My Favorite Constellation

My favorite constellation is Orion, because it’s got Betelgeuse in it. That’s the bright, reddish star that represents his left shoulder, and is my favorite star in the night sky. It was named by the Arab astronomers during the Dark Ages. Back then, the Arabs were building libraries and inventing stellar navigation while the European kings were clubbing each other over the head with big sticks and entertaining themselves by learning how to write their own names. Betelgeuse is the only star (besides Our Mister Sun) big enough and close enough (450 light years, give or take a few) to actually show as an extended object in photos taken by the Hubble Space Telescope. And it is a VERY SPECIAL STAR. Here’s why:

Betelgeuse is a red giant, which is the form a big star takes as it begins running out of fuel in its last days of releasing energy. During this phase, the core of the star contracts into an incredibly tiny and unimaginably hot blue-white pinpoint while its outer layers are blown off to form a glowing red cloud which can be many times bigger than our entire solar system. The core of the star then sits in an unsteady equilibrium, drinking its depleted stores of fuel dry and accumulating an inert central mass of iron, which is the ash left behind when fusion goes to completion. Since fusion can’t happen in iron, there’s no heat being generated in that core, and therefore there’s no pressure being generated there either, and gravity then begins to squeeze down on the core harder and harder...

...until the pressure on it is so great that the iron atoms collapse down in an instant into a huge blob of neutrons. The collapse halts suddenly and all the outermost layers of the star rebound against the neutron pit like a hammer bouncing off an anvil, and BINGO! You get a Type II SUPERNOVA. The incredible pressures generated by the bounce smash the remaining uncrushed iron atoms together to form all the elements heavier than iron, which get blown into space at tremendous speed. The radiant energy released in this process is ONE BILLION TIMES GREATER than all the energy radiated away by the star in its lifetime up to that point, which means that one single exploding star will outshine the entire galaxy that is its home, and be visible to us across the entire width of the known universe.

The progenitor star which eventually collapses into a supernova has spent the last 100 million years or so cranking out light and heat, and the collapse itself takes less than ONE SECOND. And the “inbetween state”- the red giant phase of its life- only lasts a few tens of thousands of years. Which means this: Since the universe is 13.8 billion years old, and the lifetime of a red giant is only about 10,000 years, they are RARE. We are very lucky to have one sitting right here in our neighborhood, close enough to study with telescopes. But we are lucky that it is not any closer than 450 light-years because...

...when it DOES finally blow up, it will be bright enough to be visible in full daylight. At night, it will outshine the moon and be bright enough to CAST SHADOWS. The ultraviolet radiation it produces will be strong enough to disrupt the topmost layers of our atmosphere and the burst of neutrinos it sheds at the instant that the neutron core is created will be nearly strong enough to do genetic damage to carbon-based life forms here on earth. How many neutrinos does that take, at a distance to the source of 450 light years?

Oh... that would be about 10 (exp53) of them. That's ten with FIFTY-THREE ZEROS AFTER IT.

I love, love, LOVE astrophysics. And that's my physics tutorial for a snowy Saturday morning.