Tuesday, February 3, 2009

Sirius, Venus - can be seen around/after sunset even under a streetlight on campus.

Distance to Moon, Venus, Sirius

Astronomy in the News?

Pic of the Day - Lenticular clouds near Mt. Ranier

Sky Watch

Objects mentioned so far:

Cat's Eye Nebula, planetary nebula in constellation Draco

Sirius - massive blue main sequence star with white dwarf companion

Algol - eclipsing binary system in Perseus

Other suggestions:

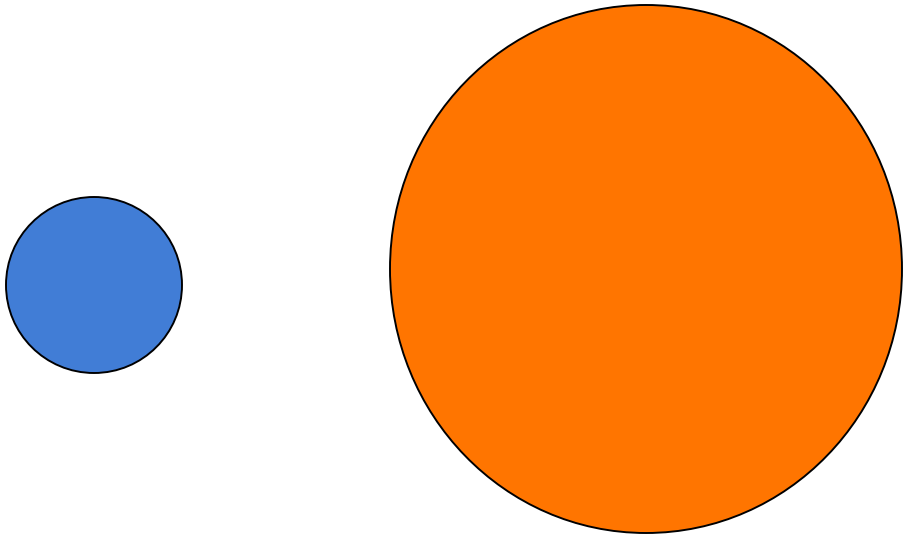
Castor, Rigel - massive blue main sequence stars

Capella, Procyon - on their way to becoming red giants

Betelgeuse, Aldebaran - red giants

Other examples of these sorts of objects…

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



Red Giant ~ 0.5 $M_\odot$ - but more evolved
Blue-white Main Sequence star ~ 2-3 $M_\odot$ - but less evolved

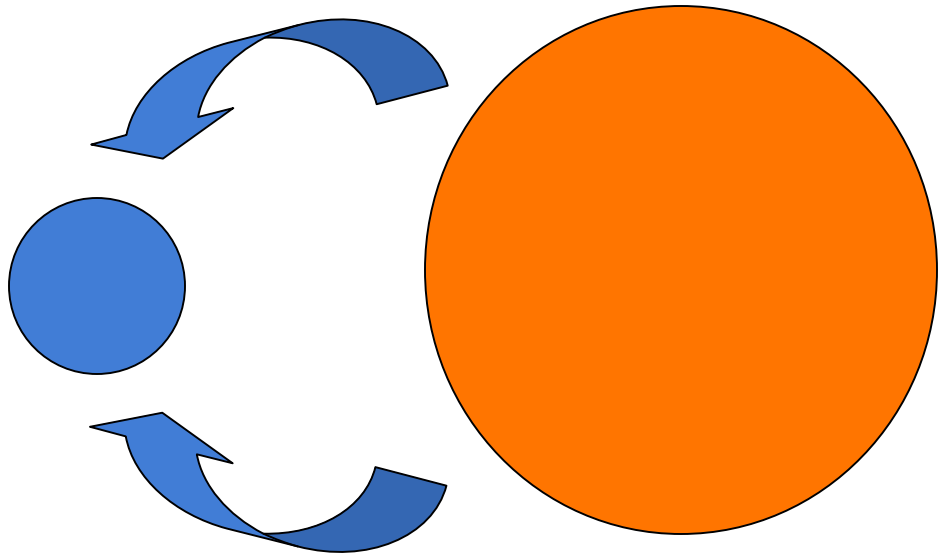
Blue star partially eclipses the brighter red star every 68.75 days, giving the impression it is a red, blinking, winking eye - demon, ghoul etc.

