Experiment 1: Using the Hubble Data Archive

Purpose:

The main objective of this experiment is too measure the brightness of a cluster of stars of two images of the same sky but differ in wavelength. From the brightness calculate the magnitude and construct a color-magnitude diagram which can be used to derive age, distance, and composition of a star cluster.

Data:

Image of J8NY01020:

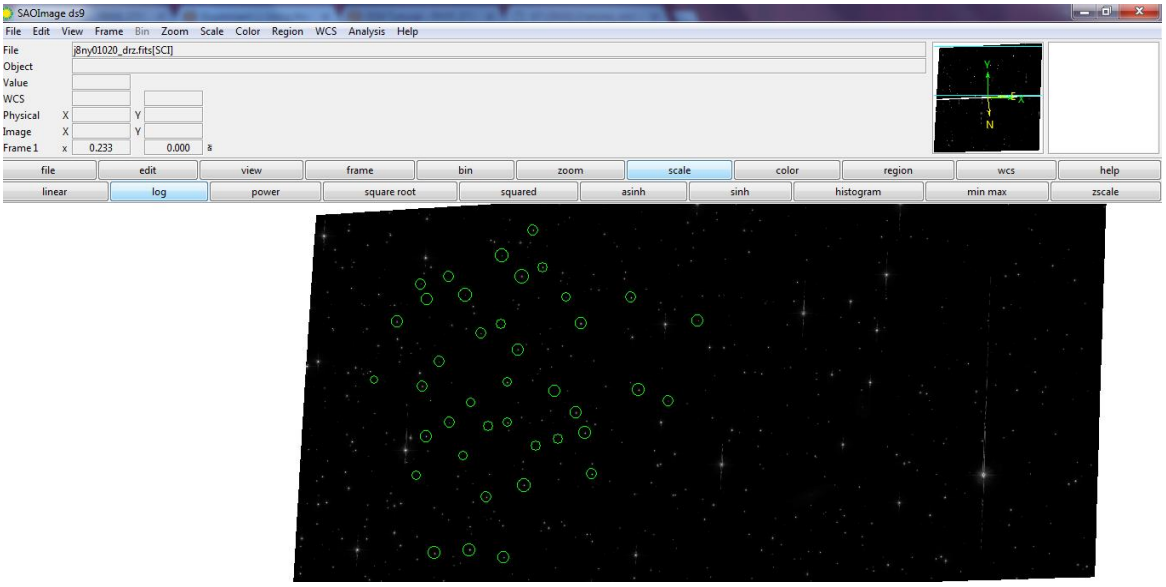
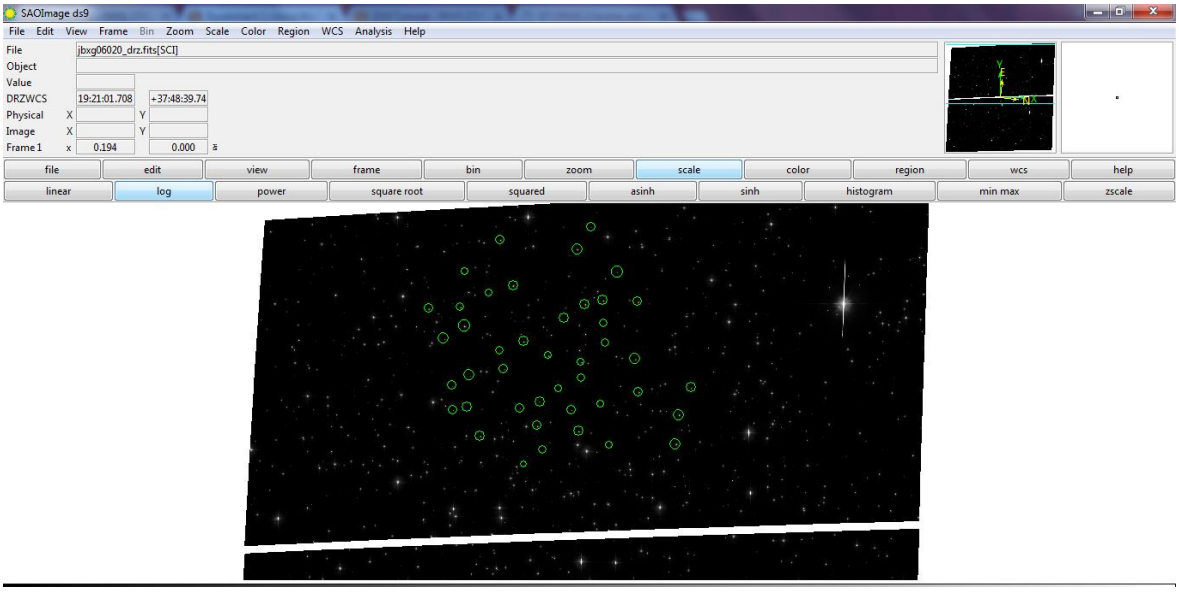


