

Supernovae in Star Evolution

Definition:

A supernova is the stage in the evolution of a star when the star explodes. The exploding star can be as bright as 10,000,000,000 Suns! This can radiate as much energy as the Sun will in its entire life time.



Image from NASA Images: www.nasa.gov

This is the supernova remnant N 63A Menagerie. It is the remains of a massive star that exploded in a star forming area of the Large Magellanic Cloud.

Formation:

- To become a **supernova** a star needs to have a mass greater than 8 times the mass of the Sun.
- When the star runs out of fuel to burn it becomes unstable and expands to a **red giant**. It then rapidly collapses because of **gravity**.
- The collapse causes the pressure, and therefore the temperature, to increase inside the star.
- This causes the star to explode in a supernova. The outer layers of the star are sent into space as star dust, and what remains will be a **neutron star** or a **black hole**.
- The star dust is important for the evolution of the universe; it spreads atomic elements and helps form new stars. Hydrogen is the original building block of the universe. All the other elements, including the ones in your body, were made inside a star.

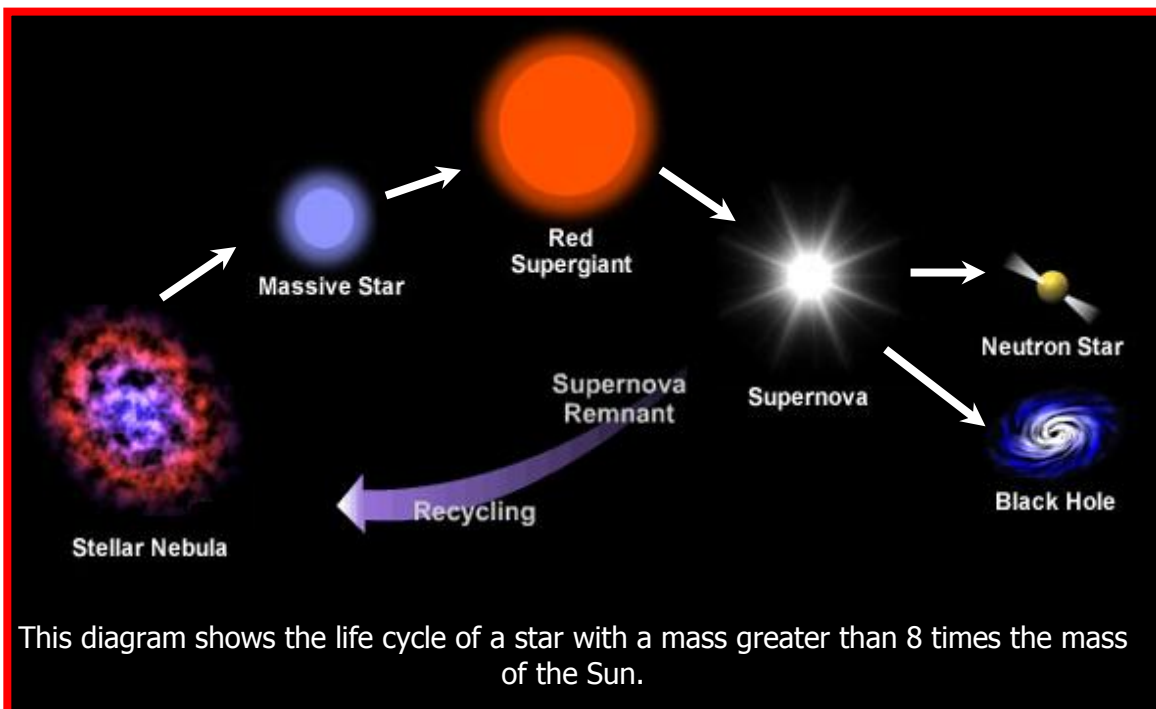


Image modified from Sea and Sky: www.seasky.org

Neutron Star or Black Hole?

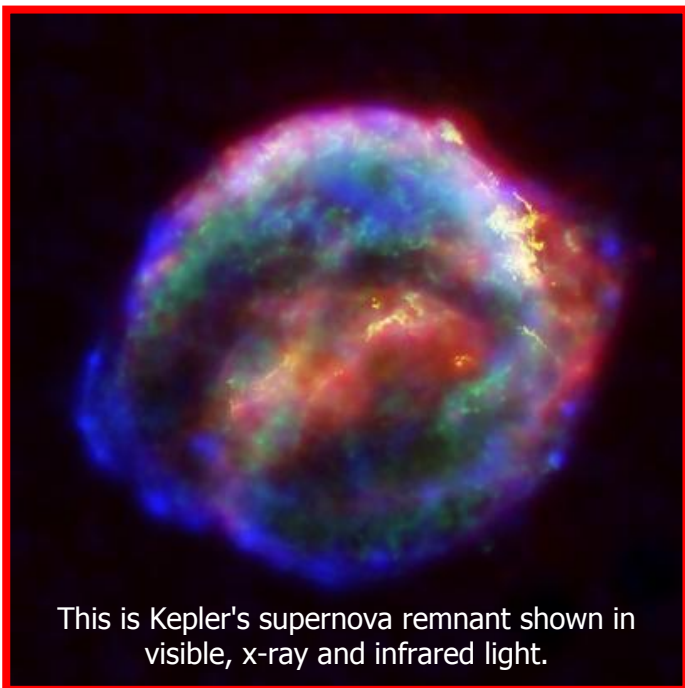
- ❖ The final fate of the star is determined by the mass of the core which remains after the supernova explosion.
- ❖ To form a neutron star the core must have a mass more than 1.4 times the mass of the Sun.
- ❖ To form a black hole the core must have a mass more than 3 times the mass of the Sun.

Neutron Star Facts:

- ❖ They have a mass 2 times the mass of the Sun.
- ❖ They have a diameter of 40 km; the size of Greater London.
- ❖ They are so dense that 1 teaspoon of a neutron star would weigh 2 billion tons. That's about 500,000 elephants!
- ❖ If a piece of popcorn was dropped on a neutron star it would cause an explosion the size of a World War II atomic bomb.

Observation:

- Supernovae occur about once every 50 years in the Milky Way (our galaxy).
- The first known supernova to be observed was in 185 AD by Chinese astronomers. It looked like an ordinary star in the sky but it was only visible for 8 months before it became too faint to see.
- The last supernova to be observed in the Milky Way was in 1604 by Kepler.



This is Kepler's supernova remnant shown in visible, x-ray and infrared light.

Image from NASA Images: www.nasa.gov

Further Reading:

- ❖ You can explore NASA's website to find out more about supernovae and other space topics at imagine.gsfc.nasa.gov/docs/science/science.html.
- ❖ You can explore the sky section of Sea and Sky to discover in more detail our solar system and the universe beyond at <http://www.seasky.org/sky.html>.



Here is the beginning of Sea and Sky's webpage on black holes. You will find pages on stars, galaxies and many other space objects if you explore the website.

Sample from Sea and Sky: www.seasky.org