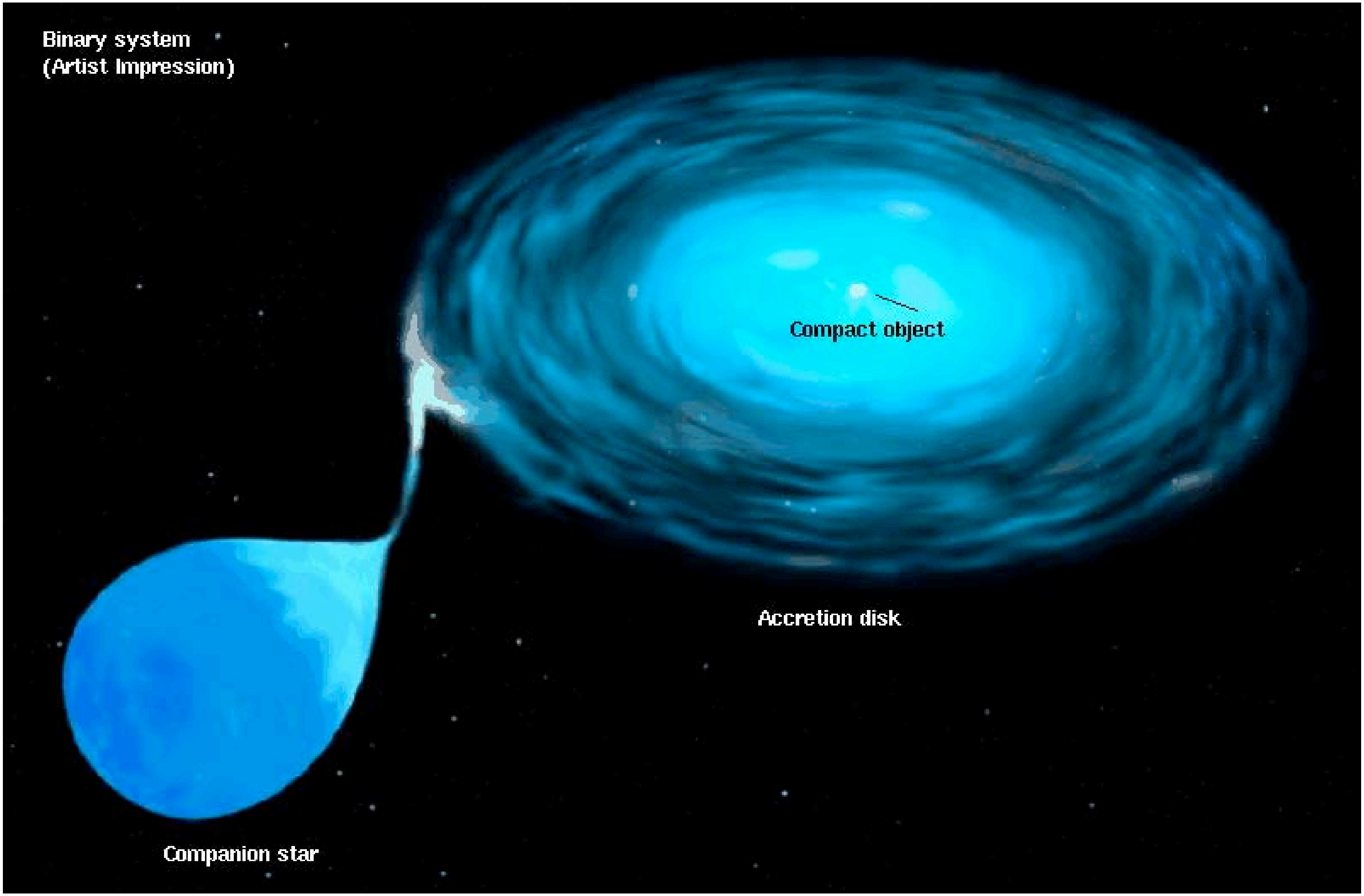
9/13/06