Image of JBXG06020



Coordinates	Star	Sum	Error	Sum	Error
	j8ny01020			jbxg06020	
19:20:53.678 , +37:46:10.04		45.7079	6.76076	9.91609	3.14898
19:20:54.109 , +37:46:15.17		0.68979	0.08305	0.38328	0.06191
19:20:54.278 , +37:45:56.19		3382.7	58.161	1337.46	36.5713
19:20:54.392 , +37:46:35.11		16.7608	4.094	0.73238	0.08557
19:20:54.608 , +37:46:54.82		4756.81	68.9697	1744.28	41.7645
19:20:54.667 , +37:46:25.42		3234.1	56.8691	1400.41	37.422
19:20:54.696 , +37:46:12.88		4306.59	65.6246	1627.43	40.3414
19:20:54.859 , +37:45:47.32		318.771	17.8541	91.4708	9.56403
19:20:54.964 , +37:45:51.31		34.5066	5.87423	2.64581	1.62659
19:20:55.090 , +37:46:07.04		166.304	12.8959	31.6998	5.63026
19:20:55.190 , +37:46:22.60		325.248	18.0346	90.7959	9.52869
19:20:55.312 , +37:46:12.83		555.244	23.5636	212.692	14.584
19:20:55.363 , +37:46:54.84		6365.7	79.7853	2024.62	44.9958
19:20:55.469 , +37:45:46.13		147.695	12.153	48.8803	6.99144
19:20:55.778 , +37:45:51.10		232.701	15.2545	47.7715	6.91169
19:20:55.819 , +37:46:42.03		3722.35	61.0111	1559.37	39.4889
19:20:56.044 , +37:46:01.05		575.141	23.9821	256.009	16.0003
19:20:56.080 , +37:46:57.51		2148.03	46.3469	909.96	30.1655
19:20:56.426 , +37:46:23.95		3877.24	62.2675	1636.86	40.4582
19:20:56.486 , +37:45:59.11		60.319	7.76653	7.41289	2.72266
19:20:56.497 , +37:46:13.87		3458.7	58.8107	1384.34	37.2068
19:20:56.639 , +37:45:42.19		469.996	21.6794	170.569	13.0602
19:20:56.650 , +37:46:39.93		2908.97	53.9349	1154.26	33.9744
19:20:56.790 , +37:46:06.03		2517.89	50.1786	1082.51	32.9016
19:20:56.982 , +37:46:30.39		23.5991	4.85789	0.19171	0.04378
19:20:57.022 , +37:45:47.92		6553.03	80.9508	2623.4	51.2192
19:20:57.351 , +37:45:36.64		3455.81	58.7861	1696.46	41.1881
19:20:57.464 , +37:46:29.43		56.8716	7.54132	8.7653	2.96062
19:20:57.478 , +37:45:46.06		3172.22	56.3224	1423.33	37.7271
19:20:57.481 , +37:46:17.27		25.536	5.05332	0.09150	0.030249
19:20:57.902 , +37:46:23.11		5741.54	75.7729	2105.79	45.8889
19:20:57.914 , +37:45:54.12		277.858	16.6691	65.1126	8.06924
19:20:58.042 , +37:46:28.36		3172.55	56.3254	1329.45	36.4616
19:20:58.118 , +37:46:38.76		4078.62	63.864	1739.63	41.7089
19:20:58.176 , +37:46:01.02		7823.99	88.4533	2618.86	51.1748
19:20:58.382 , +37:45:46.35		70.1872	8.37778	11.1537	3.33972
19:20:58.796 , +37:46:31.86		569.998	23.8746	231.972	15.2306
19:20:59.277 , +37:46:18.94		4360.13	66.0313	1710.44	41.3574
19:20:59.290 , +37:45:55.68		4159.95	64.4977	1718.52	41.4551
19:20:59.870 , +37:46:22.37		151.179	12.2955	29.4791	5.42947

