ANALYSIS OF PHYSICAL PROPERTIES OF OPEN CLUSTER M45 BY CCD PHOTOMETRY TECHNIQUE

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Abstract

In this work, the open cluster M45 was observed by CCD photometry technique using a standard UBV filter via Ritchey-Chretien Telescope, which has a diameter of 0.5 meter. The author measured data have to be analyzed by using IRIS program, shows that the true apparent magnitudes of the 30 stars in the visual and blue wavelength bands range from 8.244 to 9.000, and 8.278 to 9.005, absolute magnitudes in the visual and blue wavelength bands range from 2.544 to 3.300, and 2.578 to 3.338, respectively. The color indices range from   -0.773 to 0.955. And standard published color indices and magnitude diagrams for the 30 stars were used. In order to obtain a Hertzsprung - Russell diagram (H-R diagram) of certain stars, was sufficient to calculate the distance of the open cluster M45 from earth at 138.038 parsecs, and its age at 1.6 x 10^8 years.

Keywords: cluster M45, CCD photometry, IRIS proggram

Introduction

The study of astronomy is intended to studies the properties of celestial objects. A measurement of one basic quantity sent from celestial objects is the energy exported in the form of Electromagnetic radiation (Electromagnetic radiation). One of the goals of the astronomical observations is to measure the amount of electromagnetic radiation object from the sky to the detailed and the most accuracy. The process of measuring energy transmitted from a celestial object in the form of electromagnetic radiation is called photometry. [1].

Photometric method is a way to measure the amount of electromagnetic radiation from a celestial object using an electronic device called a Charge Couple Device or CCD. The advantage of this method is that it can capture multiple stars at one time and with high precision.[1]. This study is a photometrical experimental research. To measure the magnitude, the absolute magnitude of the wavelengths of yellow and blue light, and the color index of the open cluster M45, will be generated with H-R diagram to calculate the distance and its age.

Experiment
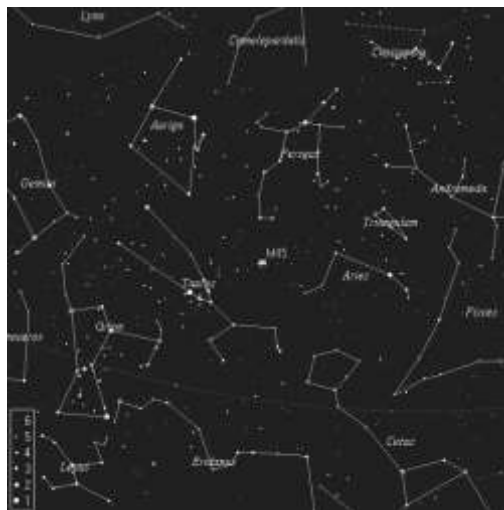
Research Objectives.
(1). Select stars to study.

Figure 1. The open clusters M45. Source: http://messier.seds.org/Pics/Map/tau_[7].
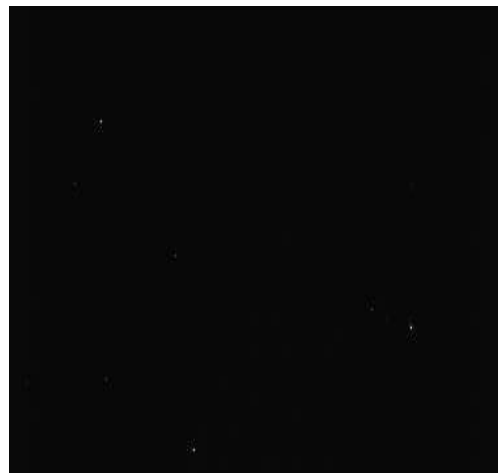

Figure 2. The open clusters M45

(2). Photometry Reduction, the IRIS image data is as follows.

2.1 Open the IRIS program by selecting File> Settings and selecting the file you want to analyze.

2.2 Click on the icon ⊟ to print the command. To print the command set is> smedian bias09 3 and press Enter to find the center of intensity in the file set preceded by bias09, 3 files as shown in Figure 3.
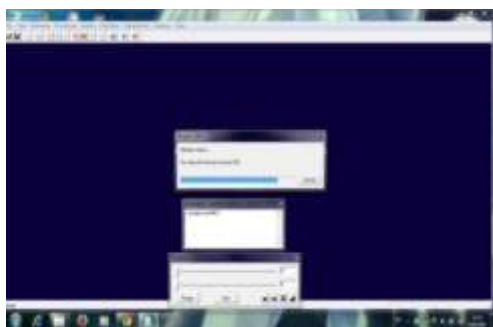

Figure 3. Finds the mean value of the intensity in the file set preceding bias09 all 3 files.
Source: IRIS program.

2.3 Type in the command> save bi> Enter and type> fill250. Enter and type save mbias> press Enter.

2.4. Type in the command > Offset2 f09 flav -250 3 Add -250 to the file f09.fit, which is a flat file of 3 images by renaming it to flav.fit.

