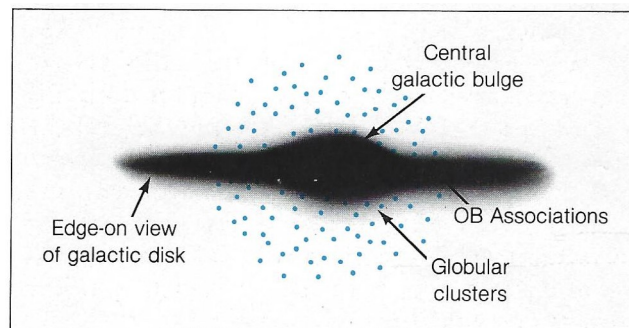


## Chapter 22. Star Clusters and Observations of Stellar Evolution



**Figure 22.2.** The Globular cluster M13.

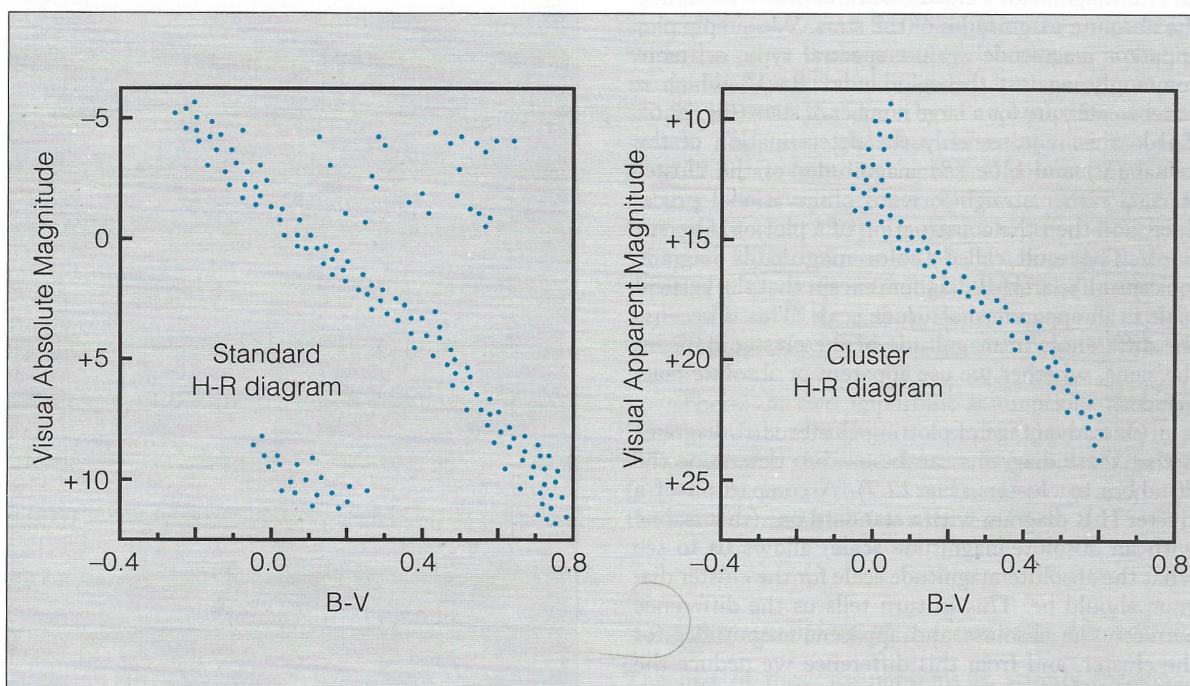
**Note.** Many stars are not uniformly distributed by occur in *clusters* Bunches (100 or so) of stars loosely associated in the galactic plane make up *galactic* or *open clusters*. Groupings of hot, luminous stars found in the plane are *OB associations*. These may not be gravitationally bound. *Globular clusters* are round collections of stars that occupy a huge sphere with its center at the center of the galaxy.



**Figure 22.5.** The location of clusters in the galaxy.

**Note.** There are two assumptions on clusters:

1. The stars are at a common distance; this allows the construction of a *color-magnitude diagram* similar to an H-R diagram. This can be compared to standard main sequence plots to determine the distance to the cluster. This is called *main-sequence fitting*.
2. The stars formed together and are all the same age and composition.



**Figure 22.7.** Main sequence fitting.

**Note.** The H-R diagrams of different clusters can be very different. As main sequence stars evolve, they move to the right on the H-R diagram. This occurs with the hottest stars first and produces a point of *main-sequence turnoff* which can be used to determine the cluster age.

