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Star Colors

Physics 135
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Abstract:

Some photometric values related to the color of Star--- and Star--- were obtained using UCSC Astronomy Advanced Lab equipment. In particular, the B-V and less accurate V-R, and R-I color indices were measured and compared to the standard star color indices from A.U. Landolt (1992) care of Paul S. Smith.

Introduction:

Color can mean a few different things to different individuals. For example, an artist may understand color to be the brain's visual perception of light reflected from a surface such as a canvas. And a physicist may view color as a direct description of a photon's frequency or wavelength. The biologist would explain why the artist sees different colors, and would also explain why the physicist's description of color is much simpler than the artist's. Fortunately astronomers have a similar view of color as the physicists, so yours and my life just got a little easier.

You know you can learn a lot of stuff from the color of a star. The color is ultimately a function of the surface temperature.

Apparatus:

This thing was done with a telescope and a CCD camera. CCD Chip (KAF-0401E, 768 (H) X 512 (V) pixel, the camera (ST-7XE/XME),

Of course I can't leave out the lovely yellow/white roof light, which was positioned approximately 15-20 ft. above ground and roughly 30 ft. away from the scope and us. (This is an item which anyone wishing to repeat this experiment should plan to leave out; however, we really had no option in the matter.)

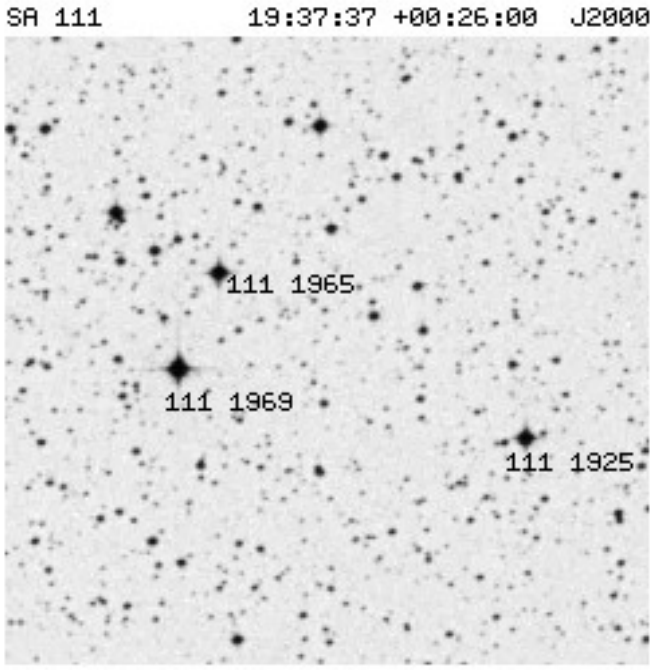
Procedure:

First found the star field we wanted and its coordinates. Then set up the telescope and CCD combination along with the connected laptops. The telescope base needed to be aligned north. The telescope was somewhat heavy. In order to find the star field more accurately, we used a process of finding relatively brighter stars in the area, centering them in the view, and then confirming the position with TheSky program. Calibrating with nearer stars enabled us a much smaller search radius than we would have if we entered in the star field's coordinates without fixing on a closer star. This is essentially minimizing the circle of error given by the object locator.

AIP4WIN failed at properly dividing the Picture – Dark by the flat, hence the data was taken without the flat fields divided. In addition, there is a bug on the lab computer, where any JIT images in the 135 student folder, will not read properly unles moved out of the directory. Hence, we used the AIP4WIN images processed, instead of the ImageJ images, which were much cleaner, yet we did not have issues with large data error.

