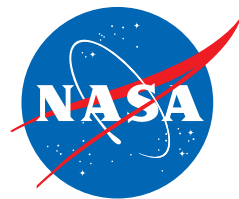


Star-Forming Nebula N90

National Aeronautics and
Space Administration



A Multiwavelength View of Star Birth

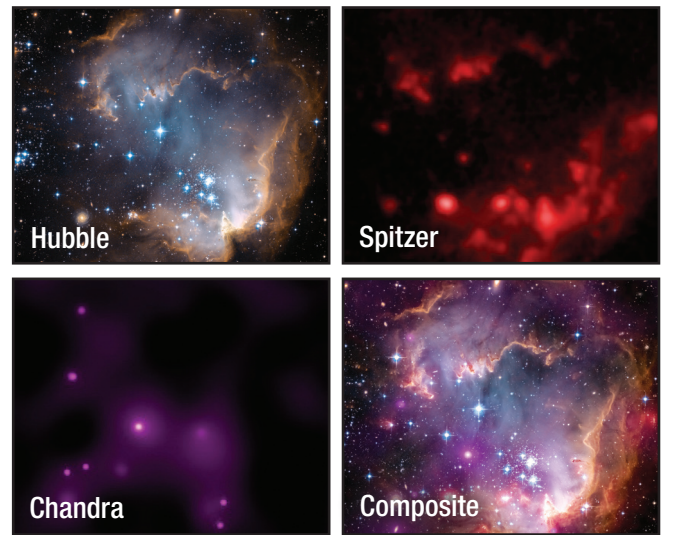
The colorful view of the star-forming nebula N90 on the front of the lithograph is a blend of observations by three of NASA's Great Observatories. Visible light from the Hubble Space Telescope, infrared light from the Spitzer Space Telescope, and X-rays from the Chandra X-ray Observatory are combined to paint a deeper and richer portrait of star birth.

The images at the right show the separate observations taken by the three Great Observatories. In the top left image from Hubble, the visible light is shown as blues, browns, yellows, and whites. Hubble showcases the bright central star cluster and the glowing edges of the surrounding gas. The cluster stars formed a few million years ago within the cloud, and now their energetic emission is eroding away the nebula. The long, finger-like pillars along the inner edge are dense pockets of gas and dust resisting that erosion.

Within these pillars new stars are forming. Their radiation is best seen in the infrared light from Spitzer, shown in red in the image at top right. The cooler gas of the dusty ridges is dark in visible observations, but glows warmly at infrared wavelengths. The brighter peaks of infrared emission reveal where new clumps of stars, not fully formed, are embedded within the gas.

Many of these stars also emit high-energy X-rays and are seen in the purple-colored observations of Chandra, at bottom left. These X-ray observations confirm a large population of newly forming stars that are too small and faint to be otherwise detected. Among the fully formed cluster stars, only the very brightest have any appreciable X-ray emission. The rest of the strong X-ray sources shown in this image come from distant background galaxies.

The combination of visible, infrared, and X-ray wavelengths, shown in the image at bottom right, provides astronomers with a fuller census of the number and types of stars that are forming and have formed in this nebula. Astronomers have found that



N90 in Multiple Wavelengths

Views of the star-forming nebula N90 are shown in visible light (upper left; Hubble Space Telescope), infrared light (upper right; Spitzer Space Telescope), and X-ray light (lower left; Chandra X-ray Observatory). Astronomers combined these observations to make the multiwavelength image at lower right.

Credit for Hubble observations: NASA, ESA, and the Hubble Heritage Team (STScI/AURA)-ESA/Hubble Collaboration

Credit for Spitzer observations: NASA/JPL-Caltech

Credit for Chandra observations: NASA/CXC/Univ. Potsdam/L. Oskinova et al.

Credit for composite image, which also appears on the front: NASA, ESA, CXC and the University of Potsdam, JPL-Caltech, and STScI

N90 is comparable to the famous Orion Nebula, with one important difference. While Orion is one of the nearest star-forming nebulae, N90 is more than a hundred times farther away in the Small Magellanic Cloud, a satellite galaxy of our Milky Way. Finding such strong similarities in these two distinctly different environments provides confirmation and confidence that our explanations of how stars form are on the right track.

