January 18, 2008

Reading: Chapters 1 - 5

Lectures posted (pdf files) on the web site

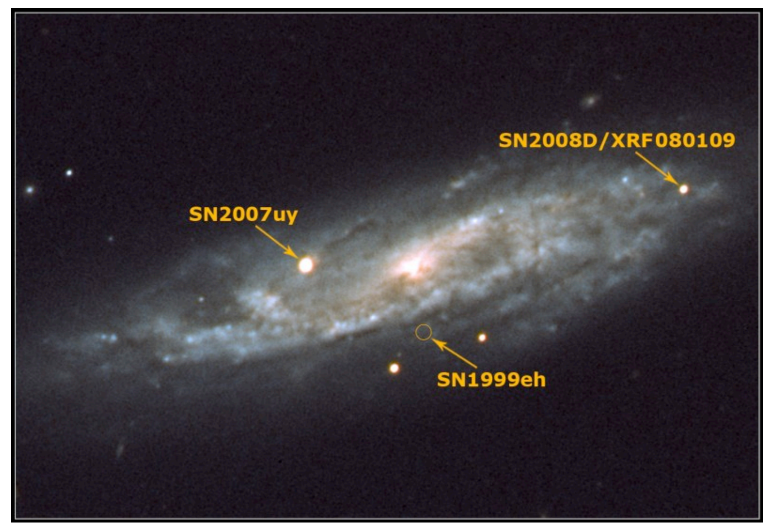
No class Monday - Martin Luther King Day

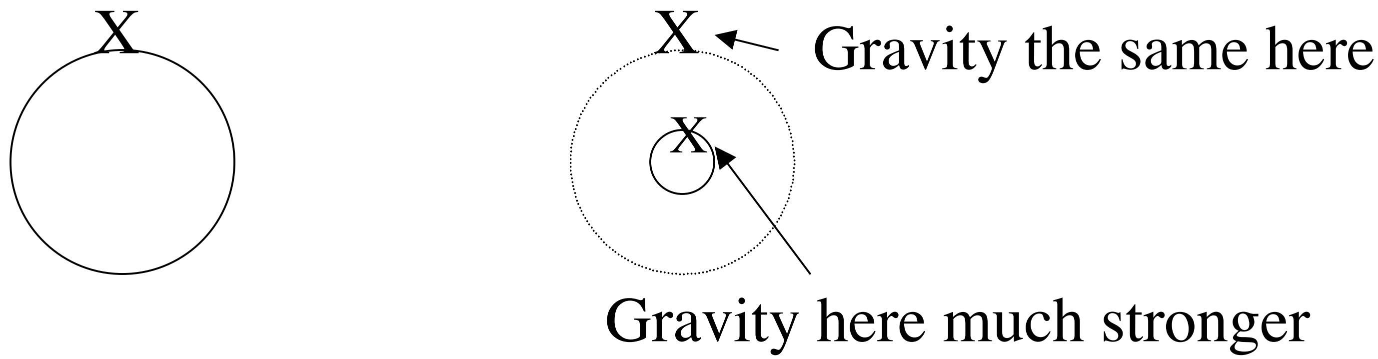
The Moon!

Astronomy in the news?

Pic of the day:

