

The Importance of Star Clusters

- 1) All stars in a cluster lie at about the same distance from the Earth.
- 2) All the stars in the cluster were formed at about the same time (within a few million years of each other)

Color-magnitude diagrams of clusters allow us to determine their relative ages, and also their relative distances.

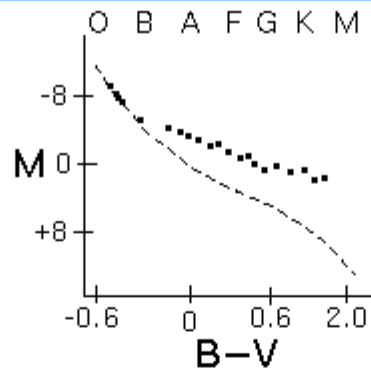
We can confirm the notion of different main sequence lifetime lengths by looking at the color-magnitude diagrams of star clusters of different ages.



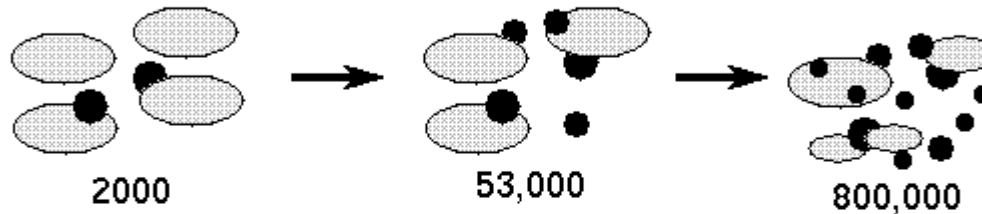
Open star clusters such as this one are not very old. Only their most massive stars have evolved to become giant stars.

Once a star has exhausted its core hydrogen, its radius and luminosity will change. With a different intrinsic brightness and size, it will no longer be located on the main sequence in the Hertzsprung-Russell Diagram.

Times given in years.
Color-magnitude
(HR) diagrams for
selected stages.

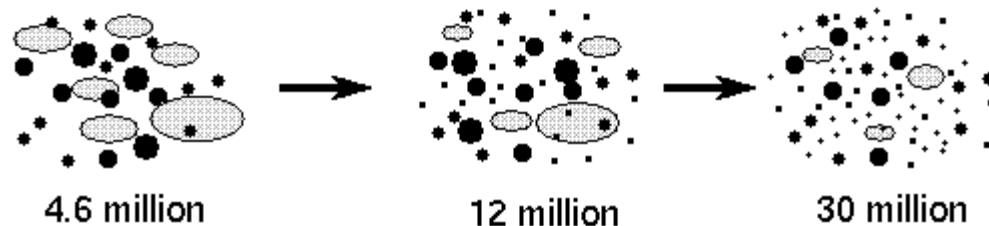
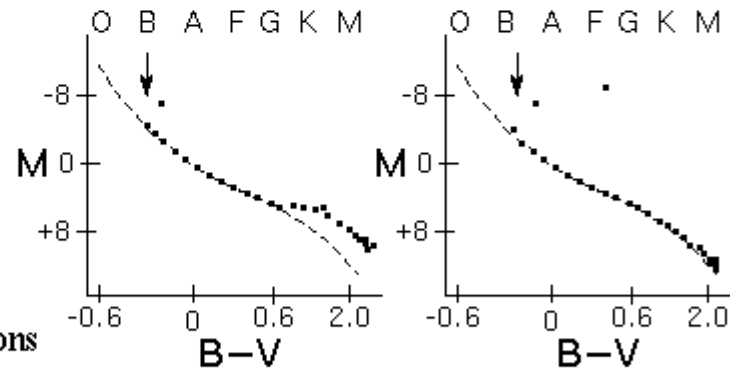


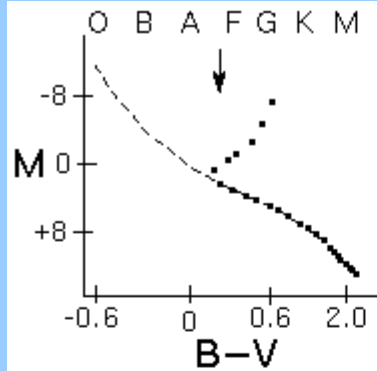
Massive stars form first.
Very young cluster has
just the massive stars on
main sequence and
lighter stars are still
collapsing toward main
sequence.