Data:

Field Center: RA = 19:37:37
Dec = +00:26:00 (J2000)



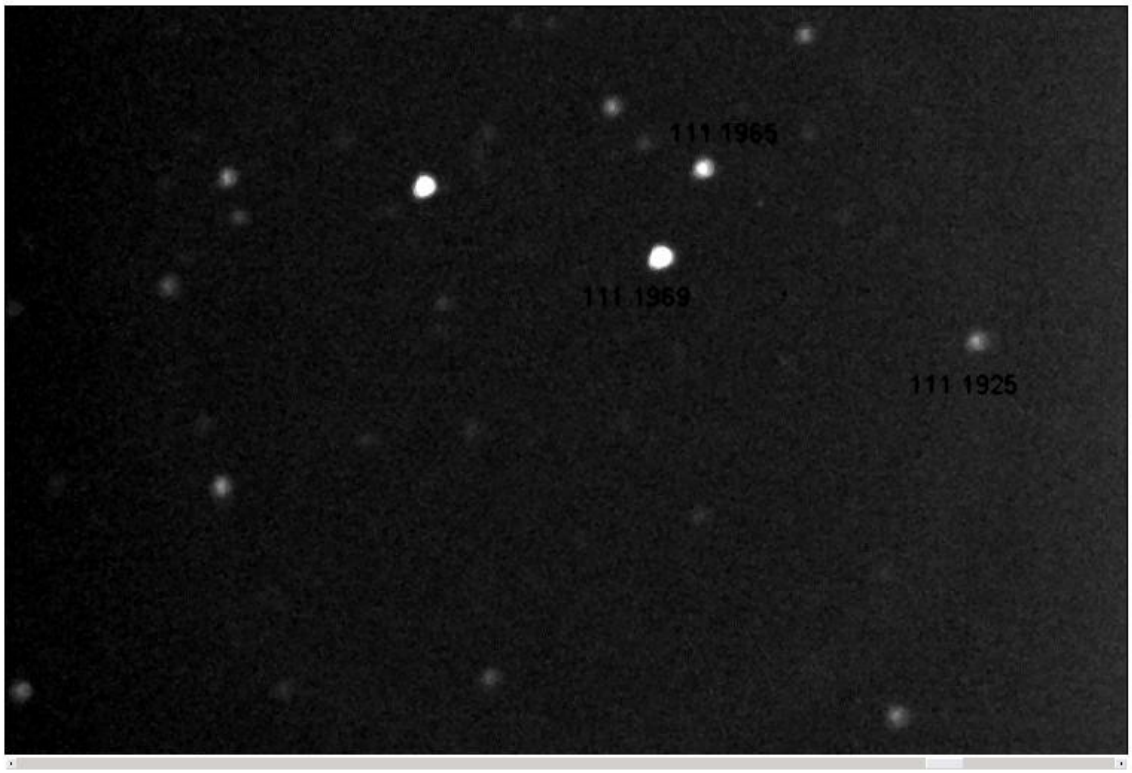
COMPARISON DATA:

Star	RA (J2000)	Dec (J2000)	*V*	*B-V*	*U-B*	*V-R*	*R-I*	Color
111 1925	19:37:29	+00:25:01	12.388	0.395	0.262	0.221	0.253	
111 1965	19:37:42	+00:26:50	11.419	1.710	1.865	0.951	0.877	**RED**
111 1969	19:37:44	+00:25:48	10.382	1.959	2.306	1.177	1.222	**RED**

OUR DATA:

Star	RA (J2000)	Dec (J2000)	*V*	*B-V*	*U-B*	*V-R*	*R-I*	Color
111 1925	19:37:29	+00:25:01	12.620	0.933	N/A	0.530	-0.700	
111 1965	19:37:42	+00:26:50	11.640	1.645	N/A	1.260	0.120	**RED**
111 1969	19:37:44	+00:25:48	10.560	1.969	N/A	1.410	0.510	**RED**

A star is classified "RED" if B-V > 1.4



Images taken at University of California Santa Cruz, Basking Engineering Roof from: ***Meade LX300gps f/10. (Processed with J-Image outlier and noise removal.***

IMAGES TAKEN 11/12/2007 3 DAYS AFTER NEW MOON 6:55 –

7:15PM Pacific Standard Time

Lunar Age	U	B	V	R	I
(days)					
0	22.0	22.7	21.8	20.9	19.9
3	**21.5**	**22.4**	**21.7**	**20.8**	**19.9**
7	19.9	21.6	21.4	20.6	19.7
10	18.5	20.7	20.7	20.3	19.5
14	17.0	19.5	20.0	19.9	19.2

Analysis:

