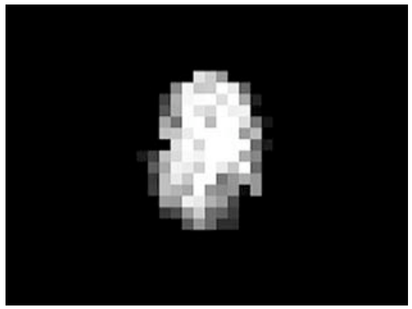
1/30/2008

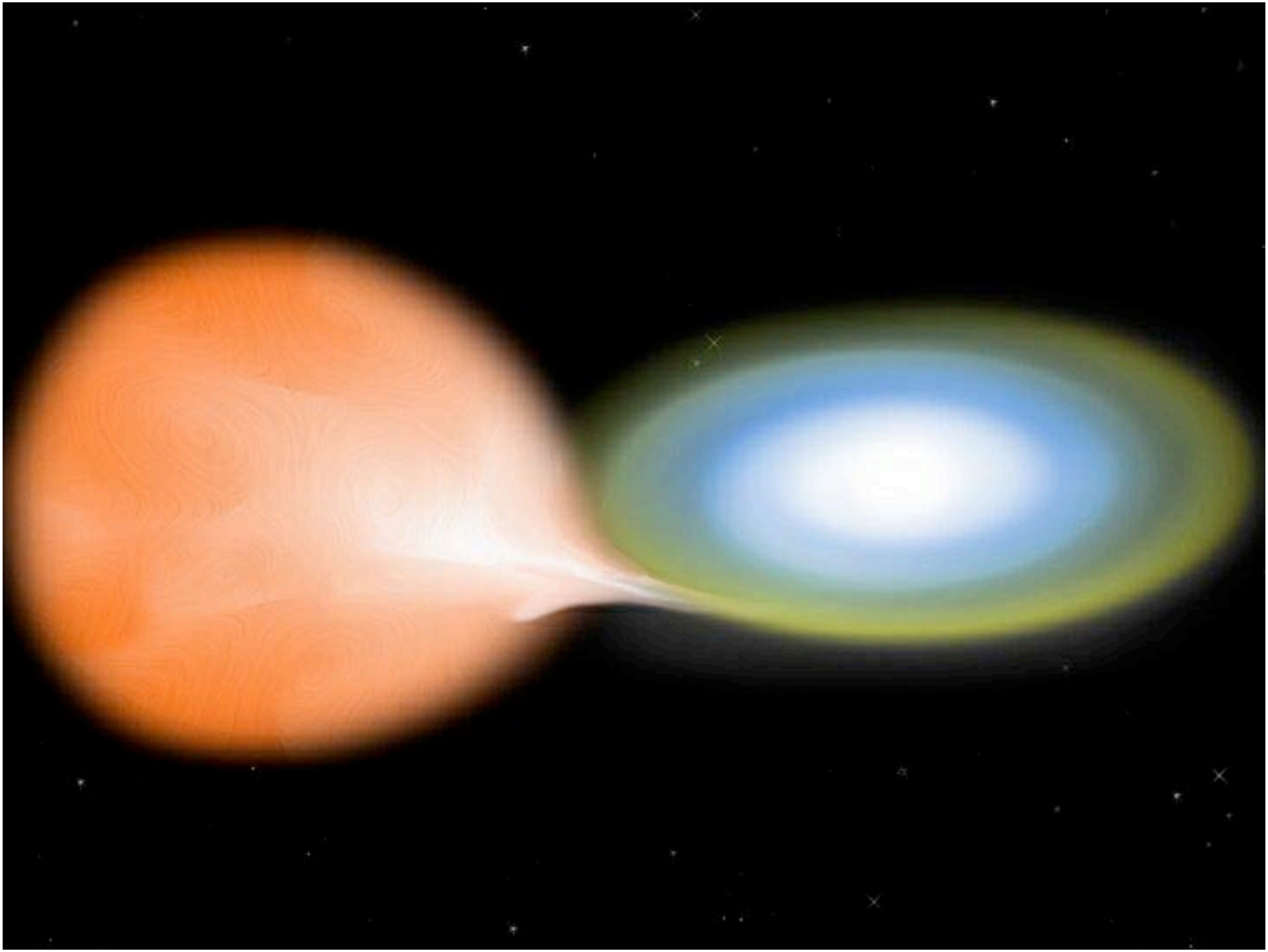
Exam 1: Friday February8 [First Sky Watch Reports Following Monday]

Chapter 5, portions of chapters 1 - 4,
40 multiple-choice questions

Astronomy in the news? Dwarf Nova in Hydra

Pic of Day - Radar image of asteroid passing just beyond Moon’s orbit, 250 meters across big enough to dig a city-sized crater.