Solution

Mass Transfer

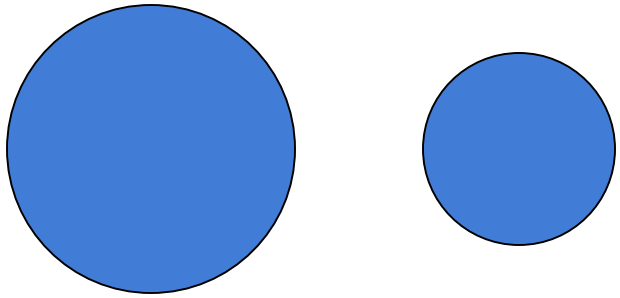
The red giant swells up, fills then overfills its Roche lobe and transfers mass to the companion.

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



One Minute Quiz

Two stars orbit one another in a binary system



Which star has the largest Roche lobe?

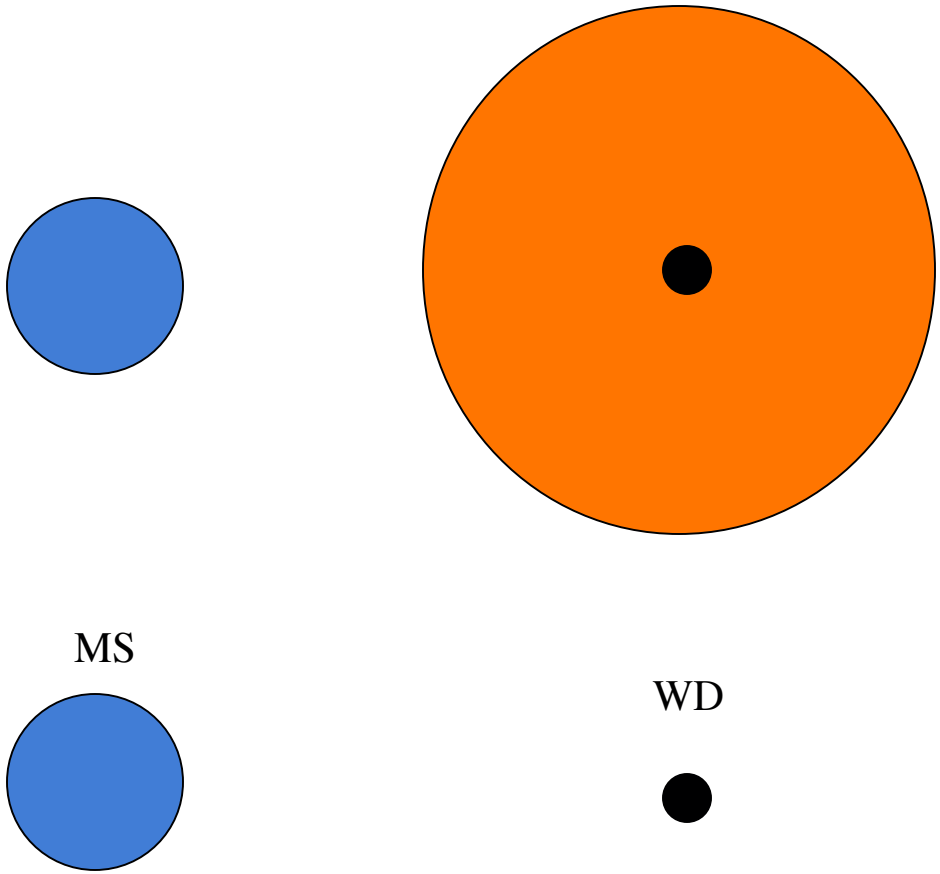
A the one on the left

B the one on the right

C insufficient information to answer the question

Which star is the most massive?

In common circumstances, 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

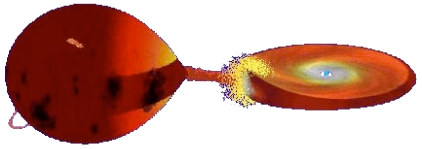


First star evolves, sheds its envelope, leaves behind a white dwarf.

