Supernova Remnant SNR 0509

National Aeronautics and Space Administration

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Supernova Explosion Creates a Bubble of Light

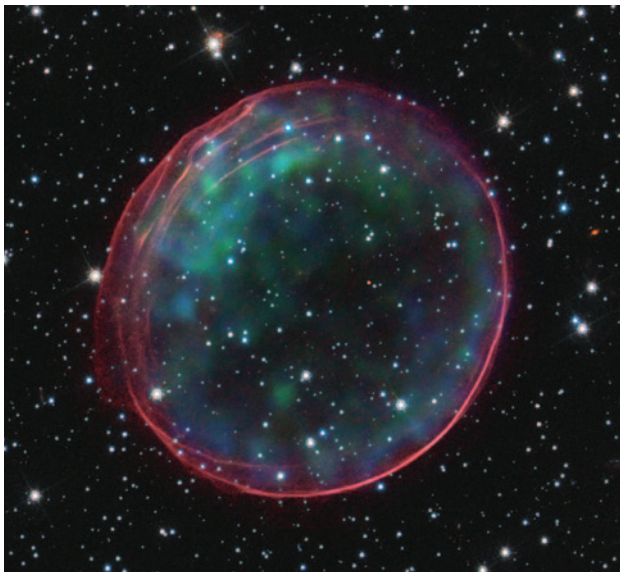
This Hubble Space Telescope image shows what appears to be a delicate bubble of gas floating serenely in space. In actuality, the bubble is the visible remnant of a powerful stellar explosion that took place in the Large Magellanic Cloud, a small, neighboring galaxy about 160,000 light-years from Earth.

The bubble, called SNR 0509-67.5 (or SNR 0509 for short), was formed from gas being swept up by the expanding shock wave from a supernova explosion. Astronomers have determined that the explosion was a Type Ia supernova, which is an especially energetic and bright variety. Type Ia supernova events are thought to result from a white dwarf star in a two-star system. The white dwarf robs its partner of material, takes on much more mass than it is able to handle, and eventually explodes. This explosion destroys the star and sends a powerful shock wave into surrounding space.

Despite the brightness of the supernova itself, the bubble seen here is quite faint. Ripples in the shell's surface are likely caused by subtle variations in the density of the surrounding interstellar gas. The brightest areas of the bubble occur wherever the thin shell of gas is viewed exactly edge-on. The bubble is 23 light-years across and is expanding at more than 11 million miles per hour (18 million kilometers per hour). Even so, it will take years before any discernible motion of the bubble is detectable from Earth.

As seen from Earth, the supernova, which occurred about 400 years ago, should have been visible to southern hemisphere observers around the year 1600. There are, however, no known records of a "new star" in the direction of the Large Magellanic Cloud near that time. A more recent supernova from that galaxy, called SN 1987A, did catch the eye of Earth viewers in 1987 and continues to be studied with ground- and space-based telescopes, including Hubble.

Credit: NASA, ESA, and the Hubble Heritage Team (STScI/AURA)



View of supernova bubble in X-ray and visible light

This composite image of the bubble-shaped supernova remnant SNR 0509-67.5 combines visible-light exposures taken by the Hubble Space Telescope and X-ray data taken by the Chandra X-ray Observatory. The soft green and blue colors in the interior of the bubble are denser regions of heated material that glow at X-ray wavelengths. This material is surrounded by pink-colored gas, which shows the present location of the shock wave. This expanding blast wave from the supernova explosion is plowing into surrounding material, heating it and causing it to glow.

Credit: NASA, ESA, CXC, SAO, the Hubble Heritage Team (STScI/AURA), and J. Hughes (Rutgers University)

VOCABULARY:

Shock wave: The expanding outer edge of a region of high pressure gas produced by a stellar explosion. This expanding pressure wave sweeps outward from the explosion site into surrounding space, compressing and heating any interstellar gas and dust as it goes.

Supernova(e): The explosive death of a star that ejects the star's outer layers into surrounding space at high velocities. The energy output causes its expanding gases to glow extraordinarily brightly for weeks or months.

You can get images and other information about the Hubble Space Telescope on the World Wide Web. Visit our website, **http://hubblesite.org/**, and follow the links.

You can find the corresponding classroom activity for this lithograph at **http://amazing-space.stsci.edu/eds/tools/type/pictures.php** or by contacting the Office of Public Outreach at the Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218.

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In Search of … Supernova Remnants

Description

Use the "Supernova Remnant SNR 0509" lithograph as the initial source of information to engage your students in a Level One Inquiry Activity. Students will use the images and text on this lithograph to generate questions about supernovae. They will conduct research to answer their questions. This curriculum support tool is designed to be used as an introductory activity in a unit that incorporates scientific inquiry or that has a stellar evolution theme.

About Inquiry-based Learning

The inquiry process is driven by a student's own curiosity, wonder, interest, or passion to understand an observation or to solve a problem. It involves a process of exploring the natural or material world. This exploration prompts students to ask questions and to make discoveries in the search for new insights. A Level One Inquiry Activity uses questions and problem-solving methods directed by the teacher. In this activity, teachers will use the lithograph images to help students formulate questions about supernovae. Teachers will suggest selected resources about supernovae to help students answer their questions. Students will provide supporting evidence for their conclusions. This process can help prepare students to become more independent thinkers.

