Today: Chapter. 12-Stars

Midterm Exam: Oct 17
Review Sheet handed out

First Extra Credit due Oct. 17

Office Hours Monday, Tuesday 3-4 PM
Stars: What do We Know?

- Temperature (T) & Spectral Type
- Distance

- Brightness
  - Luminosity ($L_{\text{star}}$) - energy output of a star
  - Apparent Magnitude ($m$) - how bright a star appears
  - Absolute Magnitude ($M$) - how bright a star really is
So many stars...so little time
Organizing the Family of Stars

- To understand the huge diversity of stars, we organize them according to their:
  - Temperature \( (T) \)
  - Luminosity \( (L_{\text{star}}/L_{\text{Sun}}) \)

- How are these properties related?
- To find out, each star is plotted as a point on a graph
  - The x-coord. is Temperature \( (T) \)
  - The y-coord. is Luminosity \( (L_{\text{star}}) \)
Hertzsprung-Russell (HR) Diagram

<table>
<thead>
<tr>
<th>Star</th>
<th>$\frac{L_{\text{STAR}}}{L_{\text{SUN}}}$</th>
<th>Temp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun</td>
<td>1</td>
<td>5800</td>
</tr>
</tbody>
</table>

The diagram plots temperature (in K) on the x-axis and brightness (in # of Suns) on the y-axis. Stars are scattered across the graph, with the Sun located at the coordinates (5800, 1). The main sequence is indicated on the graph.
# Hertzprung-Russell (HR) Diagram

<table>
<thead>
<tr>
<th>Star</th>
<th>$\frac{L_{\text{STAR}}}{L_{\text{SUN}}}$</th>
<th>Temp</th>
<th>Brightness (# of Suns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun</td>
<td>1</td>
<td>5800</td>
<td></td>
</tr>
<tr>
<td>Proxima</td>
<td>0.002</td>
<td>3000</td>
<td></td>
</tr>
<tr>
<td>Vega</td>
<td>40</td>
<td>10,000</td>
<td></td>
</tr>
<tr>
<td>$\delta$ Orion.</td>
<td>70000</td>
<td>30,000</td>
<td></td>
</tr>
<tr>
<td>Arcturus</td>
<td>200</td>
<td>4300</td>
<td></td>
</tr>
</tbody>
</table>
Most stars are found along the main sequence, including the Sun.

- Stars on the main sequence are called **dwarfs**, so the Sun is a “dwarf star”

HR Diagram

\( \text{L. vs. T.} \)
But not all stars are on the Main Sequence:

**Giant Stars** have greater luminosity.

**Supergiants** are even more luminous.

**White Dwarfs** are fainter and bluer. They are hotter than the Sun, but less luminous.
Giant stars can be 100 times the size of the Sun!

If they were in our solar system they would swallow Mercury and Venus!

Supergiant stars are even bigger! 1000 times the size of the Sun!!!
HR Diagrams

Nearest Stars

Brightest Stars

- Sirius A
- Altair
- Procyon A
- α Centauri A
- Sun
- White Dwarfs

Luminosity vs. Absolute visual magnitude (Mv) vs. Spectral type (B0 to M0) vs. Temperature
Proxima Centauri -- The Nearest Star to the Sun is a faint M star on the Main Sequence
Use of H-R Diagrams

- H-R Diagrams are the astronomers “most useful tool”
- They quickly tell us which kind of star (giant or dwarf)
- They can also reveal the mass, age & lifespan of the star.
- We can use them to determine the ultimate fate of a star...including the Sun.
The most important characteristic of a star is its **mass**.

**Mass** determines the fate of the star: whether or not it will explode.

Mass is measured in units of $M_{\text{Sun}}$.

For Main Sequence Stars: more massive stars are *hotter* and *more luminous*.

but how do we measure a star’s Mass?
Binary Stars in Astronomy

Most of our knowledge of stars’ **Masses** comes from binary stars.

In a **binary star** system two stars orbit each other.

Alberio, a double star in Cygnus

Alpha Centauri A & B, The nearest star system to the Sun
Binary Stars in Movies

Tatooine, a planet orbiting a binary star, in *Star Wars*