Strube 13.1 is a red giant not part of cluster



Freestarcharts.com. "Messier 103 - M103 - Open Cluster | Free Star Charts."  
*Messier 103 - M103 - Open Cluster | Free Star Charts.* N.p., n.d. Web. 04 Dec.  
2016. <<http://freestarcharts.com/messier-103>>.

# Open Cluster



M103: Our image

# Globular Cluster



M80

The Hubble Heritage team (1999-07-01). "[Hubble Images a Swarm of Ancient Stars](#)". *HubbleSite News Desk*. Space Telescope Science Institute. Retrieved 2006-05-26.

# Equipment & Software

20" telescope at Skyview observatory

The Sky program

CCD with Johnson-Cousins filters

CCD Soft

AstroImageJ



# Observation

Series of 20 images

B filter flats at 0.7 seconds

V filter flats at 4.2 seconds

0.7 seconds of Flatdarks

4.2 seconds of Flatdarks



<http://www.phys.ttu.edu/~ozprof/skyvie/w17.jpg>

# Observation Continued

3 series of 60 images for our B  
filter science images with a 20  
second exposure

2 series of 120 images for our V  
filter science images with a 10  
second exposure.

Lastly 10 Dark images at 10 and  
20 second exposure



[http://www.phys.ttu.edu/~ozprof/skyvie  
w17.jpg](http://www.phys.ttu.edu/~ozprof/skyview17.jpg)

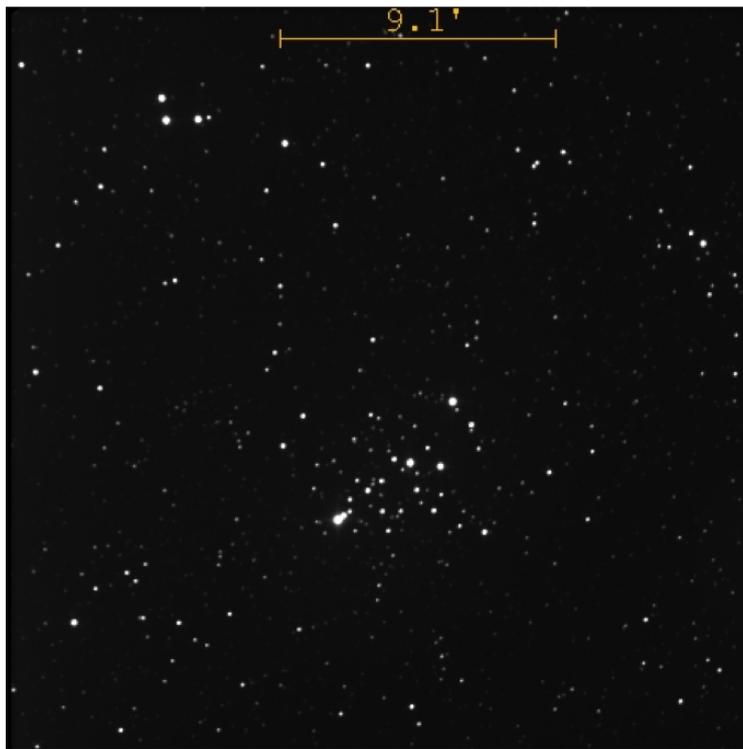
# Reduction of images

Using CCDsoft we median combined our B and V filtered flats to make two master flats

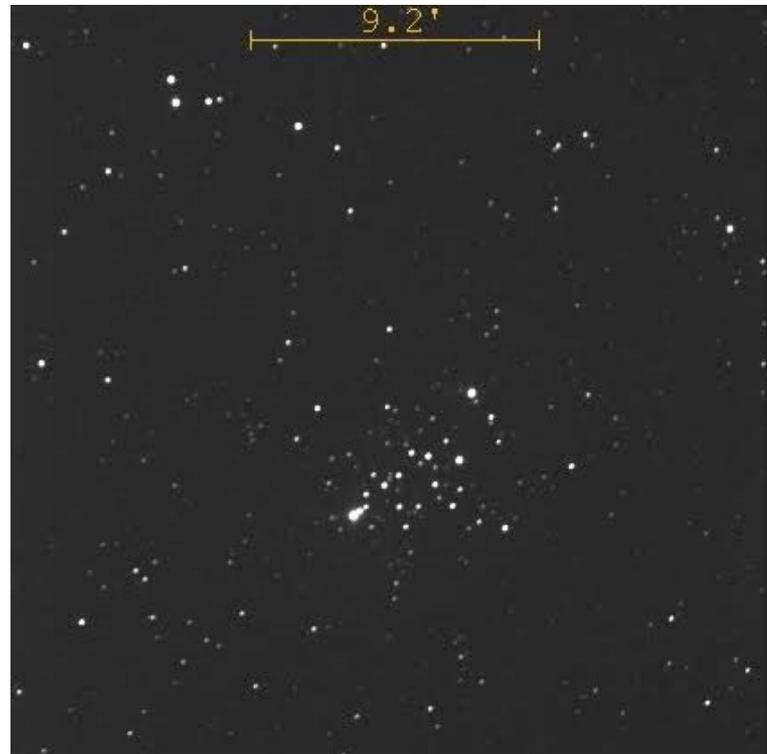
Then we median reduced our darks to make two master darks for each filter and exposure time

