National Aeronautics and
Space Administration

Goddard Space Flight Center

Warped Galaxy ESO 510-G13

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A Galaxy on the Edge: ESO 510-G13

This Hubble Space Telescope image of galaxy ESO 510-G13 shows how thin the disks of spiral galaxies appear when viewed from the side, or "edge-on."

The most prominent features in this photo [at right] are the disk of stars, gas, and dust and the glow from the bulge, composed mostly of old stars. These features are characteristic of spiral galaxies. The dark clouds of gas and dust in the disk stand out in this picture because they block the light of background stars.

The galaxy's thin disk is similar to that of our home galaxy, the Milky Way. Our galaxy's disk is about 2,000 light-years thick and 100,000 light-years wide. The Milky Way's bulge is about 13,000 light-years in diameter.

Besides a thin disk and a central bulge, spiral galaxies like the Milky Way and ESO 510-G13 possess spiral arms — long, curling structures of dust, gas, and young stars.

To see the spiral arms, astronomers must examine the galaxy from above, or "face-on." From that vantage point, a spiral galaxy can look like a nearly circular pinwheel [see image of galaxy M51, below, right].

Unfortunately, astronomers can't choose how they view galaxies, because these vast bodies of stars, dust, and gas are incredibly far away. To view a galaxy from a different angle, astronomers would have to travel millions of light-years from Earth. Some spiral galaxies, like ESO 510-G13, appear edge-on when seen from Earth. Others, like M51, appear face-on. Astronomers, therefore, study many galaxies with different orientations, hoping to gain better insight into how these celestial bodies are assembled.

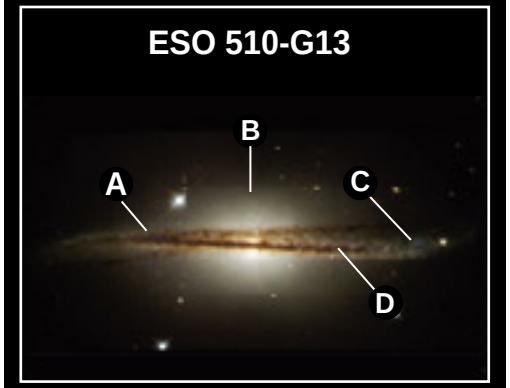
A Warp in the Disk

The edge-on portrait also reveals another intriguing feature: the disk of ESO 510-G13 is warped. The disk isn't rigid and flat like a compact disk. Rather, its shape can be deformed, like pizza dough that has been tossed into the air.

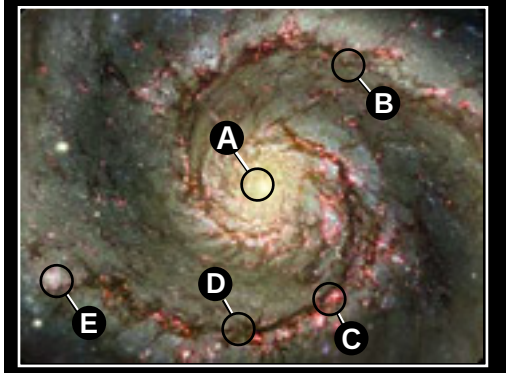
This Hubble picture illustrates that a galaxy's disk is very fragile and can be easily distorted by gravity. ESO 510-G13's disk may have been distorted by a close encounter with a small companion galaxy. Gravitational forces distort the shapes of colliding galaxies as their stars, gas, and dust merge together in a process that takes hundreds of millions of years. ESO 510-G13 may be in the process of swallowing its companion in an encounter that probably occurred within the past billion years. Eventually the disturbances will die out, and ESO 510-G13 will become like other galaxies without warps in their disks.

In the outer regions of ESO 510-G13, especially visible on the right-hand side of the image, the bent disk contains not only dark dust but also bright clusters of blue stars. These clusters are evidence that hot, young stars are being formed in the disk.

Some of the new stars may have been born from the collision of the two galaxies. When galaxies collide, clouds of dust and gas smash together and are compressed, creating a favorable environment for star birth.



ESO 510-G13: In this "edge-on" view of ESO 510-G13, the most prominent features are the galaxy's thin disk (A), central bulge (B), bright clusters of blue stars (C), and dust clouds (D).



