National Aeronautics and Space Administration

# Pillar in the Carina Nebula

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## Stars bursting to life in the Carina Nebula

This eerie pillar of gas and dust is an incubator for infant stars, which are hidden from view in this visible-light image taken by the Hubble Space Telescope.

The giant pillar resides in a turbulent stellar nursery called the Carina Nebula, located 7,500 light-years away in the southern constellation Carina.

The image shows the tip of the 3-light-year–long pillar, bathed in the glow of light from hot, massive stars off the top of the image. Scorching radiation and fast winds (streams of charged particles) from these stars are sculpting the pillar and causing new stars to form within it. Streamers of gas and dust can be seen flowing off the top of the structure.

Nestled inside this dense structure are fledgling stars. They cannot be seen in this image because they are hidden by a wall of gas and dust. Although the stars themselves are invisible, one of them is providing evidence for its existence. Thin puffs of material can be seen traveling to the left and to the right of a dark notch in the center of the pillar. The matter is part of a jet produced by a young star. Farther away, on the left, the jet is visible as a grouping of small, wispy clouds. A few small clouds are visible at a similar distance on the right side of the jet. Astronomers estimate that the jet is moving at speeds of up to 850,000 mi/h (1,400,000 km/h). The jet's total length is about 10 light-years.

The fireworks in the Carina region started three million years ago when the nebula's first generation of newborn stars condensed and ignited in the middle of a huge cloud of cold molecular hydrogen. Our Sun and our solar system may have been born inside such a cosmic crucible 4.6 billion years ago.

Hubble's Wide Field Camera 3 (WFC3) observed the Carina Nebula on July 24–30, 2009. WFC3 was installed aboard Hubble in May 2009 during Servicing Mission 4.

*Credit for Hubble image: NASA, ESA, and the Hubble SM4 ERO Team.*

## VOCABULARY

**Light-year:** The distance that light travels in a year (about 6 trillion miles or 10 trillion kilometers).

**Near-infrared:** The region of the infrared spectrum that is closest to visible light. Near-infrared light has slightly longer wavelengths and slightly lower frequencies and energies than visible light.

In this Hubble image, taken in near-infrared light with WFC3, the dense pillar and the surrounding greenish-colored gas all but disappear. Only a faint outline of the pillar remains. By penetrating the wall of gas and dust, Hubble's near-infrared vision reveals the infant star that is blasting the jet. Part of the jet nearest the star is more prominent in this view. These features can be seen because infrared light, unlike visible light, can pass through the dust.

Other infant stars inside the pillar also appear to emerge. Three examples are the bright star almost directly below the jet-producing star, a fainter one to its right, and a pair of stars at the top of the pillar. Winds and radiation from some of the stars are blowing away gas from their neighborhoods, carving out large cavities that appear as faint dark holes.

Surrounding the stellar nursery is a treasure chest full of stars, most of which cannot be seen in the visible-light image because dense gas clouds veil their light. Many of them are background stars.

*Credit for Hubble image: NASA, ESA.*

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 … Star Formation

### Description

Use the "Pillar in the Carina Nebula" 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 star formation. 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 star formation. Teachers will suggest selected resources about star formation 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. Note: The preparation section below provides resources for inquiry-based learning.

### Grade Level

High school, grades 11–12.

### Prerequisites

Students should be aware that a star is a gaseous, self-luminous object held together by its own gravity. The core of a star is extremely hot and releases energy by fusing lighter atomic nuclei into heavier nuclei. Our Sun, the center of our solar system, is a yellow star of average temperature and size.

### Misconceptions

Teachers should be aware of the following common misconceptions and determine whether their students harbor any of them. Students may have misconceptions about stars. They may think that all stars are the same, that stars live forever, or that all stars end their lives in the same way.

### Vocabulary

These are terms students may encounter while doing further research on star birth.

**Nebula:** A cloud of gas and dust located between stars.

**Star:** A huge ball of gas held together by gravity. The central core of a star is extremely hot and produces energy. Some of this energy is released as visible light, which makes the star glow. Stars come in different sizes, colors, and temperatures. Our Sun, the center of our solar system, is a yellow star of average temperature and size.

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

- "Pillar in the Carina Nebula" lithograph.
- Computer with Internet connection for conducting research.

## Instructions for the Teacher

### Preparation

- Obtain copies of the lithograph for each student. The "Pillar in the Carina Nebula" lithograph can be found at http://amazing-space.stsci.edu/capture/stars/preview-carina-pillar.php.
- Preview the Overview page, found at: http://amazing-space.stsci.edu/eds/overviews/print/lithos/carina_pillar.php. Use the "Related Materials" section to (1) become familiar with inquiry-based learning and/or (2) become familiar with star formation.
- Bookmark or identify as favorites the following suggested Websites:

STScI: "HST Reveals Stunning Detail in Herbig-Haro Object": http://hubblesite.org/newscenter/archive/releases/1993/17/text/

STScI Background: "Hubble Space Telescope's Wide Field Camera Reveals Splendor of 'Supergiant' Nebula": http://hubblesite.org/news**center/ar**chive/releases/2001/21/background/

# In Search of … Star Formation

STScI: "Tales of … Extreme star birth in the Carina Nebula": http://amazing-space.stsci.edu/resources/tales/carina.php

### Procedure

Before beginning this activity, identify your students' misconceptions about stars 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 star birth. From those ideas, identify their misconceptions and discuss them with the class. An alternative method is to collect your students' written ideas about star birth. From those ideas, compile a 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 Websites.

Ask students to prepare presentations that include the answers to their questions. Their presentations should also address the process of star formation. 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 stars. You may be asked to share this information with the rest of the class. Study the visible-light image of the Carina Nebula on the front of the lithograph, and then look at the infrared image of the Carina on the back. 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 will also 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 star birth. Your teacher will direct you to work individually or in small groups. You may make your presentation to another classmate, to another group of students, or to the entire class.

## Education Standards

### National Science Education Standards

http://books.nap.edu/html/nses/

**Science as Inquiry**

**Content Standard A:** As a result of activities in grades 9–12, all students should develop understandings about scientific inquiry:

Scientists usually inquire about how physical, living, or designed systems function. Conceptual principles and knowledge guide scientific inquiries. Historical and current scientific knowledge influence the design and interpretation of investigations and the evaluation of proposed explanations made by other scientists.

Scientific explanations must adhere to criteria such as: a proposed explanation must be logically consistent; it must abide by the rules of evidence; it must be open to questions and possible modification; and it must be based on historical and current scientific knowledge.

### 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 for practical or ethical reasons, they try to observe as wide a range of natural occurrences as possible to be able to discern patterns.

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