January 24, 2011

Astronomy in the news? Work by Texas astronomers, supermassive black hole in the galaxy M 87 is even bigger than thought, about 6 billion solar masses.

Pic of the day: South Pole of Phobos

# White Dwarfs
# (Section 5.1)

White Dwarf – dense core left behind by low mass stars (less than 8 solar masses) after red giant and planetary nebular phase.

Essentially every white dwarf formed since beginning of the Galaxy is still here 10-100 billion of them (~ 100 billion stars total), but a few white dwarfs have blown up.

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

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

***Find Sirius for the extra credit sky watch project.***

Discussion Point:

White dwarfs have about the same mass as the Sun and about the same radius as the Earth.

How does the gravity of a white dwarf compare to the Sun and the Earth, and why?

# What do we know about white dwarfs?

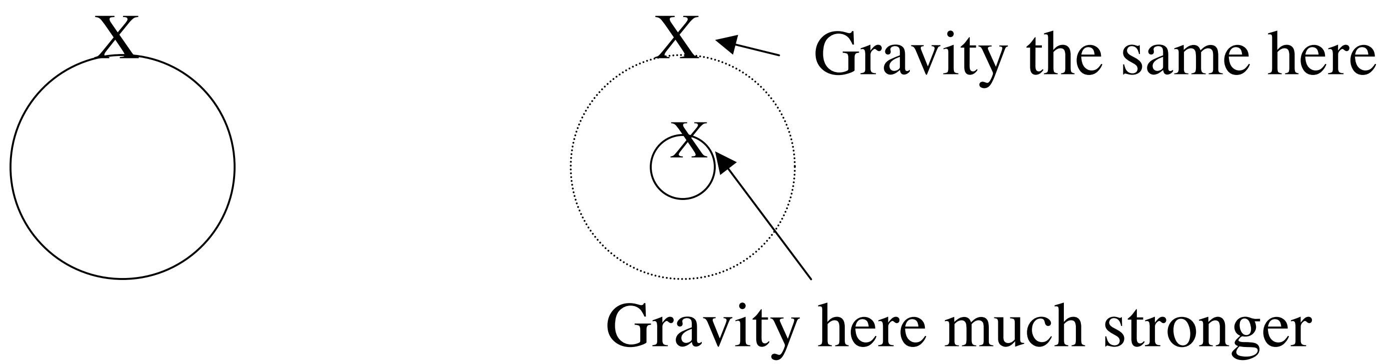
Mass ~ Sun
Most are single, 0.6 $M_\odot$ (solar masses)
Some in binary systems, higher mass

Size ~ Earth ~1% radius of Sun

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

OR MORE!

HUGE GRAVITY!



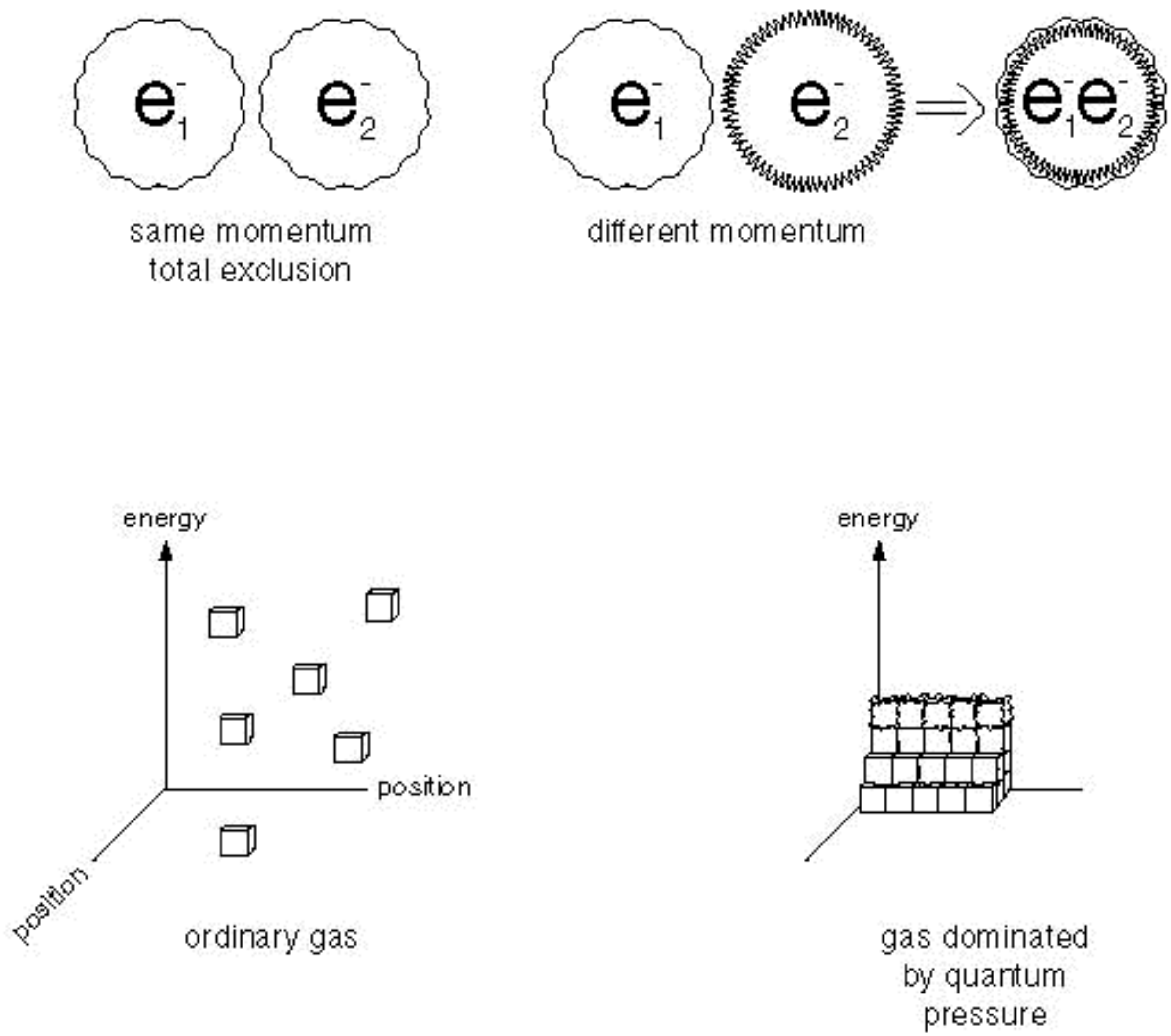

Same mass, smaller size, gravity on *surface* is larger because you are closer to the *center*.

Gravity on surface acts *as if* all mass beneath were concentrated at a point in the center -- Newton/Calculus

Huge gravity compresses a white dwarf --
requires special pressure to support it
(Section 1.2.4, Section 2.3)

- ***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. If you squeeze and "locate" a particle more precisely, its energy gets more uncertain, and larger on average.
- Exclusion Principle -- No two identical particles (electrons, protons, neutrons) can occupy same place with same energy, but they can if one has more "uncertainty" energy.
- ***Pressure depends only on density, not on temperature***

# Figure 1.4


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

Demonstration thermal pressure, quantum pressure - need volunteers.

Discussion point:

How does the different form of the pressure, thermal or quantum, affect the behavior of stars?

What happens if the star puts in excess nuclear energy?

What happens if the star loses excess energy to space?