Case Study of Star Clusters Pleiades and Hyades and their properties

What's A star Cluster?

- It's a group of stars that share a common origin and are nearly the same age.
- It's useful to study the evolutionary track of its stars since they all originate from the same chemical composition and nearly the same distance from us.

Pleiades and Hyades in Greek Methodology

- The legend says that Pleiades are the seven daughters of Titan Atlas and Pleione. After the death of their siblings, Hyades, they would kill themselves from sadness, but Zeus, the ruler of the gods, immortalized them by transferring them to stars, who formed the constellation we know today.

Through Hipparcos Catalog at the NASA's Archive, I could obtain the observable properties (B_V Color and visual magnitude) of 100 stars from the two clusters, to display H-R Diagram for both of them.

Main Search Form — Catalog(s) Search — Tip Archive — Hera — HELP

Description	Catalog	Data	Default Radius (arcmin)	Mission	Table Type
Hipparcos Main Catalog	hipparcos	N	1	STAR CATALOG	Object

1. Enter any constraints on the query below. Help on constraint syntax
(What about wildcards, spaces, and case sensitivity?)
2. To change the fields that are returned, select the box in the 'View' column beside each field desired.
3. To sort the results by any field, select one box in the 'Sort' column beside the field to sort on. Examples of query constraints:

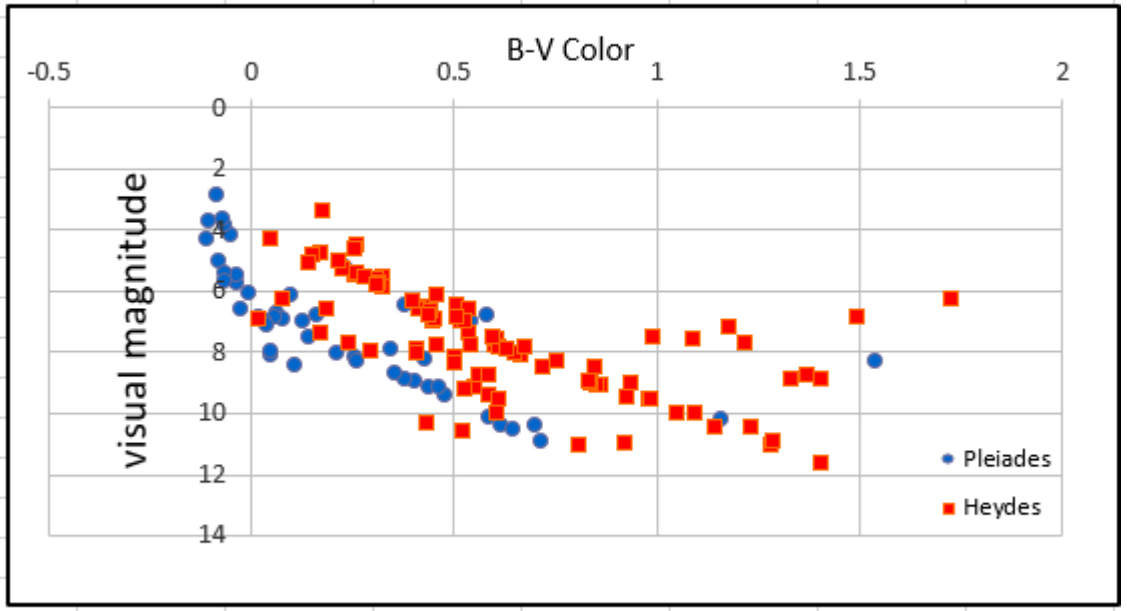
View All	Sort	Parameter (Unit)	Query Terms	Min Value	Max Value	Value Type
☑	○	name		HIP 1	HIP 99999	string
☑	○	ra		00 00 00.2188	23 59 54.9101	position
☑	○	dec		-89 46 56.834	+89 34 09.871	position
☑	○	pm_ra (mas/yr)		-4410.79	6767.26	float
☑	○	pm_dec (mas/yr)		-5813.00	10326.93	float
☑	○	parallax (mas)		-54.95	772.33	float
☑	○	spect_type		(G3w)F7	sdO:	string

Hertzsprung-Russell (H-R) diagram

- It’s the most powerful tool in astrophysics to graph the stars according to their Luminosity (magnitude) and Surface Temperature (B-V Color).