We then aligned our science images to combine them as our final images.

# Final Combined Images

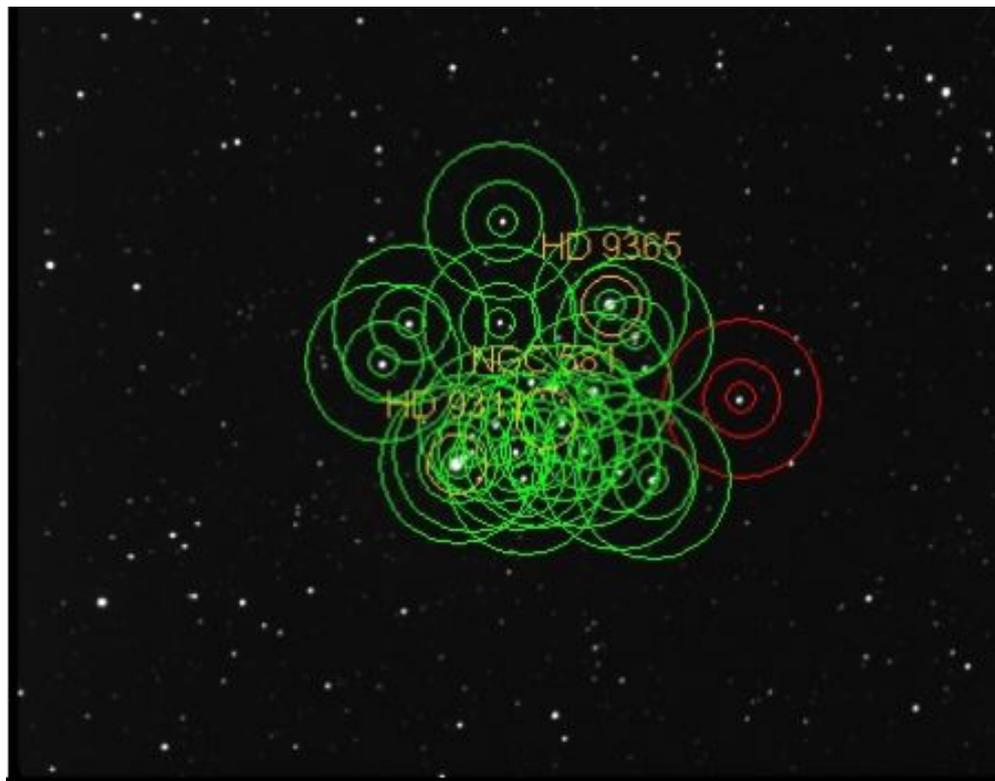


Visible Filter



Blue Filter

# AstroImageJ-Aperture



# Choosing a Guide Star

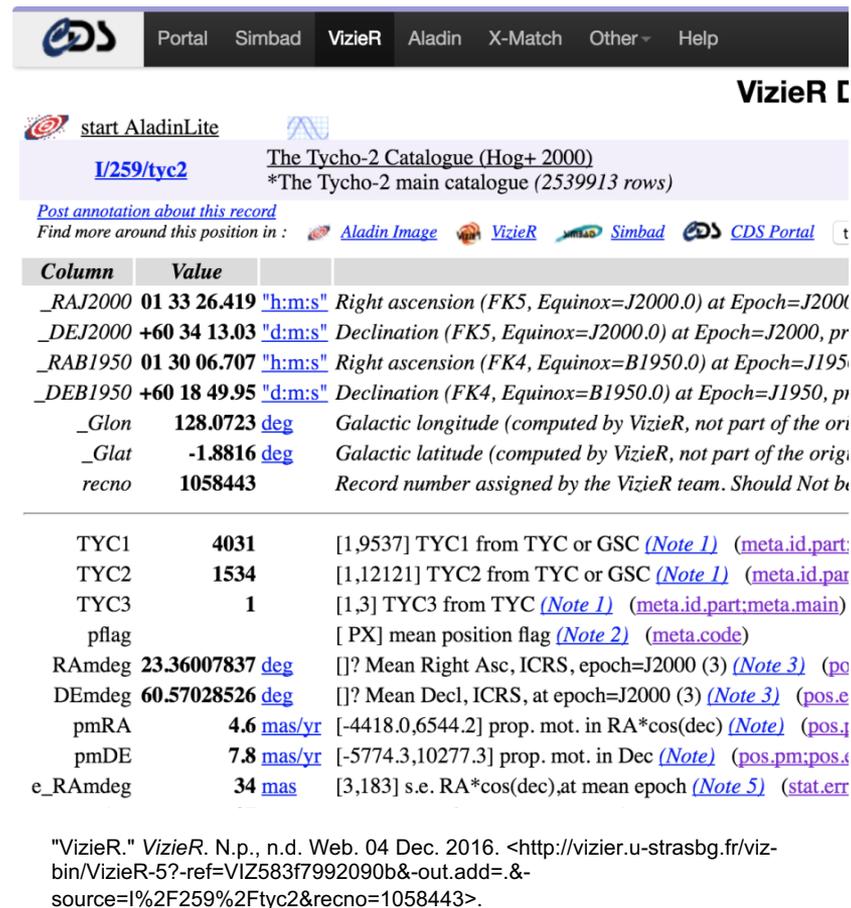
A star well catalogued using VizieR

Needed to know

magnitude in both B and V filter

RA and Dec

Corresponds to star aperture we took



The screenshot shows the VizieR web interface for the star I/259/tyc2. The header includes the CDS logo and navigation links: Portal, Simbad, VizieR, Aladin, X-Match, Other, and Help. The main content area displays the star's name, its position in the Tycho-2 Catalogue (Hog+ 2000), and a link to post an annotation. Below this is a table of coordinates and other parameters.

Column	Value	
_RAJ2000	01 33 26.419	"h:m:s" Right ascension (FK5, Equinox=J2000.0) at Epoch=J2000
_DEJ2000	+60 34 13.03	"d:m:s" Declination (FK5, Equinox=J2000.0) at Epoch=J2000, pro
_RAB1950	01 30 06.707	"h:m:s" Right ascension (FK4, Equinox=B1950.0) at Epoch=J1950
_DEB1950	+60 18 49.95	"d:m:s" Declination (FK4, Equinox=B1950.0) at Epoch=J1950, pr
_Glon	128.0723	deg Galactic longitude (computed by VizieR, not part of the ori