2.5 Type in the command > ngain2 flavffv 29500 3 to normalize the center of the image Flav.fit of 3 images to a base of 29,500, which is the value derived from the median value of flav.fit by renaming it to ffv.fit.

2.6. Type in the command> smedianffv 3 to find the middle of the light needle in the three prefixed ffv files, and then type > save mflatv to save the new file as mflatv.fit as shown in Figure 4.

Figure 4. Shows the mean value of the light needle in set of file and save a new filename
Source: IRIS program

2.7 Type in the command > smedian dark09 3 to find the center of the brightness values for all three images of each pixel.

2.8. Type the command> sub mbias 0 to remove the brightness of each pixel with mbias, then type> save dark to save the new file.

2.9. Type the command> load al091 to load one image file because reducing the signal interference at the picture. And type> sub dark 0 to remove the brightness of each pixel with dark

2.10 Type the command> bivmflatv 97500 and type save > reducal to save the new filename as the end of the photometry reduction process with IRIS.

(3). The measurement of apparent magnitude of the star member in the star cluster.

3.1 Select the Analysis menu> Aperture Photometry menu. The window will show, then sets the radius to 3 circles and sets the Magnitude constant to 20 which is the standard value. When clicked OK, a circular mark will appears. Then click on the star at the star's location. The magnitude of the star will display as shown in Figure 5.

3.2. Analyze data of filter V and filter B according to the above procedure as shown in Table 1.
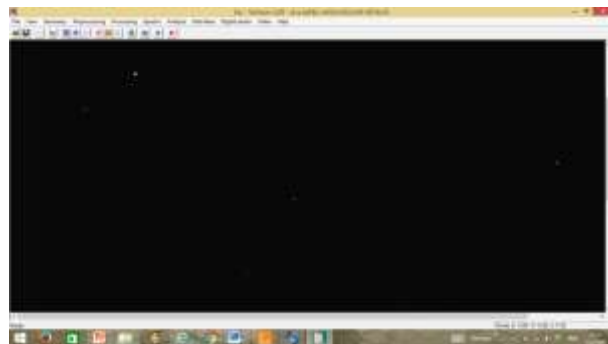
$$m - n = 2.5\log(\frac{b_n}{b_m}) \qquad (1)$$

Figure 5. Shows of the analysis results

Results and Discussions

Analysis of the color index and absolute magnitude of the open cluster M45.

1. Find out the color index of the difference when measured with two optical devices with optical response. Color index (CI) = B - V

2. The apparent magnitude is displayed in the blue light wavelength range. Wavelength light visual and the color index obtained. When writing an H-R diagram between the values displayed in the

wavelength range, the visual light and the color index will be graphed as Figure 6.

3. Analysis of the distance traveled by the main constellation of the constellation M45 star cluster, shown in Figure 7.

4. The distance modulus is 5.7 when calculated according to the equation. [2].

$$m - M = 5 \log(d) - 5 \qquad (2)$$

Instead of the modulus, d = 138.038 pc

5. Finding the absolute magnitude of the constellation M45 star member in Table 1 from the equation

$$M = m - 5 \log(d) + 5 \qquad (3)$$

6. From Table 1 of the open cluster M45, the absolute magnitude and the color index are written, H-R diagram which is shown in graph Figure 8.

7. From the H-R diagram, relationship between absolute magnitude and the color index, if compared to the evolutionary path of the star and the turn-off point to the lateral time dimension of the H-R diagram is shown in Figure 9.[3].

By estimating the age of the open cluster M45, the age of M45 is approximately 1.6×10^8 years.
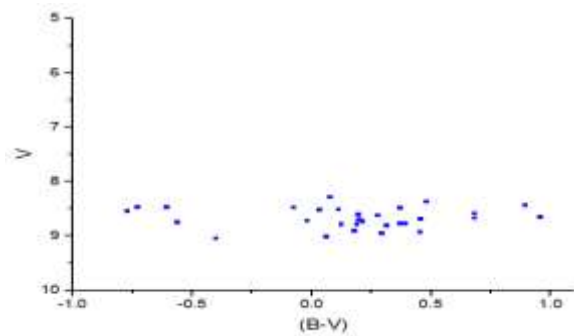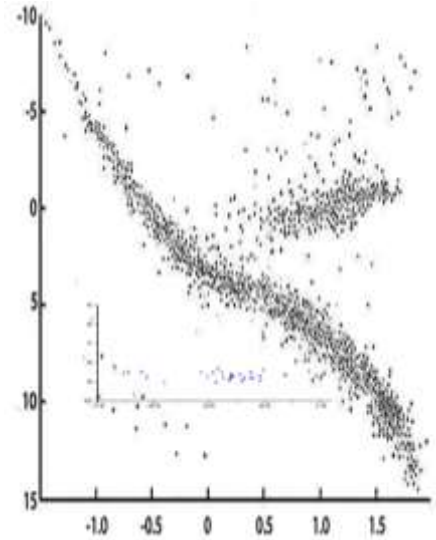

