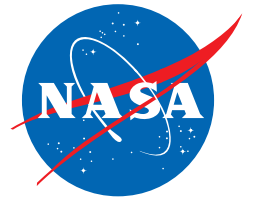


Cepheid Variable Star RS Puppis

National Aeronautics and
Space Administration



Cepheid variables: Reliable milepost markers

On a cloud-free night, the glitter of countless stars blankets the night sky. Some stars appear bright; others appear faint. We cannot tell just by gazing at them how far away they are from Earth. Astronomers have developed many methods to determine a star's distance from our planet.

About 100 years ago, however, astronomers had few ways to measure whether a star was nearby or far away. Distances could be determined within our solar system and out to some of the nearest stars, but astronomers did not have a reliable way to measure the distances to remote stars or nebulae. As far as they could tell, our Milky Way Galaxy was the entire universe.

Then, in 1912, astronomer Henrietta Swan Leavitt made a startling discovery that changed the course of astronomy. While working at Harvard College Observatory, Leavitt was recording and cataloguing variable stars, whose brightness changes from time to time. She noticed that a certain type of variable star, called a Cepheid variable, changes from bright to dim and back fairly regularly. The bright star on the front of this lithograph is an example of a Cepheid variable. Called RS Puppis, this star rhythmically brightens and dims over a six-week period. The star is about 10 times more massive than our Sun and around 200 times larger.

Leavitt went on to discover a direct relationship between the time it took a Cepheid variable to go from bright to dim to how bright it actually was. Knowing this relationship allowed astronomers to measure the distance to any place where they could see a Cepheid. These special stars are space's version of a milepost marker, helping astronomers determine how far away star clusters, nebulae, and even nearby galaxies are from Earth.

Harlow Shapley used Leavitt's discovery to measure the size of the Milky Way. Edwin Hubble used a Cepheid in the so-called Andromeda Nebula to show that it was a galaxy far beyond the Milky Way. This discovery changed the size of the universe overnight. Instead of just one galaxy, our Milky Way, astronomers uncovered a multitude of galaxies stretching across space. Today, we estimate there are about 100 billion galaxies in the cosmos.

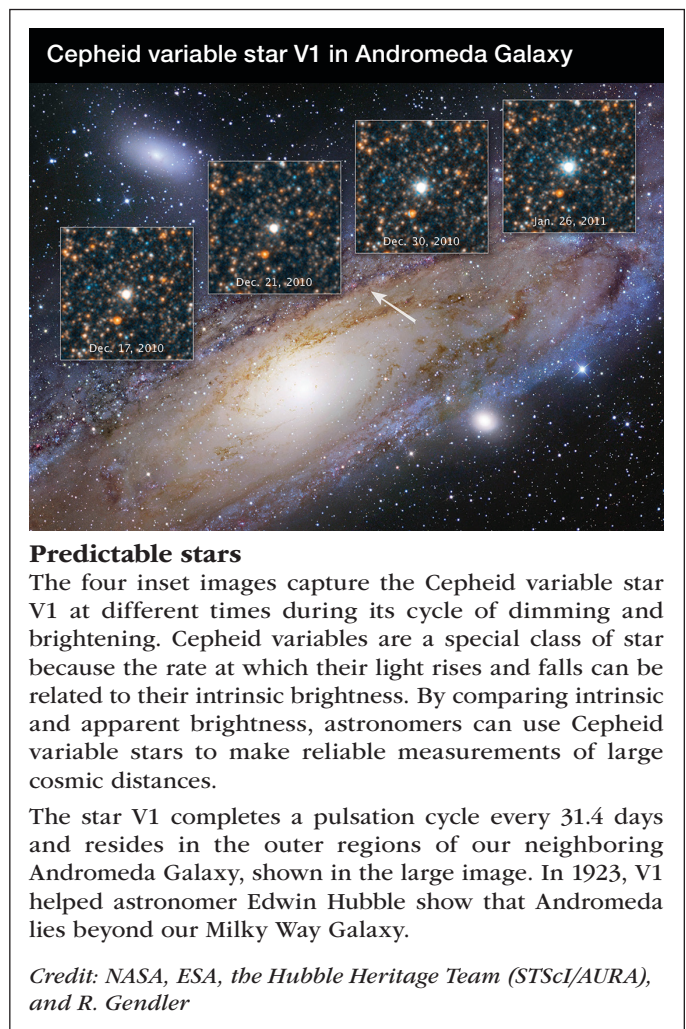
Cepheid variable stars like RS Puppis played a crucial role in determining the scale of our universe and continue to be an important tool in measuring distances within and beyond our galaxy.

