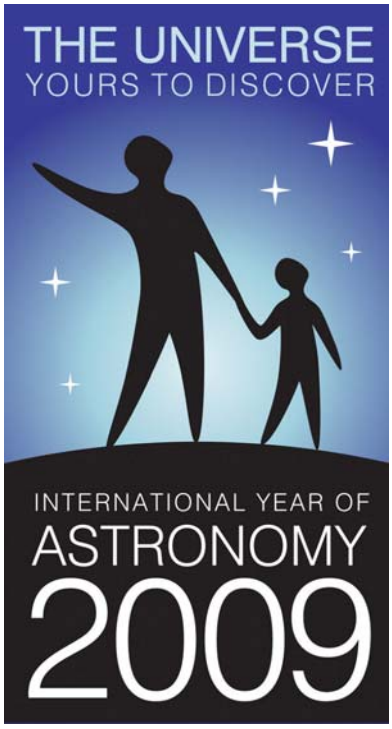
November 2009
IYA Discovery Guide



This Month's Theme:

The Lives of Stars

Featured Activity:

Lives of Stars

Featured Observing Object:

Crab Nebula

The International Year of Astronomy is a global celebration of astronomy and its contributions to society and culture, highlighted by the 400th anniversary of the first use of an astronomical telescope by Galileo Galilei.
Join us as we look up!
http://astronomy2009.us

The Astronomical Society of the Pacific increases the understanding and appreciation of astronomy by engaging scientists, educators, enthusiasts and the public to advance science and science literacy.
http://www.astrosociety.org

November's Topic:
The Lives of Stars

Back in 1054 AD, Chinese and Arab astronomers recorded seeing a "new star" that was bright enough to be visible even during the day. 450 years later, Galileo also saw a bright "star" appear, just a few years before he made his telescope. But for both of those events, no one knew what they were seeing. We have learned now that ancient astronomers saw a special event called a supernova – the flashy end to a giant star's life. Stars spend most of their lives shining brightly without much change. But the sight of their birth and death can be spectacular.

Every star begins its life in a stellar nursery of gas and dust. As enough of this star-building material falls together it becomes hot and dense enough to form a star. Because the dense clouds where stars form block visible light, it is often easier to study them using infrared light which can pass right through the clouds. NASA's Spitzer Space Telescope and Hubble Space Telescope have both used infrared light to study star formation in our own galaxy and in distant ones. You can see a stellar nursery where stars are being born if you look at the December IYA Discovery Guide, which features the Orion Nebula.


Crab Nebula: Credit Hubble Space Telescope

At the end of their lives, very large stars will go supernova. This huge explosion blows off the outer layers of the star in a bright display. It releases oxygen, iron, and other heavier elements into the surrounding space. These contribute to making a new stellar nursery and eventually get recycled into new stars. Many of the elements that make up the Earth and even us came from many supernovae that occurred billions of years ago.