_Glat	-1.8816	deg Galactic latitude (computed by VizieR, not part of the origi
recno	1058443	Record number assigned by the VizieR team. Should Not be

TYC1	4031	[1,9537] TYC1 from TYC or GSC ( <a href="#">Note 1</a> ) ( <a href="#">meta.id.part</a> ;
TYC2	1534	[1,12121] TYC2 from TYC or GSC ( <a href="#">Note 1</a> ) ( <a href="#">meta.id.par</a>
TYC3	1	[1,3] TYC3 from TYC ( <a href="#">Note 1</a> ) ( <a href="#">meta.id.part;meta.main</a> )
pflag		[ PX] mean position flag ( <a href="#">Note 2</a> ) ( <a href="#">meta.code</a> )
RAmdeg	23.36007837	deg [ ]? Mean Right Asc, ICRS, epoch=J2000 (3) ( <a href="#">Note 3</a> ) ( <a href="#">pos.e</a>
DEmdeg	60.57028526	deg [ ]? Mean Decl, ICRS, at epoch=J2000 (3) ( <a href="#">Note 3</a> ) ( <a href="#">pos.e</a>
pmRA	4.6	mas/yr [-4418.0,6544.2] prop. mot. in RA*cos(dec) ( <a href="#">Note</a> ) ( <a href="#">pos.j</a>
pmDE	7.8	mas/yr [-5774.3,10277.3] prop. mot. in Dec ( <a href="#">Note</a> ) ( <a href="#">pos.pm;pos.s</a>
e_RAmdeg	34	mas [3,183] s.e. RA*cos(dec),at mean epoch ( <a href="#">Note 5</a> ) ( <a href="#">stat.err</a>

"VizieR." VizieR. N.p., n.d. Web. 04 Dec. 2016. <<http://vizier.u-strasbg.fr/viz-bin/VizieR-5?-ref=VIZ583f7992090b&-out.add=.%&-source=I%2F259%2Ftyc2&recno=1058443>>.

