Star Clusters

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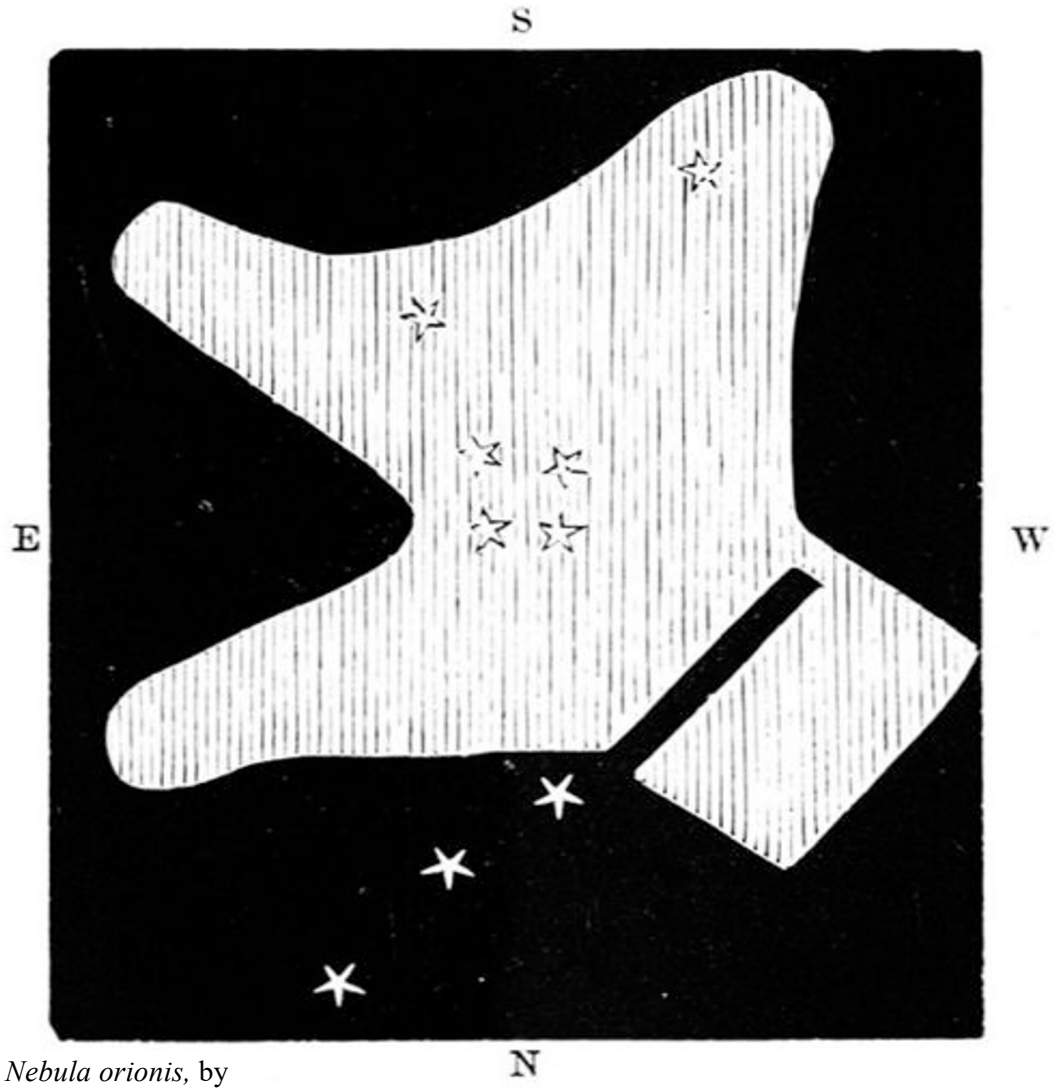
1749: Le Gentil identified 5 nebulous objects (3 were star clusters)



Nebula orionis, by Le Gentil

Star Clusters

Charles Messier, 1781:

101 nebulous objects (a few dozen clusters)