J8NY01020 PHOTFLAM = 7.68610123333333e-20

JBXG06020 PHOTFLAM = 1.82303565e-19

PHOTZPT = -21.1

To calculate the magnitude I used m = -2.5*logF – PHOTZPT and to find F I multiplied the respective PHOTFLAM of the image with the total pixel sum number. To find the error used the first method where used the error ds9 gives of the total pixel sum and found the upper and lower limit of the flux. So for example for the first coordinate of J8NY01020 the total pixel count is 45.7079 with an error of 6.76076. That means the upper bound would be 52.46866 and the lower bound will be 39.94714. Then with the upper and lower bound I plugged it into the equation for finding the magnitude to obtain the upper and lower limits of the error for magnitude. Below are the numbers for the magnitude, error, upper, lower limit of J8NY01020 and JBXG06020.

jbxg06020	magnitude	error +/-	Upper	Lower
	21.598034	0.323561	21.92159	21.27447
	26.151207	0.262727	26.41393	25.88848
	16.924853	0.037339	16.96219	16.88751
	22.687275	0.541348	23.22862	22.14593
	16.554723	0.031487	16.58621	16.52324
	16.973628	0.038188	17.01182	16.93544
	16.662678	0.033092	16.69577	16.62959
	19.489315	0.12175	19.61106	19.36757
	21.903257	0.373295	22.27655	21.52996
	20.195755	0.168724	20.36448	20.02703
	19.467476	0.120529	19.588	19.34695
	18.886802	0.092209	18.97901	18.79459
	16.238397	0.027218	16.26561	16.21118
	20.324598	0.179083	20.50368	20.14551
	19.831016	0.142553	19.97357	19.68846
	16.820969	0.035595	16.85656	16.78537
	18.848576	0.090598	18.93917	18.75798
	17.417911	0.04686	17.46477	17.37105
	16.776705	0.034876	16.81158	16.74183
	21.296877	0.281154	21.57803	21.01572
	16.90073	0.036927	16.93766	16.8638
	19.067777	0.100234	19.16801	18.96754
	17.088664	0.040266	17.12893	17.0484
	17.24542	0.043281	17.2887	17.20214
	22.315773	0.453478	22.76925	21.8623
	16.206907	0.026826	16.23373	16.18008
	16.901637	0.036942	16.93858	16.8647

	21.360773	0.289649	21.65042	21.07112
	16.994604	0.038558	17.03316	16.95605
	22.23013	0.435458	22.66559	21.79467
	16.350441	0.028659	16.3791	16.32178
	19.638455	0.130426	19.76888	19.50803
	16.994491	0.038556	17.03305	16.95593
	16.721729	0.034004	16.75573	16.68772
	16.014441	0.02455	16.03899	15.98989
	21.132367	0.260436	21.3928	20.87193
	18.858329	0.091006	18.94934	18.76732
	16.649264	0.032888	16.68215	16.61638
	16.700292	0.03367	16.73396	16.66662
	20.299283	0.176998	20.47628	20.12229

j8ny01020	magnitude	error +/-	Upper	Lower
	24.194884	0.714271	24.90915	23.48061
	27.72693	0.353845	28.08078	27.37308
	18.870033	0.059391	18.92942	18.81064
	27.023891	0.254902	27.27879	26.76899
	18.581694	0.052003	18.6337	18.52969
	18.820097	0.05804	18.87814	18.76206
	18.656979	0.053838	18.71082	18.60314
	21.782529	0.227878	22.01041	21.55465
	25.629338	1.55601	27.18535	24.07333
	22.933093	0.389813	23.32291	22.54328
	21.790569	0.22873	22.0193	21.56184
	20.866357	0.149129	21.01549	20.71723
	18.419876	0.048267	18.46814	18.37161
	22.4629	0.312734	22.77563	22.15017
	22.487813	0.316394	22.80421	22.17142
	18.703362	0.055001	18.75836	18.64836
	20.665097	0.135892	20.80099	20.5292
	19.288179	0.072011	19.36019	19.21617
	18.650706	0.053683	18.70439	18.59702
	24.510766	0.836633	25.3474	23.67413
	18.832628	0.058377	18.891	18.77425
	21.105984	0.166592	21.27258	20.93939
	19.029976	0.063933	19.09391	18.96604
	19.099655	0.06602	19.16567	19.03364
	28.479072	0.504835	28.98391	27.97424
	18.138573	0.042401	18.18097	18.09617