# Reference Star

Name: TYC1 4031

RA: 01 33 26.419

Dec: +60 34 13.03

B-mag: 11.546

V-mag :11.251

**VizieR**

start AladinLite

[I/259/tyc2](#) [The Tycho-2 Catalogue \(Hog+ 2000\)](#)  
\*The Tycho-2 main catalogue (2539913 rows)

[Post annotation about this record](#)  
Find more around this position in : [Aladin Image](#) [VizieR](#) [Simbad](#) [CDS Portal](#)

Column	Value	
_RAJ2000	<b>01 33 26.419</b> <a href="#">"h:m:s"</a>	Right ascension (FK5, Equinox=J2000.0) at Epoch=J2000
_DEJ2000	<b>+60 34 13.03</b> <a href="#">"d:m:s"</a>	Declination (FK5, Equinox=J2000.0) at Epoch=J2000, projected
_RAB1950	<b>01 30 06.707</b> <a href="#">"h:m:s"</a>	Right ascension (FK4, Equinox=B1950.0) at Epoch=J1950
_DEB1950	<b>+60 18 49.95</b> <a href="#">"d:m:s"</a>	Declination (FK4, Equinox=B1950.0) at Epoch=J1950, projected
_Glon	<b>128.0723</b> <a href="#">deg</a>	Galactic longitude (computed by VizieR, not part of the original catalogue)
_Glat	<b>-1.8816</b> <a href="#">deg</a>	Galactic latitude (computed by VizieR, not part of the original catalogue)
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TYC1	<b>4031</b>	[1,9537] TYC1 from TYC or GSC ( <a href="#">Note 1</a> ) ( <a href="#">meta.id.part:1</a> )
TYC2	<b>1534</b>	[1,12121] TYC2 from TYC or GSC ( <a href="#">Note 1</a> ) ( <a href="#">meta.id.part:2</a> )
TYC3	<b>1</b>	[1,3] TYC3 from TYC ( <a href="#">Note 1</a> ) ( <a href="#">meta.id.part:meta.main</a> )
pflag		[ PX] mean position flag ( <a href="#">Note 2</a> ) ( <a href="#">meta.code</a> )
RAmdeg	<b>23.36007837</b> <a href="#">deg</a>	[ ]? Mean Right Asc, ICRS, epoch=J2000 (3) ( <a href="#">Note 3</a> ) ( <a href="#">pos.e</a> )
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pmDE	<b>7.8</b> <a href="#">mas/yr</a>	[-5774.3,10277.3] prop. mot. in Dec ( <a href="#">Note</a> ) ( <a href="#">pos.pm:pos.j</a> )
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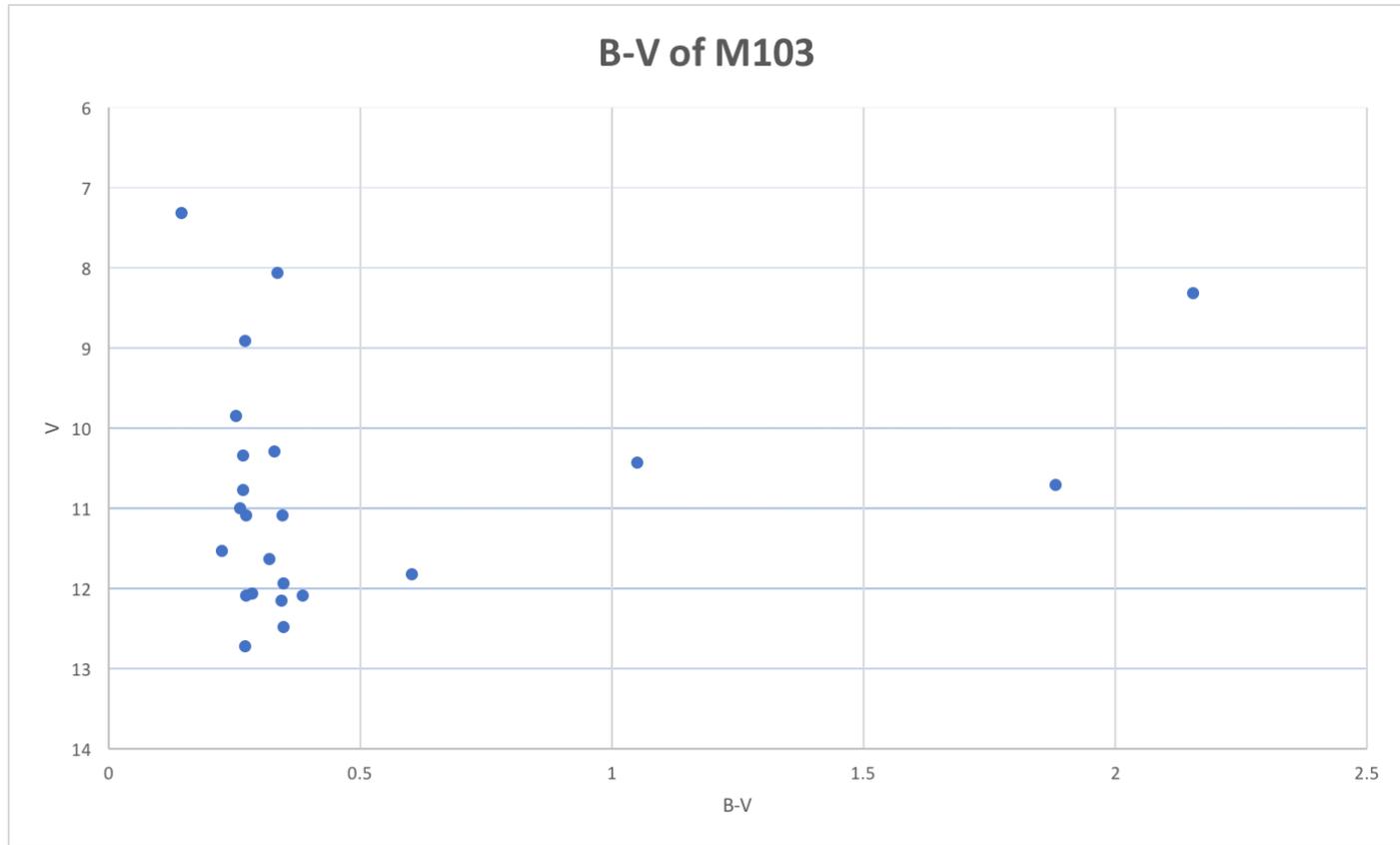
"VizieR." VizieR. N.p., n.d. Web. 04 Dec. 2016. <<http://vizier.u-strasbg.fr/viz-bin/VizieR-5?-ref=VIZ583f7992090b&-out.add=.%&source=I%2F259%2Ftyc2&recno=1058443>>.