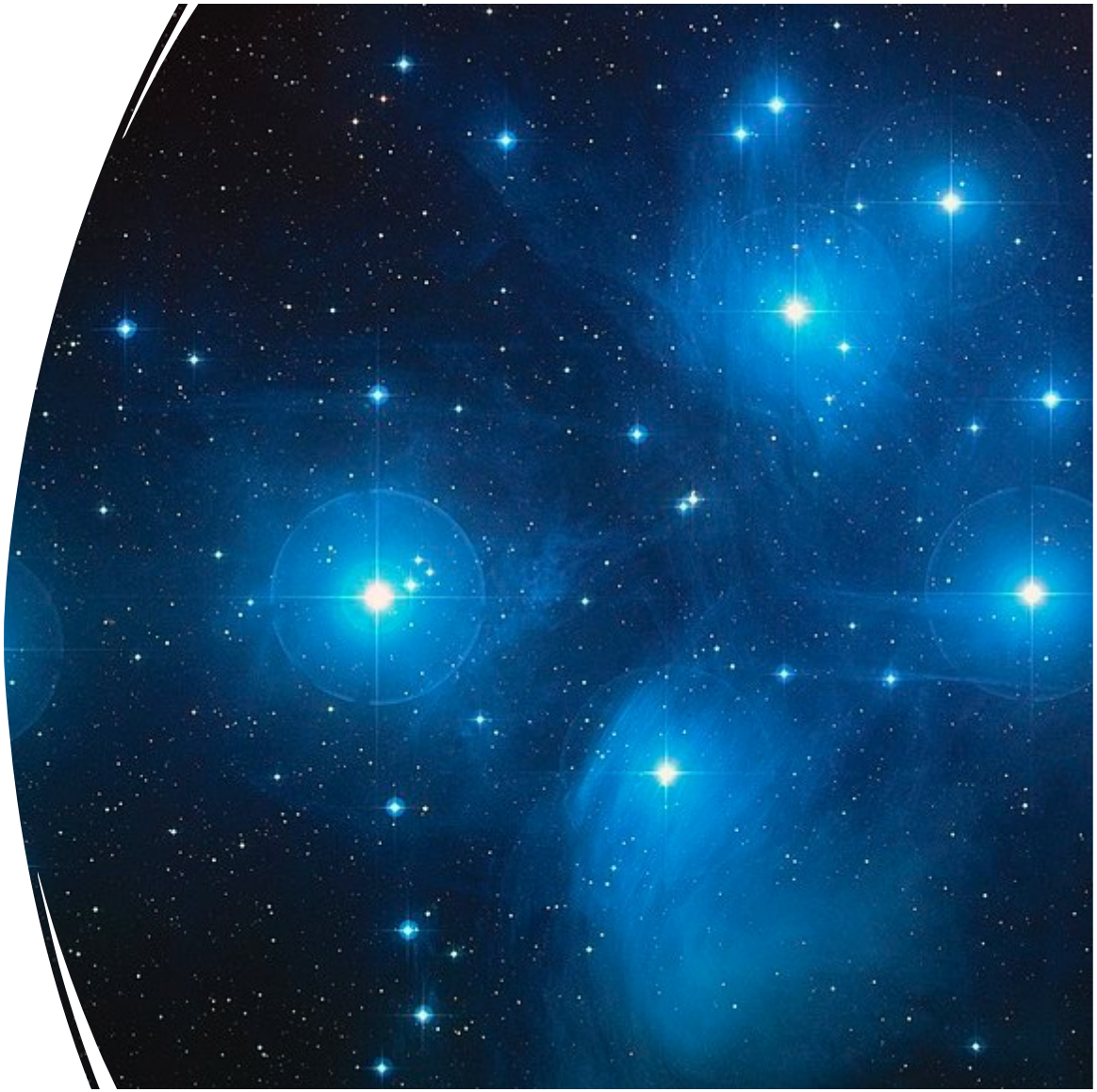
Two Types of Clusters

- **Globular clusters**
  - Centrally condensed, spherical objects
  - Contain an uncountable number of stars (tens of thousands to hundreds of thousands)
  - Named by John Herschel in 1859

- **Open clusters**
  - Irregular shapes
  - Countable (dozens to hundreds) of stars

Galactic ('Open') Clusters

- 100's of stars
- Irregular shapes
- Gas or nebulosity is sometimes seen
- Younger clusters (less than a few hundred million years old)
- Found in disc of the Galaxy

