**Discovery of White Dwarfs—1 Oct**

- Adams’ discovery
- Magnitude, apparent & absolute
- Why are white dwarfs much smaller than stars like the sun?
- Normal gas & degenerate gas

**Luminosity and flux**

- Luminosity = amount of energy per second (Watt) produced by the star
  - \( L = R^2T^4 \)
- Flux = energy per second received by a detector on earth (Watt/m²)
  - \( F = \frac{L}{D^2} \)

1. As viewed from Earth, which is the faintest star?
   A. Sun
   B. Vega
   C. Sirius

2. As viewed from a distance of 10 pc from each star, which is the faintest star?

<table>
<thead>
<tr>
<th>Star</th>
<th>Apparent mag</th>
<th>Flux [W/m²]</th>
<th>Absolute mag</th>
<th>Luminosity [W]</th>
<th>Distance [pc]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun</td>
<td>-26.7</td>
<td>1400</td>
<td>5.2×10¹⁰</td>
<td>3.9×10²⁶</td>
<td>1</td>
</tr>
<tr>
<td>Vega</td>
<td>0.0</td>
<td>2.7×10⁻⁸</td>
<td>1</td>
<td>0.5</td>
<td>2.1×10²⁸</td>
</tr>
<tr>
<td>Sirius</td>
<td>-1.45</td>
<td>1.1×10⁻⁷</td>
<td>3.9</td>
<td>1.4</td>
<td>9.0×10²⁷</td>
</tr>
</tbody>
</table>

**Apparent & Absolute Magnitude**

- Apparent mag is a logarithmic expression of flux
- If the apparent mag changes by -2.5, the flux is brighter by a factor of 10.
  - If the apparent mag changes by +2.5, the flux is fainter by a factor of 10.

1. The apparent magnitude of a star is +2.5. Its flux is
   A. 2.7×10⁻⁸W/m².
   B. 2.7×10⁻⁹W/m².
   C. 2.7×10⁻⁸W/m².
   D. 2.7×10⁻⁹W/m².
   E. 2.7×10⁻¹⁰W/m².

2. The apparent magnitude of a star is +5. Its flux is
Apparent & Absolute Magnitude

- Apparent mag is a logarithmic expression of flux.
- If the apparent mag changes by -2.5, the flux is brighter by a factor of 10.
- Fluxes and magnitudes of two stars A and B:
  \[ \frac{f_B}{f_A} = 10^{(m_B - m_A)/2.5} \]
  \[ m_B - m_A = -2.5 \log(\frac{f_B}{f_A}) \]

### Distance

<table>
<thead>
<tr>
<th>Star</th>
<th>Apparent mag</th>
<th>Flux [W/m²]</th>
<th>Absolute mag</th>
<th>Luminosity [W]</th>
<th>Distance [pc]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun</td>
<td>-26.7</td>
<td>1400</td>
<td>5.2 \times 10^{10}</td>
<td>4.8</td>
<td>3.9 \times 10^{26}</td>
</tr>
<tr>
<td>Vega</td>
<td>0.0</td>
<td>2.7 \times 10^{-8}</td>
<td>1</td>
<td>0.5</td>
<td>2.1 \times 10^{28}</td>
</tr>
<tr>
<td>Sirius</td>
<td>-1.45</td>
<td>1.1 \times 10^{-7}</td>
<td>3.9</td>
<td>1.4</td>
<td>9.0 \times 10^{27}</td>
</tr>
</tbody>
</table>

****Sirius A and Sirius B****

- We are Walter Adams of the Mt. Wilson Observatory in 1914. We are studying the double star Sirius A and B. (Sirius A & B orbit each other.)
- Sirius B is much fainter than Sirius A.

### Absolute & Absolute Magnitude

- Apparent mag is a logarithmic expression of flux.
- If the apparent mag changes by -2.5, the flux is brighter by a factor of 10.
- Absolute mag is a logarithmic expression of luminosity.
- Abs mag of a star is its apparent mag if the star is moved to a distance of 10 pc.
- If the abs mag changes by -2.5 mag, the luminosity is brighter by a factor of 10.

1. The absolute magnitude of a star is -2. Its luminosity is:
   A. 2.1 \times 10^{26} W.
   B. 2.1 \times 10^{27} W.
   C. 2.1 \times 10^{28} W.
   D. 2.1 \times 10^{29} W.
   E. 2.1 \times 10^{30} W.

1. Sirius B may be faint for two reasons. It may be small or it may be:
   A. farther away
   B. closer
   C. cooler
   D. hotter
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   A. farther away
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   - Adams found that Sirius A and B have about the same color. Therefore Sirius B is smaller.

Sirius A and Sirius B

- Adams found that Sirius A and B have about the same color. Therefore Sirius B is smaller.
  - \( L = R^2 T^4 \)
- How much smaller is Sirius B?
- Apparent mag of Sirius A is \(-1.5\)
- Apparent mag of Sirius B is \(8.7\)

1. The mag of Sirius B is approximately ___ steps of 2.5 fainter than that of Sirius A.
   A. 4
   B. 5
   C. 6
   D. 10

2. The flux of Sirius B is approximately ___ fainter.
   A. a factor 10
   B. a factor of 100
   C. a factor of 1000
   D. a factor of 10,000.

http://chandra.harvard.edu/photo/2000/0065/0065_optical.jpg

Summarizing question

- Why was finding of Sirius B’s spectral class crucial to discovery of white dwarfs?