September 3, 2009

Astronomy in the News?

“Hot jupiter” in 22 hour orbit spiralling rapidly into its host star.

Pic of the Day - Neptune’s moon, Despina, casting a shadow on the surface of Neptune.

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*

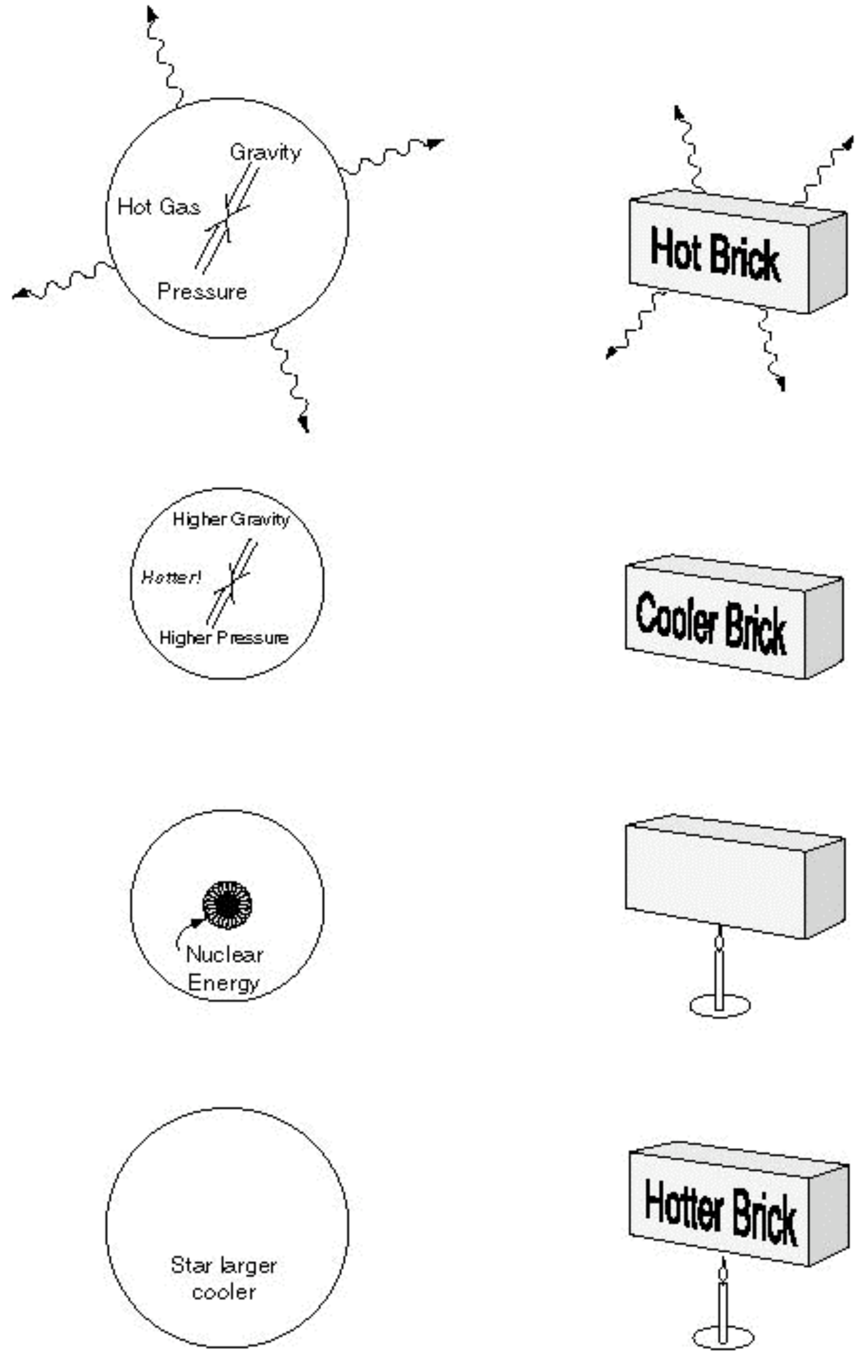
put in energy, hotter, more nuclear burning -- explosion!