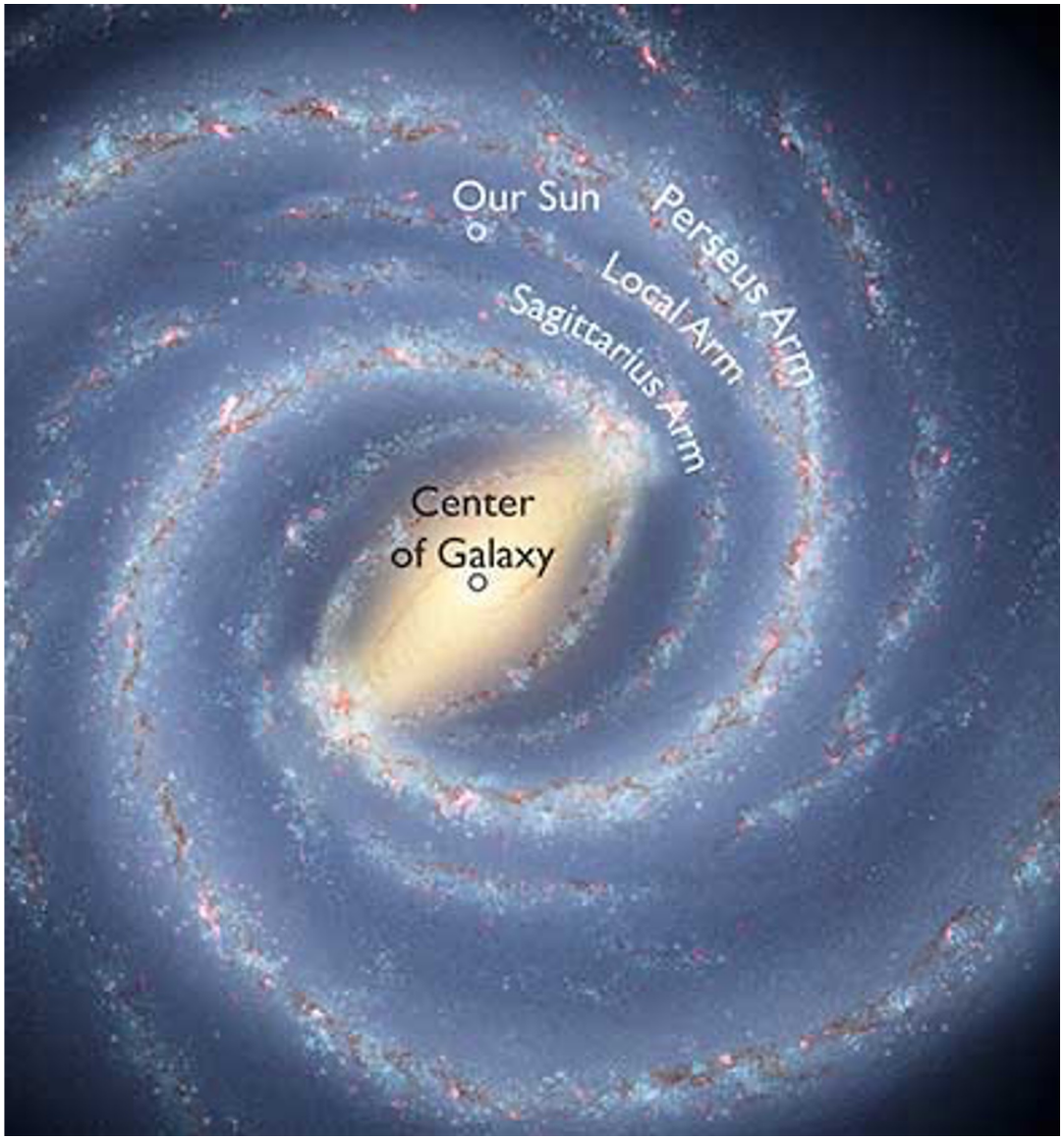


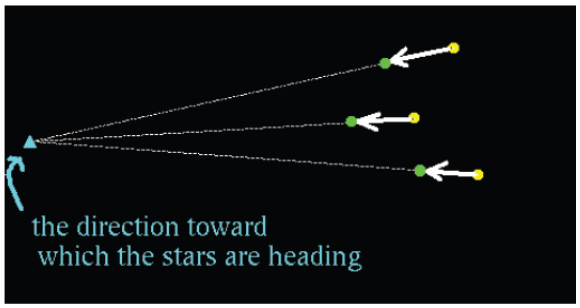
Globular Clusters

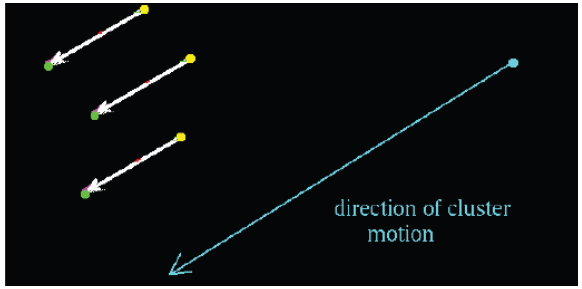
- 10^5-10^6 stars
- Spherical shape
- Centrally condensed
- NO gas or nebulosity
- Found in the Halo
- Formed when galaxy was young (some of the oldest objects found in a galaxy)

