National Aeronautics and Space Administration

Supernova Remnant SN 1006

Ancient Supernova Explosion Creates "Ribbon of Light"

In 1006 A.D., observers from Africa to Europe to the Far East witnessed and recorded the arrival of a "new star" that appeared suddenly in the sky. For several weeks, people could see the star with unaided eyes even during the day, and it remained visible for about 2½ years before fading away. It is likely the brightest star ever observed by humans.

Astronomers now know the object's true identity. It was a star that exploded as a supernova, called SN 1006, about 7,000 light-years from Earth in the constellation Lupus.

The stellar explosion sent a blast wave racing outward through space at nearly 20 million miles an hour for a thousand years. The blast wave is sweeping up and heating any interstellar gas and dust in its path. Today we see a "supernova remnant," a large, nebulous bubble some 60 light-years across, surrounding the site of this explosion.

The Hubble picture shown on the front is a close-up view of a tiny portion of this expanding blast wave. As hydrogen atoms are caught up in the blast wave, they emit wisps of light that are perceived by Hubble's camera as a faint ribbon of light. The hydrogen atoms then quickly become ionized and stop emitting light. Thus, Hubble sees a "snapshot" of how the expanding blast wave appears at any given instant. The orange-colored dots in the image are background galaxies, and the white points of light are background and foreground stars in our Milky Way Galaxy.

The "ribbon of light" is actually a bit of an optical illusion. The ribbon actually has depth. It appears like a ribbon because Hubble is looking almost exactly along the edge of the expanding bubble.

Astronomers have observed the SN 1006 remnant in many different wavelengths of light, each of which reveals different aspects of the supernova remnant. They have combined the observations to make a complete picture of the bubble-shaped object. This full view is shown in the image at right.

Interestingly, the optical emission is only visible along one section of this huge expanding bubble. The blast wave is exciting and ionizing the hydrogen gas in that area, making the gas glow in visible light. Even though the blast wave is still expanding at 6 million miles per hour, it takes years between observations to detect any motion of the ribbon filament against the background stars because it is so far away.

Credit for Hubble image: NASA, ESA, and the Hubble Heritage Team (STScI/AURA).
Acknowledgment: W. Blair (Johns Hopkins University)

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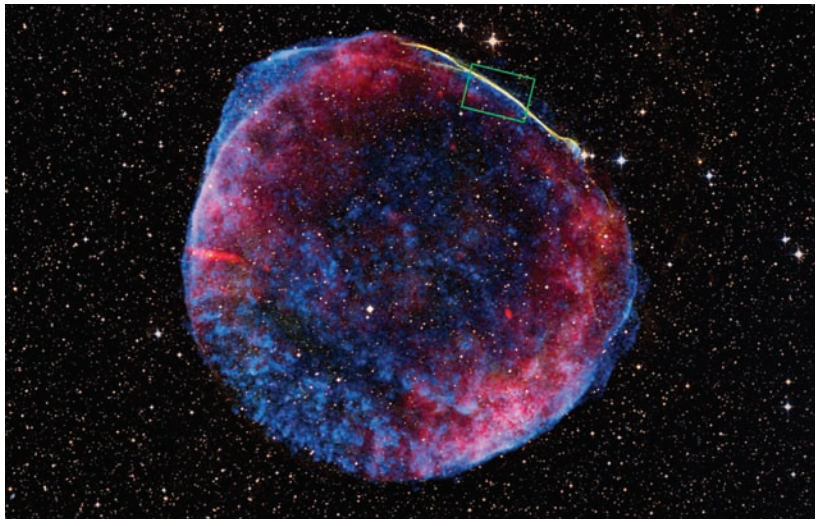

A Multiwavelength View of SN 1006

This multi-color image offers an overview of the leftovers of a dying star that exploded more than 1,000 years ago. The blast wave from this supernova produced a huge, expanding, bubble-shaped structure. To get the full view of this object, astronomers combined observations taken in visible, X-ray, and radio wavelengths. They assigned colors to the X-rays and radio waves because these wavelengths cannot be seen by the human eye. The fluffy red features represent radio waves; the blue, X-rays; and the yellow, visible light. The small green box at the top of the image corresponds to the region shown in the Hubble image.

Photo Credit: NASA, ESA, and Z. Levay (STScI).

VOCABULARY

Blast wave: The leading edge of energy produced by a stellar explosion.
Ionization: The process of removing electrons from neutral atoms.

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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In Search of … Supernova Remnants

Description

Use the "Supernova SN 1006" 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 supernova remnants. They will conduct research to answer their questions. They also will analyze the images of the supernova remnant to determine why the remnant has such an unusual shape and to learn what the remnant reveals about the process of stellar death. 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 use the lithograph images to help students formulate questions about supernova remnants. Teachers suggest selected resources about supernova remnants to help students answer their questions and examine the process of stellar death. Students provide supporting evidence for their conclusions. This process can help prepare students to become more independent thinkers. Note: The preparation section below provides resources for inquiry-based learning.

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

Blast wave: The leading edge of energy produced by a stellar explosion. This expanding pressure wave sweeps outward from the explosion site into surrounding space, sweeping up and heating any interstellar gas and dust as it moves outward.

Supernova(e): The explosive death of a star which throws the star's outer layers into surrounding space at high velocities.

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 and present their findings. They then will reflect on their learning.

Materials

- "Supernova SN 1006" lithograph.
- Computer with Internet connection for conducting research.

In Search of … Supernova Remnants

Instructions for the Teacher

Preparation

•Obtain copies of the lithographs for each student. The SN 1006 lithograph can be found at http://amazing-space.stsci.edu/capture/stars/preview-sn1006.php.
•Preview the "Overview" page, found at: http://amazing-space.stsci.edu/eds/overviews/print/lithos/sn1006.php. Use the "Related Materials" section to (1) become familiar with inquiry-based learning and/or (2) become familiar with supernova remnants.
•Note that a similar list of "Related Web sites" can be found on the preview page for the lithograph: http://amazing-space.stsci.edu/capture/stars/preview-sn1006.php. Identify the appropriate Web sites for your students to use.

Procedure

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

Ask students to study the images on both the front and 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 on the preview page provide a starting point for their research. Tell students how to access other Web sites.

Ask students to prepare presentations in which they answer their questions. Their presentations also should address why SN 1006 looks the way it does and what its appearance reveals about the process of stellar death. 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 how stars change over time and how they die. You may be asked to share this information with the rest of the class. Study the image of the supernova remnant on the back of the lithograph, and then look at the image on the front. 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 ask you to determine why SN 1006 looks the way it does and what its appearance reveals about the process of stellar death. Your teacher will provide Web sites to use for your research. Your teacher 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 stellar death. Your teacher will direct you to work individually or in small groups. You may make your presentations to another classmate, to another group of students, or to the entire class.

Education Standards

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.

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