12.14: High-Mass Star Stellar Endings

There are two possible stellar ending scenarios, depending on the star's original mass. **If the star is less than three solar masses, <3 M_{sun}, this is the neutron star limit.** If it is a single star (*not* part of a binary star system), the star will eventually cool as a large cinder in space. Yet if the star is part of a **binary system**, the star will continue accreting material, jetting energy into space until all of the stellar fuel is exhausted.

If the star is greater than three solar masses, >3 M_{sun}, then the ultimate cosmic extinction occurs: a Black Hole. There is a discussion among astronomers how massive of a star is needed to form a black hole; ranges from >3 M_{sun} to 25 M_{sun}. Black holes originate as the high-mass star's iron core collapses, just prior to the star going Supernova. This is called a **Type 2 Supernova**.

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With a black hole scenario, a catastrophic collapse of the star's core continues. This does not allow matter, or even light, to escape a certain point, called the **Event Horizon**. That is due to the fact that the escape velocity from a black hole is greater than the speed of light. The event horizon size is called the **Schwarzchild radius**. Black holes eject energy back out when overloaded with matter flowing into the black hole. Eventually, black holes will crush to a final, infinitely dense and small point called a **Singularity**.

Questions astronomers are asking about black holes include:

- The challenge with answering these questions at this time is that we can never know what happens inside a black hole because we cannot get the data out.

  We cannot see black holes directly, so how do we know they exist? There are several types of evidence of black holes. First, we see close binaries with gas flowing into nothing. The extreme Doppler shifts of stars has been observed, with apparently nothing in the area of the star to cause the extreme Doppler shift. A number of warped star fields have been observed, called **gravitational lensing**. And evidence that is somewhat direct occurs when a gas is pulled into a black hole by its strong gravitational force; the gas heats up and radiates back out into space.