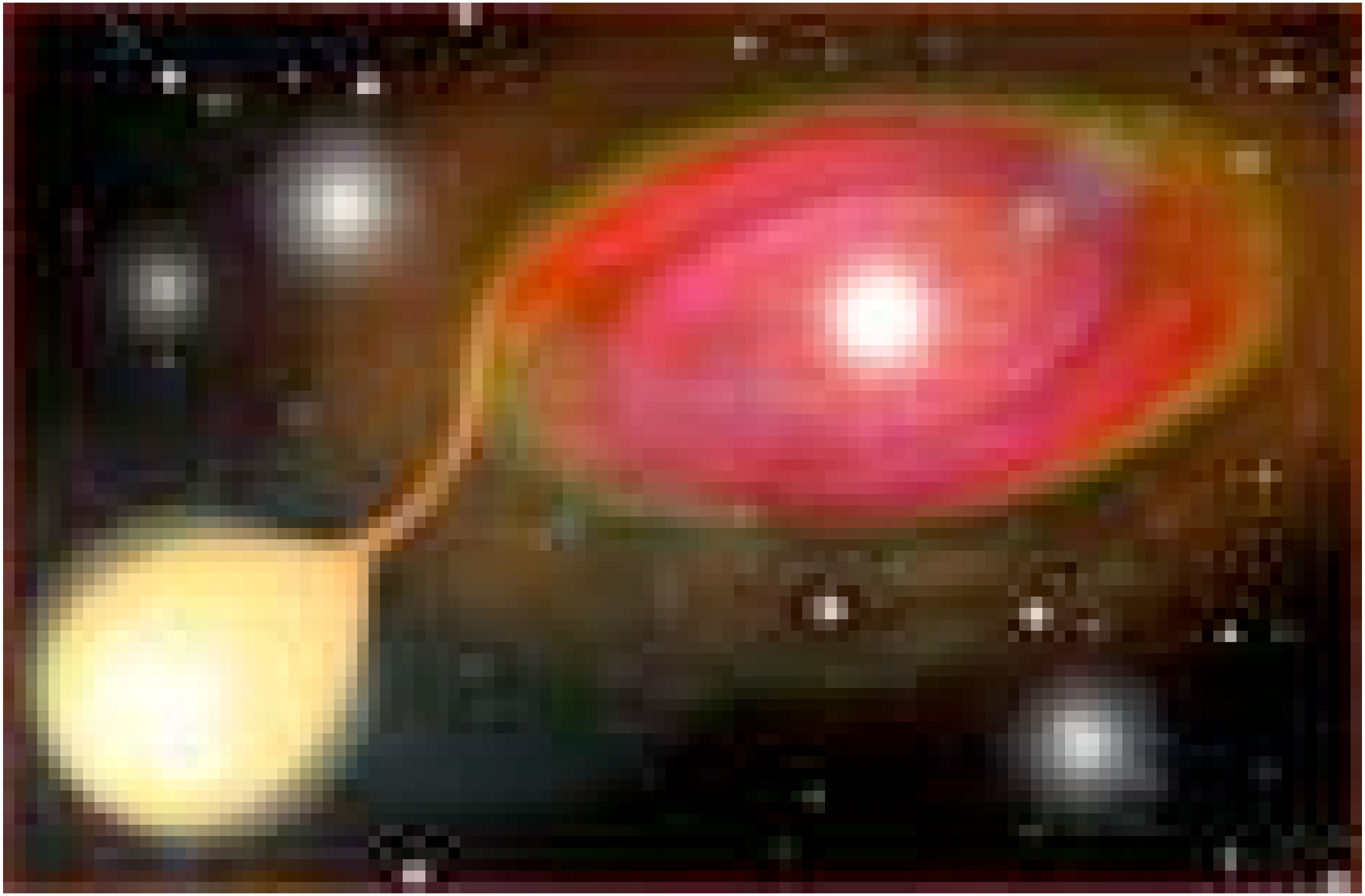
First Test, Chapters 1 - 5, Friday, September 22

