Stellar species and evolution

3.1 Stellar populations and color-magnitude diagrams

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3.1 Stellar populations and color-magnitude diagrams

- Brightness and color of stars

Depends on the evolutionary stage of the star
(mass and age of the star)

- Metallicity and chemical composition of stars

Depends on the process of chemical evolution

- Review – Chemical Evolution

The process of element creation in stars and during supernova explosions, as well as the time evolution of the cycle of stellar birth and death

3.1 Stellar populations and color-magnitude diagrams

- To investigate the properties of stars, we need to obtain absolute values such as luminosity and mass.
Therefore we can accurately know the distance to the star system
- Example: Properties of stars in the solar neighborhood and stars in globular clusters

- B → blue, how blue the star is
- V → visual, visible light, greenish part
Note: B and V are on the same horizontal axis
- B - V is small. A blue, hot star.
- B - V is large. Bright and low temperature star. Spectroscope → spectrum

- Apparent Magnitude mv Affected by Distance
- Absolute magnitude (actual magnitude) Mv - True actual brightness, unaffected by distance
- B band, V band…wavelength range

3.1 Stellar populations and color-magnitude diagrams

- Figure 3.1 shows a variety of stars, from young to old, gathered in the solar neighborhood (stars nearby).
- Main sequence stars are stars in the stage where hydrogen fusion is occurring in their centers.

- What can be inferred from Figure 3.1
- The red giant branch has a large B-V, meaning it is redder and cooler.

- The main sequence, or dwarf, stars are not limited to any particular absolute magnitude, color, or temperature, but are distributed widely.

- In the main sequence, nuclear combustion occurs in the central hydrogen, where four hydrogen nuclei are converted into one helium nucleus through a nuclear fusion reaction. → This causes stars to shine.

- A star spends 80% of its life as a dwarf

- The subgiant branch is a precursor to the evolution of a red giant, and is dimmer and hotter than a red giant.

- There are few stars between the main sequence and the red giant branch

3.1 Stellar populations and color-magnitude diagrams

- What can be seen from Figure 3.2 (The color-magnitude diagram of M68, a globular cluster in the Milky Way)
- Gry is 1 billion.
- There are few stars with small B-V on the main sequence. In other words, blue and bright stars are already off the main sequence.
- The presence of a horizontal branch and an asymptotic giant branch suggests that it is old.

Also as a review

- Horizontal branch: A star in the stage where helium burning is occurring steadily in the core.
- Asymptotic giant branch: A carbon-oxygen core with an outer shell
- 2 bands → B band and V band

What I didn't understand

- Because the distribution of stars near the turning point is narrow, stars are born in globular clusters all at once at a certain time.

→ Why can we say that with such certainty?

- Comparing this with the distribution of stars suggests that star formation in this globular cluster occurred approximately 12 billion years ago and then stopped shortly thereafter.

→ Why focus on 12 billion years when there are three lines: 11 billion, 12 billion, and 13 billion?

⭐<u>Isochrones show where stars born from the same gas would be located 11 billion years ago.</u>
<u>Figure 3.2 shows three isochrones, spanning 11 billion years, 12 billion years, and 13 billion years. In this case, the distribution 12 billion years ago is thought to match M68.</u>

- What can be seen from Figure 3.3
- Tuc47 is a globular cluster with this name.
-"Unlike M68 in Figure 3.2, the red horizontal branches are prominent." In other words, compared to M68 in Figure 3.2, there are no horizontal branches with small B-V, and there are many horizontal branches with large B-V.
→ (Red Horizontal Branch) vs (Blue Horizon Branch)

What I didn't understand
Why do RR Lyrae variables appear after the RHB and BHB?
⭐RR Lyrae variables are stars that fell between the RHB and BHB. They periodically reach a specific temperature and brightness. Helium flashes → This depends on how much mass they lose.

- What can be inferred from Figure 3.4
- 47Tuc is systematically redder than M68.
- The metallicity of stars in a cluster varies; the more metallic a cluster is, the more the distribution of stars in the color-magnitude diagram shifts toward the red, i.e., the larger the B-V.