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.***

$\Rightarrow$ 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:

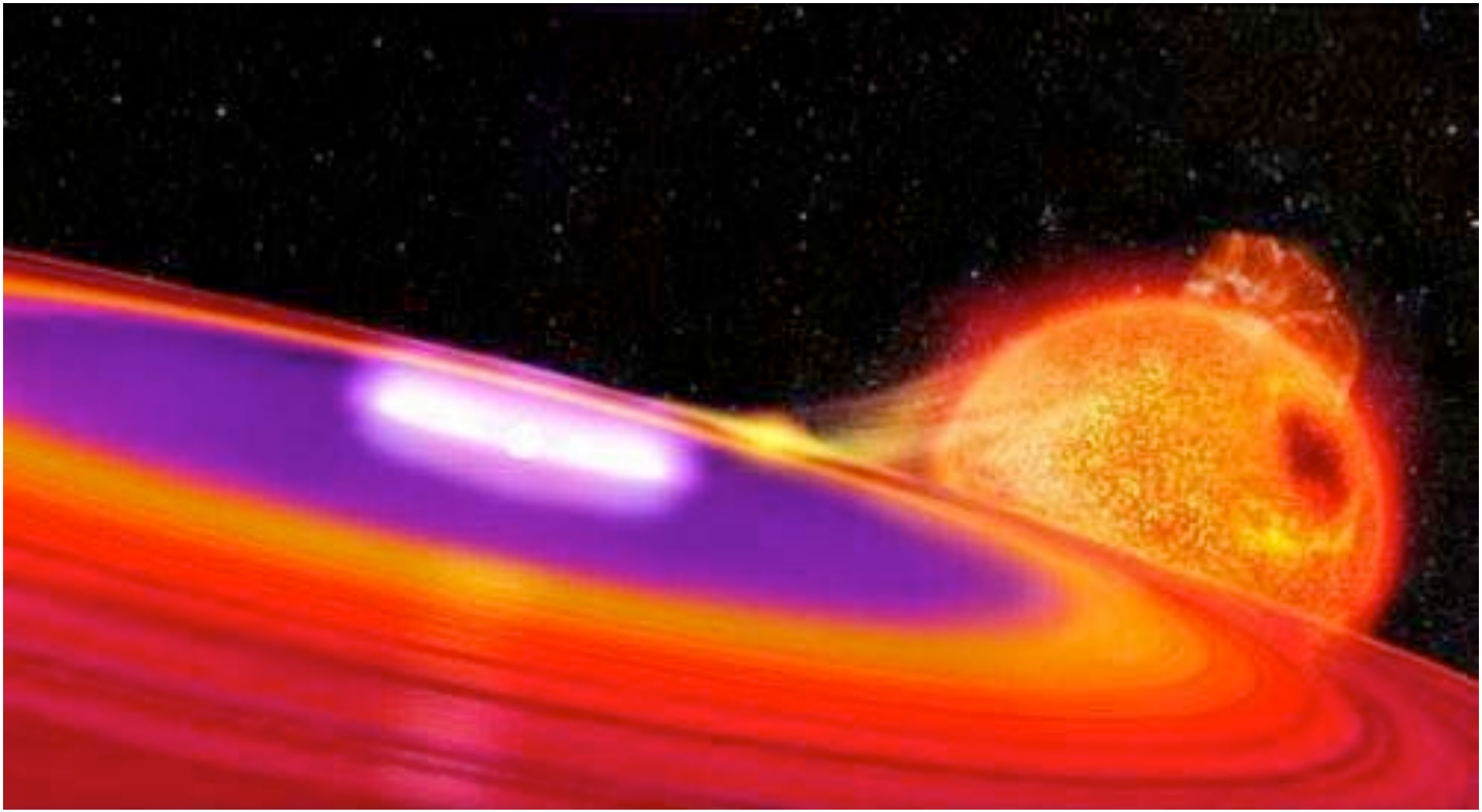
Two stars are born orbiting one another in a binary system. Which star will transfer matter first?

