Brighter stars in the night sky

Faintest stars visible to naked-eye

Difference in apparent brightness between each magnitude step is 2.512
1 parsec (pc) = 3.26 ly

Absolute Magnitude

Apparent Magnitude

1 parsec (pc) = 3.26 ly
Magnitude

- **Stellar Brightness**
  - Apparent Magnitude \((m_v)\) - Brightness from Earth
  - Absolute Magnitude \((M_v)\) - Brightness from 10 pc

Absolute magnitude depends only on a star’s luminosity

<table>
<thead>
<tr>
<th>Magnitude Difference</th>
<th>Brightness Ratio (Brightness Difference)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>((2.512)^1)</td>
</tr>
<tr>
<td>2</td>
<td>((2.512)^2)</td>
</tr>
<tr>
<td>3</td>
<td>((2.512)^3)</td>
</tr>
<tr>
<td>4</td>
<td>((2.512)^4)</td>
</tr>
<tr>
<td>5</td>
<td>((2.512)^5)</td>
</tr>
<tr>
<td>6</td>
<td>((2.512)^6)</td>
</tr>
<tr>
<td></td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>6.3</td>
</tr>
<tr>
<td></td>
<td>15.9</td>
</tr>
<tr>
<td></td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>251</td>
</tr>
</tbody>
</table>
## Spectral Classification

<table>
<thead>
<tr>
<th>Spectral type</th>
<th>Example(s)</th>
<th>Temperature Range</th>
<th>Key Absorption Line Features</th>
<th>Brightest Wavelength (color)</th>
<th>Typical Spectrum</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Stars of Orion’s Belt</td>
<td>&gt;30,000 K</td>
<td>Lines of ionized helium, weak hydrogen lines</td>
<td>&lt;97 nm (ultraviolet)*</td>
<td><img src="image" alt="O spectrum" /></td>
</tr>
<tr>
<td>B</td>
<td>Rigel</td>
<td>30,000 K – 10,000 K</td>
<td>Lines of neutral helium, moderate hydrogen lines</td>
<td>97 – 290 nm (ultraviolet)*</td>
<td><img src="image" alt="B spectrum" /></td>
</tr>
<tr>
<td>A</td>
<td>Sirius</td>
<td>10,000 K – 7,500 K</td>
<td>Very strong hydrogen lines</td>
<td>290 – 390 nm (violet)*</td>
<td><img src="image" alt="A spectrum" /></td>
</tr>
<tr>
<td>F</td>
<td>Polaris</td>
<td>7,500 K – 6,000 K</td>
<td>Moderate hydrogen lines, moderate lines of ionized calcium</td>
<td>390 – 480 nm (blue)*</td>
<td><img src="image" alt="F spectrum" /></td>
</tr>
<tr>
<td>G</td>
<td>Sun, Alpha Centauri A</td>
<td>6,000 K – 5,000 K</td>
<td>Weak hydrogen lines, strong lines of ionized calcium</td>
<td>480 – 580 nm (yellow)</td>
<td><img src="image" alt="G spectrum" /></td>
</tr>
<tr>
<td>K</td>
<td>Arcturus</td>
<td>5,000 K – 3,500 K</td>
<td>Lines of neutral and singly ionized metals, some molecules</td>
<td>580 – 830 nm (red)</td>
<td><img src="image" alt="K spectrum" /></td>
</tr>
<tr>
<td>M</td>
<td>Betelgeuse, Proxima Centauri</td>
<td>&lt;3,500 K</td>
<td>Molecular lines strong</td>
<td>&gt; 830 nm (infrared)</td>
<td><img src="image" alt="M spectrum" /></td>
</tr>
</tbody>
</table>

*All stars above 6,000 K look more or less white to the human eye because they emit plenty of radiation at all visible wavelengths.*

©Addison Wesley Longman, Inc.
Spectral Classification
(a temperature scale)

Sun (G2) 6,000 K

Oh  Hot  30,000 K
Be
A
Fine
Girl /Guy
Kiss
Me  Cool  3,500 K
Absolute Magnitude - Luminosity

- **Stellar Luminosity** -- Total amount of light energy emitted each second
  - Surface Area
  - Temperature
Stellar Luminosity

\[ E \propto T^4 \]

Both stars same Temperature

6,000 K

1 \( L_{\text{sun}} \)

6,000 K

1 \( L_{\text{sun}} \)
Stellar Luminosity $\rightarrow$ Temperature

$E \propto T^4$

Both stars are the same size

6,000 K

$1 \ L_{\text{sun}}$

12,000 K

$16 \ L_{\text{sun}}$
Stellar Luminosity $\rightarrow$ Temperature

Both stars are the same size

$6,000 \, \text{K}$

$1 \, L_{\text{sun}}$

$18,000 \, \text{K}$

$81 \, L_{\text{sun}}$

$E \propto T^4$

3 times hotter
Stellar Luminosity → Size

Both stars same Temperature

\[ E \propto R^2 \]

6,000 K

\[ 1 \quad L_{\text{sun}} \]

6,000 K

\[ 4 \quad L_{\text{sun}} \]
Stellar Luminosity $\rightarrow$ Size

Both stars same temperature

$E \propto R^2$

1 $L_{\text{sun}}$

9 $L_{\text{sun}}$

3R
Stellar Luminosity –
Total amount of light energy emitted each second
- Surface Area
- Temperature

$E \propto R^2T^4$
The H-R Diagram

The Sun

$L = 1 \ L_{\text{sun}}$  G2

H-R Diagram

Temperature

Luminosity

$10^{-4}$

$10^{-2}$

$10^{2}$

$10^{4}$

$10^{6}$

O  B  A  F  G  K  M
Figure 1: HR Diagram

- Absolute Magnitude
- Luminosity ($L_{\odot}$)
- Spectral Type

- Main-Sequence
- HD 199579
- Phi Ori
- Pi And
- Vega
- Altair
- Eta Arietis
- Sun
- 70 Ophiuchi
- 61 Cygni
- Gliese 185
- Kruger 60B
THE END