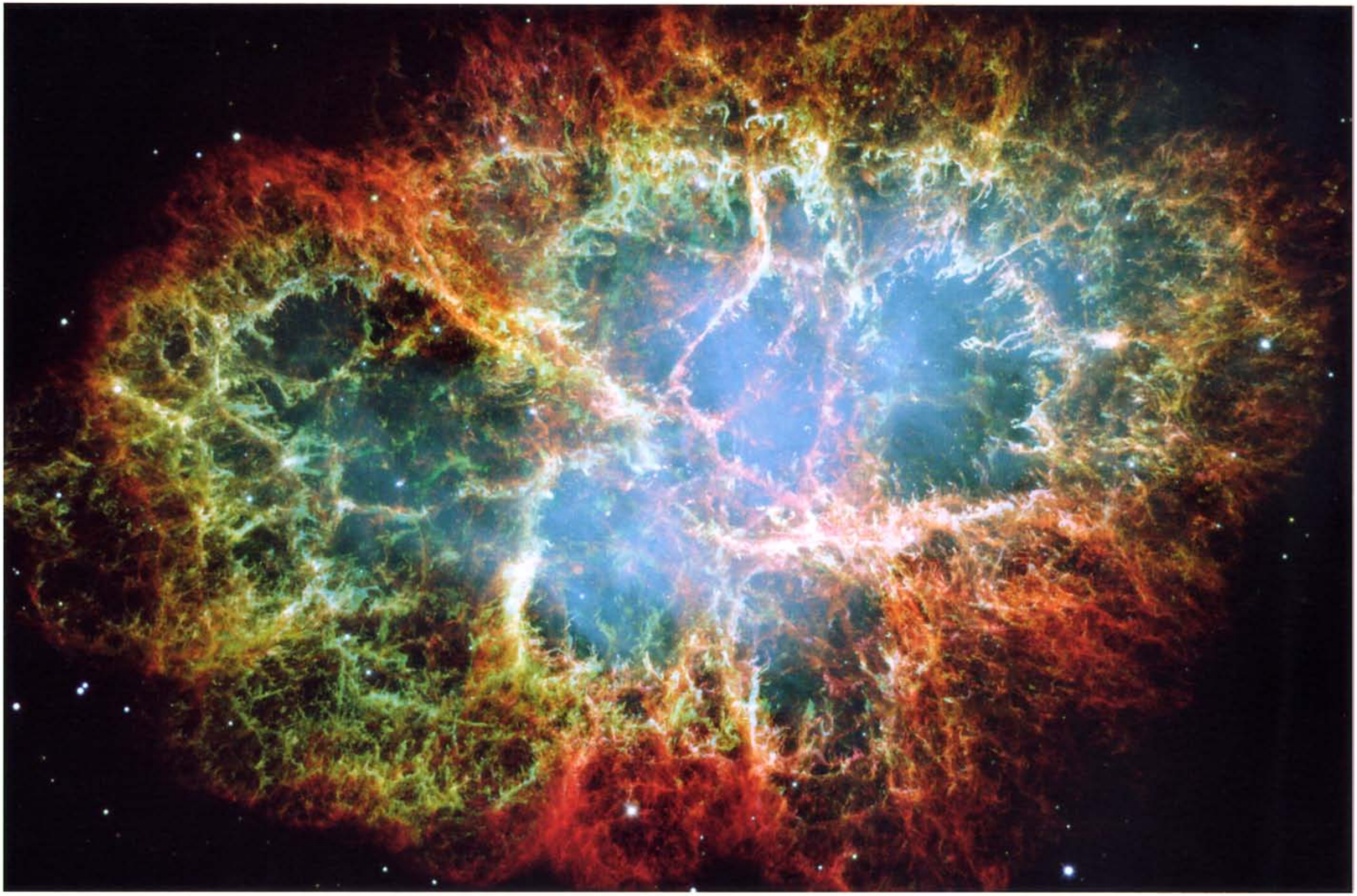
The supernova that was observed in 1054 faded after about a year. Now, when we look at the same place in the sky we see a supernova remnant called the Crab Nebula (right). You can locate this blast of material with the Finder Chart in this guide. Giant stars also leave something else behind. In the Crab nebula, there is a neutron star that is so dense that a teaspoon would weigh as much as a train of boxcars loaded to maximum capacity that stretched all the way from Canada to Mexico! And the very biggest stars leave behind a black hole, which is even denser and more mysterious, and also invisible.

NASA is studying black holes and other high-energy x-ray and gamma-ray sources with the Suzaku and XMM-Netwon Missions. The Swift and Fermi missions are orbiting Earth to study the dramatic deaths of very large stars. To learn more about the lives of these giant stars and to see what happens to stars like our Sun at the end of their lives, see the activity included in this packet.

Learn more about the Lives of Stars from NASA.
Find more activities featured during IYA 2009.
See what else is planned for the International Year of Astronomy.



National Aeronautics and Space Administration



The Crab Nebula (M1)

The Crab Nebula (M1)

Celestial Fireworks

Americans celebrate Independence Day by peppering the sky with fireworks. Nearly a thousand years ago, on July 4, 1054, a more powerful explosion brightened the heavens.

Chinese astronomers witnessed the debut of a bright star appearing in the sky within the constellation Taurus. They described the "guest star" as about as brilliant as the full Moon. This star was so bright that people saw it during the day for almost a month. The star remained visible in the evening sky for more than a year before fading from sight.

More than 700 years later, while hunting for comets, Charles Messier spotted an interesting fuzzy object in the same area of the sky as the Chinese guest star. He noted that it was not a star, nor a comet, and placed it on his list of objects that comet hunters should avoid. It became well known to astronomers as the first entry in Messier's catalogue, published in 1774.

