Book - 1 copy on 2 hour reserve in Physics/Math/Astronomy.

Handouts from first class

Astronomy in the News?

Pluto

Lockheed Martin gets contract for Shuttle replacement

Pic of the Day - Gemini South
Background check

What is a main sequence star?

What is a red giant star?

Write a few sentences, talk with your neighbors.
Most common stellar “corpse.” Come from low mass stars → plentiful.
Sky Watch Extra Credit:

Try to find the constellation Lyra, location of the Ring Nebula, Messier 57.

Other planetary nebulae.

Also Moon, Jupiter, Big Dipper for orientation, NSEW, learning to use a star chart,
White Dwarfs

Essentially every white dwarf formed since beginning of Galaxy is still here 10-100 billion of them (~ 100 billion stars total)

Most are dim, undiscovered, see only those nearby, none naked eye

Sirius, brightest star in the sky, has a white dwarf companion. Can’t see the companion with the naked eye, too small, dim, but Sirius is easy if you look for it at the right time.

*Find it for the extra credit project.*
What do we know about white dwarfs?

Mass ~ Sun
Most are single, 0.6 M_☉ (solar masses)
Some in binary systems, higher mass

Size ~ Earth
~1% radius of Sun

Density = \( \frac{\text{mass}}{\text{volume}} \) \( \rightarrow \) \( \frac{10^6 \text{ grams}}{\text{c. c.}} \) \( \sim \) \( \frac{\text{tons}}{\text{cubic centimeter}} \)

OR MORE!

HUGE GRAVITY!
Same mass, smaller size, gravity on *surface* is larger because you are closer to the *center*.

Gravity on surface acts *as if* all mass beneath were concentrated at a point in the center -- Newton/Calculus
Huge gravity compresses star --
requires special pressure to support it (Chapter 1)

- Normal pressure -- thermal pressure
- Motion of hot particles -- Pressure depends on Temperature
- Quantum Pressure -- Quantum Theory
- Uncertainty Principle -- Can’t specify position of any particle exactly
- Exclusion Principle -- No two identical particles can occupy same place with same energy
Figure 1.4

\[ \text{same momentum total exclusion} \quad \text{different momentum} \]

\[ \text{energy} \]

\[ \text{position} \]

\[ \text{ordinary gas} \quad \text{gas dominated by quantum pressure} \]
One Minute Exam:

Where is gravity strongest, A, B, or C?

Talk to your neighbors.

Same mass in all three cases
Quantum Pressure -- just depends on squeezing particles, electrons for white dwarf, to very high density -- depends on density only -- *does not* depend on temperature

**Important Implication:**

<table>
<thead>
<tr>
<th>Normal ★</th>
<th>Radiate energy, temperature/pressure try to drop, star compresses, gets <strong>hotter</strong> (and higher pressure)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Dwarf</td>
<td>Radiate energy, <em>temperature does not matter</em>, pressure remains constant, star gets <strong>cooler</strong></td>
</tr>
</tbody>
</table>

**Opposite behavior**

<table>
<thead>
<tr>
<th>Normal Star - Regulated</th>
<th>put in energy, star expands, cools</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Dwarf - Unregulated</td>
<td>put in energy, hotter, more nuclear burning -- explosion!</td>
</tr>
</tbody>
</table>