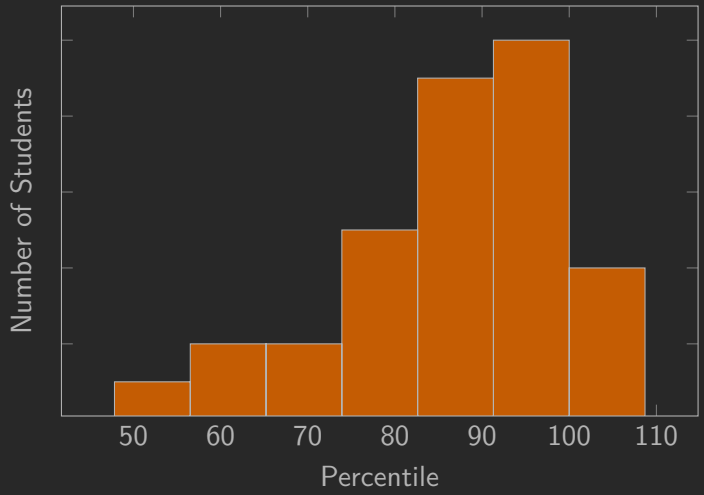
# Announcements


- WebWork due on Monday
- For the next few chapters we may be bouncing around a little, I'll try to keep you appraised of the relevant chapter sections
- Physics Tea at 3!
- Physics Seminar on laser fusion at 3:30pm in Collins 318
- Polling: `rembold-class.ddns.net`

# Test Summary!




- High: 108%
- Mean: 83%
- Median: 86%

# Going over test


Quickly going over the test to make sure everyone understands their score.

# Review Question

Which of the following is not an always true statement about star groupings on a HR diagram (as we've drawn them)?

A. Luminous objects are toward the top

B. Cooler objects are toward the right

C. Bluer objects are towards the bottom

D. Large objects are toward the upper right

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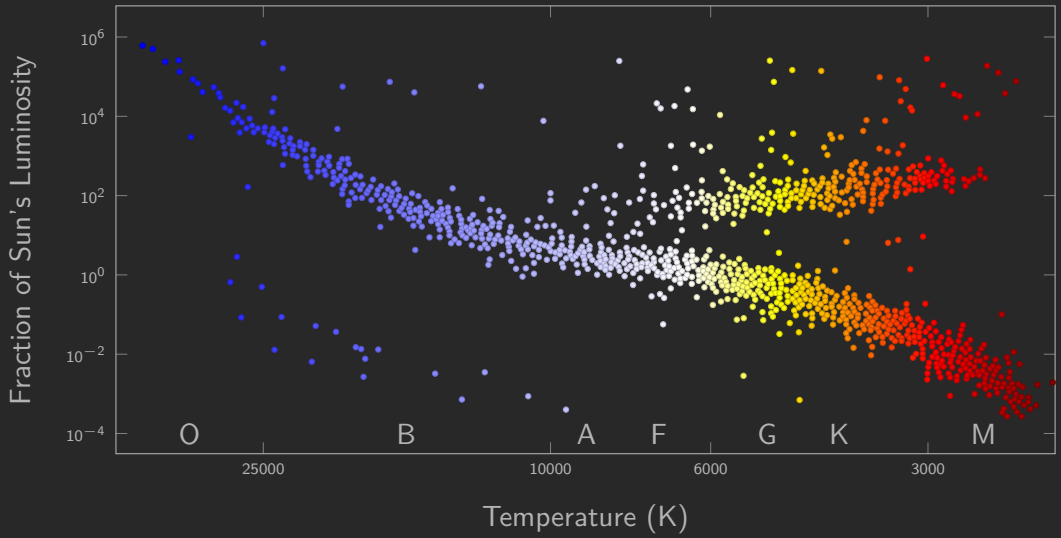
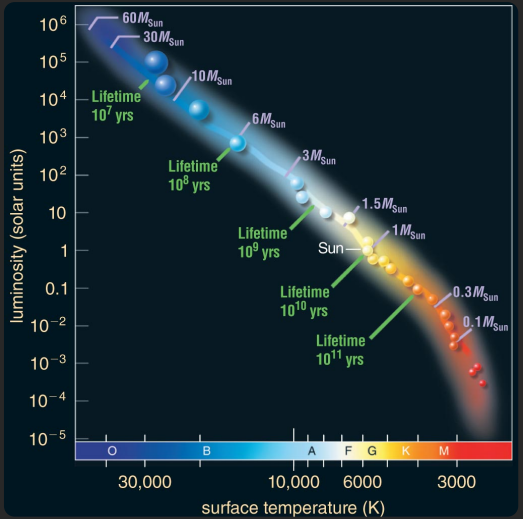
# Hertzsprung-Russel Diagrams