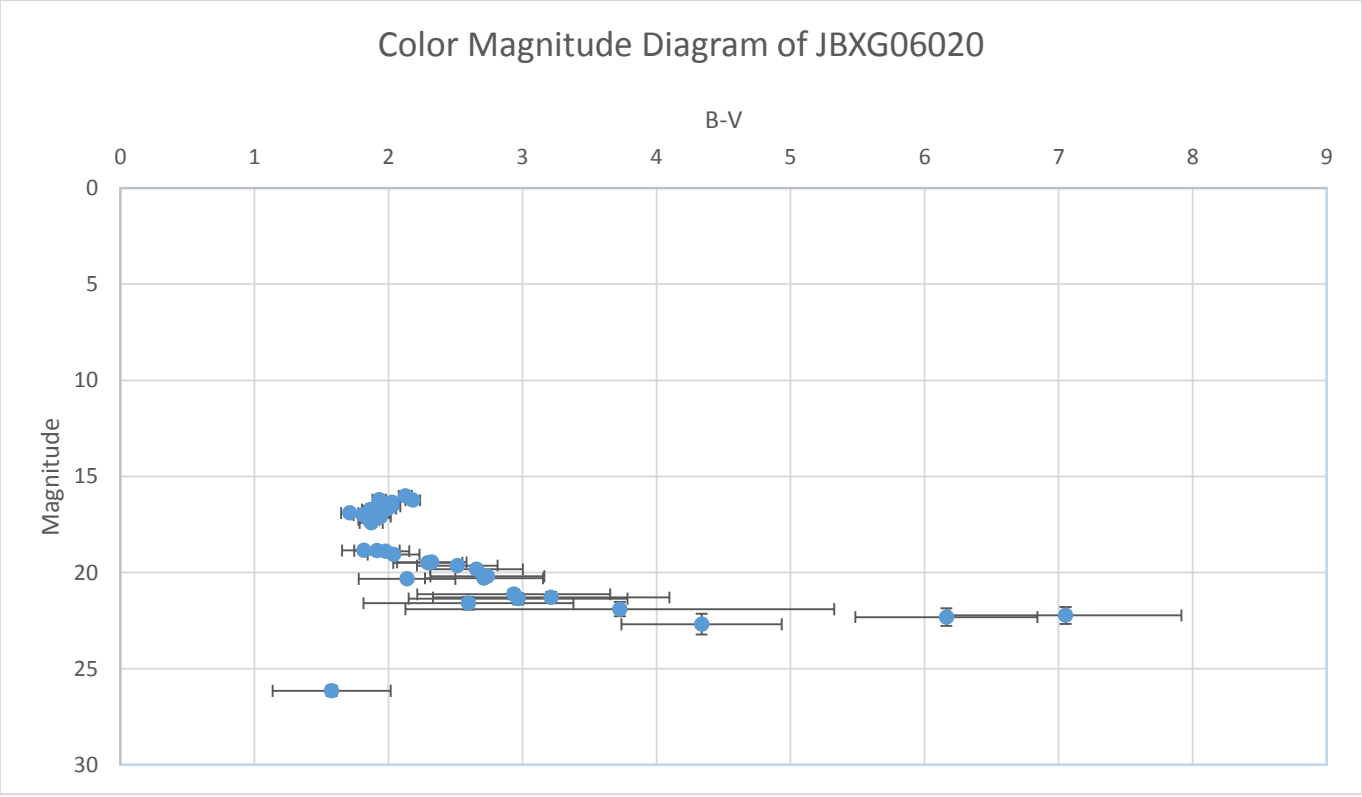
18.611876	0.052731	18.66461	18.55914
24.328818	0.763422	25.09224	23.5654
18.802471	0.057571	18.86004	18.7449
29.282175	0.745878	30.02805	28.5363
18.377197	0.047328	18.42452	18.32987
22.151572	0.270496	22.42207	21.88108
18.876555	0.05957	18.93612	18.81698
18.584593	0.052073	18.63667	18.53252
18.140454	0.042438	18.18289	18.09802
24.067187	0.670746	24.73793	23.39644
20.772146	0.142778	20.91492	20.62937
18.602965	0.052515	18.65548	18.55045
18.597848	0.052392	18.65024	18.54546
23.011949	0.404559	23.41651	22.60739

