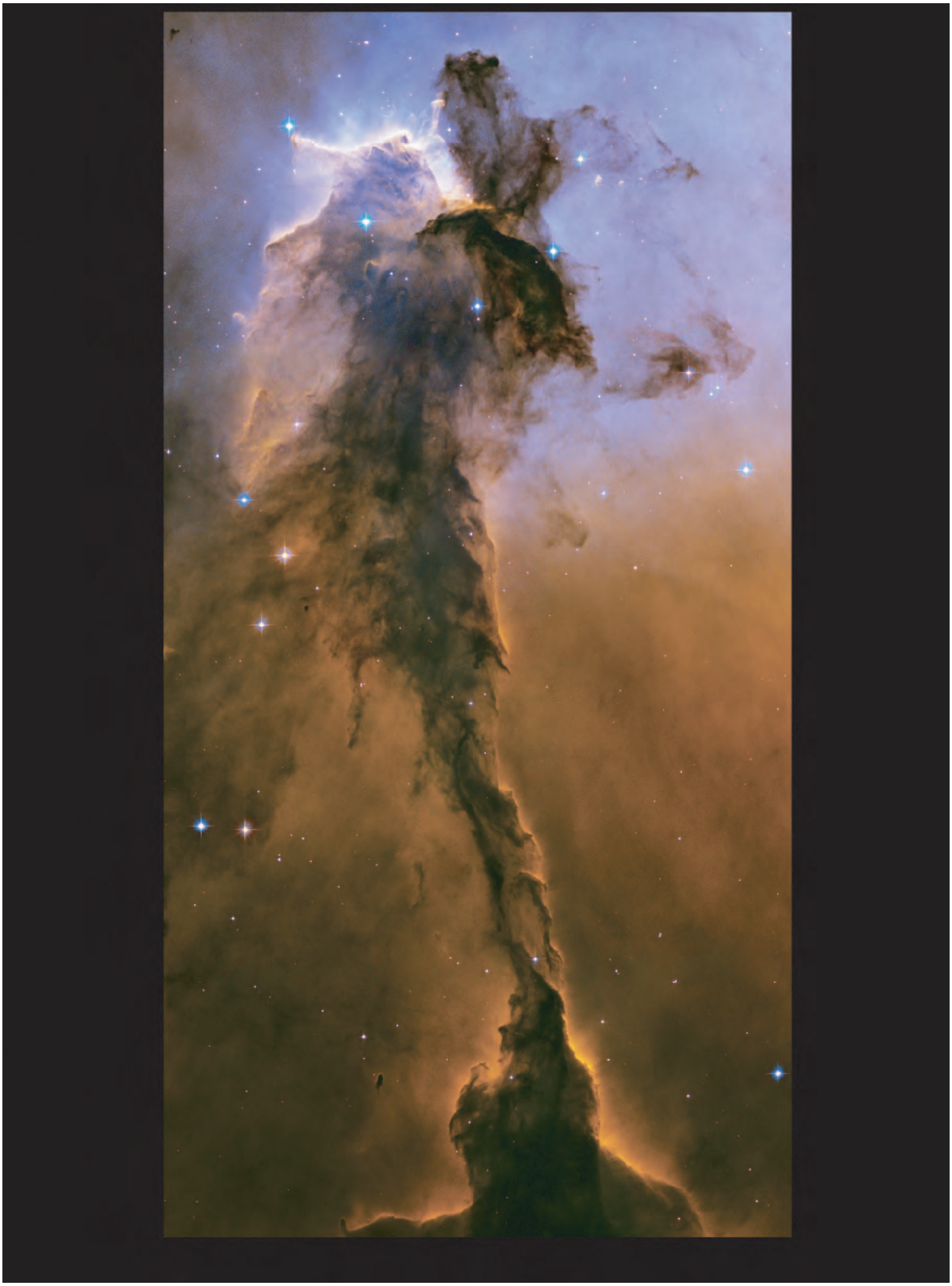
National Aeronautics and Space Administration
Goddard Space Flight Center

Stellar Spire in the Eagle Nebula



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The Eagle Has Risen

Appearing like a winged fairy-tale creature poised on a pedestal, this object is actually a billowing tower of cold gas and dust rising from a stellar nursery called the Eagle Nebula. The soaring tower is 9.5 light-years or about 57 trillion miles high, about twice the distance from our Sun to the next nearest star.