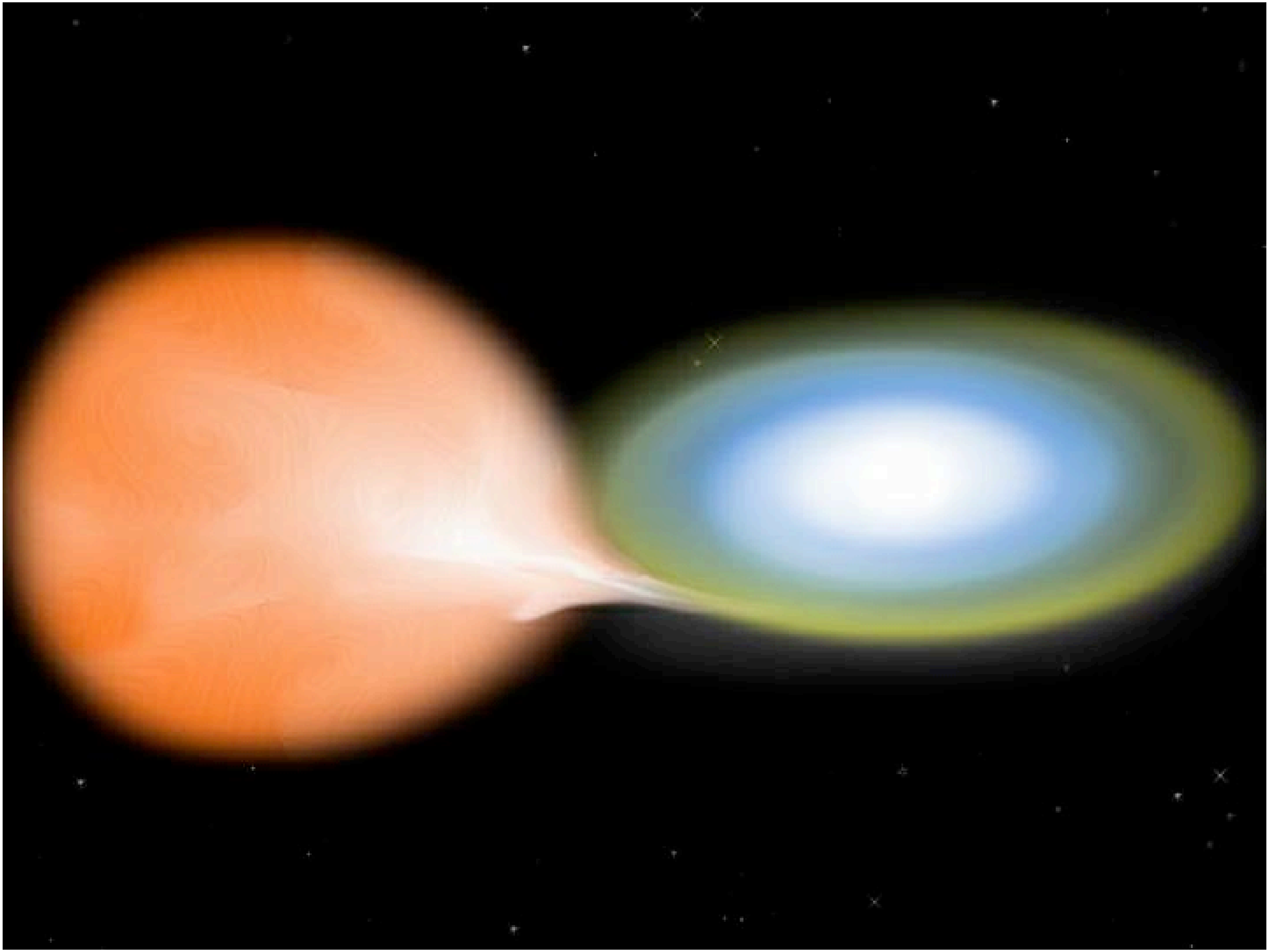
Astronomy in the news?