Cluster Questions

- What holds them together?
- What must control whether a cluster survives for billions of years or is dispersed after perhaps 100 million years?







How Do We Assess Cluster Membership?

Proper Motion!

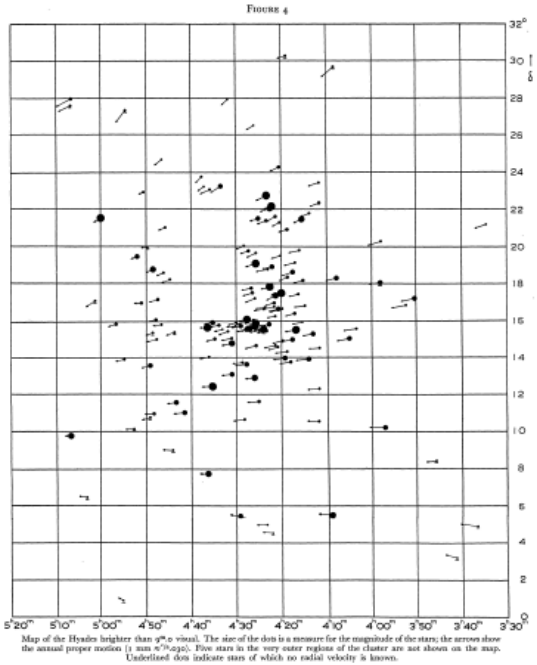
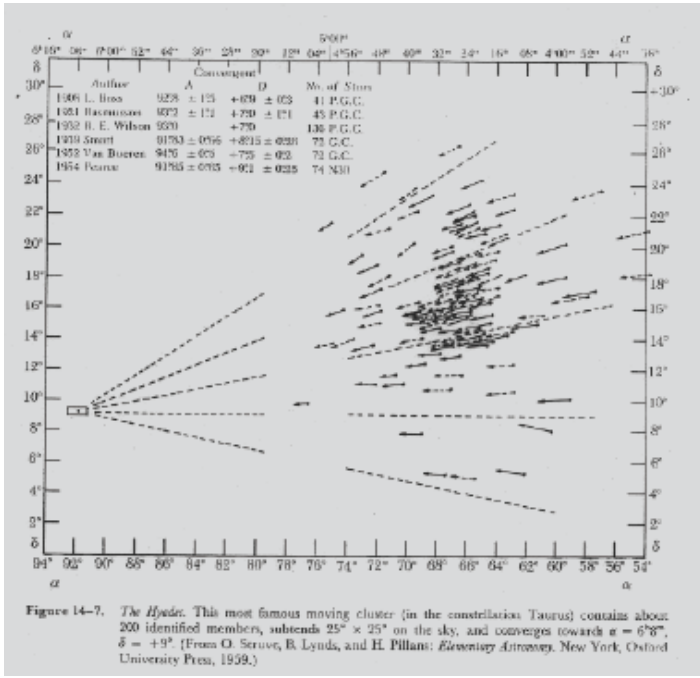