Seventy years later, British astronomer Lord Rosse used the largest telescope of his day to spy Messier's fuzzy object. The object consisted of glowing strings of gas and dust, called a nebula. He christened it the "Crab" because its tentacle-like structure resembled the legs of the crustacean.

The Crab Nebula is actually the glowing remains of a star. In 1054, a star about 10 times the mass of our Sun reached the end of its life and exploded as a supernova. The gas in the nebula represents the outer layers of the star, blown across interstellar space at several million miles per hour. The colors in the filaments and outer regions of this Hubble image, taken in visible light, represent the elements oxygen and sulfur. They were created in the star during its life and were expelled by its explosive death.

The development of telescopes that detect other wavelengths of light, such as radio waves and X-rays, allowed astronomers to see features in the Crab Nebula that cannot be seen in visible light. In 1968, they uncovered a rapidly spinning neutron star — the dense, compact core of the exploded star — at the nebula's center. Only about six miles (10 kilometers) across, the neutron star would fit inside a small city. Radio astronomers observed bursts of radio waves 30 times a second and called it a pulsar. These radio outbursts are caused by twin searchlight beams that sweep across our viewpoint, making the neutron star appear to blink on and off. The Crab Pulsar was the first pulsar discovered. Electrons whirling at nearly the speed of light within the neutron star's intense magnetic field create abundant high-energy X-ray emissions. The same process powers the nebula's eerie interior bluish glow seen in this Hubble image.

Due to its relative proximity to Earth and energetic emissions at many wavelengths, the Crab Nebula is one of the most studied objects in space. It has revealed intricate details of the death throes of massive stars. Eventually, the elements created in this supernova explosion will be recycled through interstellar gas clouds and will become part of the next generation of stars.

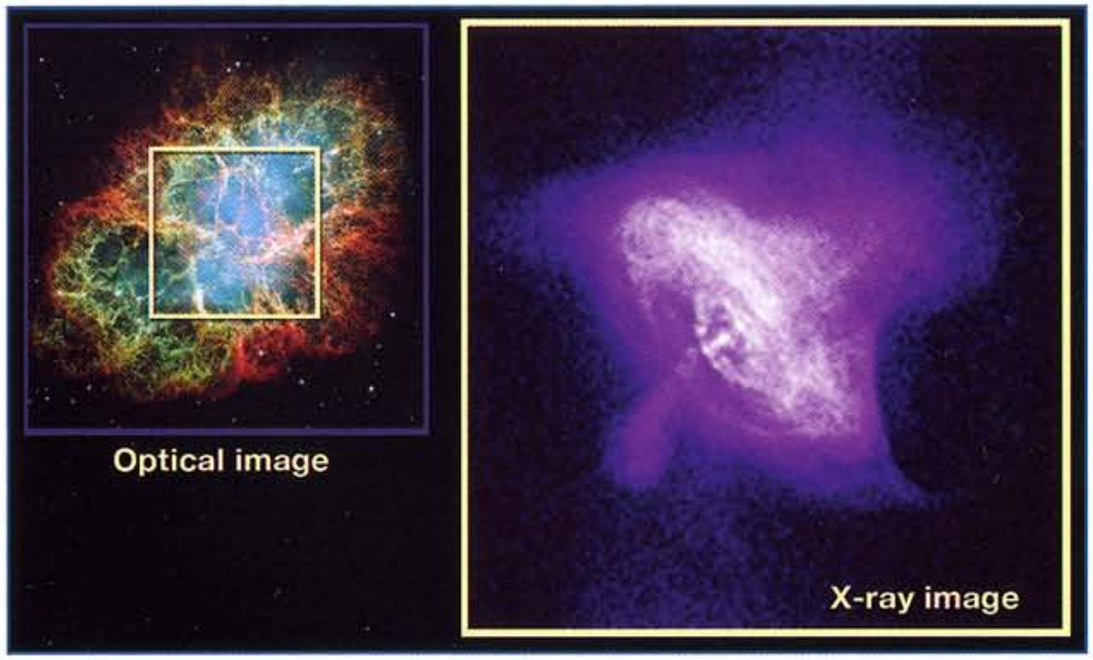
Credits for Hubble image: NASA and ESA.

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Buried deep within the Crab Nebula is the powerhouse creating the high-energy fireworks detected by astronomers. The image on the left, taken in visible light by the Hubble telescope, shows the pulsar's location at the heart of the nebula. The pulsar cannot be seen in visible light.