# Shine Bright (like a diamond)




- A star's mass and luminosity do not increase at the same rate:
  - O star
    - $60M_{\odot}$
    - $100000L_{\odot}$
  - G star
    - $1M_{\odot}$
    - $1L_{\odot}$
  - M star
    - $0.2M_{\odot}$
    - $0.01L_{\odot}$
- Brighter stars have shorter lifetimes than dimmer stars!

# The End of the Line


- What about those stars not on the main sequence?
- Fusing hydrogen into helium does not account for them
- $\Rightarrow$Stars that have exhausted their supply of hydrogen
- Two main types:
  - Giants
    - In crisis mode: "Fuse all the things!"
  - Dwarfs
    - In dejection, having lost all their fuel
    - Memories of once being a Giant

# Star Clusters

# Star Cluster Basics

- Ch 22.2
- All stars form from gaseous clouds
- So often times many can form together
- Why are we excited about them?
  - They are all about the same distance away.
  - They are all about the same age.
- Main types:
  - Open clusters
  - Globular clusters

# Open Clusters

- Found in the galaxy disk
- Up to several thousand stars
- Stars tend to be young
- Most famous the Pleiades cluster
  - Visible with your naked eye
  - Can find easily with a quick scan of the sky

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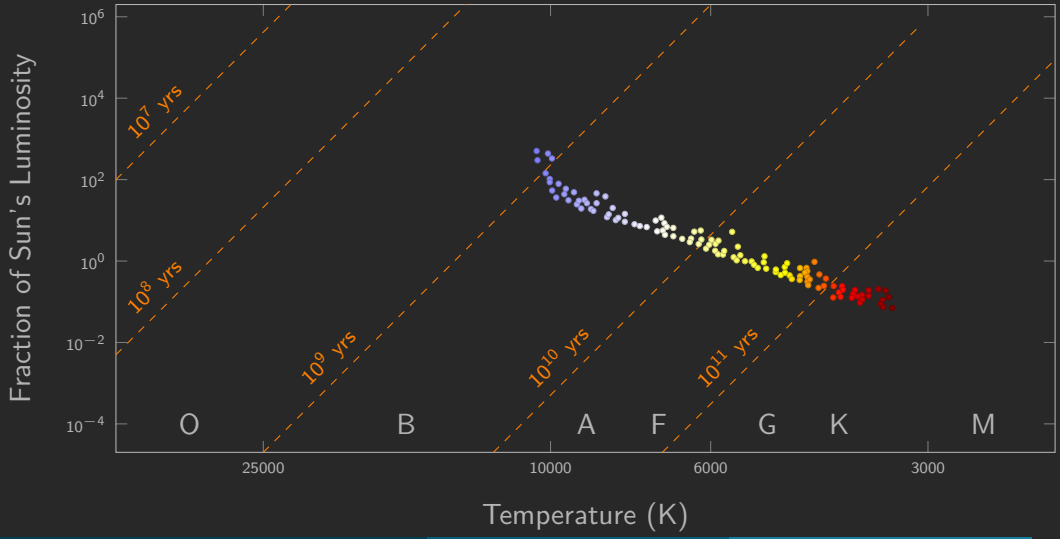
# Globular Clusters

- Generally found in the galaxy halo
  - Above or below the disk
- Much older stars
- A very concentrated density of stars
- My favorite is M13, in the constellation Hercules

# Getting Carded

- Clusters are all generally about the same age
- A small amount of variation
- Should mostly be in the “same phase of life”
- But brighter stars should show their age quicker!
- The key question:
  - Where do the cluster stars leave the Main Sequence?