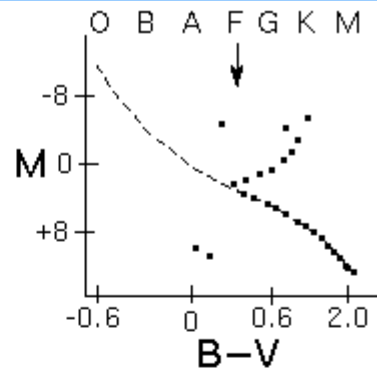
Massive stars evolve quickly.
Any O-type stars have lived
and died by 12 million year
stage! Some B-type stars
start to leave main sequence
stage while K and M-type
stars are still collapsing.

Star formation models
confirmed by observations
of real clusters.



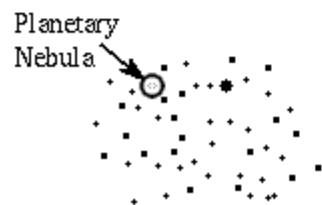
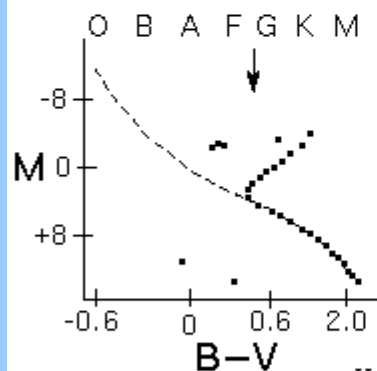


500 million

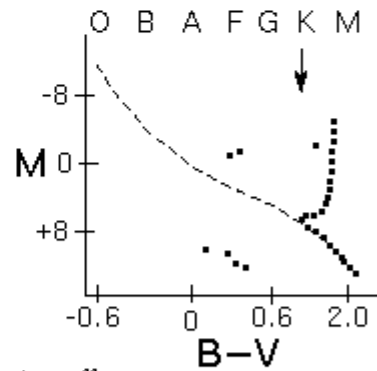


2 billion

As cluster ages, the massive stars die leaving the less massive stars on the main sequence. Arrow marks the *main sequence turnoff*.