Stars in the Eagle Nebula are born in clouds of cold hydrogen gas that reside in chaotic neighborhoods, where energy from newborn stars sculpts fantasy-like landscapes in the gas. The tower is a giant incubator for these newborn stars. A torrent of ultraviolet light from a band of massive, hot, young stars [*off the top of the image*] is eroding the pillar.

The starlight also is responsible for illuminating the tower's rough surface. Ghostly streamers of gas can be seen boiling off this surface, creating the haze around the structure and highlighting its three-dimensional shape. The column is silhouetted against the background glow of more distant gas.

The edge of the dark hydrogen cloud at the top of the tower is resisting erosion, in a manner similar to that of brush among a field of prairie grass that is being swept up by fire. The fire quickly burns the grass but slows down when it encounters the dense brush. In this celestial case, thick clouds of hydrogen gas and dust have survived longer than their surroundings in the face of a blast of ultraviolet light from the hot, young stars.

The newborn stars are being created by dense gas collapsing under gravity and by pressure from gas that has been heated by the neighboring stars. The first wave of stars began forming before the massive star cluster began venting its scorching light. Denser regions of cold gas within the tower began collapsing under their own weight to make stars. The bumps and fingers of material in the center of the tower are examples of these stellar birthing areas. These regions may look small but they are roughly the size of our solar system. The fledgling stars continued to grow as they fed off the surrounding gas cloud. They abruptly stopped growing when light from the star cluster uncovered their gaseous cradles, separating them from their gas supply.

Ironically, the young cluster's intense starlight also is inducing star formation in some regions of the tower. Examples can be seen in the large, glowing clumps and finger-shaped protrusions toward the top of the structure. The stars heat the gas at the top of the tower and create a shock front, as seen by the bright rim of material tracing the edge of the nebula at top, left. As the heated gas expands, it acts like a battering ram, pushing against the darker cold gas. The intense pressure compresses the gas, making it easier for stars to form. This scenario will continue as the shock front moves slowly down the tower.

The dominant colors in the image were produced by gas energized by the star cluster's powerful ultraviolet light. The blue color at the top is from glowing oxygen. The red color in the lower region is from glowing hydrogen. The image of the Eagle Nebula, also known as M16, was taken with NASA's Hubble Space Telescope.

FAST FACTS

Location: Constellation Serpens

Distance from Earth: 6,500 light-years

VOCABULARY

Light-year: The distance that a particle of light (photon) will travel in a year — about 10 trillion kilometers (6 trillion miles)

Ultraviolet light: Electromagnetic radiation with shorter wavelengths and higher energies and frequencies than visible light. UV light is lower in frequency than X-rays.

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

This **wide view of the Eagle Nebula** reveals a sculpted landscape of gas and dust where stars are being born. The image was taken with the National Science Foundation's NOAO Mosaic CCD camera on the 0.9-meter telescope at the Kitt Peak National Observatory in Arizona. The outlined areas point out regions photographed by the Hubble Space Telescope. ***A***, Hubble's Wide Field and Planetary Camera 2 made this image in 1995 of three towers of gas and dust that are incubators for newborn stars. ***B***, Hubble's recent view of another gaseous incubator for stars, taken with the Advanced Camera for Surveys.

T. A. Rector (NRAO/AUI/NSF and NOAO/AURA/NSF) and B. A. Wolpa (NOAO/AURA/NSF)

You can get images and other information about the Hubble Space Telescope on the World Wide Web. Visit our website, **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.

SPACE TELESCOPE SCIENCE INSTITUTE

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In Search of . . . Star Formation

Description

Using the "Stellar Spire in the Eagle Nebula" lithograph, engage your students in a Level One Inquiry activity to introduce the topic of star formation. A Level One Inquiry activity can help prepare students to be more independent thinkers. Students conduct research to answer questions they have about star formation.

Grade Level

High school: Grades 10–12

Prerequisites

At the very least, 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 should determine whether their students harbor any of them. Students may have misconceptions regarding the true nature of stars and think that all stars are exactly the same. All stars are not the same. Stars vary in brightness, color, mass, temperature, and age. For example, blue stars tend to be hot, bright, and very massive. They burn through their available fuel quickly and thus have short life spans. When massive stars die, they end their lives as supernovae.