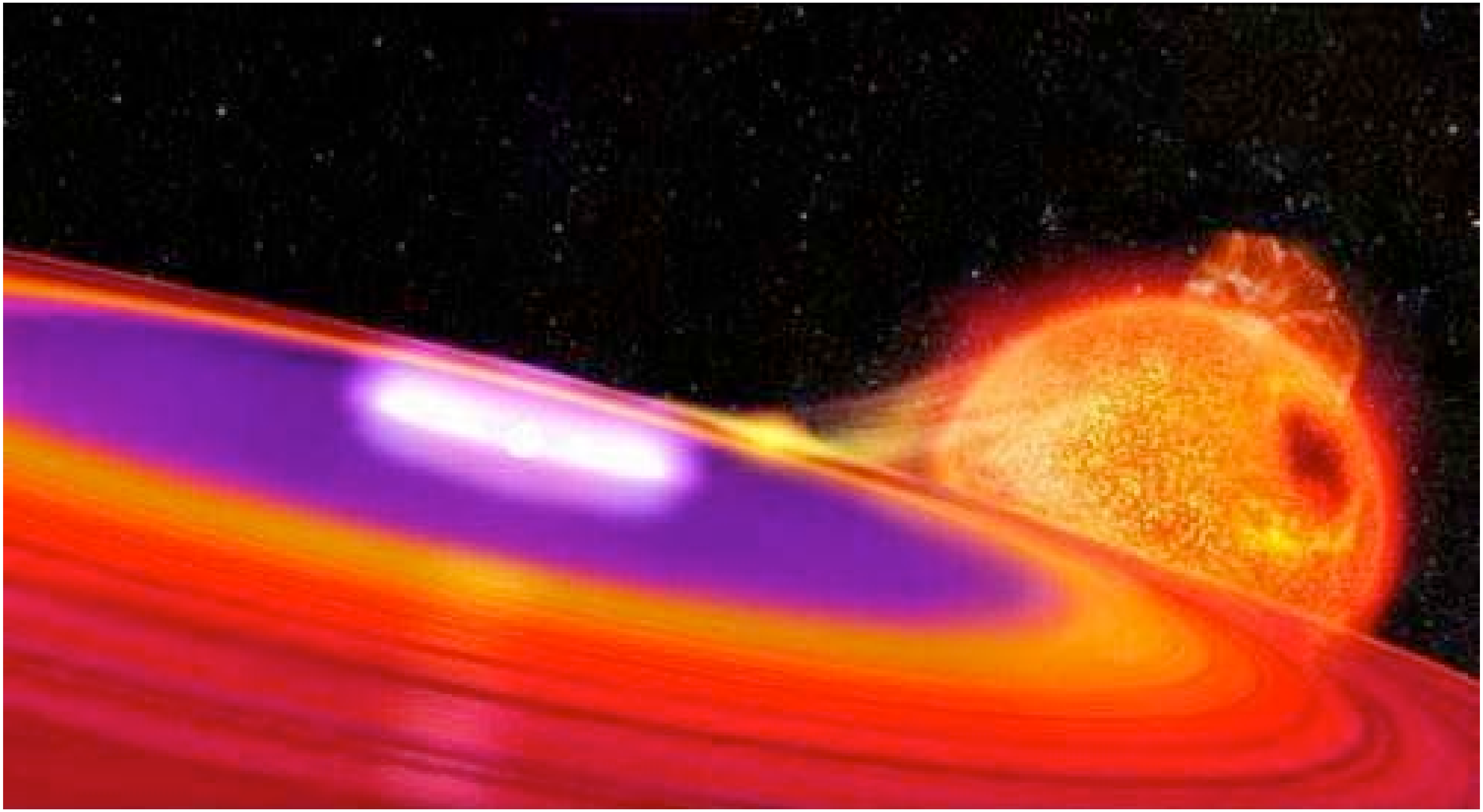
Pluto in context

Pic of the Day - Launch of Shuttle Atlantis


Binary system
(Artist Impression)
Compact object
Accretion disk
Companion star







One Minute Exam

In dwarf nova systems, the activity causing the outburst occurs

A In the mass transferring star

B In the accretion disk

C On the surface of the white dwarf

§5.3 Origin of Cataclysmic Variables

Cataclysmic variables often have a ***main sequence companion transferring mass*** -- how can this be?