# Calculation of data

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1		Label	slice	Saturated	J.D.-24000	JD.UTC	JD_SOBS	HJD.UTC	BJD_TDB	AIRMASS	ALT_OBJ	CCD-TEMP	EXPTIME	RAOBJ2K	DECOBJ2K	Source_R	FWHM_M	Source_R	Sky_Rad(r	Sky_Rad(r	rel_flux_c	rel_flux_1	rel_flux_1	rel_flux_1
2	1	aligned_1	1	0	57689.61	2457690	NaN	NaN	NaN	1.345507	NaN	-19.9771	20	NaN	NaN	10.93215	1.2	15	40	80	0	2.336588	1.180663	8.809567
3	2	aligned_2	2	0	57689.68	2457690	NaN	NaN	NaN	1.172986	NaN	-20.4176	10	NaN	NaN	11.01095	1.2	15	40	80	0	2.409137	1.157323	8.616126
4																								
5	Bref	11.546																						
6	Vref	11.251																						
7																								
8	Bmag	10.62454	11.36569	9.183614	12.35135	10.1056	7.460424	11.76142	10.60799	11.27128	11.04888	10.47587	8.397813	11.48247	12.4796	12.50485	11.44094	12.59868	12.37169	12.28501	12.99377	12.83335	11.9567	12.43443
9	Vmag	10.29635	11.09236	8.91272	12.06744	9.852635	7.315812	11.53697	10.34194	11.00991	10.78158	8.321969	8.063499	10.43191	12.09482	12.16103	11.09497	10.7174	12.09854	11.93696	12.72385	12.48534	11.63673	11.83264
10																								
11	B-V	0.328198	0.273322	0.270894	0.283908	0.252966	0.144612	0.224458	0.266058	0.261373	0.267297	2.153897	0.334315	1.050552	0.384774	0.343816	0.34597	1.881277	0.27315	0.34805	0.269918	0.348015	0.319972	0.601785
12																								
13																								

$$m_2 = -2.5 \log(F_2/F_1) + m_1$$

# B-V Diagram



# Advice For Future Students

Pay attention to CCD Soft and AstroImageJ labs

Bring Finder Charts

Bring bug spray (zika)

Be patient

Be warm

Bring entertainment

Use red cellophane on devices

Twilight app for phones

Read user guide for AstroImageJ before starting



# Conclusion

Overall our project was a great learning experience to get our foot in the door for real astronomy.



Learned to

- Run a computer linked telescope
- Rotate the dome
- Take calibration images
- How to use The Sky, CCD Soft, and AstrolImageJ
- Reduce images
- Multi-aperture photometry
- Using a catelouge
- Basics of B-V diagrams