VOCABULARY

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

FAST FACTS

Location: In the constellation Tucana (the toucan bird).

Distance from Earth: About 200,000 light-years from Earth.

Dimensions: N90 is about 150 light-years across.

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 ... the Electromagnetic Spectrum

Description

The “Star-Forming Nebula N90” lithograph serves as the initial source of information to engage students in a Level One Inquiry Activity. In this activity, educators will use lithograph images to help students formulate questions about why astronomers observe celestial objects in all regions of the electromagnetic spectrum. Educators will suggest selected resources about the electromagnetic spectrum to help students answer their questions. Students will then conduct research and provide supporting evidence for their conclusions. 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 an educator. The process of inquiry-based learning can help prepare students to 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

Educators should be aware of the following common misconceptions and determine whether their students harbor any of them. Students 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. They may not be aware that some wavelengths of the electromagnetic spectrum show celestial features not evident in other wavelengths of light.

Vocabulary

Terms students may encounter while doing further research on the electromagnetic spectrum include:

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:

- “Star-Forming Nebula N90” lithograph
- Computer with Internet connection for conducting research

Instructions for Educators

Preparation

- Obtain copies of the lithograph for each student. The “Star-Forming Nebula N90” lithograph can be found at <http://amazing-space.stsci.edu/capture/stars/preview-n90.php>.
- Preview the Overview page at: <http://amazing-space.stsci.edu/eds/overviews/print/lithos/n90.php>. Use the “Related Materials” section to become familiar with the electromagnetic spectrum.
- Bookmark or identify as favorites the following suggested websites:
 - STScI: “Young Stars Sculpt Gas with Powerful Outflows” <http://hubblesite.org/newscenter/archive/releases/galaxy/2005/35/image/a/>
 - STScI: “Hubble Finds Infant Stars in Neighboring Galaxy” <http://hubblesite.org/newscenter/archive/releases/galaxy/2005/04/>
 - NASA’s Tour of the Electromagnetic Spectrum <http://missionscience.nasa.gov/ems/index.html>
 - Revealing the Universe in All of its Light! http://coolcosmos.ipac.caltech.edu/cosmic_classroom/multiwavelength_astronomy/multiwavelength_astronomy/index.html
 - The Multiwavelength Astronomy Gallery http://coolcosmos.ipac.caltech.edu/cosmic_classroom/multiwavelength_astronomy/multiwavelength_museum/gallery.html

In Search of ... the Electromagnetic Spectrum

Procedure

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. Point out that the images on the back were taken of the star-forming nebula in separate regions of the electromagnetic spectrum. Each wavelength of the electromagnetic spectrum reveals different characteristics and/or features of an object. Then have students 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. Have students 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.

Have students prepare presentations or written reports that include the answers to their questions. Their presentations or reports also should address why astronomers use the electromagnetic spectrum to view celestial objects. Specifically, students should select a celestial object and identify at least three images taken in different regions of the electromagnetic spectrum. They then should explain what each wavelength of the electromagnetic spectrum reveals about their object. The presentation can be in the form of a skit, a story, a graphic organizer, or a PowerPoint show – 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.

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LG-2013-10-066-GSFC (2/2)

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 star-forming nebula on the front of the lithograph, and then look at the images on the back. Write down as many questions as you can about what you see in the images, keeping in mind that the focus of this activity is what each region of the electromagnetic spectrum reveals about a celestial object. When instructed by your teacher, 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 using websites suggested by your teacher. Your teacher also will ask you to create a presentation or a written report that should include a celestial object viewed in at least three different regions of the electromagnetic spectrum. You should explain what each wavelength of the electromagnetic spectrum reveals about the object. 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 why astronomers use the entire 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, practical, or ethical, they try to observe as wide a range of natural occurrences as possible 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.

Educational Product

Educators & Students

Grades 8–12