The Life of an Average Star

A: a nebula

* A cloud of gas and dust 300 trillion miles in diameter; light would take 50 years to cross it!
* It may glow from the heat of contraction where matter has begun to gather.
* If the sun were $^1/_8$ of an inch in diameter.......

a nebula would be 700 miles wide, the distance from NY to Chicago!

B1: globules

* Random concentrations of matter in a nebula 1 trillion miles wide, the size of 100 solar systems!
* As the matter collects, friction continues to heat these "clumps" until they strongly radiate *infrared* light.
* If the sun were an $^1/_8$ of an inch in diameter.......

a globule would be $2^1/_2$ miles across!

B2: protostars

* An increasingly dense globule that has core temperatures around 3,000 °F, far hotter than an infant globule's below 0 °F temperatures; size will range from 15 billion miles (2 SS's) to 225 million miles (diameter of Mars' orbit) in width.
* All of its heat will still only come from its *gravitational contraction*; no nuclear reactions have occurred yet (hydrogen + hydrogen=helium)
* If the sun were $^1/_8$ of an inch in diameter.......

a protostar would be 180 feet across!

C: a main sequence star

* Protostar core reaches several million degrees; nuclear reactions begin and a star is born! Its diameter will reach about 900,000 miles.
* Its life will last approximately 10 billion years, until its fuel (hydrogen) begins to run out.......

D: red giant

* As the core collapses, the frictional heat created will cause the star to swell for a few hundred million years, engulfing Mercury and baking Venus and Earth!
* The increased heat of contraction will start other nuclear reactions (ex.: helium + helium=carbon + oxygen) several times, causing other shrinking and expanding episodes.
* Eventually, the core will be almost all carbon and the last expansion will swallow Venus and Earth.
* If the sun were $^1/_8$ of an inch in diameter.......

a red giant would be 33 inches in diameter!

E&F: dwarves

* The final core expansion will blow off a star's outer layers leaving a *white dwarf* that shines only from the heat of its last contraction; no more nuclear reactions.
* As that heat is exhausted, the star's remnant will dim to become a *black dwarf.*
* If the sun were $^1/_8$ of an inch in diameter.......

a dwarf would be $^1/_{900}$ of an inch in diameter!

The Spectacular Endings of Massive Stars

If a star is 10 times more massive than our sun:

* The cores of these heat up to much higher temperatures, making the star give off more blue light in some instances, making them ***blue giants.***
* As their fuel is consumed much quicker than average stars like our own, these stars will have shorter lifetimes even though they start off with more mass.
* As they near their end, they become ***supergiants*** instead of giants and their cores will be mostly iron which will not take part in any nuclear reactions, no matter how high the temperatures get!
* When these monsters collapse on their dense cores, they explode, a ***supernova***, leaving behind an incredibly dense core about the size of a large city made up entirely of neutrons --- ***a neutron star.***

If a star is more than 30 times more massive than our sun:

* These follow lifelines similar to the above until they collapse on their cores to form what can be considered a point in space of infinite density called a ***black hole***, an object with gravity so strong that not even light can escape it!

What!?!?!?

Background info:

* The table in front of you is made of atoms and molecules small enough to have great spaces between them and between their nuclei and electrons so that intense gravity could turn the table into an object so small that not even the best microscopes in the world would be able to see it!
* All of the matter in the universe is believed to have once occupied a space only about 2 miles across, 20 billion years ago before the ***big bang***!
* These ideas allow for the existence of black holes and other incredibly dense objects in space!

* There are "points of no return" around black holes called ***event horizons*** where someone would not be able to keep from being pulled into the hole, no matter what they tried!
* Question: How do we know that something light can not escape exists? In other words, if we can't see it, how would we ever find a black hole?