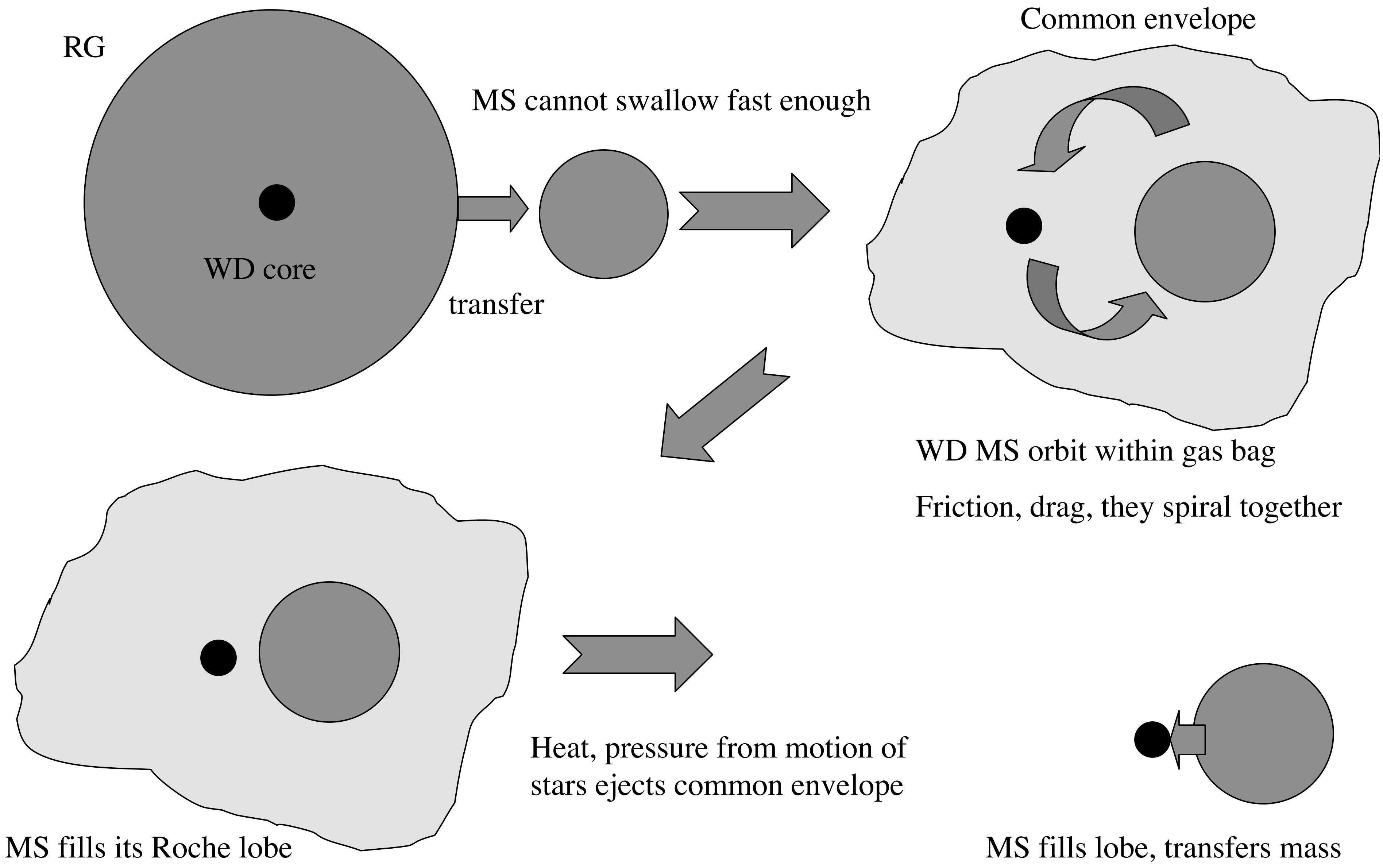
The two stars must once have been far apart to allow the originally more massive star to make a red giant with a white dwarf core.