The X-ray image on the right, taken by the Chandra X-ray Observatory, shows two rings of material around the Crab Pulsar. Winds from the central pulsar slam into the surrounding material, creating knots and clouds of energetic X-ray–emitting particles. The pulsar also powers two turbulent jets shooting off perpendicular to the rings at half the speed of light.

Credits for Chandra X-Ray Telescope image: NASA and ESA.

FAST FACTS / VOCABULARY

Location: Constellation Taurus

Distance: 6,500 light-years away

Neutron star: A neutron star is the collapsed remnant of a massive star after a supernova. A neutron star is one of the few possible endpoints of a star's life.

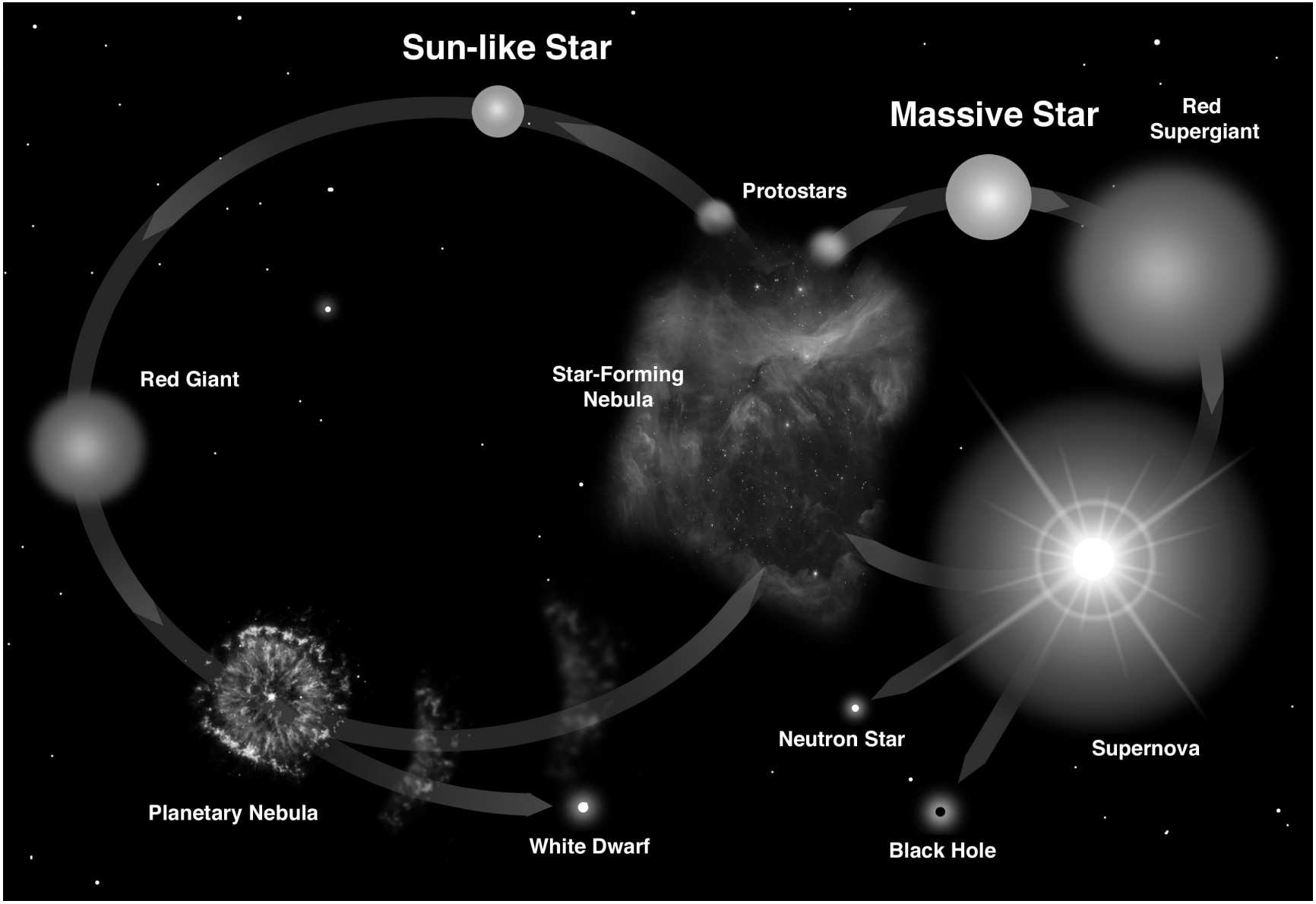
You can get images and other information about the Hubble Space Telescope on the World Wide Web. Visit **http://www.stsci.edu/outreach** and follow the links.

