A Horse of a Different Color

National Aeronautics and Space Administration

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To celebrate the 23rd anniversary of the Hubble Space Telescope, NASA released a new view of the Horsehead Nebula that provides an intriguing astronomical variation on the phrase, "a horse of a different color."

The Horsehead Nebula, also known as Barnard 33, was first recorded in 1888 by Williamina Fleming at the Harvard College Observatory. Visible-light images show a black silhouette, a "dark nebula," that resembles a horse's head. Dark nebulae are generally most noticeable because they block the light from background stars.

To see deeper into dark nebulae, astronomers use infrared light. Hubble's infrared image of the Horsehead transforms the dark nebula into a softly glowing landscape. The image reveals more structure and detail in the clouds.

Many parts of the Horsehead Nebula are still opaque at infrared wavelengths, showing that the gas is dense and cold. Within such cold and dense clouds are regions where stars are born.

At the top of the nebula, a bright star is surrounded by glowing gas. This star formed when gravity compressed some of the cold, dense gas of the nebula. The newborn star now illuminates the gas from which it formed. It is just one of many examples of star birth in and around the nebula.

The long-term story of this dark nebula is about the action and reaction of a gas cloud to star formation. Stars form within dark nebulae. Hot, newborn stars emit intense radiation that heats the gas and makes it glow. As deeper and deeper layers are heated, the bright cloud boundary slowly advances through the dark gas. Ultimately, young stars destroy the nursery in which they were born.

The Horsehead Nebula is only a temporary structure that will be eroded away in about 5 million years. While it lasts, astronomers will study it using not only visible and infrared light, but also all the other types of light, including ultraviolet, X-ray, and radio. Astronomers use all the colors of the rainbow and all the "colors" across the entire electromagnetic spectrum of light to uncover hidden details.

Beyond a new beautiful image, Hubble's infrared insight helps us learn more about the Horesehead Nebula and other stellar nurseries. This astronomical "horse of a different color" provides new details and helps piece together a more complete scientific story of star formation.

Two views of Horsehead Nebula

These two images reveal different views of the Horsehead Nebula. The visible-light image on the left was taken by a ground-based telescope. The near-infrared image on the right was taken by the Hubble Space Telescope.

In the image at left, the gas around the Horsehead Nebula shines a bright pink, in contrast to the darkness of the Horsehead itself. This pink glow occurs along the edge of the dark cloud and is created by the bright star, Sigma Orionis, above the Horsehead, but not seen in this image. The longer wavelengths of infrared light, shown in the image at right, penetrate deeper into the cloud. As in the visible-light image, the regions exposed to the light of Sigma Orionis glow brightly. The opaque cloud has become more transparent. Many more background stars, and even some distant galaxies, can be seen through the thinner parts of the nebula.

Visible-light image - *Credit: Nigel Sharp/NOAO Copyright AURA Inc./NOAO*
Near-infrared image - *Credit: NASA, ESA, and the Hubble Heritage Team (STScI/AURA)*

VOCABULARY:

Infrared (IR) Light: The part of the electromagnetic spectrum that has slightly lower energy than visible light, but is not visible to the human eye. Just as there are low-pitched sounds that cannot be heard, there is low-energy light that cannot be seen. Infrared light can be detected as the heat from warm-blooded animals.

Nebula: A cloud of gas and dust located between stars and/or surrounding stars. Nebulae are often places where stars form.

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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Goddard Space Flight Center
8800 Greenbelt Road
Greenbelt, Maryland 20771

www.nasa.gov

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In Search of … the Electromagnetic Spectrum

Description

Use the "Horsehead 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 why astronomers observe celestial objects in all portions of the electromagnetic spectrum. 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 an electromagnetic spectrum 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 why astronomers observe celestial objects in all portions of the electromagnetic spectrum. Teachers will suggest selected resources about the electromagnetic spectrum to help students answer their questions. Students will provide supporting evidence for their conclusions. This process can help prepare students become more independent thinkers.

Grade Level

Middle to high school, grades 8-12

Prerequisites

Students should know that visible light is a small slice of the entire electromagnetic spectrum and that the majority of the spectrum is invisible to the human eye.

Misconceptions

Teachers should be aware of the following common misconceptions and determine whether their students harbor any of them. Students may have misconceptions about the electromagnetic spectrum. They may think that all radiation is harmful, that filters change the color of light, or that red objects in space are hot and blue objects are cold.

Vocabulary

Electromagnetic Spectrum

The entire range of wavelengths of electromagnetic radiation, including radio waves, microwaves, infrared light, visible light, ultraviolet light, X-rays, and gamma rays.

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

- "Horsehead Nebula" lithograph.
- Computer with Internet connection for conducting research.

Instructions for the Teacher

Preparation

- Obtain copies of the lithograph for each student. The "Horsehead Nebula" lithograph can be found at **http://amazing-space.stsci.edu/capture/stars/preview-horsehead.php**.
- Preview the Overview page at **http://amazing-space.stsci.edu/eds/overviews/print/lithos/horsehead.php**. Use the "Related Materials" section to become familiar with how astronomers use the electromagnetic spectrum to view celestial objects.
- Bookmark or identify as favorites the following suggested websites:
  - STScI: Hubble Sees a Horsehead of a Different Color **http://hubblesite.org/newscenter/archive/releases/2013/12**
  - STScI: By Popular Demand: Hubble Observes the Horsehead Nebula **http://hubblesite.org/newscenter/archive/releases/2001/12/**
  - STScI: Hubble Reveals Orion in Picture-Perfect Glory **http://amazing-space.stsci.edu/news/archive/2006/01/**
  - NASA's Tour of the Electromagnetic Spectrum **http://missionscience.nasa.gov/ems/index.html**

In Search of … the Electromagnetic Spectrum

Procedure

Before beginning this activity, identify your students' misconceptions about the electromagnetic spectrum 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 the electromagnetic spectrum. From those ideas, identify their misconceptions and discuss them with the class. An alternative method is to collect your students' written ideas about the electromagnetic spectrum. 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 in the "Preparation" section 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 also should address how astronomers use the electromagnetic spectrum to view celestial objects and should include at least three images of a selected celestial object taken in different portions of the electromagnetic spectrum. The 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 if they have any additional questions.

Instructions for the Student

Your teacher will ask you to write down what you know and understand about the electromagnetic spectrum. You may be asked to share this information with the rest of the class. Study the image of the Horsehead Nebula on the front of the lithograph, and then look at the image 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 and will ask you to create a presentation to demonstrate your understanding of the material you collected through your research. Your presentations also should address how astronomers use the electromagnetic spectrum to view celestial objects and should include at least three images of a selected celestial object taken in different portions of the electromagnetic spectrum. 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 how astronomers use the electromagnetic spectrum to view celestial objects. Your teacher will direct you to work individually or in small groups. You may be instructed to make your presentation to another student, to a 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 for practical or ethical reasons, they try to observe as wide a range of natural occurrences as possible to be able to discern patterns.

4. The Physical Setting

F. Motion

By the end of the 8th grade, students should know that:

- There are a great variety of electromagnetic waves: radio waves, microwaves, infrared waves, visible light, ultraviolet rays, X-rays, and gamma rays. These wavelengths vary from radio waves, the longest, to gamma rays, the shortest.

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