Need room!!

The stars are observed now to be close together with the main sequence star filling its Roche lobe.

The main sequence star has not expanded to become a red giant, how come it is filling its Roche lobe?

Answer: § 3.9 Common Envelope Evolution



One Minute Exam

In most dwarf nova systems, the star transferring mass is a main sequence star. This means:

A The main sequence star was once a red giant, but lost mass

B The main sequence star used to be further away from the white dwarf

C The main sequence star and the star that made the white dwarf were born close together.

§ 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!

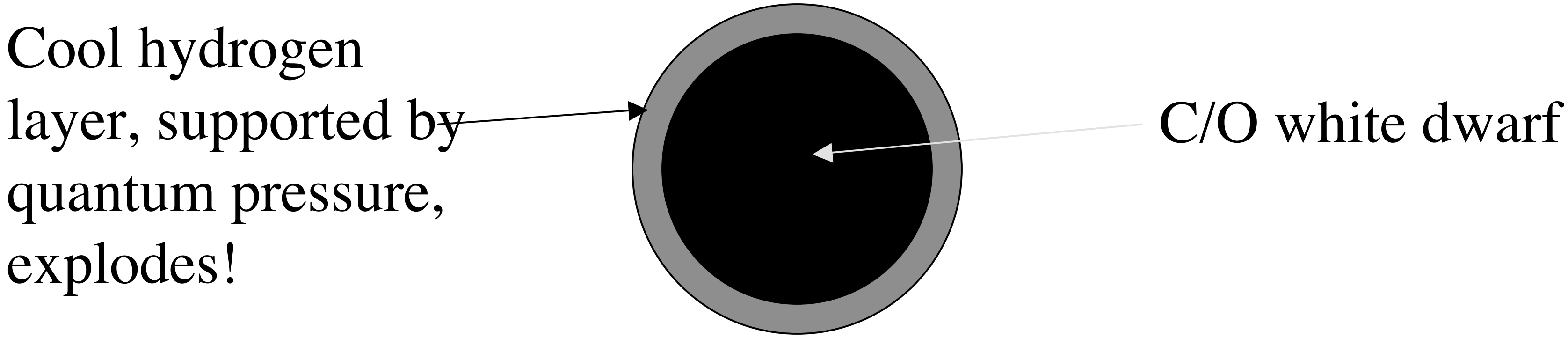
Hydrogen transfers from a main sequence star to a white dwarf in a binary system.

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

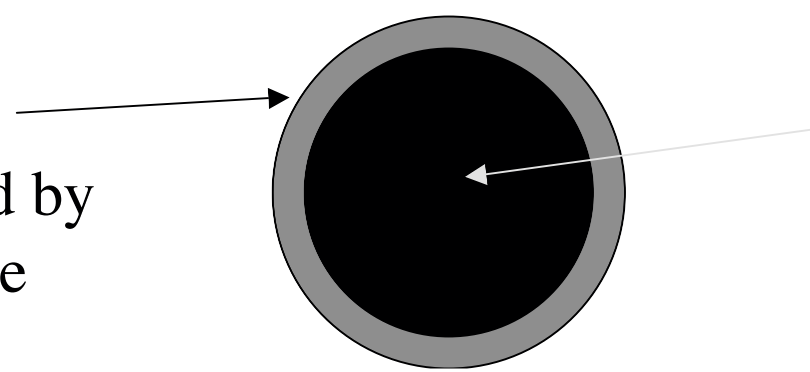
Hydrogen transfers from a main sequence star to a white dwarf in a binary system.

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 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

Answer - A (C is true whether or not the first white dwarf survives, so does not determine when there are two WDs)