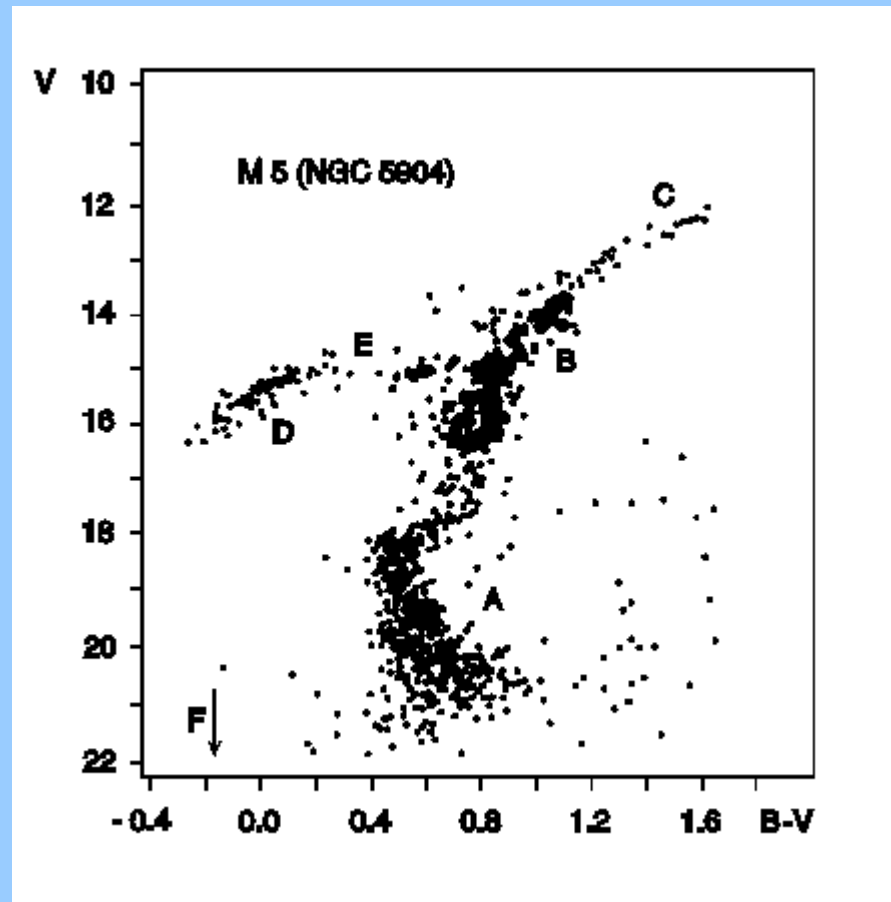
7 billion



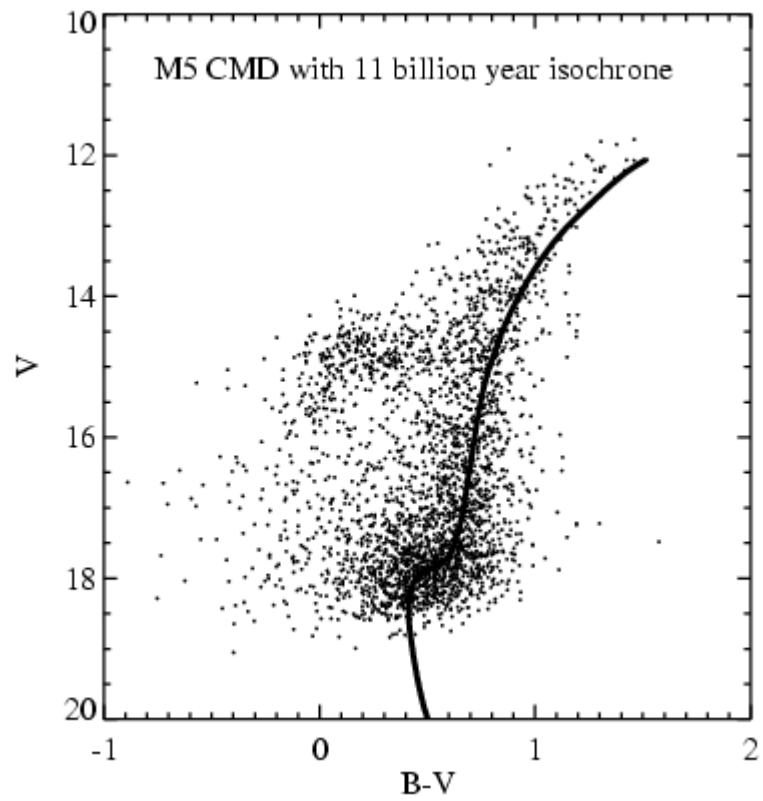
14 billion

