ASTR 1020: Stars & Galaxies
February 22, 2008

• MasteringAstronomy Homework on The HR Diagram is due Feb. 25th.
• Reading: Chapter 16, sections 16.1-16.3.

Astronomy In the News
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Learning Assistants for Fall
• LAs get direct experience with teaching.
• LAs in Astronomy can have any major.
• LAs are paid for your teaching duties!
• Information/Recruitment session on March 5th from 6-8 pm in MCD Biology Interactive Classroom (free food!).

Today’s Class:
The HR Diagram & Star Clusters
• Masses & Lifetimes of Stars.
• Measuring stellar ages with Star Clusters.

Hertzsprung-Russell (H-R) diagram

Stellar Properties Review
Luminosity: from brightness and distance
$(0.08 \text{ M}_\odot) \times 10^4 \text{ L}_\odot \sim 10^6 \text{ L}_\odot$ $(100 \text{ M}_\odot)$

Temperature: from color and spectral type
$(0.08 \text{ M}_\odot) \times 3,000 \text{ K} \sim 50,000 \text{ K}$ $(100 \text{ M}_\odot)$

Mass: from period (p) and average separation (a) of binary-star orbit
$0.08 \text{ M}_\odot \sim 100 \text{ M}_\odot$
Mass & Lifetime

Sun’s life expectancy: 10 billion years

Life expectancy of 10 $M_{\odot}$ star:
- 10 times as much fuel, uses it $10^4$ times as fast
  
  $10 \text{ million years} = 10 \text{ billion years} \times 10 / 10^4$

Life expectancy of 0.1 $M_{\odot}$ star:
- 0.1 times as much fuel, uses it 0.01 times as fast
  
  $100 \text{ billion years} = 10 \text{ billion years} \times 0.1 / 0.01$

Until core hydrogen (10% of total) is used up

Main-Sequence Star Summary

High Mass:
- High Luminosity
- Short-Lived
- Large Radius
- Blue

Low Mass:
- Low Luminosity
- Long-Lived
- Small Radius
- Red

What are giants, supergiants, and white dwarfs?

Off the Main Sequence

- Stellar properties depend on both mass and age: those that have finished fusing H to He in their cores are no longer on the main sequence
- All stars become larger and redder after exhausting their core hydrogen: giants and supergiants
- Most stars end up small and white after fusion has ceased: white dwarfs

Clicker Question:
Which of these stars will have changed the least 10 billion years from now?

Which of these stars will have changed the least 10 billion years from now?
What have we learned?

• What is a Hertzsprung-Russell diagram?
  – An H-R diagram plots stellar luminosity of stars versus surface temperature (or color or spectral type)
• What is the significance of the main sequence?
  – Normal stars that fuse H to He in their cores fall on the main sequence of an H-R diagram
  – A star’s mass determines its position along the main sequence (high-mass: luminous and blue; low-mass: faint and red)

What have we learned?

• What are giants, supergiants, and white dwarfs?
  – All stars become larger and redder after core hydrogen burning is exhausted: giants and supergiants
  – Most stars end up as tiny white dwarfs after fusion has ceased

Star Clusters

• Our goals for learning
• What are the two types of star clusters?
• How do we measure the age of a star cluster?

What are the two types of star clusters?

Open cluster: A few thousand loosely packed stars

Globular cluster: Up to a million or more stars in a dense ball bound together by gravity
How do we measure the age of a star cluster?

Main-sequence turnoff point of a cluster tells us its age

What have we learned?

- What are the two types of star clusters?
  - Open clusters are loosely packed and contain up to a few thousand stars
  - Globular clusters are densely packed and contain hundreds of thousands of stars
- How do we measure the age of a star cluster?
  - A star cluster’s age roughly equals the life expectancy of its most massive stars still on the main sequence