§ 5.4 Final Evolution of Cataclysmic Variables

Some CVs have managed to reach large masses
$M_{wd} \sim M_{ch}$ Chandrasekhar mass, 1.4 solar masses, like U Sco

If get close enough to M_{ch}, attain high density,
ignite carbon in center
Quantum Deregulated → violent explosion
Supernova (Chapter 6)

What CVs have white dwarfs that reach M_{ch}?

Not classical novae

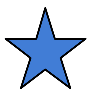
explosion of surface H shell also rips off a bit of the white dwarf mass - we see excess carbon & oxygen in ejected matter

white dwarf shrinks in mass rather than grows.

Likely outcome in this case - 2nd star finally burns out H, tries to form red giant, likely makes a 2nd common envelope => ***Two WDs!***

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, temperature/pressure try to drop, star compresses, gets **hotter** (and higher pressure)

White Dwarf

Radiate energy, *temperature does not matter*, pressure remains 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!

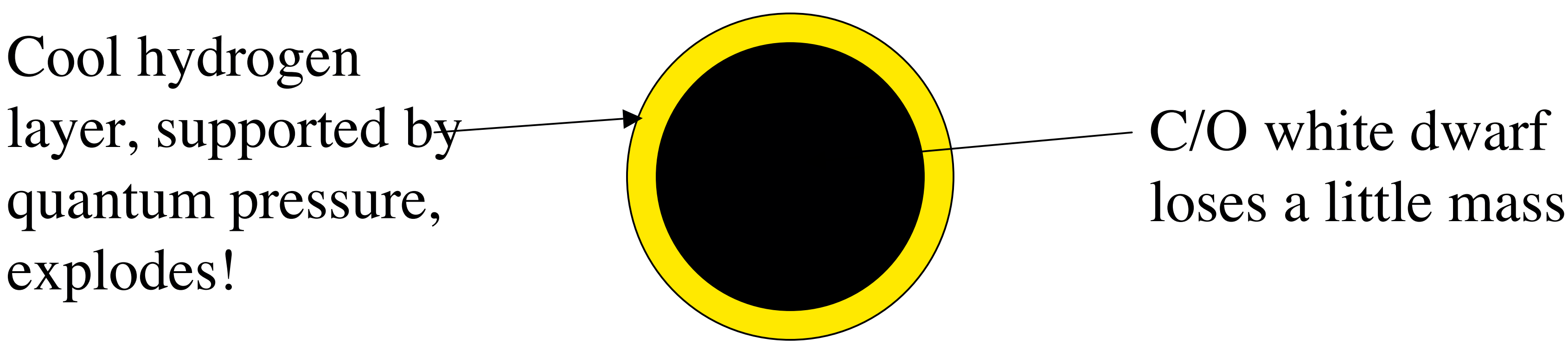
Hydrogen transfers from a main sequence star to a white dwarf in a binary system.

Modest rate of transfer, hydrogen has a chance to radiate and cool as it is added to the surface of the white dwarf, ends up cool but dense, supported by the ***quantum pressure***. If the hydrogen begins to burn the result is:

Unregulated hydrogen burning, an explosion --> ***Classical Nova***

White dwarf loses mass, cannot grow to Chandrasekhar mass

Second star eventually makes its own white dwarf --> 2 WD



Clearly some systems like recurrent nova U Sco with nearly 1.4 solar mass white dwarf escape this fate - How?

Recent work suggests that transfer of mass at just the right fast rate allows the H layer to stay hot, ***thermal pressure, regulated***

H burns to He, He to C and 0 that are added to white dwarf

M_{wd} grows in C/0 mass

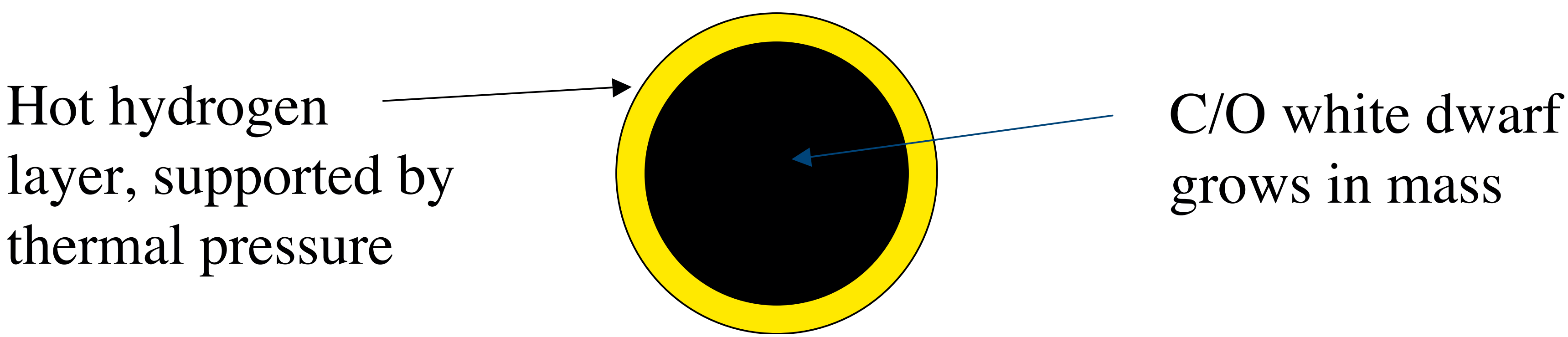
Hydrogen transfers from a main sequence star to a white dwarf in a binary system.