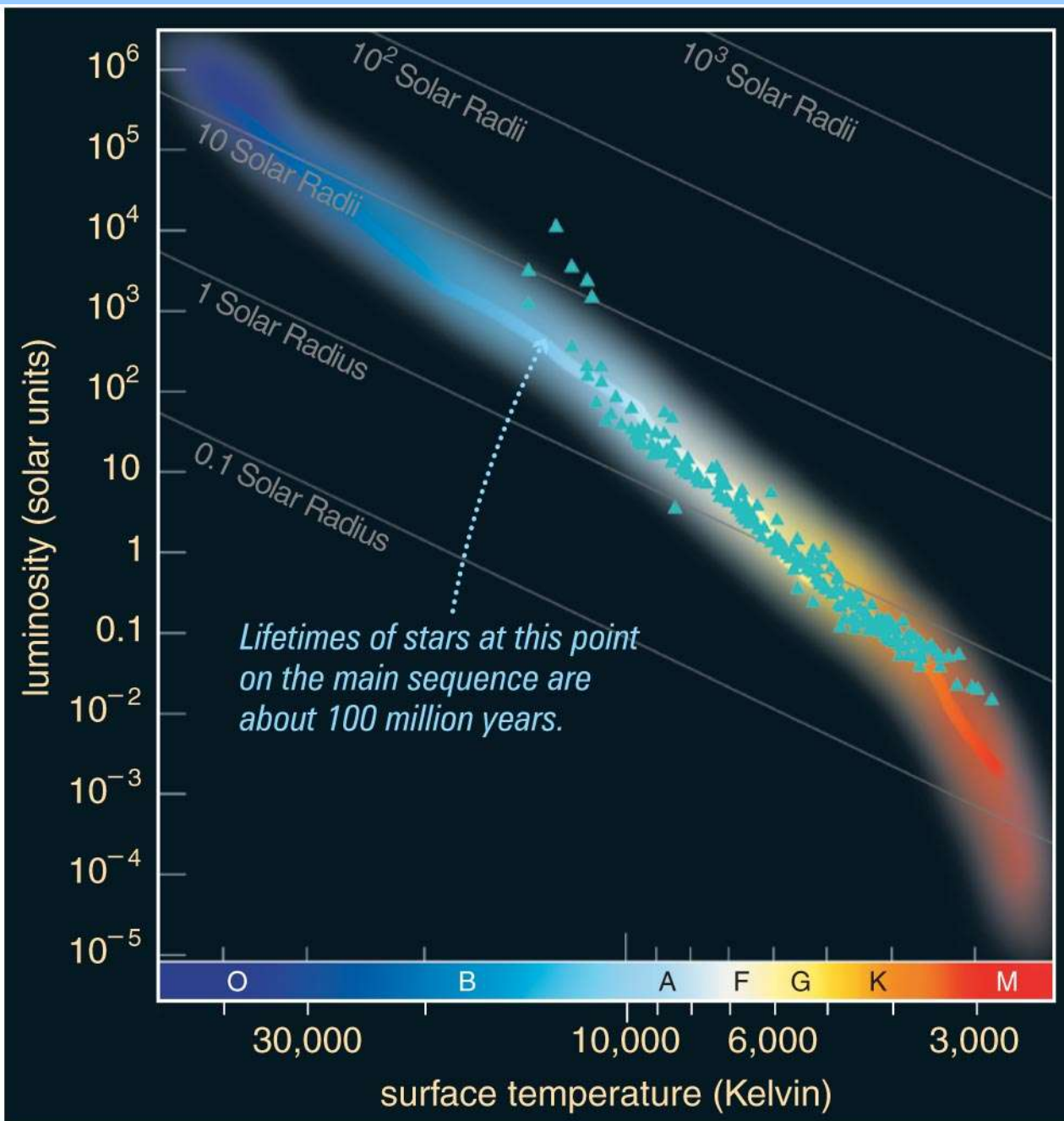
Use the *main sequence turnoff* to find the age of the star cluster.