The corresponding classroom activity for this lithograph can be found at: **http://amazing-space.stsci.edu/** or may be obtained by contacting the Office of Public Outreach at the Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218.

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the lives of stars

THE LIVES OF STARS

What is a red giant, a white dwarf, or a supernova? Where do these fit into the lives of stars? Follow the arrows on the diagram and discover the stages in the life of a small Sun-like star compared to the stages in the life of a massive star (a star more than 8 to 10 times the mass of our Sun).

Stars of all sizes are born as *Protostars* from a cloud of gas and dust in our galaxy (a *Star-Forming Nebula*). When the protostar compresses under the force of gravity and its core becomes hot enough, the star begins fusing hydrogen into heavier elements in its core.

Stages in the life of a sun-like star (A life of BILLIONS of years):

Sun-like Star: For billions of years, the star remains stable, fusing hydrogen in its core.

Red Giant: After several billion years, the star uses up the hydrogen in its core, and it turns into a red giant, now mostly fusing helium.

Planetary Nebula: At this point the star goes through an unsettled stage where it starts losing its outer atmosphere in a planetary nebula which forms around the star.

On the diagram, the cycle continues from the planetary nebula back into the cloud of gas and dust. This represents the recycling of the elements created in the star back into the interstellar medium to provide material to make new stars.

White Dwarf: The leftover core of the star cools down and shrinks to a white dwarf. After billions of years, the white dwarf cools off so much that it no longer glows and becomes the dark, cold remains of the star.

Stages in the life of a massive star (A life of MILLIONS of years):

Massive Star: For millions of years, the star remains stable, fusing hydrogen in its core.

Red Supergiant: After several million years, the star uses up the hydrogen in its core and it turns into a red supergiant. The star continues to fuse atoms in its core into heavier and heavier elements until the core starts filling up with iron. Because the fusion process stops at iron, the core collapses under its own weight, no longer held up by the heat generated during fusion.

Supernova: An explosive shock wave and the energy generated from the core collapse starts moving outward, heating the surrounding layers of the star, and BOOM. Most of the star is blasted into space in a supernova explosion. On the diagram, the cycle continues from the supernova back into the cloud of gas and dust. This represents the recycling of the heavy elements created in the star and during the supernova explosion into the interstellar medium to provide the material to make new stars — and planets.

Neutron Star or Black Hole: After the explosion, the remaining core of the star turns into a neutron star or, if the core is more than three times the mass of the Sun, it turns into a black hole.

Which NASA missions study supernovae, black holes, and high-energy radiation from space?

Some of the NASA missions are:

GLAST: http://www.nasa.gov/glast

Swift: http://swift.gsfc.nasa.gov

Chandra: http://chandra.harvard.edu/

In collaboration with European Space Agency (ESA)
XMM-Newton: http://xmm.sonoma.edu

In collaboration with Japanese Aerospace Exploration Agency (JAXA)
Suzaku: http://suzaku-epo.gsfc.nasa.gov/

The Night Sky Network's International Year of Astronomy (IYA) Discovery Guides are supported and sponsored by these NASA Forums and missions:

Space Telescope Science Institute's Origins Education Forum
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NASA JPL's PlanetQuest Exoplanet Exploration Program
Special Advisor: Michael Greene
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NASA Education Forum on the Structure and Evolution of the Universe
NASA Education Forum on Solar System Exploration
NASA Education and Public Outreach at Sonoma State University
NASA Goddard Space Flight Center Suzaku Mission E/PO Program
NASA's Kepler Discovery Mission



The Night Sky Network is a nationwide coalition of amateur astronomy clubs bringing the science, technology, and inspiration of NASA's missions to the general public.

We share our time and telescopes to provide you with unique astronomy experiences at science museums, observatories, classrooms, and under the real night sky.
http://nightsky.jpl.nasa.gov

The International Year of Astronomy (http://astronomy2009.us) aims to help citizens of the world rediscover their place in the Universe through the daytime and nighttime sky. Learn more about NASA's contributions to the International Year of Astronomy at http://astronomy2009.nasa.gov