A The most massive star

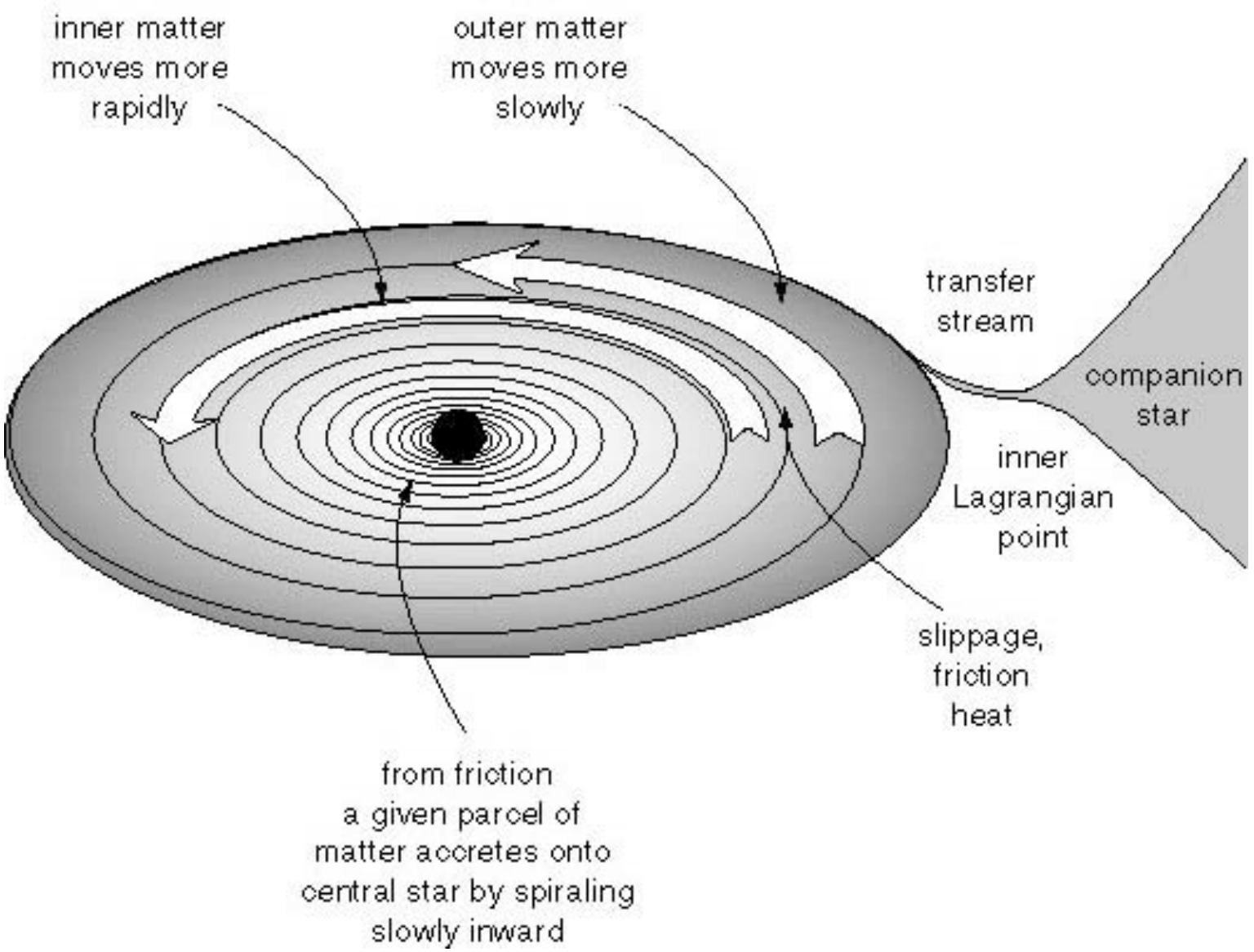
B The least massive star

C The one with the smaller Roche lobe

D The one with the smaller radius



Basic Disk Dynamics - Figure 4.1



Basic Disk Dynamics

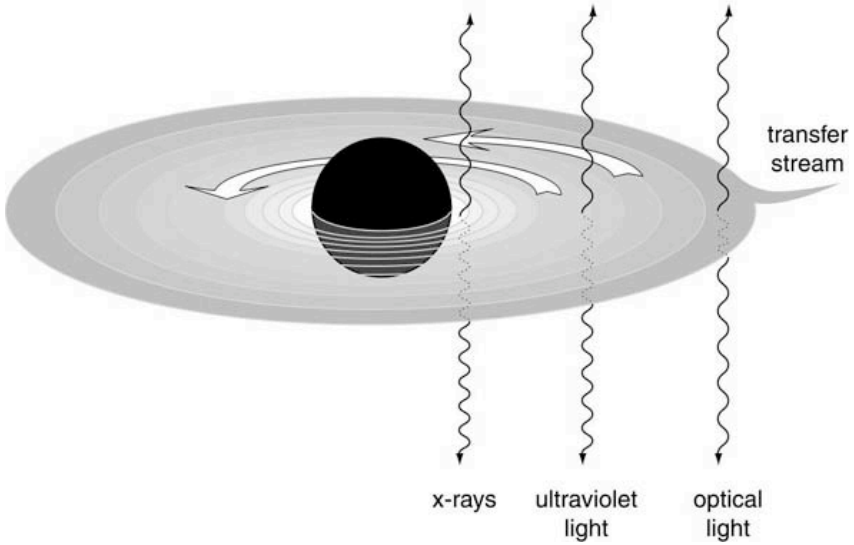
Orbits closer to the center are faster.