Figure 1.3

A normal star can and will radiate away thermal energy and hence structural energy.

A brick cannot radiate its structural energy,

A white dwarf cannot radiate away its quantum energy.



Same mass in all three cases

One Minute Exam:

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

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.

If more mass is added, the white dwarf must collapse or explode!

One Minute Exam

If nuclear reactions start burning in an ordinary star like the Sun, 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

One Minute Exam

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

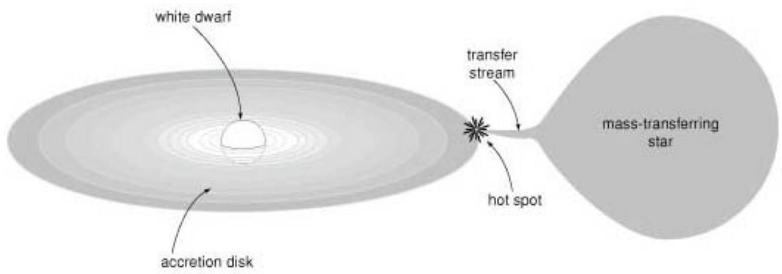
A the temperature goes up

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

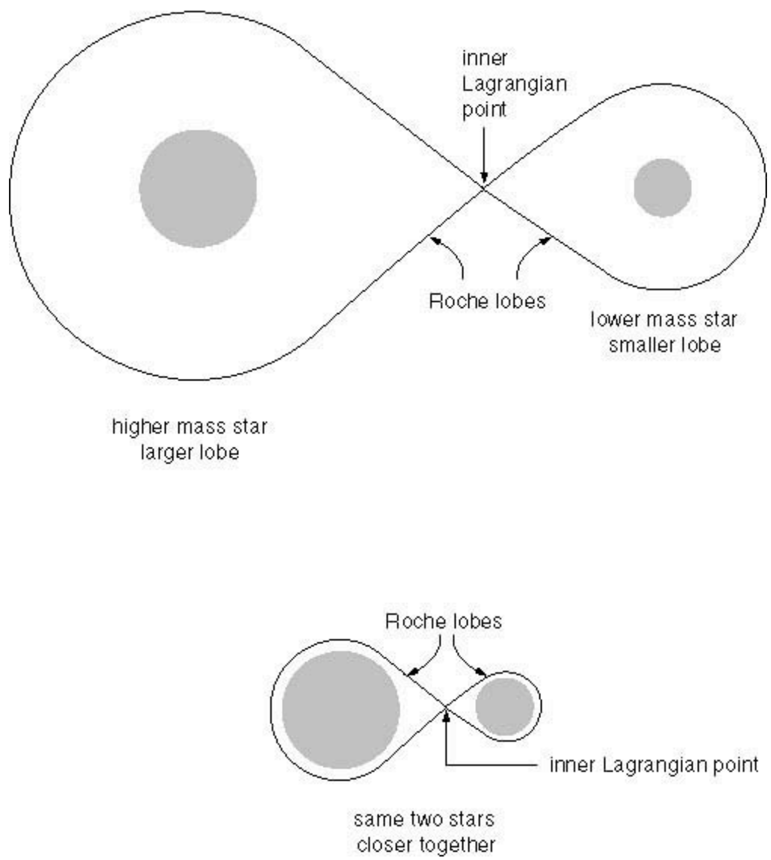
total mass of 2 stars: method to "weigh" the system, get total, subtract "normal" star, get weight of WD, NS, BH

Binary Stars - Chapter 3

Roche Lobes   Fig 3.1

Roche lobe is the gravitational domain of each star. Depends on size of orbit, but more massive star always has the largest Roche lobe.