FIGURE 4

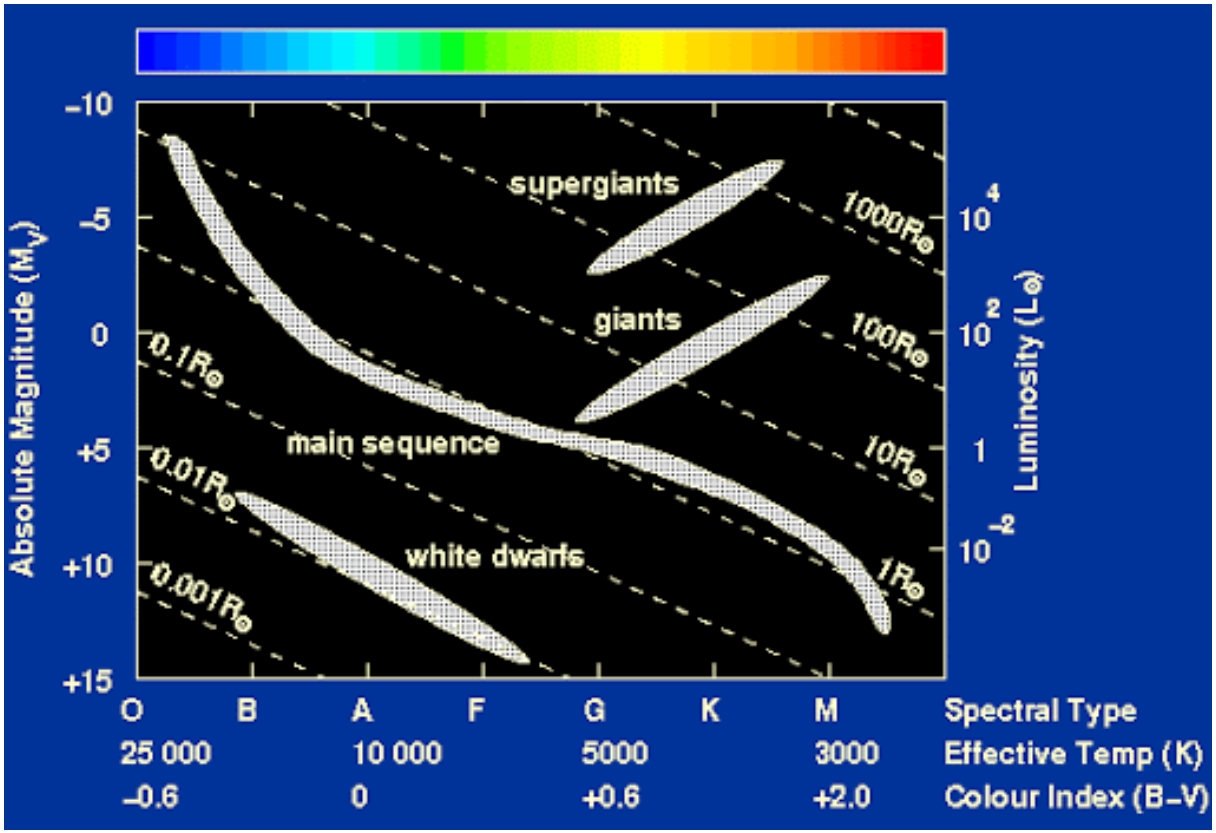
Map of the Hyades brighter than 9m.0 visual. The size of the dots is a measure for the magnitude of the stars; the arrows show the annual proper motion (1 mm = 0".030). Five stars in the very outer regions of the cluster are not shown on the map. Underlined dots indicate stars of which no radial velocity is known.



