September 22, 2010

Exam 2 Friday, October 1

Reading, Sections 6.4, 6.5, 6.6. Chapter 7.

Sections 1.2, 2.1, 2.4, 2.5, 3.3, 3.4, 3.5, 3.10 (binary stars), 4.1, 4.2, 4.3, 4.4 (accretion disks), 5.2, 5.4 (cataclysmic variables) for background

Astronomy in the News? Was the San Bruno pipeline explosion a detonation? Likely, but lost in conspiracy theories and misinformation. Utah fire started with detonations, an overheated submachine gun.

Full Moon and Jupiter nearly align tonight

Pic of the Day – Shuttle Shadow

Goal

To understand the process of thermonuclear explosion in a white dwarf to make a Type Ia supernova.

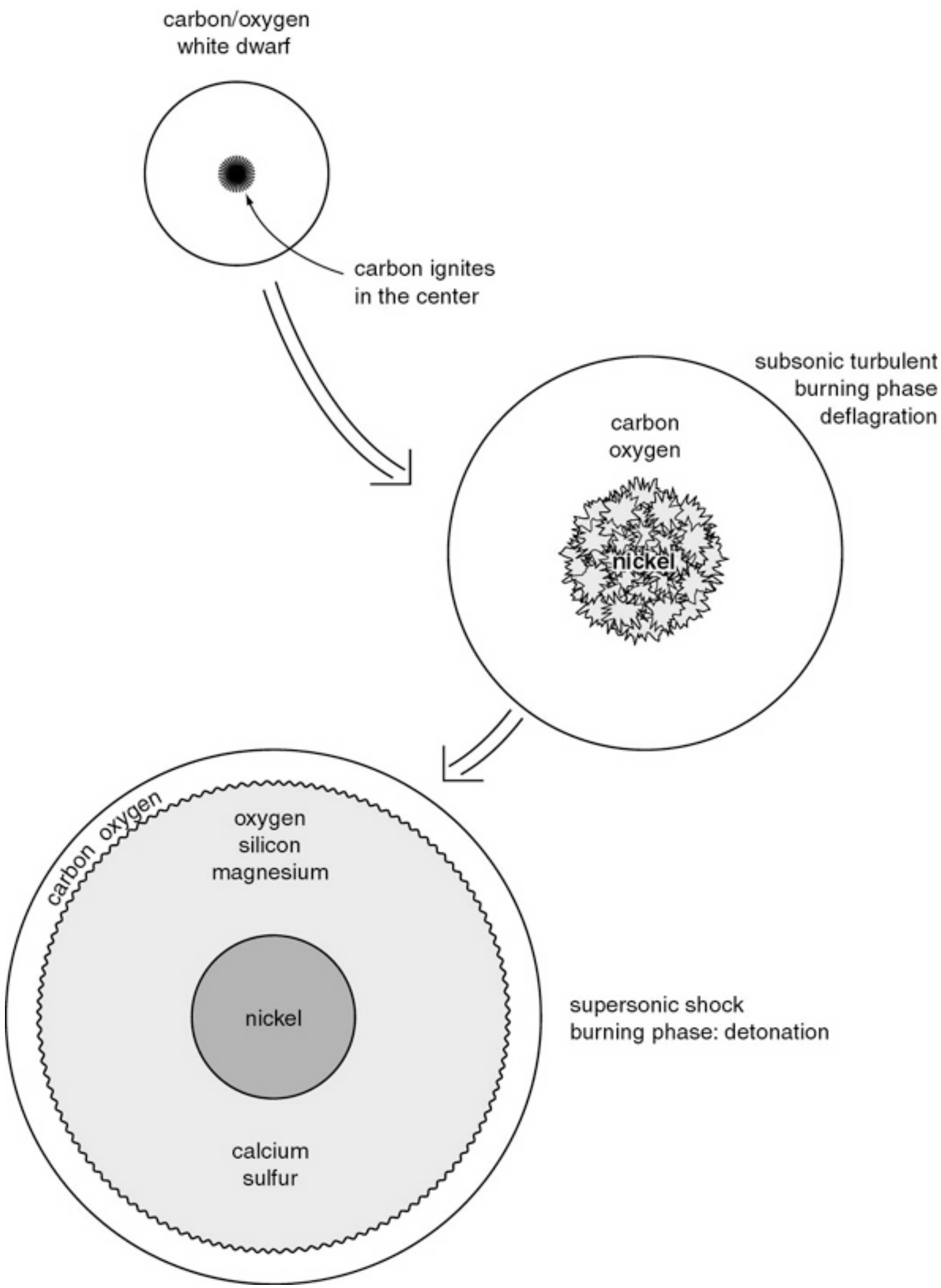


Figure 6.4

Presence of nickel, conversion of nickel to iron explained later

One Minute Exam

Astronomers detect Silicon when a Type Ia supernova is brightest and iron after it has faded. This means:

➡ The exploded material is made of equal parts silicon and iron

⬅ The white dwarf that exploded could not be made of carbon and oxygen

⬆ The iron is in the inner portions of the ejected matter, the silicon in the outer portions

⬇ The supernovae was powered by the collapse of an iron core

One Minute Exam

Why does a subsonic deflagration “flame” alone fail to account for the observations of a Type Ia supernova?