65 Filter Color	Picture #	Mag	± sigma	Average	± sigma		Average	± sigma
IR	1	10.248	0.01					
IR	2	10.300	0.01					
IR	3	10.273	0.01					
IR	4	10.243	0.01					
IR	5	10.241	0.01	10.26	0.01			
Red	1	10.364	0.01			Red-IR	0.12	0.01
Red	2	10.379	0.01					
Red	3	10.378	0.01					
Red	4	10.397	0.01					
Red	5	10.376	0.01	10.38	0.01			
Visual	1	11.629	0.01			Visual-Red	1.26	0.01
Visual	2	11.691	0.01					
Visual	3	11.651	0.01					
Visual	4	11.608	0.01					
Visual	5	11.609	0.01	11.64	0.01			
Blue	1	13.395	0.05			Blue-Visual	1.65	0.053
Blue	2	12.614	0.024					
Blue	3	13.449	0.050					
Blue	4	13.452	0.051					
Blue	5	13.505	0.053	13.28	0.053			

25 Filter Color	Picture #	Mag	± sigma	Average	± sigma		Average	± sigma
IR	1	12.727	0.02					
IR	2	12.875	0.03					
IR	3	12.770	0.03					
IR	4	12.779	0.03					
IR	5	12.780	0.03	12.79	0.03			
Red	1	12.077	0.02			Red-IR	-0.7	0.03
Red	2	12.119	0.02					
Red	3	12.075	0.02					
Red	4	12.092	0.02					
Red	5	12.082	0.02	12.09	0.02			
Visual	1	12.616	0.02			Visual-Red	0.53	0.03
Visual	2	12.692	0.03					
Visual	3	12.624	0.03					
Visual	4	12.616	0.02					
Visual	5	12.563	0.02	12.62	0.03			
Blue	1	13.570	0.05			Blue-Visual	0.93	0.049
Blue	2	13.525	0.047					
Blue	3	13.546	0.048					
Blue	4	13.552	0.048					
Blue	5	13.581	0.049	13.55	0.049			

Star	RA (J2000)	Dec (J200	V	B-V	U-B	V-R	R-I	Color	Class
111 1969	19:37:44	+00:25:48	10.38	1.96	2.31	1.18	1.22	RED	
111 1965	19:37:42	+00:26:50	11.42	1.71	1.87	0.95	0.88	RED	
111 1925	19:37:29	+00:25:01	12.39	0.4	0.26	0.22	0.25		

Star	V	B-V	V-R	R-I					
111 1969	10.56	1.969	1.41	0.51		0.18	0.010	0.23	0.72
						0	0.000	0	0
111 1965	11.64	1.645	1.26	0.12		0.22	-0.065	0.31	0.76
						0	0.000	0	0
111 1925	12.62	0.933	0.53	-0.7		0.23	0.538	0.31	0.95

69 Filter Color	Picture #	Mag	± sigma	Average	± sigma		Average	± sigma
IR	1	8.650	0					
IR	2	8.671	0					
IR	3	8.664	0					
IR	4	8.636	0					
IR	5	8.639	0	8.65	0			
Red	1	9.139	0			Red-IR	0.51	0
Red	2	9.156	0					
Red	3	9.165	0					
Red	4	9.172	0					
Red	5	9.160	0	9.16	0			
Visual	1	10.559	0.01			Visual-Red	1.41	0.01
Visual	2	10.585	0.01					
Visual	3	10.567	0.01					
Visual	4	10.550	0.01					
Visual	5	10.559	0.01	10.56	0.01			
Blue	1	12.562	0.03			Blue-Visual	1.97	0.03
Blue	2	12.529	0.030					
Blue	3	12.516	0.030					
Blue	4	12.531	0.030					
Blue	5	12.529	0.030	12.53	0.031			

2nd

69 Filter Color	Picture #	Mag	± sigma	Average	± sigma		Average	± sigma
IR	1	8.624	0					
IR	2	8.622	0					
IR	3	8.636	0					
IR	4	8.614	0					
IR	5	8.610	0	8.62	0			
Red	1	9.129	0			Red-IR	0.52	0
Red	2	9.141	0					
Red	3	9.153	0					
Red	4	9.155	0					
Red	5	9.146	0	9.14	0			
Visual	1	10.551	0.01			Visual-Red	1.41	0.01
Visual	2	10.569	0.01					
Visual	3	10.564	0.01					
Visual	4	10.546	0.01					
Visual	5	10.553	0.01	10.56	0.01			
Blue	1	12.580	0.03			Blue-Visual	2	0.026
Blue	2	12.547	0.025					
Blue	3	12.548	0.025					
Blue	4	12.557	0.026					