Author	A	D	No. of Stars
1906 L. Boss	9258 ± 15	+679 ± 03	41 P.G.C.
1951 Bacmeister	9272 ± 12	+739 ± 11	45 P.G.C.
1952 R. E. Wilson	9270	+770	136 P.G.C.
1939 Smart	91783 ± 0056	+8215 ± 0038	72 G.C.
1952 Van Bueren	9476 ± 009	−755 ± 012	72 G.C.
1954 Pearce	91785 ± 0015	+912 ± 0225	74 N30

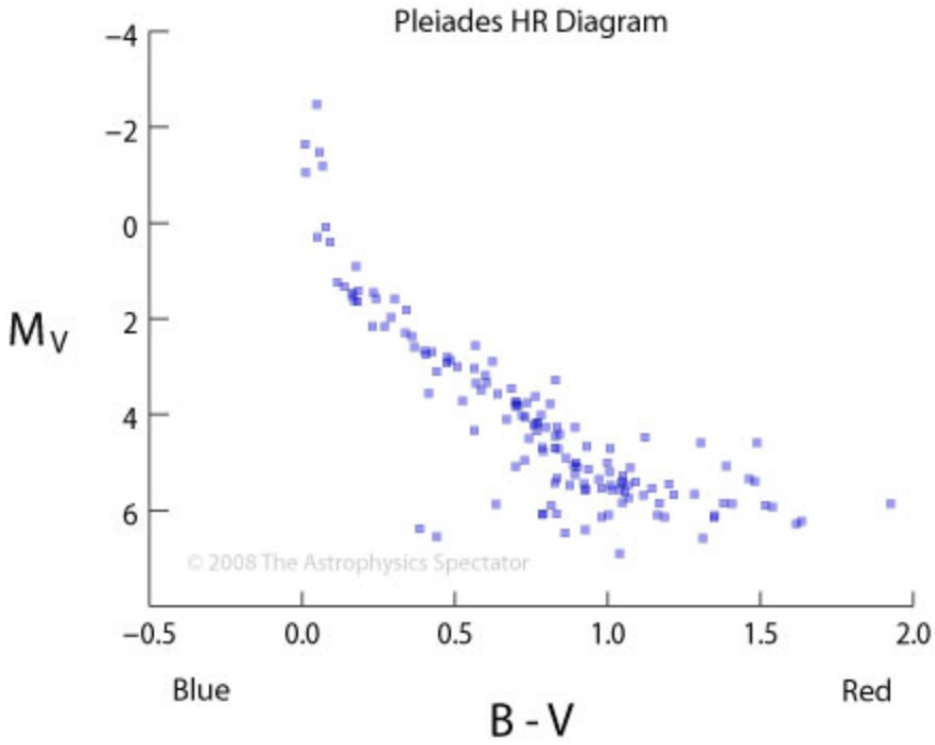
Figure 14–7. *The Hyades.* This most famous moving cluster (in the constellation Taurus) contains about 200 identified members, subtends 25° × 25° on the sky, and converges toward $\alpha = 6^h8^m$, $\delta = +9°$. (From O. Struve, B. Lynds, and H. Pillans: *Elementary Astronomy.* New York, Oxford University Press, 1959.)