This creates rubbing and friction and heat, everywhere in the disk.

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

A Slow down

B Speed up

D Move outward

C Pass from one Roche lobe to another

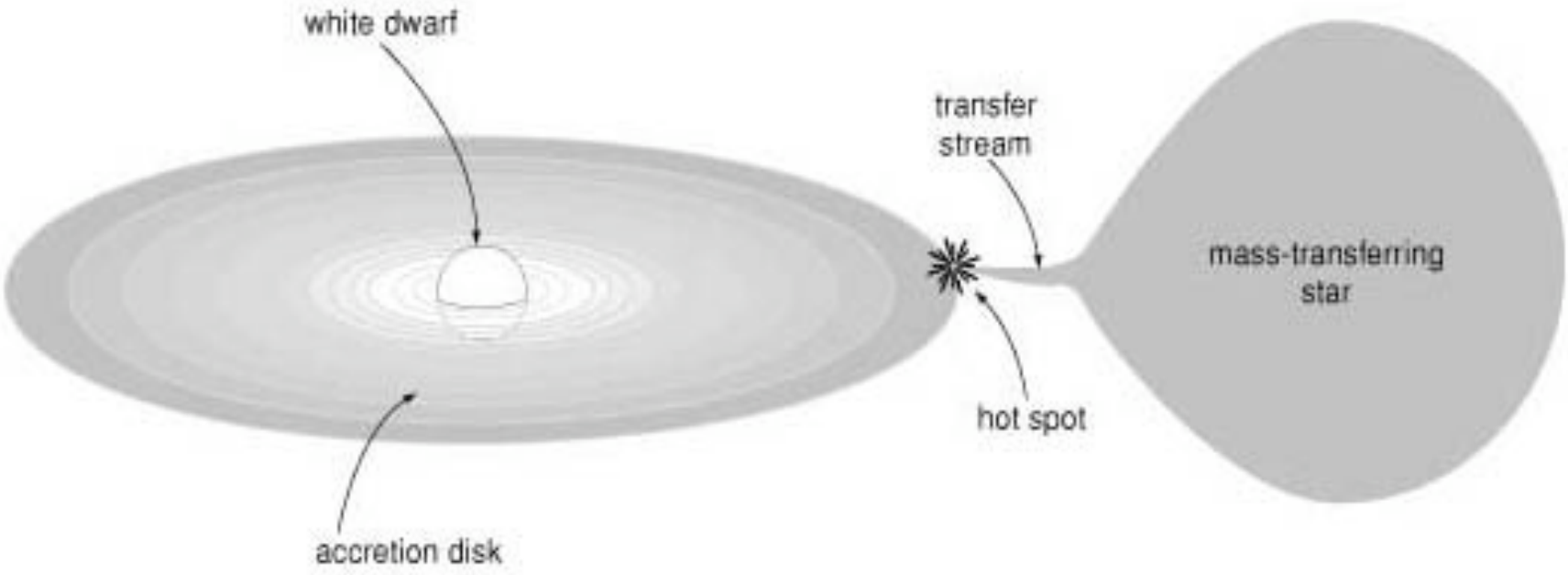
Cataclysmic Variables

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***.