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VOCABULARY

Cepheid variable star: A very bright pulsating star (up to 100,000 times brighter than the Sun and visible at great distances) whose light and energy output vary noticeably over a set period of time. The time period over which the star varies is directly related to its light output or luminosity, making these stars useful standard candles for measuring intergalactic distances.

Credit for "Cepheid Variable Star RS Puppis": NASA, ESA, the Hubble Heritage Team (STScI/AURA), and H. Bond

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.





In Search of ... Cepheid Variable Stars

Description

The “Cepheid Variable Star RS Puppis” 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 Cepheid variable stars. Educators will suggest selected resources about Cepheid variable stars 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 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 an educator. The process of inquiry-based learning can help prepare students to become more independent thinkers.

Grade Level

High school, grades 10-12

Prerequisites

Students should know that stars vary in brightness, color, age, temperature, and mass, and that mass determines a star’s evolution and how its life will end. Students also should be aware that some stars are naturally variable and, in some cases, this variability can be used to determine distances.

Misconceptions

Educators 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

Terms students may encounter while doing further research on Cepheid variable stars include:

Galaxy: A collection of stars, gas, and dust bound together by gravity.

Nebula: A cloud of gas and dust located between stars and/or surrounding stars. Nebulae are often places where stars form. The term was originally used for any indistinct celestial cloud, including some objects that were later recognized as galaxies.

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:

- “Cepheid Variable Star RS Puppis” lithograph
- Computer with Internet connection for conducting research

Instructions for Educators

Preparation

- Obtain copies of the lithograph for each student. The “Cepheid Variable Star RS Puppis” lithograph can be found at: <http://amazing-space.stsci.edu/capture/stars/preview-rspuppis.php>.
- Preview the Overview page at: <http://amazing-space.stsci.edu/eds/overviews/print/lithos/rspuppis.php>. Use the “Related Materials” section to become familiar with Cepheid variable stars.
- Bookmark or identify as favorites the following suggested websites:
 - STScI: “Tales of ... The star that changed the universe”: <http://amazing-space.stsci.edu/resources/tales/variablestar.php>
 - STScI: “Hubble Watches Super Star Create Holiday Light Show”: <http://hubblesite.org/newscenter/archive/releases/star/variable-star/2013/51/>
 - STScI Newscenter Archive: “Variable Stars”: <http://hubblesite.org/newscenter/archive/releases/star/variable-star/>
 - NASA’s Imagine the Universe: “Cepheid Variables as Cosmic Yardsticks”: http://imagine.gsfc.nasa.gov/docs/science/mysteries_11/cepheid.html

In Search of ... Cepheid Variable Stars *(cont'd)*

- The Woman Astronomer: “Henrietta Leavitt ”:
<http://www.womanastronomer.com/hleavitt.htm>
- AAVSO: “Henrietta Leavitt – Celebrating the Forgotten Astronomer”:
<http://www.aavso.org/henrietta-leavitt-%E2%80%93-celebrating-forgotten-astronomer>

Procedure

Identify your students’ misconceptions about Cepheid variable 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 variable stars. From those ideas, identify their misconceptions and discuss them with the class. An alternative method is to collect your students’ written ideas about variable stars. 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 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 the historic importance of Cepheid variable stars. 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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Instructions for the Student

Your teacher will ask you to write down what you know and understand about Cepheid variable stars. You may be asked to share this information with the rest of the class. Study the image of Cepheid Variable Star RS Puppis 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. 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. Your teacher will provide websites to use for your research. Your teacher also will ask you to create a presentation or a written report 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 the importance of Cepheid variable stars. 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.

National Science Education Standards

http://www.nap.edu/openbook.php?record_id=4962

G. History and Nature of Science

As a result of activities in grades 9 – 12, all students should develop understanding of historical perspectives.

- The historical perspective of scientific explanations demonstrates how scientific knowledge changes by evolving over time, almost always building on earlier knowledge.

Educational Product

Educators & Students

Grades 10–12