H-R Diagram

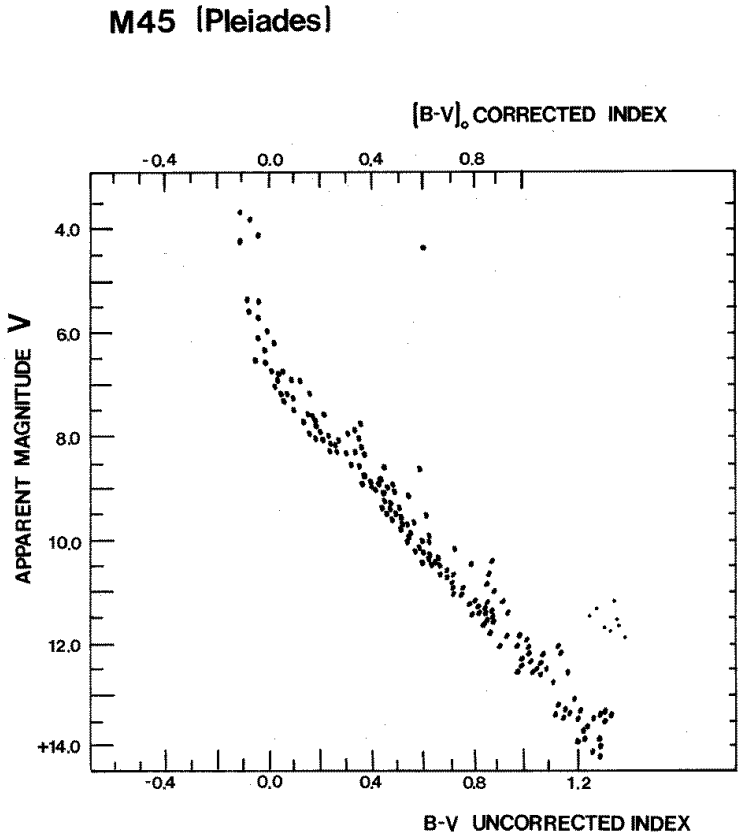

supergiants
giants
main sequence
white dwarfs
1000R⊙
100R⊙
10R⊙
1R⊙
0.1R⊙
0.01R⊙
0.001R⊙
Absolute Magnitude (M_V)
–10
–5
0
+5
+10
+15
Luminosity (L⊙)
10^4
10^2
1
10^–2
O
B
A
F
G
K
M
Spectral Type
25 000
10 000
5000
3000
Effective Temp (K)
–0.6
0
+0.6
+2.0
Colour Index (B–V)

Using Apparent Magnitudes

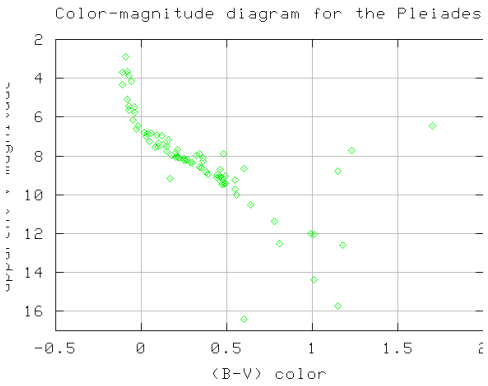
- As a cluster is a group of stars, we can assume they are all at the same distance.
- Unlike a normal H-R diagram (which has luminosity or absolute magnitude on the y-axis) we can use apparent magnitude when making an H-R diagram of a cluster.

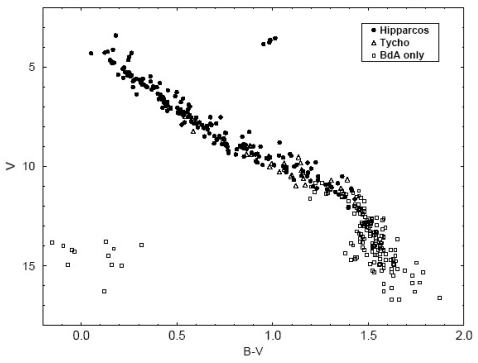


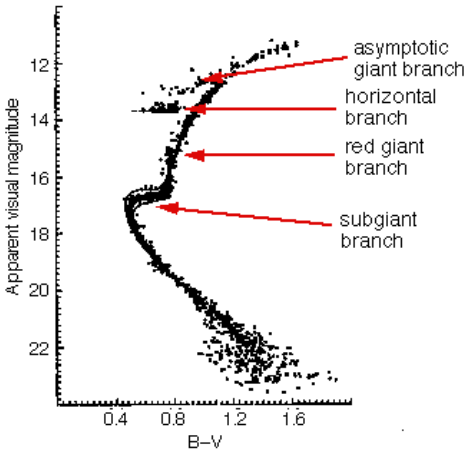
A Cluster H-R Diagram

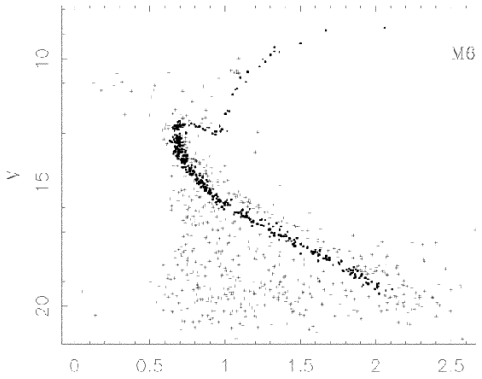


How do you compare cluster distances?
Why do some clusters not show more red stars on the main sequence?









The scatter at the faint, red end of the H-R diagram is because those stars are hard to observe at larger distances!