				65	25			
	VIS 3	Quantity	Main star	Comp 1	Comp 2			
G =	2.3	mean	1028.4	1022.67	1028.89			
		C on	###	###	###			
		P on	1768	1768	1768			
Tint =	45	C off	1802559.1	1802559.1	1802559.1			
		P off	1768	1768	1768			
		<C back>	1019.55	1019.55	1019.55			
D =	1	C star	15653.87	5528.54	16513.12			
		N star	36003.91	12715.63	37980.18			
		m	-6.35	-5.22	-6.41	69-65=	-1.13	0.09
Zconst =		<N back>	2344.96	2344.96	2344.96	69-25=	0.06	0.27
		D*T int	45	45	45	65-25=	1.19	0.09
		σ² ro1	400	400	400			
σ ro1 =	20	σ² q1	0.44	0.44	0.44			
		sum(D12:D15)	2790.4	2790.4	2790.4			
		σ Nstar	3146.88	3143.18	3147.2			
σ q1 =	0.67	N star/σ Nstar	11.44	4.05	12.07			
		σ m	0.09	0.27	0.09			
		sqrt(D17)	52.82	52.82	52.82			
		σ PT	10.57	10.57	10.57			
		G σ PT	24.31	24.31	24.31			
		N on	###	###	4183866.1			

69=	10.564		
		69-65=	-1.087
65=	11.651	69-25=	-2.060
		65-25=	-0.973
25=	12.624		

Conclusion:

Our data was fairly close to the professionally observed data, hence the amount of time we took, to make sure outliers were cancled was key. Image processing is not an easy thing, and we realized that AIP4WIN was not capable of producing good data alone. I realized that it was perfect for magnitude calculations, but not for image processing. Image J and Iris, were much easier to use for noise reduction, but Image J had the fullest capabilities, and was able to remove outliers (Dead pixels) upon command ,and was also wonderful at despeckleing the image. As one can see, the image of the visual field provided above have little to no noise since ImageJ was used to process.

Our data was taken 3 days after a new moon, but the weather had not been the best, which can be a reason for some values being off by 10%, except that of the Infrared Readings and Ultraviolet. We were not able to gather any Ultraviolet readings at all with our filters. Additionally, our Infrared readings with proper in scaling, which helped us determine which

star had more Infrared spectrum, but the scaling was off by more than 50% at times, hence I would state that the Red, Blue and Visual filters we used with our Meade lx telescope, were fine, yet the quality of the Ultraviolet and Infrared filters we used were unacceptable, but one has to keep in mind that the atmosphere blocks a lot of UV rays, hence height is key and we were obviously not high enough in the atmosphere, and the Infrared readings could easily be disturbed by nearby cities, since my phone, and radar detectors use the IR spectrum, hence another cause for outliers. In conclusion, our Red, Blue and Visual data is pretty solid, hence stars 111-1965 and 111-1969 are indeed Red stars, and may be possibly close to Red Giant stage, but there is definitely a Red giant in Orion that should Supernova anytime soon, which will let us gather some data on neutrino mass, speed, abundance and the birth of the universe.

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References:

http://binary.ucsc.edu/dewey/classes/index.php/Physics/Astronomy_135:_Advanced_Astrophysics_Lab

http://www.astro.utoronto.ca/~patton/astro/mags.html

http://james.as.arizona.edu/~psmith/atlasinfo.html

http://james.as.arizona.edu/~psmith/charts/c125.html

http://astro.ucsc.edu/~dewey/P135/ManualsEtc/LX200GPSmanual.pdf

http://astro.ucsc.edu/~dewey/P135/ManualsEtc/ST7EManual.pdf

http://astro.ucsc.edu/~dewey/P135/ManualsEtc/kaf0401e.pdf

http://astro.ucsc.edu/~dewey/P135/ManualsEtc/s_n.pdf

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