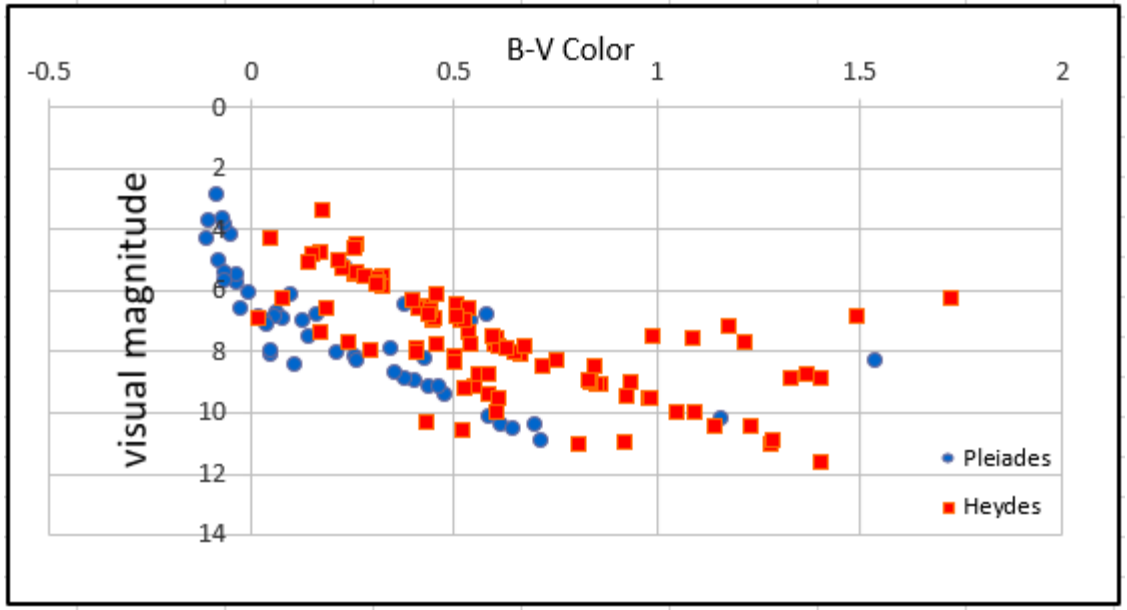
The data are downloaded in Excel sheet and can then be plotted on H_R diagram as shown

1	bv_color Hyades	vmag Hyades	bv_color Pleiades	vmag Pleiades
3	0.509	6.44	0.066	6.83
4	0.537	7.41	-0.051	4.14
5	0.179	3.4	-0.063	3.87
6	1.408	11.66	0.542	6.98
7	0.808	11.05	0.021	6.83
8	0.536	6.59	0.128	6.96
9	0.324	5.58	-0.105	3.72
10	1.231	10.47	-0.07	3.62
11	0.664	8.1	-0.082	5.05
12	0.258	5.47	-0.036	5.76
13	0.17	4.78	0.377	6.47
14	0.428	6.5	-0.034	5.45
15	0.651	8.04	-0.11	4.3
16	0.865	9.08	-0.027	6.62
17	0.295	7.98	0.063	6.73
18	1.494	6.86	-0.067	5.44
19	0.599	7.79	-0.064	5.66
20	0.325	5.9	0.347	7.93
21	1.408	8.89	0.078	6.95



More than plotting the data is analyzing it

- The plot for each cluster represents stars from nearly the same age but they are on different evolutionary level. This difference depends on the initial mass the star formed with. The higher the mass the faster its evolution and death. However, the stars seem to be arranged in a straight line, which represent the main life period of the star (Main Sequence).



- The dots on the upper left side represent stars with high temperature and high brightness and these values decrease as the stars move to down right side, approaching the star’s death.

What else can we obtain from the diagram?

We can know that Hyades is closer to the earth: for every two stars (one from Hyades and one from Pleiades) with the same BV Color, Hyades's star has less visual magnitude which means more brightness. Since the brightness of any light source decreases with the distance, Hyades's star is closer to the earth.

The distance to Hyades is known (47 parsec), so we can calculate the distance to Pleiades by taking two points with similar BV color each from one cluster and substitute in the following law

From Pleiades: (0.463, 9.17) From Hyades: (0.45, 6.96)

$$m2 - m1 = 5log(\frac{d2}{d1}) \quad (1)$$

$$9.17 - 6.96 = 5log(\frac{d2}{47}) \quad (2)$$

$$d2 = 2.7669 \times 47 = 130 \quad (3)$$

So, the distance to Pleiades is estimated to be $130\ parsec$ or nearly $4 \times 10^{15}\ km$.