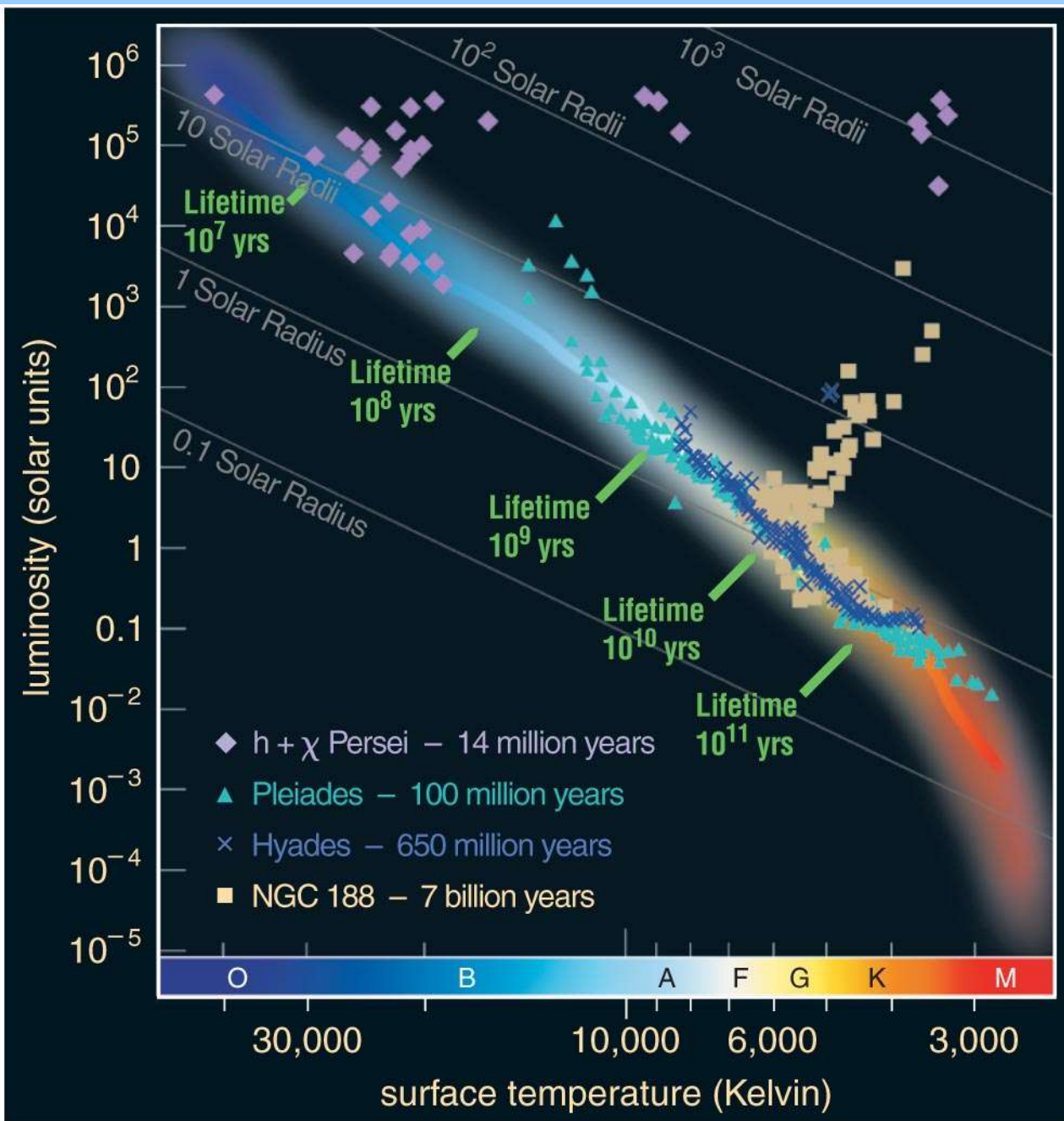
Stellar evolution models confirmed by observations of real clusters.



Globular clusters such as M5 are old. Only the lower mass stars are still main sequence stars.

