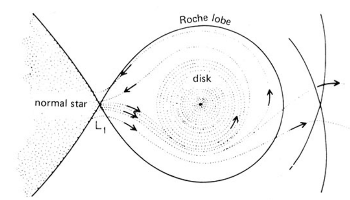
Quiz 8 Feedback

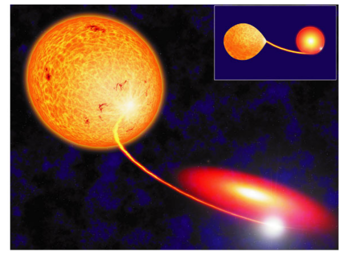
1. Why does mass transferred to a white dwarf in a binary go into an accretion disk? How do we know a disk is present?

- The mass stream comes off the companion star with angular momentum from the orbit of that star with respect to the white dwarf. It therefore has a "sideways" component of motion, and ends up orbiting the white dwarf, which is so small (compact) that there is plenty of room for the disk.
- We know an accretion disk is present because it emits radiation: extra light in addition to the light coming from the two stars. Typically the accretion disk is quite hot, so it may emit a lot of UV radiation. Chapter 4 in Wheeler's book talks about this "third object" as a "flat star," and titles section 4.3: "Let there be light – and X-rays" (p. 58).

Accretion Disks in Interacting Binaries

(View from above)

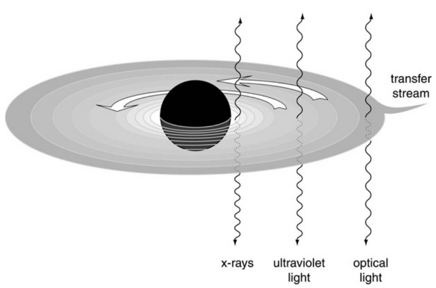




Mass being transferred from one star to the other in a binary system retains *orbital angular momentum*. This gives it sideways motion.

The matter therefore goes into a spinning accretion disk around the other star. If the latter is a white dwarf instead of a Main Sequence star, there's a lot more room for the accretion disk!

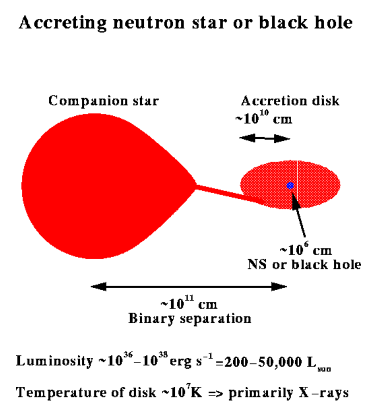
Anatomy of an Accretion Disk



Wheeler, Fig. 4.2.

The inner part of the accretion disk is hotter than the outer part, so the inner disk emits radiation of shorter wavelength and higher frequency. Specifically, we expect to see UV light from the accretion disk around a white dwarf, and X-rays for a neutron star or black hole.

X-ray binaries: with NS or BH's



Mass flows from the companion star arrives near the NS or BH with high angular momentum (from the orbit); collects in a spinning "accretion disk," a holding tank for transferred mass. The disk is hot because of viscous forces (friction), so it emits optical, UV, ***and X-ray*** light.

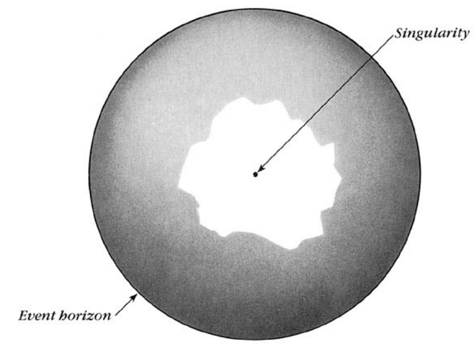
This slide was shown for the index card on 11/27.

Quiz 8 Feedback

2. What and where is the event horizon of a black hole?

- The *event horizon* is a hypothetical boundary of a region in space, around an extremely compacted mass. The mass is at the center, in the singularity, which theoretically has zero radius, hence the density is infinite (see 11/13 Card file).
- One way of defining the event horizon is as the location where the escape velocity equals *c*, the speed of light. (This is a "Newtonian" way of thinking about black holes.)
- Another ("Einsteinian") definition is in terms of curved space: the event horizon is the place, at a certain distance from the singularity, where gravitational bending of light is so severe, even light rays travelling radially outward are turned back in.

Structure of a "Simple" Black Hole



A plain black hole, with no net charge or rotation, has a very simple structure. It consists of the singularity, a central point where all the mass is located, and a hypothetical surface, the event horizon, surrounding it at a distance known as the Schwarzschild radius.

Bending Light: Closing of the "Light Cone"

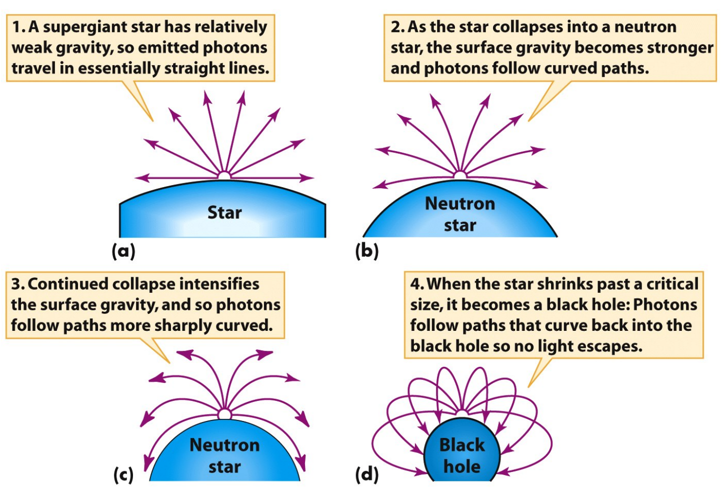


Figure 22-8
Universe, Eighth Edition

"Embedding diagram" for a Black Hole

Denser objects curve space more sharply, so the dip has steeper "sides." Black holes go to infinite density at the center, so they "punch a hole" in space-time.