➡ All the ejected matter would be iron.

⬅ A neutron star would be left behind.

⬆ The ejected matter would contain lots of carbon

⬇ The ejected matter would have silicon on the outside and iron on the inside

Normal Type Ia ***are*** Chandrasekhar mass, 1.4 $M_\odot$, carbon/oxygen white dwarfs; many, if not all, are old.

Only credible idea is to grow a white dwarf by mass transfer in a binary system.

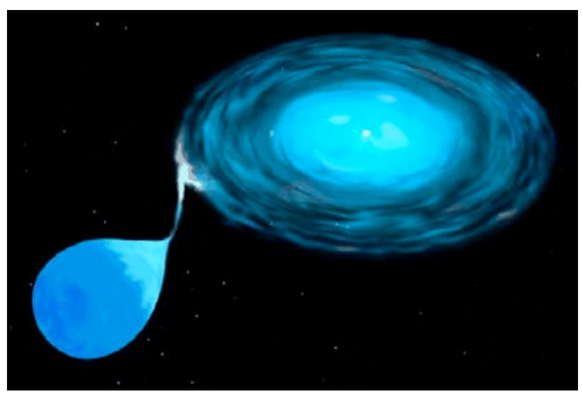
No direct evidence for binary systems, some recent indirect hints.

Hint from polarized light - not quite round – *why?*

How does nature grow a white dwarf to 1.4 $M_\odot$?

The progenitors of Type Ia supernovae may look like this:

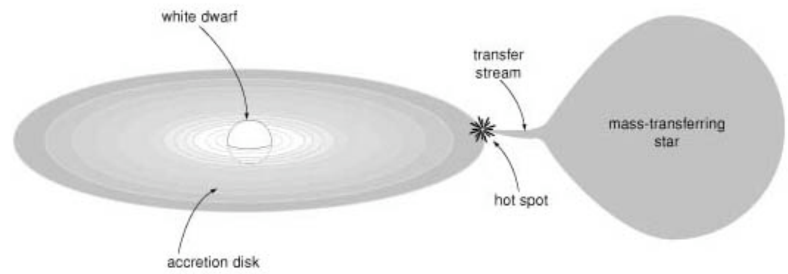
What's going on?



Goal

To understand how stars evolve in binary systems.

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

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

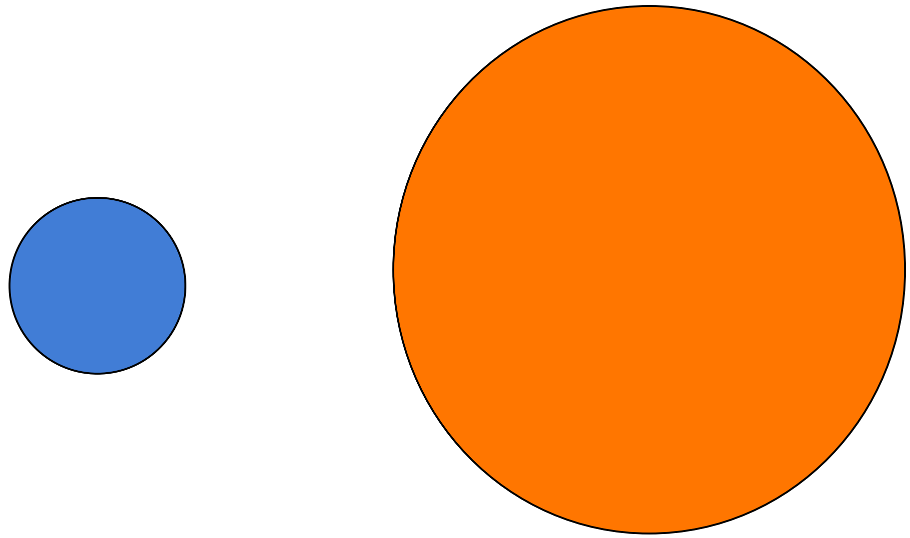
The Hebrews knew Algol as **Rosh Ha'Satan**, Satan's Head, or perhaps **Rosh Ha'Shed**, head of the devil or of a genie.