M51: This "face-on" portrait of the spiral galaxy M51 illustrates the galaxy's central bulge (A), grand spiral arms (B), glowing hydrogen gas (C), dust clouds (D), and bright clusters of blue stars (E).

VOCABULARY

ESO: An acronym for the European Southern Observatory's catalogue of celestial objects.

Central Bulge: A round structure at the center of spiral galaxies composed mostly of old stars and some gas and dust.

Interstellar Cloud: Dust and gas existing between stars.

Light-year: The distance that light can travel in a year, which is 9.46 trillion km (5.86 trillion miles).

Spiral Galaxy: A large pinwheel-shaped system of stars, dust, and gas clouds.

FAST FACTS

Constellation: Hydra

Distance from Earth: 150 million light-years

Image Credits: NASA and the Hubble Heritage Team (STScI/AURA). Acknowledgment: C. Conselice (U. Wisconsin/STScI).

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.

EDUCATOR GUIDE

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.

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In Search of . . . Galaxies

Description

Using the Warped Galaxy lithograph, engage your students in a Level 1 inquiry activity to introduce the topic of galaxies. A Level 1 inquiry activity can help prepare students to be more independent thinkers. Students conduct research to answer questions they have about the image and/or the text.

Grade Level

Middle to high school: Grades 7–12

Prerequisites

At the very least, students should be aware that galaxies are groups of stars, gas, and dust that are held together by gravity. They also should know that galaxies don't necessarily look alike. Teachers should be aware of their students' knowledge concerning galaxies and use the information presented below and elsewhere to help them successfully complete this activity.

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 make-up, 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. The shapes of galaxies vary — some are elliptical, others are spiral, and still others have no definite shape.

Galaxies aren't even the same size — small galaxies may have only a few million stars in them and stretch across several thousand light-years. Large galaxies may have several trillion stars and span hundreds of thousands of light-years. Vast distances separate the large numbers of stars in galaxies. Galaxies are so far away that they appear as fuzzy patches in the sky. Only three are visible with the unaided eye: Andromeda and the Large and Small Magellanic Clouds.

Vocabulary

Colliding Galaxies: When two or more galaxies are close enough, their gravity begins to attract each other. The attraction increases as the galaxies travel even closer together. These galaxies can collide and possibly merge to form one galaxy. Note: The stars in each galaxy are far apart and usually don't collide when galaxies merge.

Elliptical Galaxy: A galaxy having an elliptical shape. Some elliptical galaxies are nearly spherical while others are more oblate, resembling footballs. It is essentially a big bulge composed mostly of old stars and containing little interstellar matter (the gas and dust found in the space between stars).

Galaxy: A collection of a million to a trillion stars, along with gas and dust, all held together by gravity.

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

See the lithograph for additional vocabulary terms.

Purpose

The purpose of this activity is to apply a Level 1 inquiry technique, using images and text, to introduce the topic of galaxies. 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

- Warped Galaxy Lithograph
- Magnifying glass
- Computer with Internet connection for researching answers
- Press Release on Warped Galaxy: **http://hubblesite.org/newscenter/archive/2001/23/image/a**. A list of related links is provided with the press release.

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 warped galaxy 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 galaxies or about the image on the front of the lithograph or the text on the back. Ask 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, briefly analyze them, asking students to identify those most commonly asked.

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 galaxy, use the link in the Materials section and click on the JPEG or TIFF image. 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 warped galaxy on the front of the lithograph and then read the back of the lithograph. Now write down three questions that you would like to have answered about galaxies or about the image on the front of the lithograph or the text on the back. Be prepared to share your questions with the class and work with your classmates to refine the questions. Your teacher will ask you to investigate further by researching textbooks, encyclopedias, and / or the Internet. For a more detailed view of the warped galaxy, use the Internet to see a higher-resolution JPEG or TIFF image of the galaxy.

Education Standards

Benchmarks for Science Literacy

http://www.project2061.org/

Grades 6–8

The Physical Setting

A. The Universe

By the end of the eighth 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 Standard

http://www.nap.edu

Grades 9–12

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/

Reading Standard 7

Benchmark 1: Level 3 (grades 6–8) and Level 4 (grades 9–12)

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, catalogues, job-related materials, schedules, speeches, memoranda, public documents, maps).