Grade Level

High school, grades 11–12.

Prerequisites

Students should know that stars vary in brightness, color, age, temperature, and mass. A star's mass determines its lifetime and fate. Students also should be aware that stars spend most of their lives fusing hydrogen into heavier elements in their cores. The depletion of this fuel source (hydrogen) initiates the final stages in the lives of stars.

Misconceptions

Teachers should be aware of the following common misconceptions and should determine whether their students harbor any of them. Students may have misconceptions regarding the evolution and fate of stars. They may think all stars end their lives the same way – as supernovae. A star's mass at birth determines whether the star becomes a planetary nebula or a supernova.

Students may think that stars do not change. Stars, in fact, evolve. This process, however, occurs over millions to billions of years, depending on the star's mass. Most stellar changes, such as the birth of a star, happen over many human lifetimes. The supernova phenomenon, the explosion of a star at the very end of its lifetime, produces observable changes that occur on timescales of seconds to months to years.

Vocabulary

These are terms students may encounter while doing further research on stellar evolution:

Supernova remnant: The material that remains following the explosive death of a star. The remnant is visible in many kinds of light because of the expanding blast wave that sweeps up and heats the interstellar gas and dust as it moves outward.

See the lithograph for additional vocabulary terms.

Purpose

The purpose of this activity is to engage students in a Level One Inquiry Activity with astronomical images and information. Students will gain experience using the Internet to search for information. They will practice the process skills of observing and analyzing. Students also will organize their material, present their findings, and reflect on what they have learned.

Materials

- "Supernova Remnant SNR 0509" lithograph.
- Computer with Internet connection for conducting research.

Instructions for the Teacher

Preparation

- Obtain copies of the lithograph for each student. The "Supernova Remnant SNR 0509" lithograph can be found at **http://amazing-space.stsci.edu/capture/stars/preview-snr0509.php**.
- Preview the Overview page, found at: **http://amazing-space.stsci.edu/eds/overviews/print/lithos/snr0509.php**. Use the "Related Materials" section to become familiar with stellar evolution.

In Search of … Supernova Remnants

- Bookmark or identify as favorites the following suggested websites:
  - STScI: Tales of ... A history of the Crab Nebula **http://amazing-space.stsci.edu/resources/tales/crab.php**
  - STScI: Tales of … Key events in the history of Supernova 1987A **http://amazing-space.stsci.edu/resources/tales/1987a.php**
  - STScI news releases about stars that form supernovae: **http://hubblesite.org/newscenter/archive/releases/star/supernova/**
  - STScI news releases about nebulae classified as supernova remnants: **http://hubblesite.org/newscenter/archive/releases/nebula/supernova-remnant/**

Procedure

Before beginning this activity, identify your students' misconceptions about supernovae by having them write down anything they know and understand about this topic. Use those statements to evaluate your students' misconceptions. Have students volunteer their ideas about supernovae. From those ideas, identify their misconceptions and discuss them with the class. An alternative method is to collect your students' written ideas about supernovae. From those ideas, compile a list of their misconceptions and discuss them with the class.

Ask students to study the images on the front and the back of the lithograph. Then tell your students to write as many questions as they can about the features visible in the images. Collect the questions and group them by common themes. Ask students to read the information on the back of the lithograph. Then ask them if they found the answers to any of their questions. Tell students to use the Internet to research their questions. The Internet sites listed above provide a starting point for their research. Tell students how to access other websites. Ask students to prepare presentations that include answers to their questions. Their presentations also should address Type Ia supernovae. This presentation can be in the form of a skit, a story, a graphic organizer, a PowerPoint show, or a written report — any method that conveys a student's understanding of the topic to another student, to a group of students, or to the entire class. Students may work individually or in groups. Ask students to check whether their original questions were answered during their research or from talking with other students. Then ask students if they have any additional questions.

Instructions for the Student

Your teacher will ask you to write down what you know and understand about supernovae. You may be asked to share this information with the rest of the class. Study the images on the front and the back of the lithograph. Write down as many questions as you can about what you see in the images. Read the back of the lithograph to find answers to your questions.

Using your questions as a guide, conduct research on the Internet to find the answers to your questions. Your teacher will provide websites to use for your research. Your teacher also will ask you to create a presentation to demonstrate your understanding of the material you collected through your research. The presentation could be a skit, a story, a graphic organizer, a PowerPoint show, or whatever format that will communicate the information you learned about supernovae. Your teacher will direct you to work individually or in small groups. You may be instructed to make your presentation to another classmate, to another group of students, or to the entire class.

Education Standards

AAAS Benchmarks: Project 2061
http://www.project2061.org/publications/bsl/online/bolintro.htm

1. The Nature of Science

B. Scientific Inquiry

By the end of the 12th grade, students should know that:

- Sometimes, scientists can control conditions in order to obtain evidence. When that is not possible, practical, or ethical, they try to observe as wide a range of natural occurrences as possible to discern patterns.

4. The Physical Setting

A. The Universe

By the end of the 12th grade, students should know that:

- Eventually, some stars exploded, producing clouds containing heavy elements from which other stars and planets orbiting them could later condense. The process of star formation and destruction continues.

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