Vocabulary

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.

Star formation: The process by which stars form from a cloud of cool, dense gas. Some disturbance, maybe the shock wave from an exploding star, causes the cloud to contract. Under its own gravitational force, the cloud continues to contract into a smaller and smaller core. The pressure builds up in the core as the density increases, heating the core to temperatures exceeding 8 million Kelvin. At these high temperatures, the energy of the colliding hydrogen nuclei overcomes their natural repulsion. Nuclear fusion begins, and a star is born.

See the lithograph for additional vocabulary terms.

Purpose

The purpose of this activity is to apply a Level One Inquiry technique using images and text to introduce the topic of star formation. In this activity, the components of inquiry learning that students can practice are: asking questions, planning and conducting investigations, using critical thinking skills, and communicating results. Students will make observations, formulate questions, and read for a purpose.

Materials

- "Stellar Spire in the Eagle Nebula" lithograph
- Magnifying glass
- Computer with Internet connection for researching

— Electronic images from the "Stellar Spire in the Eagle Nebula" lithograph and related links are available at **http://hubblesite.org/news/2005/12**.

Instructions for the Teacher

Preparation

- Obtain a lithograph for each student.
- Make arrangements to use the media center and/or the computer lab with Internet connections.

Procedure

Ask students to look at the image of the Eagle Nebula on the front of the lithograph and/or read the information on the back. Ask them to write down three questions they want answered about star formation. Students should look at the image on the front of the lithograph or read the text on the back for inspiration. Allow students to refine their questions by discussing them with classmates. Another option is to have students share their questions with the class and work with the class on refining them. After gathering the questions, identify the most commonly asked questions and briefly analyze them with students.

Then ask students to examine the image with a magnifying glass to search for smaller details. Alternately, students can research textbooks, encyclopedias, and/or the Internet. For a more detailed look at the nebula, use the link in the Materials section above. Go to the main menu on the left and click on "Images" to see a selection of available photos. Students can work individually or can be placed in groups based upon common questions/interests. Students can report their findings in a variety of ways: written reports, oral reports, and/or posters or other visual aids.

Instructions for the Student

Study the image of the Eagle Nebula and read the back of the lithograph. Then write down three questions that you want answered about star formation. Examine the image on the front of the lithograph and/or read the text on the back for inspiration. Be prepared to share your questions with the class. Your teacher will ask you to learn more about star formation by researching textbooks, encyclopedias, and/or the Internet. For a more detailed view of the Eagle Nebula image, use the Internet to view the digital photos.

Education Standards

Benchmarks for Science Literacy
American Association for the Advancement of Science:

http://www.project2061.org/tools/benchol/bolframe.htm

Grades 9–12:

4. The Physical Setting

A. The Universe

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

- On the basis of scientific evidence, the universe is estimated to be over ten billion years old. The current theory is that its entire contents expanded explosively from a hot, dense, chaotic mass. **Stars condensed by gravity out of clouds of molecules of the lightest elements until nuclear fusion of the light elements into heavier ones began to occur.** Fusion released great amounts of energy over millions of years. Eventually, some stars exploded, producing clouds of heavy elements from which other stars and planets could later condense. **The process of star formation and destruction continues.**

National Science Education Standards

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

Content Standard D: As a result of their activities in grades 9–12, all students should develop an understanding of the origin and evolution of the universe.

- Early in the history of the universe, matter, primarily the light atoms hydrogen and helium, clumped together by gravitational attraction to form countless trillions of stars. Billions of galaxies, each of which is a gravitationally bound cluster of billions of stars, now form most of the visible mass in the universe.

McREL Language Arts Standard and Benchmarks

http://www.mcrel.org/compendium/standardDetails.asp?subjectID=7&standardID=7

Reading Standard 7:

Level 4 (Grades 9–12)

1. Uses reading skills and strategies to understand a variety of informational texts (e.g., textbooks, biographical sketches, letters, diaries, directions, procedures, magazines, essays, primary source historical documents, editorials, news stories, periodicals, catalogs, job-related materials, schedules, speeches, memoranda, public documents, maps).

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