Higher rate of transfer, hydrogen does ***not*** have a chance to radiate and cool as it is added to the surface of the white dwarf, it stays hot and is supported by the ***thermal pressure***. If the hydrogen begins to burn the result is:

Regulated burning, bright flash, but no hydrogen explosion --> ***Recurrent Nova***

White dwarf gains mass, can grow to near Chandrasekhar mass

Eventually may ignite carbon in the center, quantum deregulated, explode whole star as a ***supernova***



A binary system could be a classical nova for some time
then accrete faster, convert to recurrent nova, grow WD to M_{ch}

Some white dwarfs may be born with larger mass.

Some white dwarfs grow to near the Chandrasekhar mass and explode, some don't.

We still don't fully understand why…

One Minute Exam

We expect classical nova systems to end up making two white dwarfs orbiting one another because:

A The first white dwarf loses mass and hence cannot grow and explode

B The first white dwarf will accrete mass until it reaches the Chandrasekhar limit

C The main sequence star transferring mass must eventually make a white dwarf

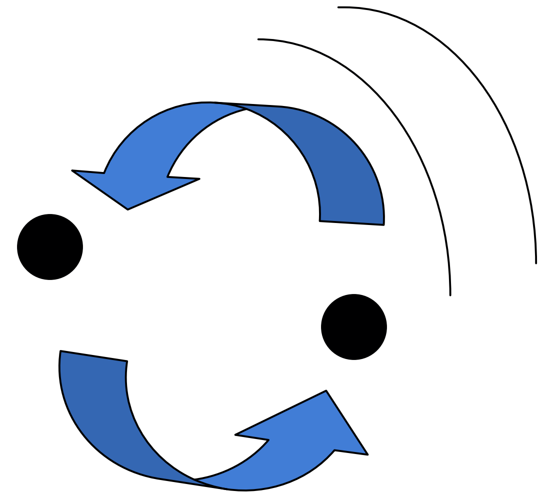
D The hydrogen layer is supported by thermal pressure

We do observe 2 white dwarfs in orbit in some cases - is that the end?

No: ***gravitational radiation*** (§ 3.10)

ripples in curved space-time

like paddle on surface of pond



remove energy from orbit - acts as drag

If you try to slow down an orbiting object what happens?

Falls inward, speeds up,
Get more gravitational radiation, more inspiral

Given enough time (billions of years) 2 white dwarfs must spiral together!

One Minute Exam

Name three situations where we have talked about friction and drag causing orbiting stuff to fall inward and ***move faster***.

Flow of gas in accretion disk

Two stars orbiting in a common envelope

Two orbiting white dwarfs losing energy to gravitational radiation

What happens when two white dwarfs spiral together?

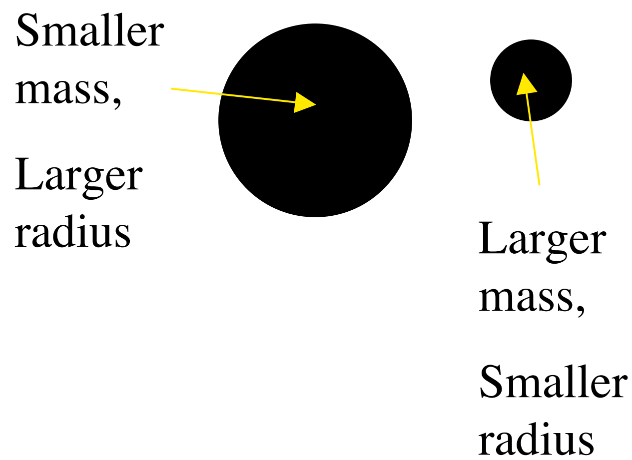
Larger mass WD has smaller radius

Which WD has the smaller Roche lobe?

The smaller mass

Which fills its Roche Lobe first?

Must be the smaller mass



As small mass WD loses mass, its ***radius gets larger***,
but its ***Roche Lobe gets smaller***! Runaway mass transfer.

Small mass WD transfers essentially all its mass to larger mass WD

Could end up with one larger mass WD

If larger mass hits M_{ch} → could get explosion => Supernova

End of Material for Test 1

Reading

Chapter 1: 1.2.3, 1.2.4,

Chapter 2: 2.3

Chapter 3: 3.1, 3.2, 3.3, 3.4, 3.8, 3.9, 3.10

Chapter 4: 4.1, 4.2, 4.3, 4.4, 4.5

Chapter 5: ALL