To calculate the B-V I subtracted J8NY01020 – JBXG06020 since J8NY01020 is the bluer wavelength. To find the errors of the color I used the square root of the sum of the squares of the individual errors. For example for the first coordinate the error of J8NY01020 is 0.714271 and the error of JBXG06020 is 0.323561 so the absolute error for the color of that star is (0. 714271^2 + 0.323561^2)^(1/2) which equals to 0.78414.

Color	error +/-
2.59685	0.78414
1.575723	0.440718
1.945179	0.070154
4.336615	0.598358
2.026972	0.060792
1.846468	0.069476
1.994301	0.063195
2.293213	0.258363
3.726081	1.600161
2.737338	0.424761
2.323094	0.258543
1.979554	0.175334
2.181479	0.055413
2.138302	0.36038
2.656796	0.347025
1.882393	0.065514
1.81652	0.163324
1.870268	0.085916
1.874001	0.064017
3.213889	0.882611

1.931898	0.069075
2.038208	0.194422
1.941312	0.075557
1.854235	0.078942
6.163298	0.678602
1.931667	0.050175
1.710238	0.064384
2.968044	0.816522
1.807867	0.06929
7.052045	0.863688
2.026756	0.055329
2.513117	0.300298
1.882064	0.070959
1.862864	0.062192
2.126013	0.049027
2.93482	0.719533
1.913817	0.169315
1.953702	0.061963
1.897556	0.062278
2.712666	0.441584

Analysis:



From the color magnitude diagram it seems that most of the starts have a B- V of around 1.8-2 and looking at table for Intrinsic Color of Main Sequence Stars oldest starts of 300 Gyears have a B-V of 1.64. With that being said my data consist of the cluster having a B-V of at least 1.8 meaning the age of the cluster must be at least 300Gyears. One big cause this discrepancy is the star in one image has at times drastically different from the other image. For example JBXG06020 has a magnitude of a star at 22.23013 while J8NY01020 records it at 29.282175. Here is a look of the star in their respective images:

J8NY01020:

JBXG06020:

As seen above the same star on JBXG06020 is significantly dimmer. The total pixel sum of this star is 0.0915006 on the JBXG06020 image and 25.536 for J8NY01020. Meaning there is a difference on the order of 3 magnitudes between the two images. This star accounts for the biggest discrepancy between the two starts and is the reason why in the color-magnitude graph a star all the way to the right of the graph. As a result the same stars on both images differ by large amount for certain stars. To calculate the distance if we take the most left point of the diagram with a B-V of 1.57 then that would make it a M5 star. Meaning its apparent magnitude is 13.94 and just by plugging into the equation.

It's also important to mention that every B-V for all the stars are greater than 0 meaning that by chance every star that I picked have redder magnitudes then that of blue.

m – M = 5*log(d) – 5 the distance of that star comes to 27.68 parsecs +/- 3.36 parsecs to find the error of the distance I took the upper and lower limit of the magnitude then I calculated the upper and lower limit of the distances and used the average difference as the distance error.

Conclusion:

To conclude there seems to be a handful of outliers in the x-axis with a b-v of >3 and if assume that all the stars that I picked are main sequence stars they fall out of the appendix for intrinsic colors of main sequence starts. A possible explanation for these outliers is when switching between images the total pixel sum of the same star has a drastically different magnitude. This has a snowball effect when calculating the magnitude which results in a large b-v number. However majority of the starts lie within the 1.5-2.0 range but that would mean every star I picked are M5 stars.