Figure 7. H-R diagram of the M45 cluster member
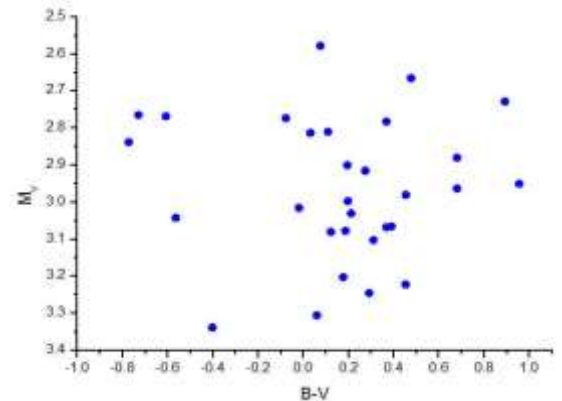
Figure 8. H-R diagram shows the relationship between absolute magnitude and the color index.

Figure 6. H-R diagram of a member of open cluster M45

Table 1. Shows the magnitudes of the Iris program and the apparent magnitude absolute magnitude values and color indices in the wavelengths B and V of the constellation M45.

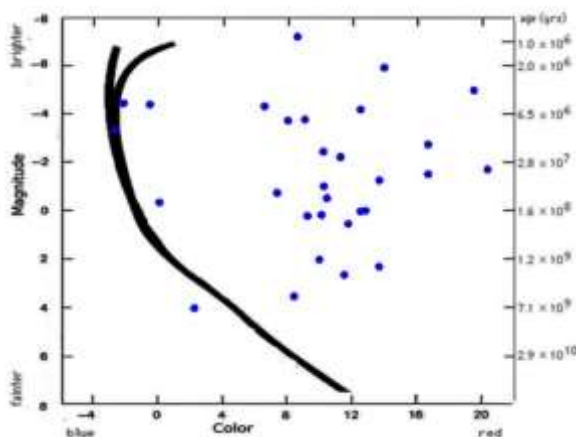| Number	Name	Apparent magnitude B	Apparent magnitude V	Absolute magnitude B	Absolute magnitude V	Color Index
1.	A	8.979	8.945	3.279	3.245	0.291
2.	B	8.465	8.513	2.765	2.813	0.031
3.	C	8.472	8.482	2.772	2.782	0.367
4.	D	8.685	8.365	2.985	2.665	0.477
5.	E	8.857	9.038	3.157	3.338	-0.403
6.	F	8.513	8.428	2.813	2.728	0.892
7.	G	8.816	8.765	3.116	3.065	0.390
8.	H	8.685	8.715	2.985	3.015	-0.020
9.	I	8.633	8.697	2.933	2.997	0.197
10.	J	8.750	8.580	3.050	2.880	0.680
11.	K	8.607	8.742	2.907	3.042	-0.565
12.	L	8.734	8.680	3.034	2.980	0.454
13.	M	9.000	9.005	3.300	3.305	0.059
14.	N	8.244	8.278	2.544	2.578	0.075
15.	O	8.787	8.767	3.087	3.067	0.367
16	P	8.629	8.730	2.929	3.030	0.211
17	Q	8.755	8.650	3.055	2.950	0.955
18	R	8.908	8.902	3.208	3.202	0.176
19	S	8.487	8.510	2.787	2.810	0.109
20	T	8.888	8.615	3.188	2.915	0.274
21	U	8.896	8.468	3.196	2.768	-0.609
22	V	8.484	8.465	2.784	2.765	-0.730
23	W	8.853	8.802	3.153	3.102	0.310
24	X	8.410	8.473	2.710	2.773	-0.078
25	Y	8.882	8.922	3.182	3.222	0.452
26	Z	8.727	8.663	3.027	2.963	0.680
27	AA	8.732	8.600	3.032	2.900	0.194
28	BB	8.409	8.538	2.709	2.838	-0.773
29	CC	8.785	8.777	3.085	3.077	0.186
30	DD	8.757	8.780	3.057	3.080	0.121

Figure 9 compares the turn-off point of an open cluster M45 with the time scale

Conclusion

From the analysis of the apparent magnitude of the members of the open cluster M45 in the blue (B) and the visual (V) wavelengths, the open cluster M45 in the blue wavelength range is in the range of 8.278 to 9.005 and the visual wavelength (V) range is from 8.244 to 9.000, and found out that the star from the program is close to the star's standard. Stars obtained from the IRIS program have absolute magnitudes in the visual and blue wavelength bands range from 2.544 to 3.300, and

2.578 to 3.338, The color indices range from -0.773 to 0.955.

Standard published color indices and magnitude diagrams for the 30 stars were used. In order to obtain a Hertzsprung - Russell diagram (H-R diagram) of certain stars to find the distance by Main Sequence Fitting, was sufficient to calculate the distance of an open cluster M45 from earth at 138.038 parsecs, and its age at 1.6×10^8 years.

References

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[3]   B.W. Carrol, and D.A., Ostile, *An Introduction to Modern Astrophysics*. (United State of *America*: Addison - Wesley Publishing Company, 1996).

[4]   http://messier.seds.org/Pics/Map/tau.

[5]   http://simbad.u-strasbg.fr/simbad/