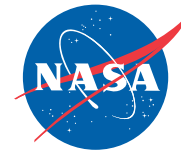


M101: The Pinwheel Galaxy





M101: The Pinwheel Galaxy

A Star-studded Galaxy

Giant spiral galaxies were not built in a day. Construction on these mammoth objects, like Messier 101 (M101) shown in this Hubble Space Telescope image, lasted billions of years.

This photograph of M101, nicknamed the Pinwheel Galaxy, showcases a spiral galaxy's well-known features. A galaxy is a collection of stars, gas, and dust held together by gravity. Galaxies come in three different varieties: spirals, ellipticals, and irregulars.

Spiral galaxies, like M101, have well-defined spiral arms that wind around the galaxy within a rotating pancake-shaped disk of material. In this Hubble telescope "face-on" view of M101, bright blue areas of star formation pepper the spiral arms, which look like the arms of a pinwheel. Dark, thin dust lanes follow the spiral structure into a yellowish central bulge containing older stars.

In fact, M101's disk is so thin that the Hubble telescope easily sees many more distant galaxies lying behind it. Seeing these background galaxies shows that a galaxy's disk is really mostly empty space.

The Hubble image of M101 is 95,000 light-years across. A beam of light would travel 95,000 years to get from one side of the pictured galaxy to the other. M101 is estimated to contain hundreds of billions of stars. If each star were a drop of water, one would need about five Olympic-size swimming pools to hold the hundreds of billions of stars. Many of the stars are smaller, cooler, and redder than our Sun. The hot, blue stars along the spiral arms are rare, but they are so bright they stand out in this image.

The galaxy lies 25 million light-years from Earth in the northern constellation Ursa Major (The Great Bear). We are seeing M101 as it looked 25 million years ago. The light we are seeing from the galaxy began its journey to Earth at the beginning of our planet's Miocene Period, when mammals flourished and the Mastodon first appeared.

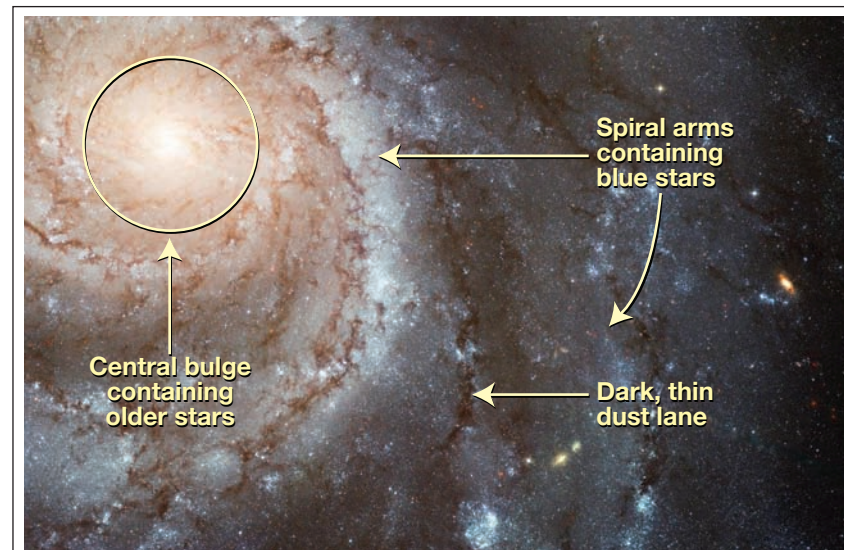
VOCABULARY

Messier Catalogue (M): A catalogue of about a hundred of the brightest galaxies, star clusters, and nebulae compiled in the late 1700s by French astronomer Charles Messier.

Elliptical Galaxy: A galaxy that appears elliptical in shape; some are more elongated, while others are more spherical. It is essentially a big mass of mostly old stars and contains very little gas or dust (interstellar matter).

Irregular Galaxy: A galaxy whose shape is neither elliptical nor spiral. It appears unorganized and is often rich in gas and dust (interstellar matter).

Credit for Hubble Image: NASA and ESA. Acknowledgments: K.D. Kuntz (GSFC), F. Bresolin (University of Hawaii), J. Trauger (JPL), J. Mould (NOAO), and Y.-H. Chu (University of Illinois, Urbana). Credit for CFHT Image: Canada-France-Hawaii Telescope/J.-C. Cuillandre/Coelum. Credit for NOAO Image: G. Jacoby, B. Bobannan, M. Hanna/ NOAO/AURA/NSF.



This close-up view of spiral galaxy M101 shows many details that may be overlooked when viewing the full image. For example, dark, thin dust lanes are clearly visible in the spiral arms. Clusters of young, blue, hot stars dot the spiral arms. The bright nucleus at upper left appears brighter and redder than the rest of the galaxy seen in the image. Stars near the bulge, which surrounds the nucleus, are older and redder than those in other regions of the galaxy. M101's disk is so thin that several background galaxies can be seen. A spiral galaxy, for example, appears at the edge of a spiral arm at far right.

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.





In Search of ... Spiral Galaxies

Description

Using the images and text on the “M101:The Pinwheel Galaxy” lithograph, engage your students in a Level One Inquiry activity to explain the organization of stars, gas, and dust in spiral galaxy systems. A Level One Inquiry activity can help students become independent thinkers. Students may conduct research to expand their understanding by describing how a galaxy’s structure affects its formation and appearance.