Supernovae in a distant spiral galaxy





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

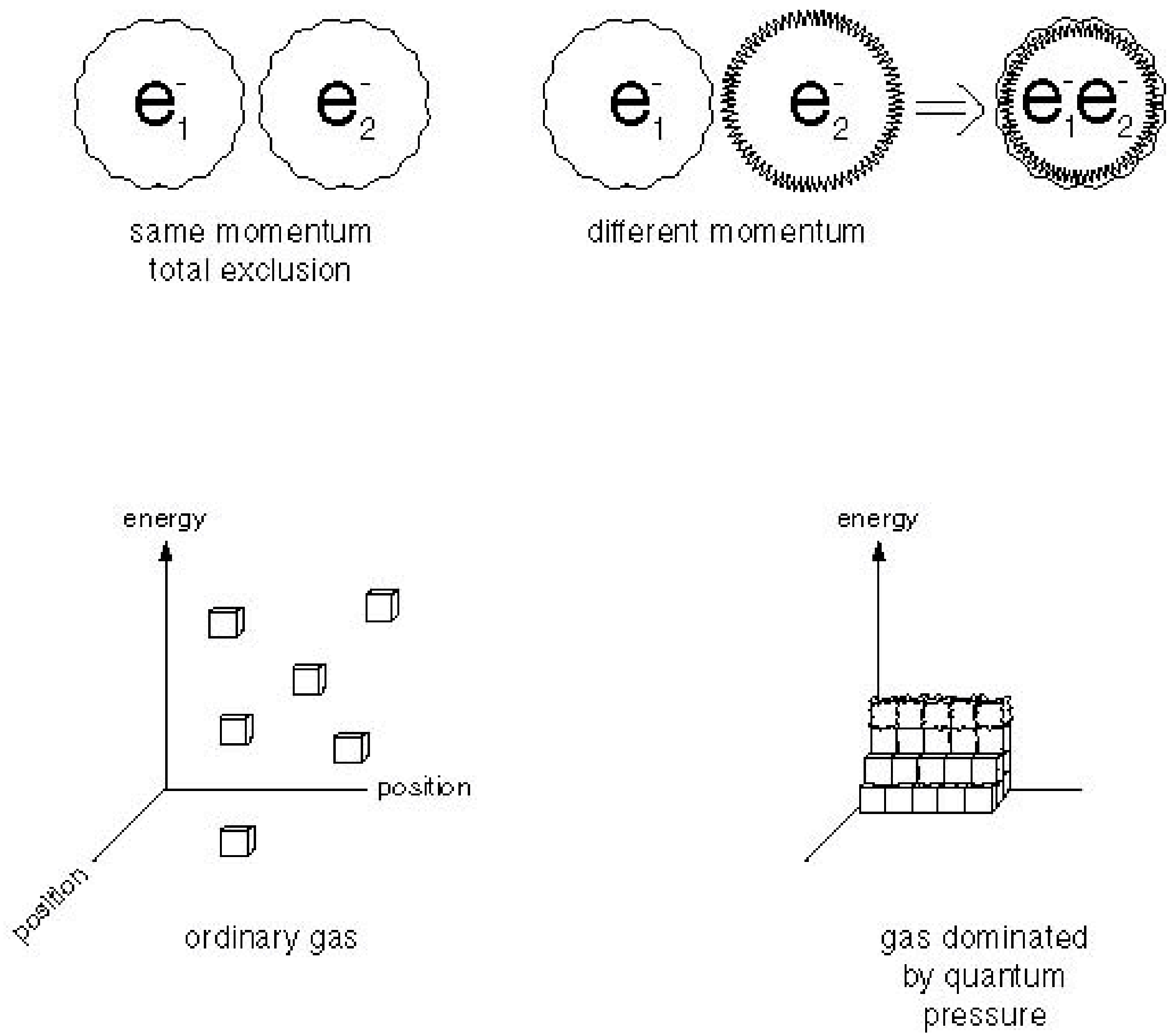
Gravity is much higher on the surface of a white dwarf than the surface of the Sun although they have nearly the same mass. Why?

Gravity is much higher on the surface of a white dwarf than the surface of the Earth even though they are about the same size. Why?

Huge gravity compresses a white dwarf --
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 (electrons, protons, neutrons) can occupy same place with same energy

Figure 1.4


same momentum
total exclusion
different momentum
energy
position
position
ordinary gas
energy
gas dominated
by quantum
pressure

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:

Normal ★ Radiate energy, pressure tries to drop, star contracts and gets **hotter** (and higher pressure)

White Dwarf Radiate energy, *temperature does not matter*, pressure, size, remain constant, star gets **cooler**