# The Pleiades



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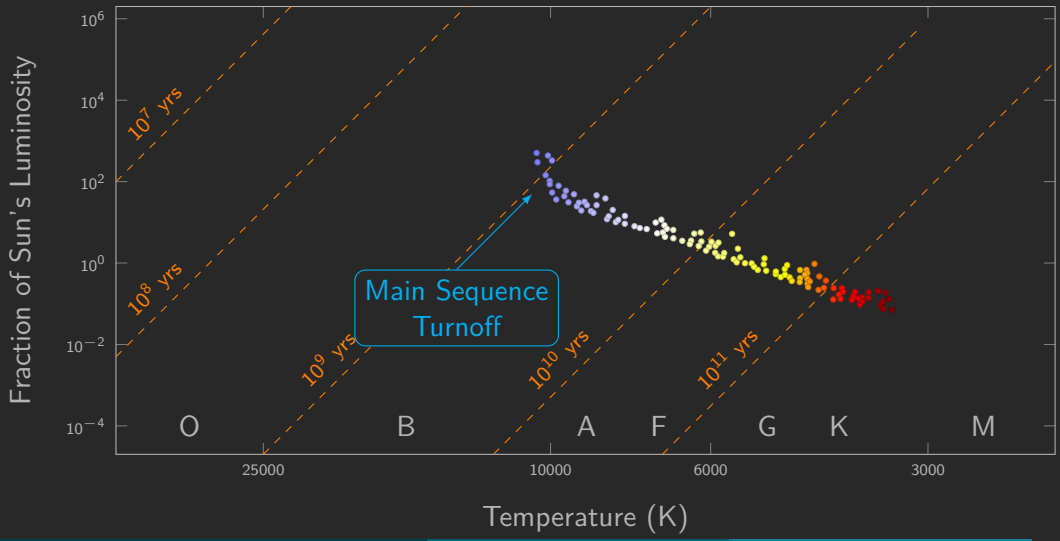
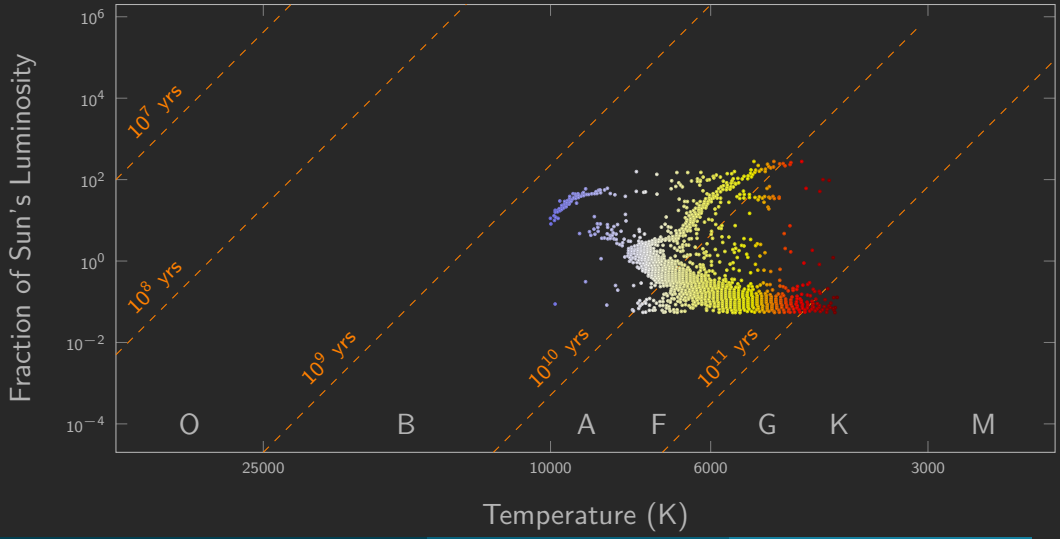