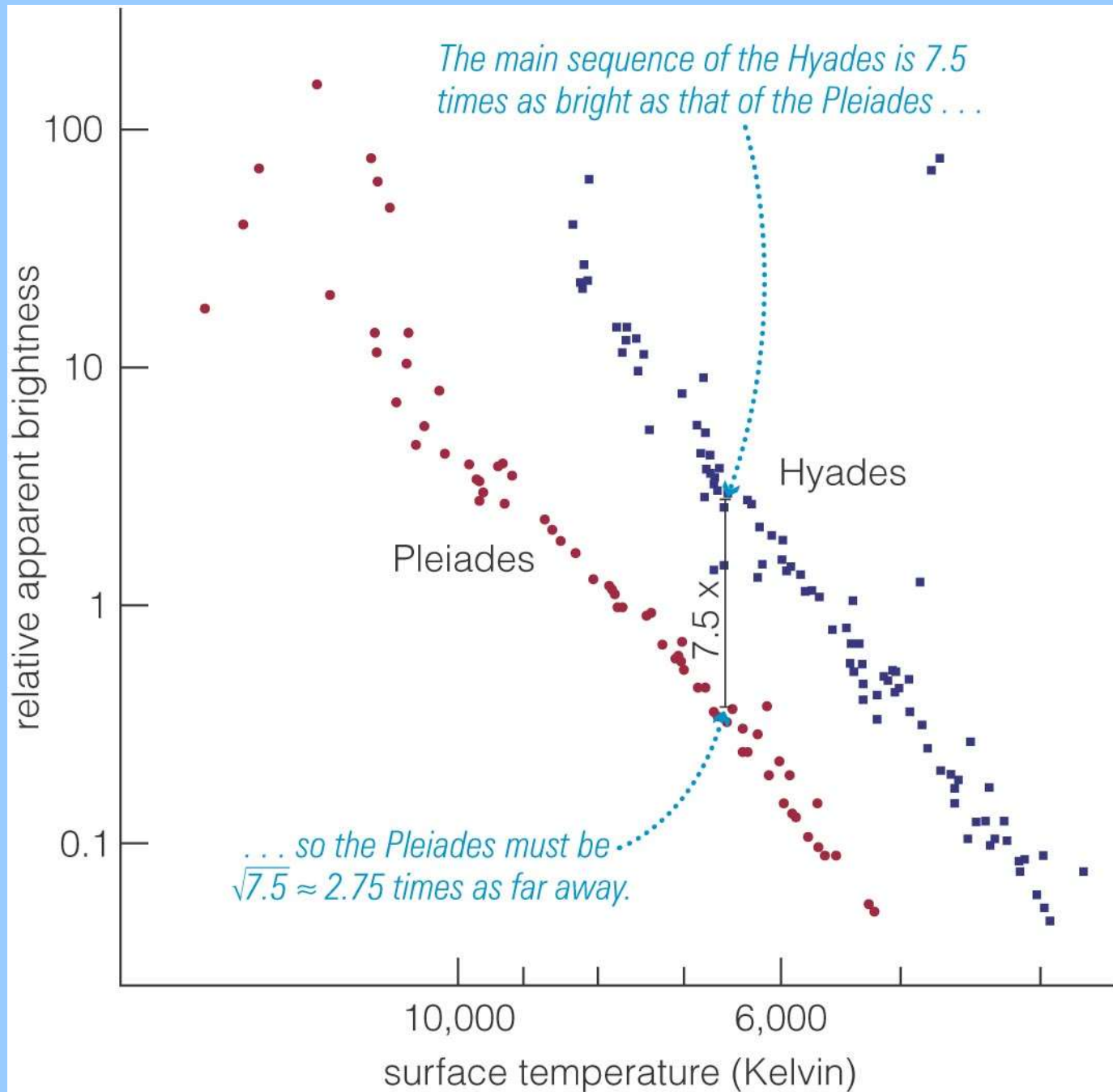






We assume that main sequence stars of various spectral types are essentially the same, no matter what cluster they form in. Their compositions may differ slightly, but for a given mass, a main sequence star has a very predictable temperature and intrinsic luminosity.

Thus, if we can determine how many magnitudes fainter the main sequence stars are in one cluster compared to another, we can determine the relative distances of the clusters.



The HIPPARCOS satellite (launched 1989) was able to determine the trigonometric parallaxes of the stars in the Hyades star cluster. Main sequence fitting allows us to derive the distances of other star clusters using the Hyades distance as reference. Thus, with a two step calibration we can determine the true distances (not just the relative distances) of star clusters.