Opposite behavior

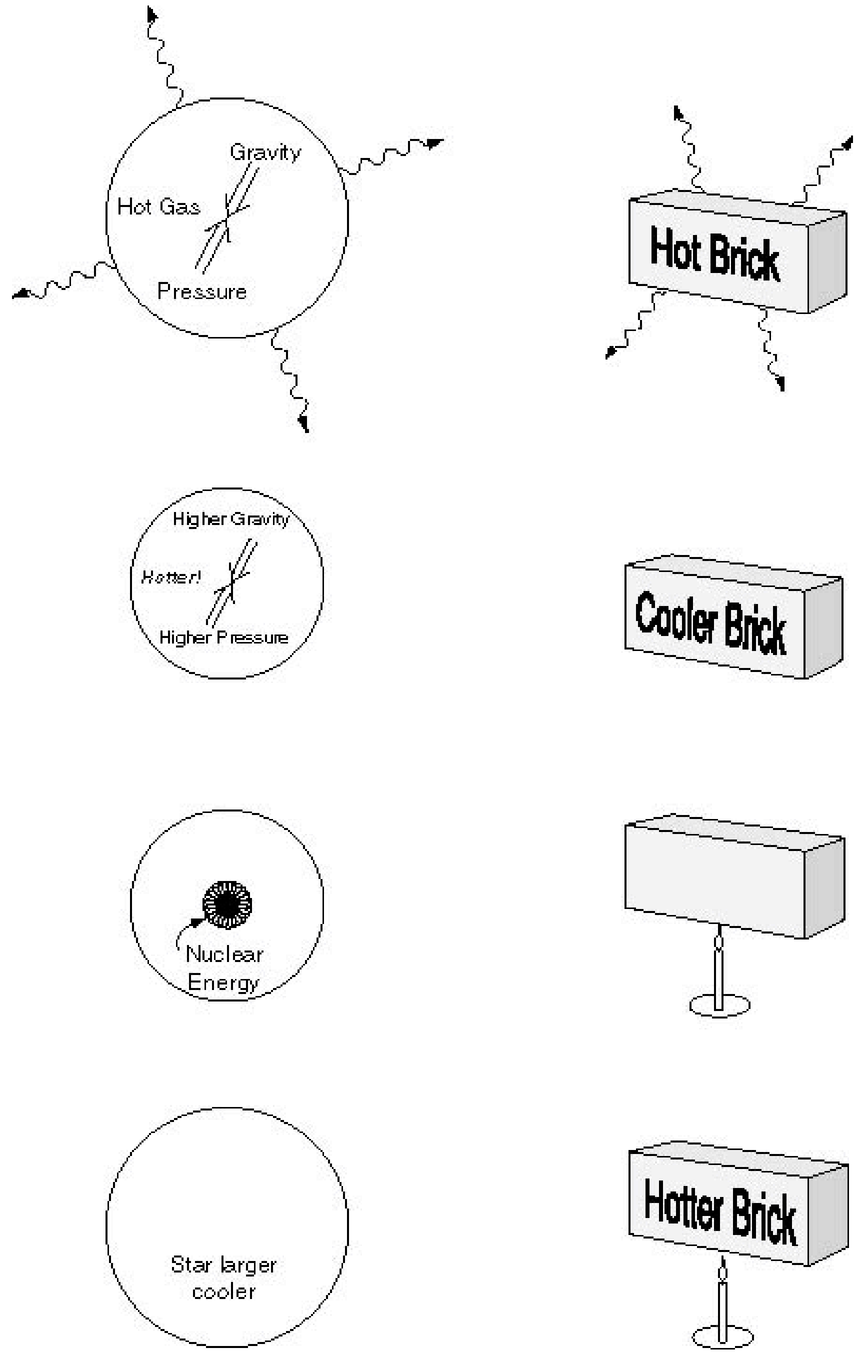
Normal Star - *Regulated*	put in energy, star expands, cools
White Dwarf - *Unregulated*	put in energy, hotter, more nuclear burning -- explosion!

Same mass in all three cases

One Minute Exam:

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

Figure 1.3


Gravity
Hot Gas
Pressure
Hot Brick
Higher Gravity
Hotter!
Higher Pressure
Cooler Brick
Nuclear
Energy
Star larger
cooler
Hotter Brick

Behavior of white dwarf, Quantum Pressure, worked out by
S. Chandrasekhar in the 1930's

Limit to mass the Quantum Pressure of electrons can support

Chandrasekhar limit ~ 1.4 $M_{\odot}$
density ~ billion grams/cc ~ 1000 tons/cubic centimeter

Maximum mass of white dwarf.

One Minute Exam

If nuclear reactions start burning in a white dwarf, what happens to the temperature?

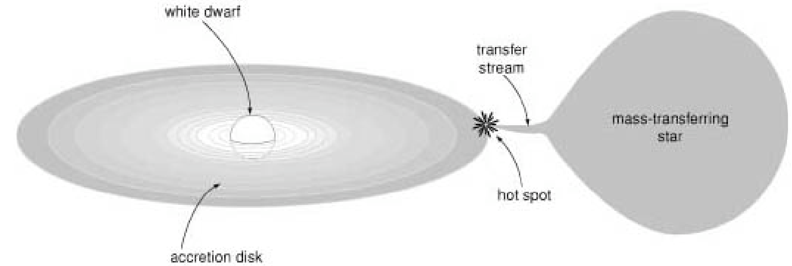
A the temperature goes up

B the temperature remains constant

C the temperature goes down

D insufficient information to answer the question

White dwarfs in Binary Systems



Binary Evolution: **Chapter 3**

Kepler's 3rd Law $P^{2\text{(squared)}}$ proportional to $a^{3\text{ (cubed)}}$

Period
Time to orbit

size of orbit

Newton: P^2 proportional to

$$\frac{a^3}{M_1 + M_2}$$

total mass of 2 stars: method to "weigh" the system, get total, subtract "normal" star, get weight of WD, NS, BH