September 24, 2010

Exam 2 Friday, October 1

Reading, Sections 6.4, 6.5, 6.6. ***Chapter 7 will be on 3rd exam.***

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? Yesterday was the Equinox as well as Full Moon, making that a Super Harvest Moon. Jupiter will stay in the Eastern evening sky, the nearly full Moon will pass it again in a month.

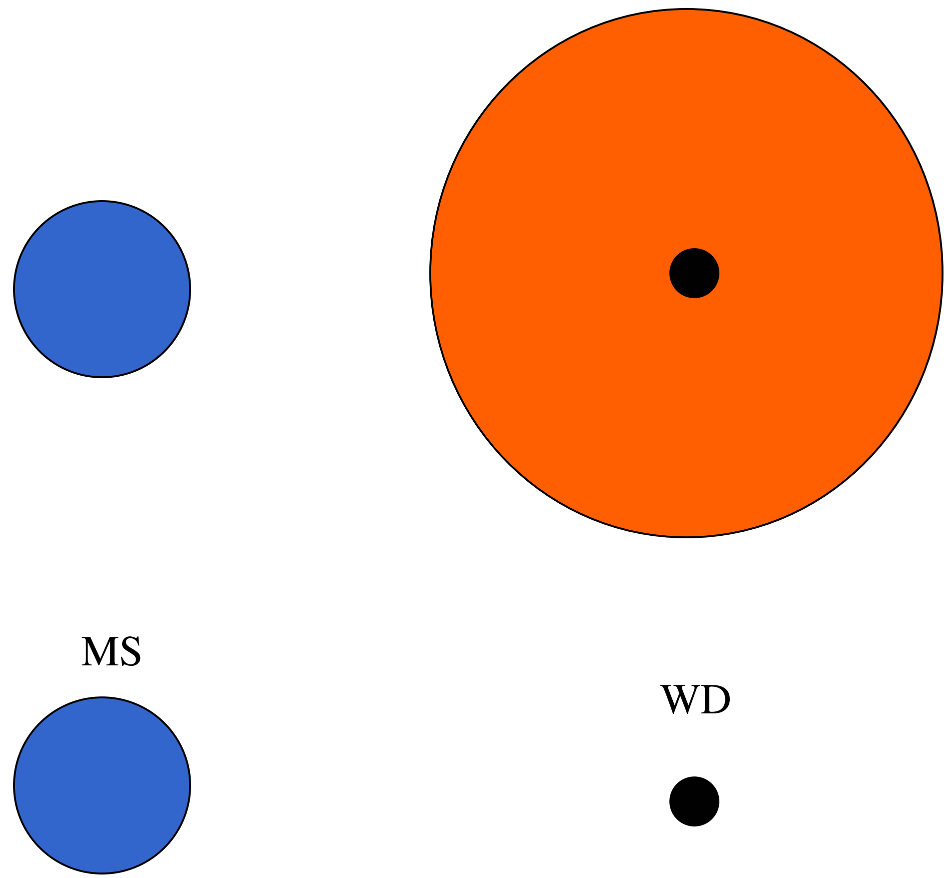
Docking latches on International Space Station would not release Soyuz lander, stranding two Russians and an American temporarily.

Pic of the Day – Super Harvest Moon from Hungary

## Goal

To understand how stars, and Type Ia supernovae, evolve in binary systems.

In common circumstances for binary star systems, all the hydrogen envelope is transferred to the companion (or ejected into space), leaving the core of the red giant as a white dwarf orbiting the remaining main sequence star



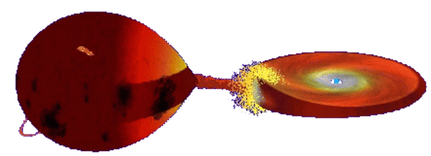
First star evolves, sheds its envelope, leaves behind a white dwarf.

Then the second star that was ***originally*** the less massive evolves, fills its Roche Lobe and sheds mass onto the white dwarf.

The white dwarf is a tiny moving target, the transfer stream misses the white dwarf, circles around it, collides with itself, forms a ring, and then settles inward to make a flat disk.

Matter gradually spirals inward, a process called ***accretion.***

⇒ the result is an ***Accretion Disk*** (Chapter 4).



***An accretion disk requires a transferring star for supply and a central star to give gravity, but it is essentially a separate entity with a structure and life of its own.***

One Minute Exam:

Two stars are born orbiting one another in a binary system. Which star will transfer matter first?

