Stellar Astronomy and Astrophysics (SS12)

Stefan Jordan and Ralf Klessen

Exercise 11 for July 10, 2012

11.1 The Helium Main Sequence

Similar to the "normal" main sequence, defined for stars consisting mostly of hydrogen and generating energy through hydrogen fusion, a "helium main sequence" can be theoretically defined, for stars consisting purely of helium and generating energy through helium fusion.

a: Where in the HRD would you expect, *qualitatively*, the location of the He-MS as compared to the H-MS?

b: If the stellar core could be regarded as a star by itself, in which evolutionary phase might it fall on the He-MS or close to it?

c: Regarding now the star *as a whole*, what could happen to it that would bring it very close to the He-MS? Try to think of two different processes that could, theoretically, lead to such a state. How (un)likely are these processes in reality, in your opinion?

11.2 The Helix Nebula

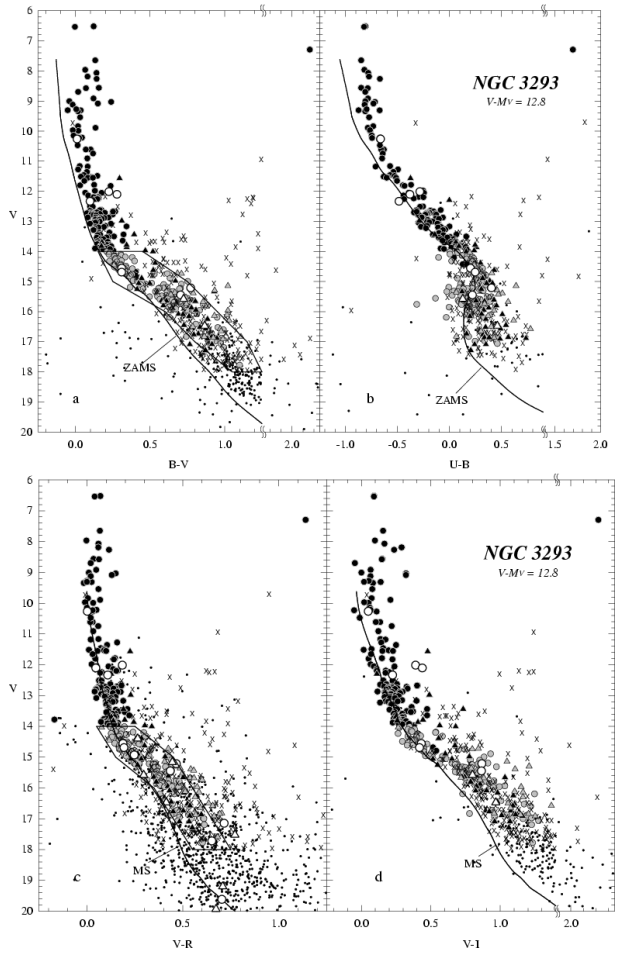
The Helix nebula is a planetary nebula with an angular diameter of $16'$ that is located approximately 213 pc from Earth.

a: Calculate the diameter of the nebula.

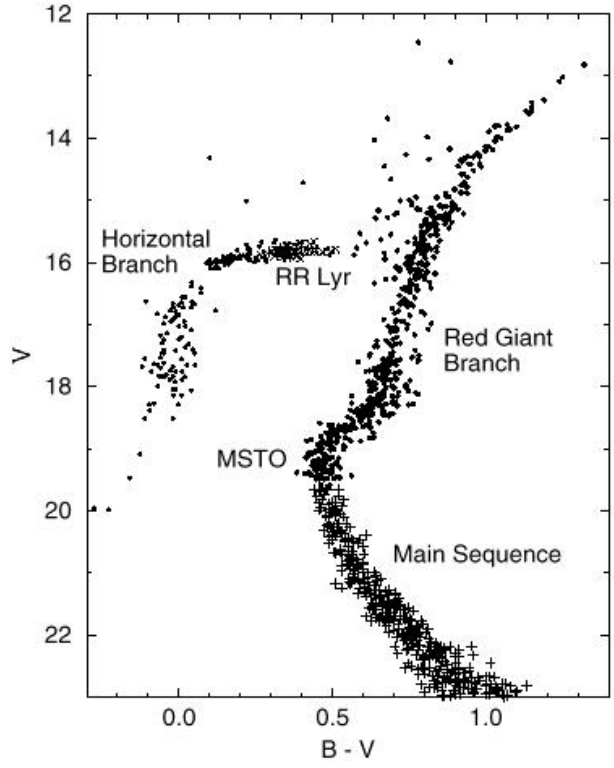
b: Assuming that the nebula is expanding away from the central star at a constant velocity of 20 km/s, estimate its age.

11.3 Stellar Evolution

An old version of stellar evolution, popular at the beginning of the beginning of the twentieth century, maintained that stars begin their lives as large, cool spheres of gas, like the giant stars on the H-R diagram. The then contract and heat up under the pull of their own gravity to become hot, bright blue O stars. For the remainder of their lives they lose energy, becoming dimmer and redder with age. As they slowly move down the main sequence, they eventually end up as cool, dim, red M stars. Explain how observations of stellar cluster, plotted on an H-R diagram, contradict this idea.



Color-magnitude diagram of the young open cluster NGC 3293.



Color-magnitude diagram of the globular cluster M15.