# Globular Cluster: M55



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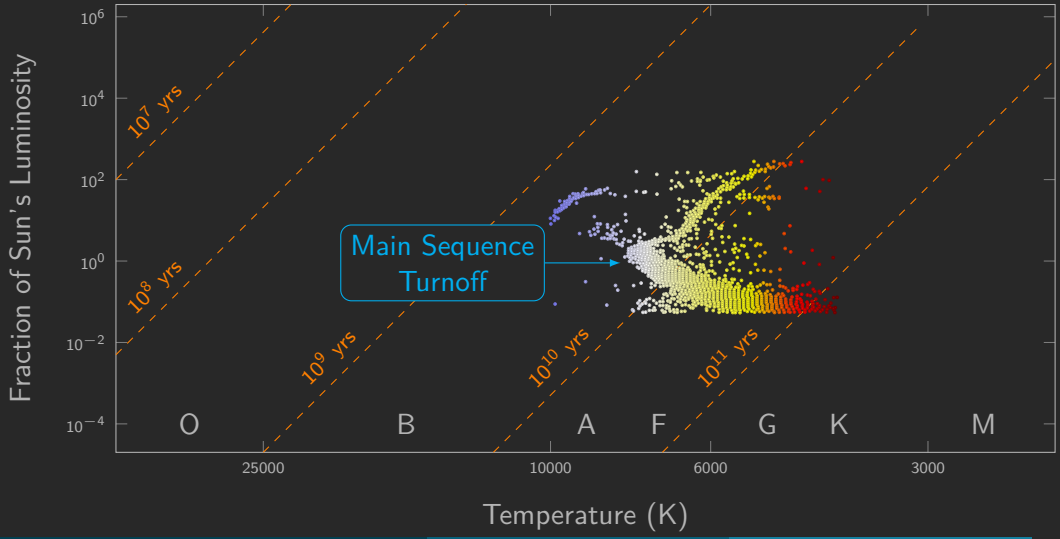


# Understanding Check!

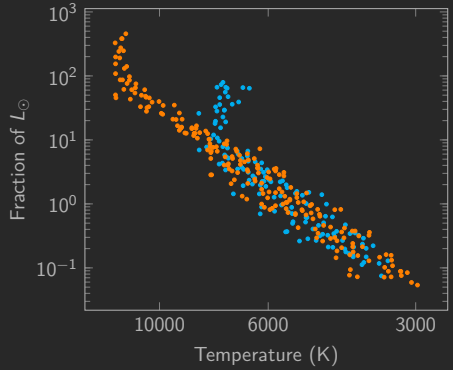
Which of the following statements is true, given the HR diagram to the right?

A. The cyan cluster is older than the orange cluster

B. No stars on the cyan cluster are on the main sequence any longer

C. The cyan cluster and orange cluster are the same age

D. The cyan cluster is definitely a open cluster



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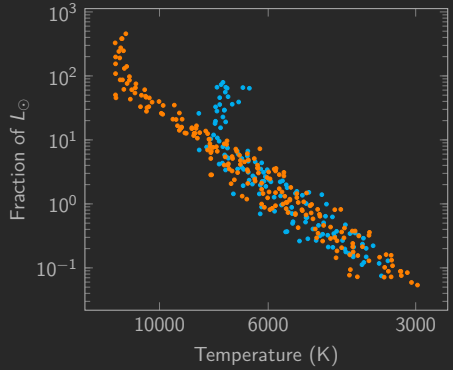

# Some additional points


- For really old systems, not only do we see fewer stars on the main sequence, but we start seeing stars in the dwarf star population/region
  - Implies dwarfs are likely the final resting state of at least some stars
- To summarize what we know thus far:
  - Stars spend most their time on the main sequence
    - Happily burning hydrogen in their cores
  - When they run out of hydrogen, they turn off the main sequence
    - Up and to the right, implying a larger size
  - At least some go from being giants to shrinking to dwarfs at the end of their life
  - If there is another stage, the universe isn't old enough yet for us to have seen it!

# Making a Star: Gather Your Ingredients

- Ch 21.1 and 21.2
- Stars are formed in giant molecular clouds
  - Dense, cold, dusty regions of interstellar space

# Easiest to See in Infrared

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# Bring it in. . .

- Need gravity to be greater than any internal gas pressure
  - Easiest with dense, cold regions
  - Hence the molecular clouds
- Densest regions attract the most gas
  - Breaks a cloud up into various smaller clouds
  - Each smaller, dense cloud can continue to contract to become a protostar