→ The most massive star

← The least massive star

↑ The one with the smaller Roche lobe

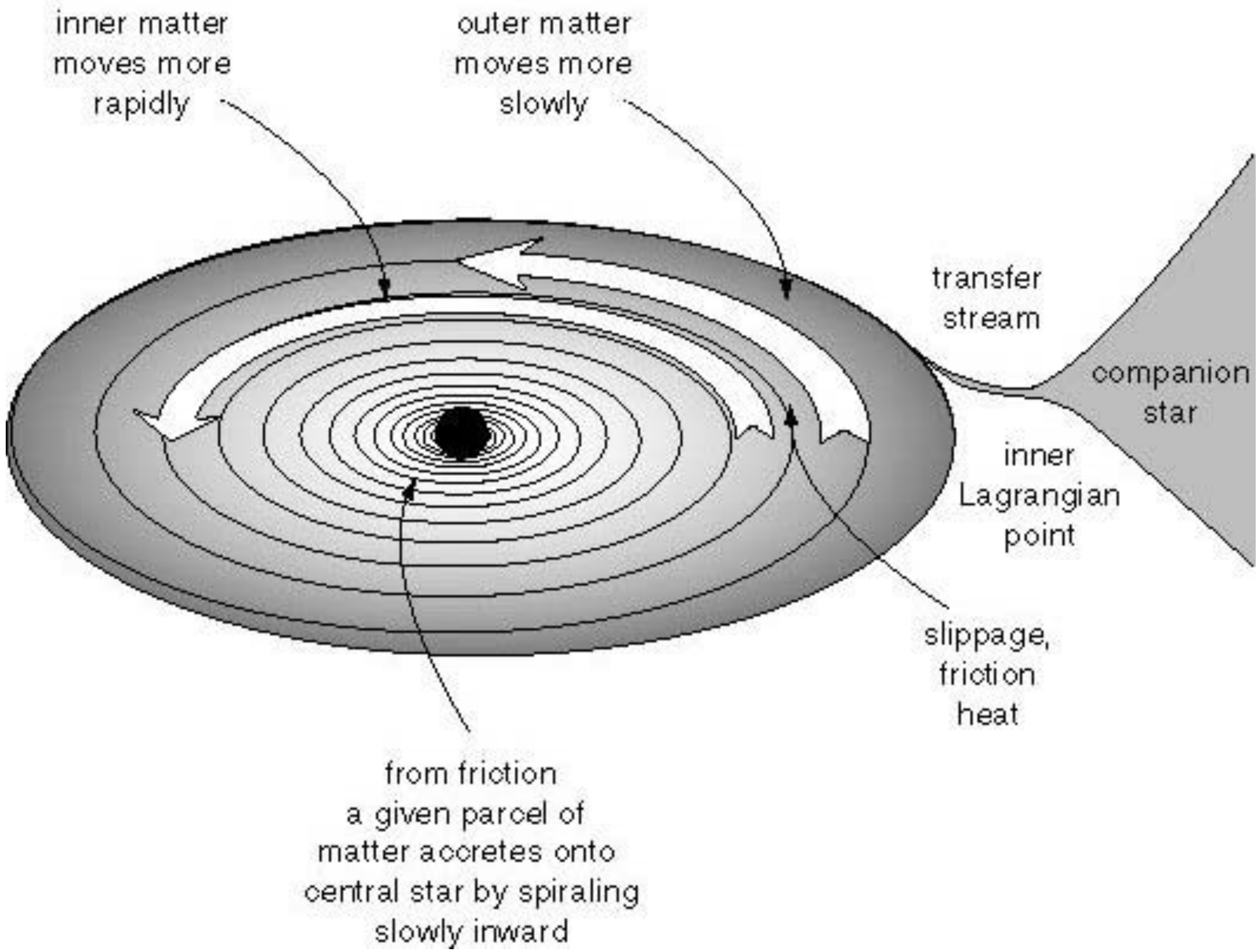
↓ The one with the smaller radius

Goal – to understand how accretion disks work, what sort of radiation they emit.

# Demonstration of Accretion Disk Dynamics

Need a volunteer

# Basic  Disk Dynamics - Figure 4.1



# Basic Disk Dynamics

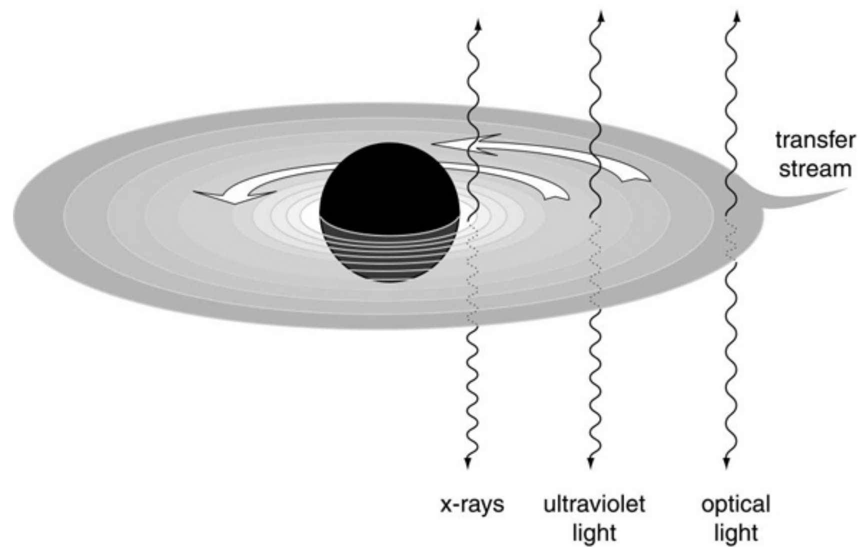
Orbits closer to the center are faster.
This creates rubbing and friction and heat, everywhere in the disk.