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.

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

Discussion Point:

Explain to your neighbor why this is a dilemma.

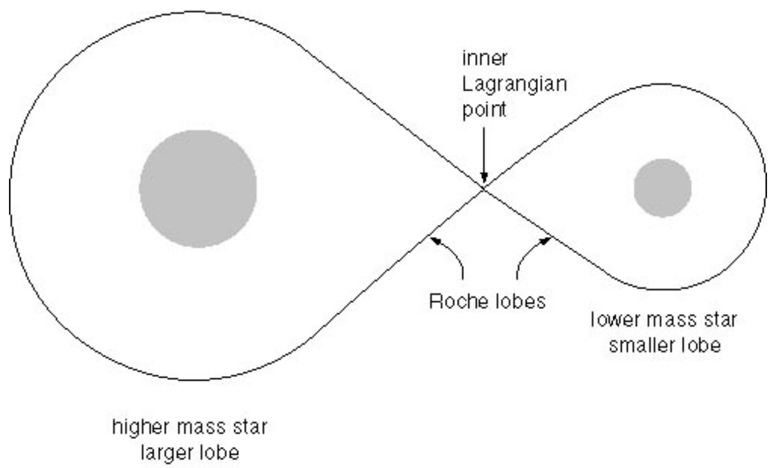
Do you remember how Kepler’s 3rd law can be used to measure the total mass of the binary system?

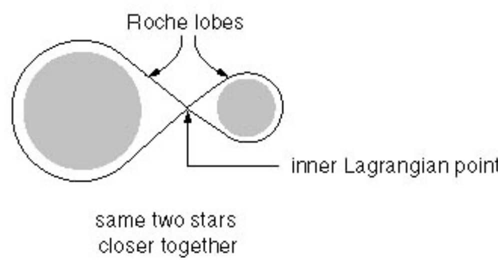
Binary Stars - Chapter 3

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





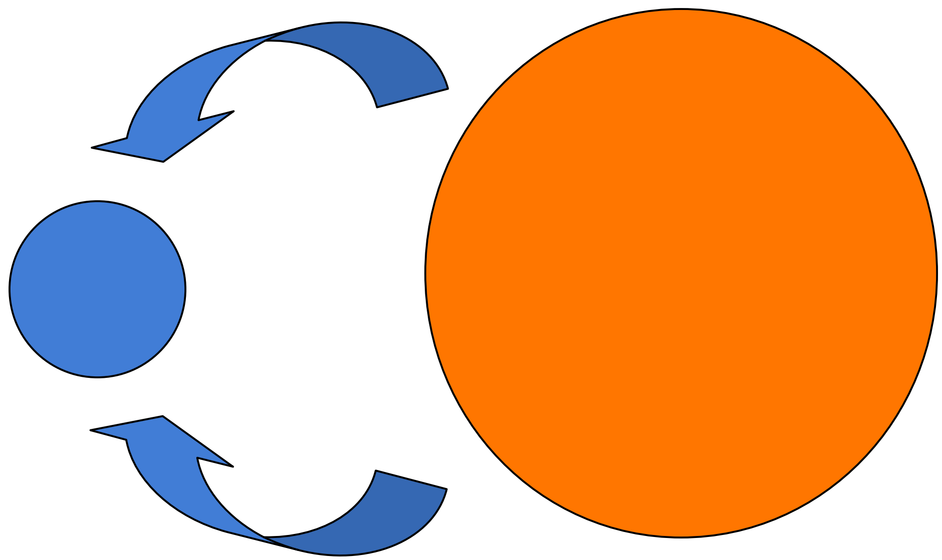
Caution: the most massive star may not have the largest radius!

Solution to Algol Paradox

Mass Transfer

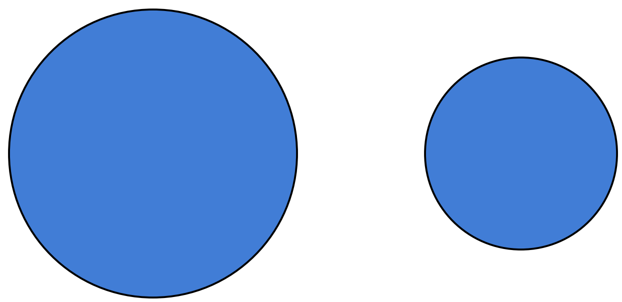
The red giant swells up, fills then overfills its Roche lobe and transfers mass to the companion.

The star that will become the red giant starts as the more massive star, but ends up the less massive.



One Minute Exam

Two stars orbit one another in a binary system



Which star has the largest Roche lobe?

the one on the left

the one on the right

insufficient information to answer the question

Which star is the most massive?