Cataclysmic Variables

Dwarf Nova - flare × 10 brighter
intervals of weeks to months
last days to weeks

Recurrent Nova - flare × 1000 brighter
every 10-100 years
last weeks to months

Classical Nova - 10^4 to 10^5 times brighter
never observed to recur -- suspect 10^4 years
last months to years

Supernova - (one type might originate in a cataclysmic variable)
flare once 10^{10} × brighter (10 billion times)
last months to years

Dwarf Nova

Activity in the ***accretion disk***, not transferring star or central star.

Mechanism - store and flush, works when the transfer rate is low.

Disk is first cool, semi-transparent,
heat radiates away
little accretion, input more than accretion,
matter accumulates in STORAGE STATE

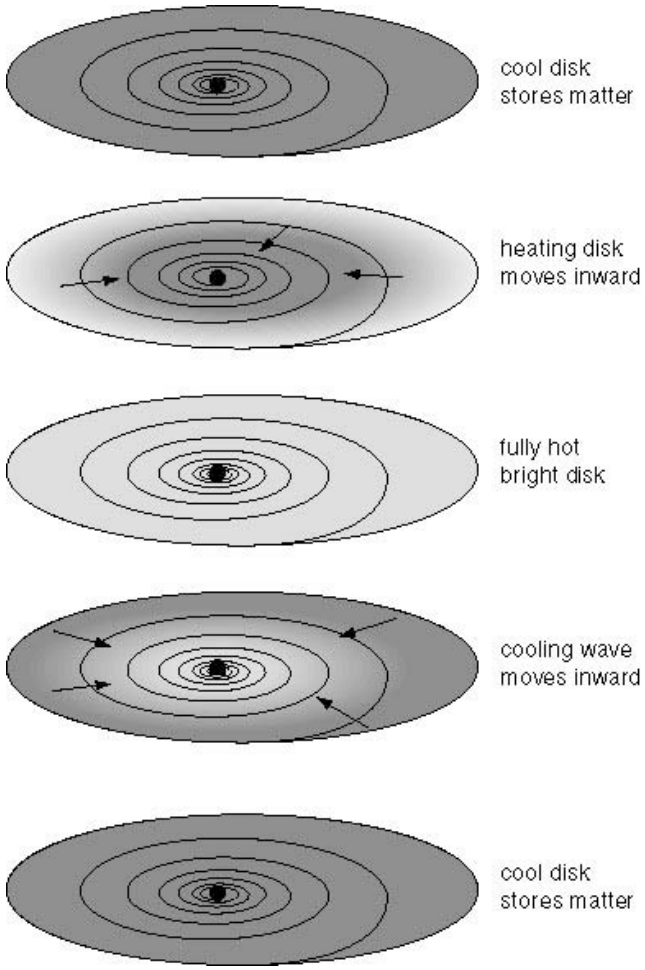
Disk gets denser, opaque, traps heat.
hotter disk generates ***more friction and heat***

⇒***Run away to bright, hot disk***

HOT, BRIGHT, FLUSHING STATE

More rapid flow through disk, faster than input
⇒ disk thins out, turns semi-transparent,
cools, returns to STORAGE STATE

REPEAT



Demonstration of Dwarf Nova

Accretion Disk Instability

Need a volunteer

Sky Watch

Dwarf Novae:

SS Cygni - brightest dwarf novae in the sky, but a bit too dim for naked eye. In constellation Cygnus, tough this time of year.

U Geminorum - in the constellation Gemini

Self-graded pop quiz

Draw a picture of two stars with their Roche lobes and label which star has the largest mass.

Draw a picture of a Cataclysmic Variable and label all the key parts.