Friction tries to slow the orbiting matter, but it falls ***inward*** and ends up moving ***faster***.
(Just as removing heat from a normal star causes it to get hotter)
Slow settling inward by friction -- ***accretion***

Friction also causes ***heat.***

Hotter on inside, cooler on outside

Optical → UV → X-rays
WD NS, BH



One Minute Exam:

In an accretion disk, friction causes moving matter to

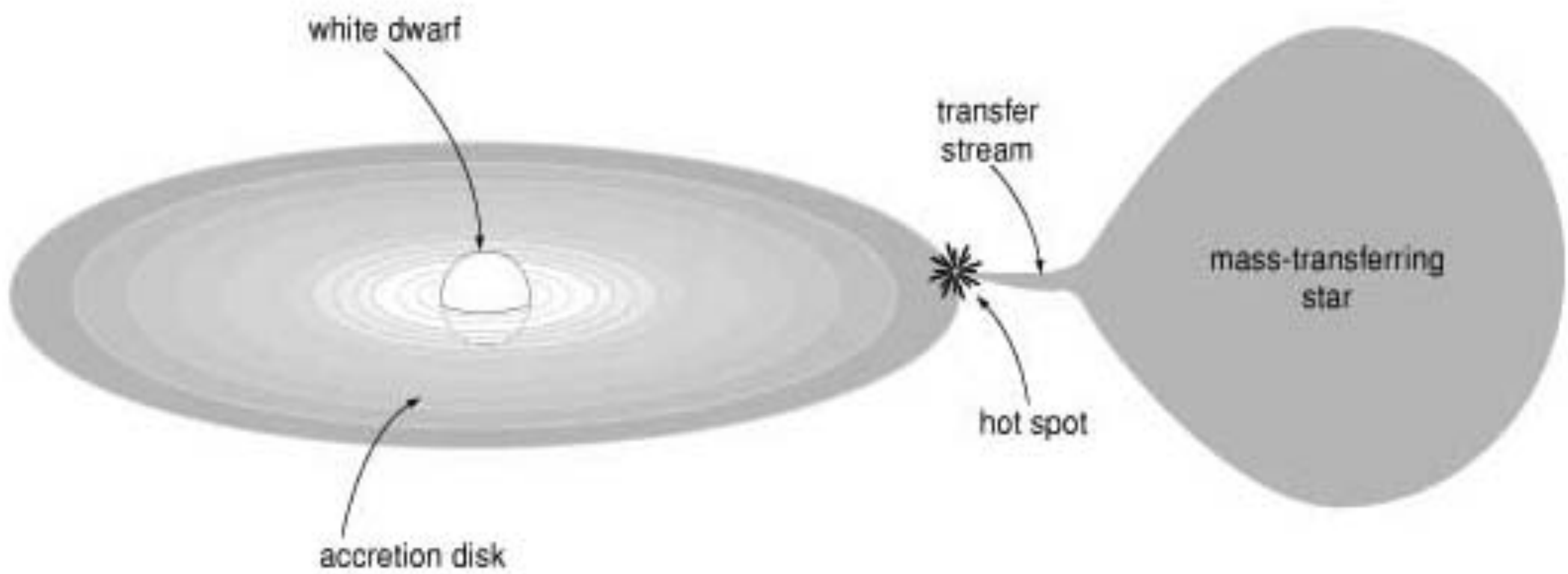
- Slow down
- Speed up
- Move outward
- Pass from one Roche lobe to another

Goal – to understand how white dwarfs in binary star systems can, and cannot grow to the Chandrasekar mass and explode.

# Cataclysmic Variables

Second stage of mass transfer
General Category "Novae"
"New" stars flare up, see where none had been seen before.

All CVs share same general features: ***transferring star***, ***transfer stream***, ***hot spot***, ***accretion disk***, and ***white dwarf***.



Classical Novae: Problem with losing mass from white dwarf during surface explosions.

Recurrent Novae like USco: do seem to have large mass white dwarfs, encouraging, but maybe not enough of them.

## § 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

Type Ia Supernova?!

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, mass transfer => ***Two WDs!***

Sky Watch

Classical Novae:

CP Pup, toward constellation Puppis in 1942

Pup 91, another toward Puppis in 1991 (not same place in our Galaxy, just accidently off in the same approximate direction)

QU Vul, toward constellation Vulpecula, white dwarf composed of Oxygen, Neon, and Magnesium rather than Carbon and Oxygen.

GK Per toward constellation Perseus - has had both a classical nova eruption in 1901 and dwarf nova eruptions.

Sky Watch

Recurrent Novae:

U Sco in the constellation Scorpius is a Recurrent Nova,
It may be a candidate to explode as a supernova!

Might see Scorpius. Also has neutron stars and black holes.

T Pyx in constellation Pyxis.

One Minute Exam

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

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

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

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

⬇ The second white dwarf has the Chandrasekhar mass