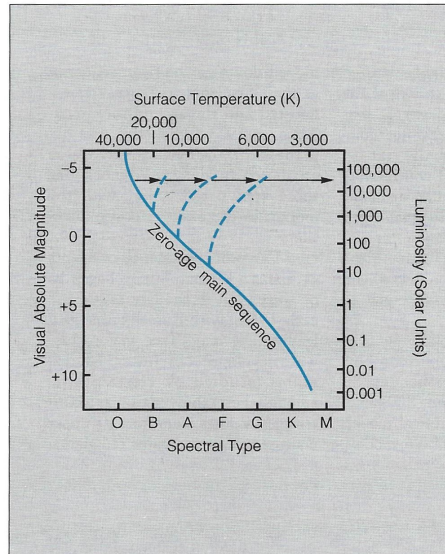


Figure 22.8. Evolution of the main sequence.

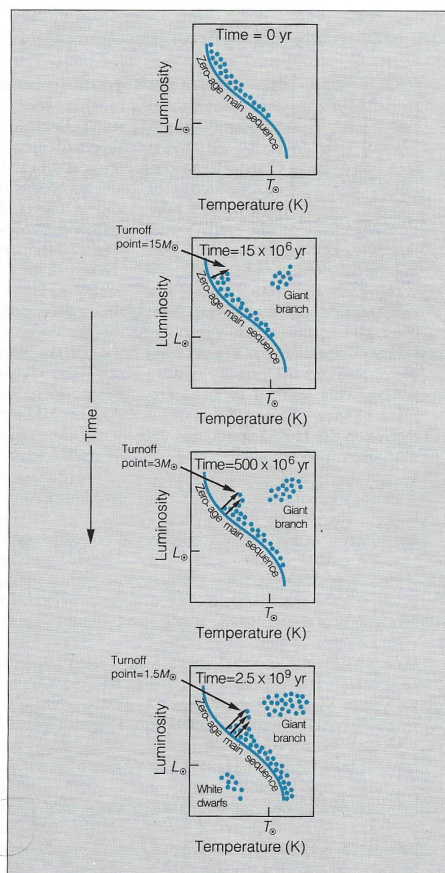


Figure 22.9. Evolution of the H-R diagram for a star cluster.

**Note.** Near OB associations, there may be clouds of gas and dust which reflect the starlight producing *reflecting nebulae*. In the process of star formation, the gas itself may glow as it heats up producing an *H II region*. The presence of these two phenomena indicate current or recent star formation. Examples of such areas are the Orion Nebula, the Pleiades, and the Horsehead Nebula.

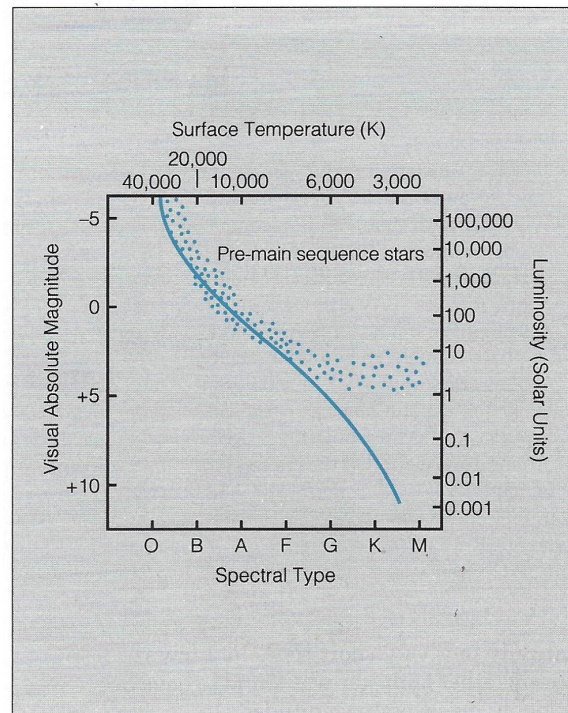


**Figure 22.12.** A dark cloud (the Horsehead Nebula).



**Figure 22.14.** A visible light image of the Orion Nebula (left) and an infrared image (right).

**Note.** The formation of stars is much like the formation of the Sun. As stars in a region form, we have some not condensed enough to reach the main sequence.



**Figure 22.17.** Pre-main sequence stars.

*Revised: 7/11/2021*