3.1

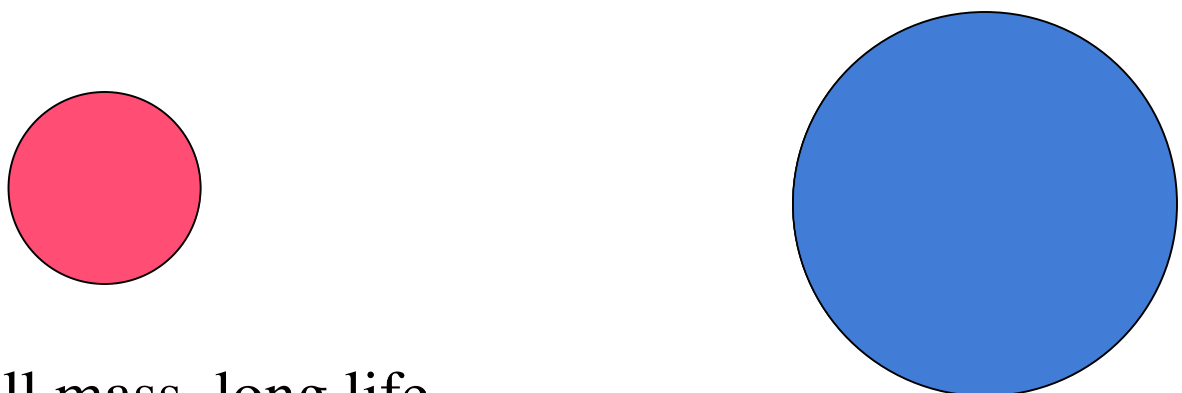


Caution: the most massive star may not have the largest radius!

Fundamental property of stellar evolution:

A more massive star has more fuel, but is also *hotter to give the pressure to support the higher mass against gravity*, brighter, burns that fuel faster.

=> ***stars with higher mass on the main sequence evolve more quickly than stars with lower mass.***



small mass, long life

high mass, short life

Algol, Beta Perseus, second brightest star in the constellation Perseus

Ancient Arabs called the star **Al-Ghul**, the Ghoul

The Hebrews knew Algol as **Rosh Ha'Satan**, Satan's Head, or perhaps **Rosh Ha'Shed**, head of the devil or of a genie.

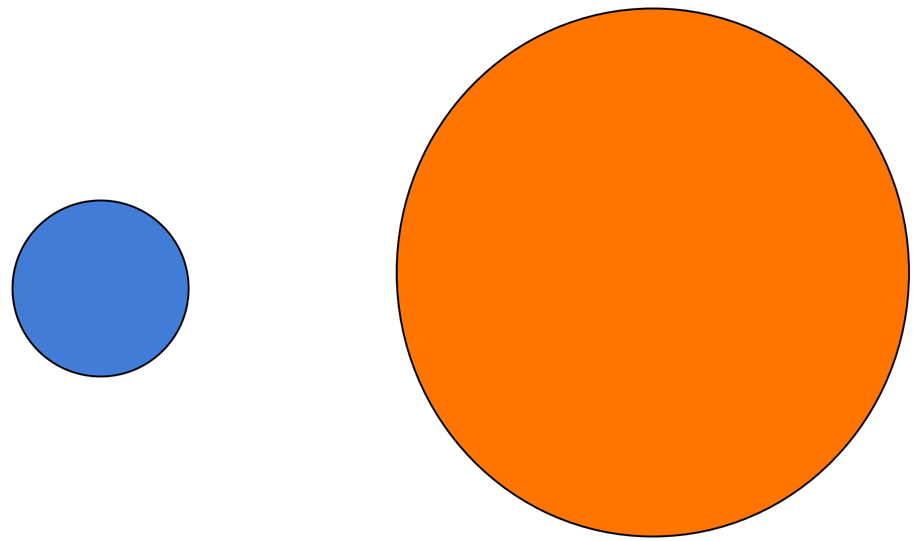
The Chinese called it **Tseih She**, the Piled-up Corpses

In Greek mythology, Algol is the head of the Gorgon Medusa that Perseus carries under his left arm.

Find Algol for your Sky Watch Project.

Requires special dedication this time of year.

Algol paradox: Algol is a binary star system with a Red Giant orbiting a blue-white Main Sequence companion.



Which is most massive?

Use Kepler's law to measure total mass, then other astronomy (luminosity of main sequence star tells the mass) to determine the individual masses.

Answer: the unevolved main sequence star!

Red Giant ~ 0.5 $M_{\odot}$ - but more evolved

Blue-white Main Sequence star ~ 2-3 $M_{\odot}$ - but less evolved