Grade Level

Middle – high school, grades 6–12.

Prerequisites

The number of stars visible through a telescope is dramatically greater than can be seen with the unaided eye. Advances in technology allow scientists to collect, store, and manipulate data obtained from telescopes. They communicate their results with other scientists. Students should be aware that galaxies are very large collections of stars, gas, and dust held together by gravity.

Students should also be aware of the characteristics of stars, which make up the visible portion of galaxies. Stars have different masses, colors, and brightness. These characteristics influence a galaxy’s appearance.

Misconceptions

Teachers should be aware of the following common misconceptions and determine whether their students harbor any of them. Students may have misconceptions regarding the makeup, distances, and sizes of galaxies. They may not understand that galaxies are groups of stars — not just single stars — that come in a variety of shapes, sizes, and colors. Small galaxies may have only a few million stars in them and stretch across several thousand light-years. Large galaxies, however, may have several trillion stars and span hundreds of thousands of light-years. The shapes of galaxies vary — some are elliptical, others are spiral, and still others have no definite shape. Students may also have misconceptions about

the appearance of galaxies, either thinking that we can view galaxies from different points or that galaxies are easily seen in the night sky. A galaxy’s appearance depends on its orientation with respect to Earth; we cannot change that orientation. Galaxies are so far away that the visible ones appear as fuzzy patches in the sky. Only three galaxies are visible to the unaided eye. Andromeda is visible in the Northern Hemisphere. The Large and Small Magellanic Clouds, satellite galaxies of the Milky Way, are visible in the Southern Hemisphere.

Vocabulary

System: A system is an organized group of related objects or components that forms a whole. Systems can consist, for example, of organisms, machines, fundamental particles, galaxies, ideas, numbers, transportation, and education.

Purpose

The purpose of this activity is to apply a Level One Inquiry technique, using images and text, to introduce the system of spiral galaxies and explore their organization. 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, make comparisons, formulate questions, and read for a purpose.

Materials

- “M101:The Pinwheel Galaxy” lithograph
- “Whirlpool Galaxy” lithograph — available on the Amazing Space Website at <http://amazing-space.stsci.edu/capture/galaxies/preview-whirl.php>
- “Warped Galaxy” lithograph — available on the Amazing Space Website at <http://amazing-space.stsci.edu/capture/galaxies/preview-warped.php>
- “Sombrero Galaxy” lithograph — available on the Amazing Space Website at <http://amazing-space.stsci.edu/capture/galaxies/preview-sombrero.php>
- Computers with Internet connection for researching

Procedure

Before starting this activity, evaluate your students' misconceptions about galaxies by having them write down anything they know and understand about galaxies. You can use these statements to evaluate your students' misconceptions. Ask students to volunteer their ideas, or collect their papers, compile a list of misconceptions, and discuss them with the class. Ask students to review the galaxy image on the front of the "M101: The Pinwheel Galaxy" lithograph and write down three questions they have about the galaxy in the image. Ask the students to read the information on the back of the "M101: The Pinwheel Galaxy" lithograph and check if any of their questions are answered in the text. In addition, students can use the images and text from the materials list to research their questions. Students may also use the Internet to research answers to their questions. Provide instructions for accessing the appropriate Websites. Have students prepare a report on the organization and structure of spiral galaxies. The research may be extended to include an explanation of how the galaxy's structure affects its formation and appearance and visa versa. The report could be in the form of a slide show, a skit, a story, a Power Point presentation, or a three-dimensional model and written account — anything that conveys their understanding of the topic to another student, a group of students, or the entire class.

Instructions for the Student

Your teacher will ask you to write down what you know and understand about galaxies. You may be asked to share this information with the rest of the class. Study the images of the galaxy on the front of the "M101: The Pinwheel Galaxy" lithograph. Write down three questions about the galaxy. Then read the information on the back of the lithograph. Were any of your questions answered in the text? Your teacher will guide your search and will ask you to present a report on the structure of spiral galaxy systems. This report could be in the form of a slide show, a skit, a story, a Power Point presentation, a three-dimensional model, or whatever you believe will allow you to express yourself completely. You may be allowed to work individually or in small groups. You can make your

presentations to another classmate, another group of students, or the class as a whole.

Science Education Standards Benchmarks for Science Literacy

American Association for the Advancement of Science:

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

The Physical Setting

A. The Universe

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

- The Sun is a medium-sized star located near the edge of a disk-shaped galaxy of stars, part of which can be seen as a glowing band of light that spans the sky on a very clear night. **The universe contains many billions of galaxies, and each galaxy contains many billions of stars.** To the naked eye, even the closest of these galaxies is no more than a dim, fuzzy spot.

National Science Education Standards

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

Content Standard: K–12

Unifying Concepts and Processes

STANDARD: As a result of activities in grades K–12, all students should develop an understanding and abilities aligned with the following concepts and processes:

- Systems, order, and organization. The natural and designed world is complex; it is too large and complicated to investigate and comprehend all at once.

Scientists and students learn to define small portions for the convenience of investigation. The units of investigation can be referred to as “systems.” A system is an organized group of related objects or components that form a whole. Systems can consist, for example, of organisms, machines, fundamental particles, galaxies, ideas, numbers, transportation, and education. Systems have boundaries, components, resources flow (input and output), and feedback.