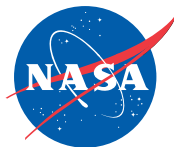


National Aeronautics and
Space Administration

Goddard Space Flight Center

M104: The Sombrero Galaxy





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"HATS OFF" TO THE SOMBRERO GALAXY

This photogenic galaxy looks like a broad-brimmed Mexican hat floating in space. Appropriately called the Sombrero Galaxy, its catalogue name is Messier 104 (M104). Thick dust lanes make up the brim of the galaxy. The brim winds into the brilliant white crown, made up of a central bulge of older stars. These stars are much like those in the middle of our own Milky Way Galaxy.

As seen from Earth, this galactic hat is tilted nearly edge-on, emphasizing a galaxy's three-dimensional structure. The central bulge, for example, can be seen extending above and below the galaxy's flat disk. This view also shows that the disks of galaxies are thin. Dust in the galaxy's wide, flat disk blocks out light from the Sombrero, appearing like a shadow against the bright bulge of stars.

In this image, NASA's Hubble Space Telescope easily resolves the Sombrero's rich system of star clusters, called globular clusters. Astronomers estimate that the Sombrero contains nearly 2,000 globular clusters—10 times as many as orbit our Milky Way. The ages of the clusters are similar to those in the Milky Way, ranging from 10 billion to 13 billion years old. The Sombrero is suspected of harboring a central black hole that is billions of times more massive than our Sun.

The Sombrero resides about 30 million light-years away at the southern edge of the dense Virgo cluster of galaxies. The galaxy is so far away that the light we are seeing today began its journey toward Earth 30 million years ago, about the time our earliest known ape-like ancestors appeared on our planet. A relatively bright galaxy, the Sombrero lies just beyond the limit of the naked eye and is easily visible through the telescopes of amateur stargazers. The hat-shaped galaxy contains several hundred billion stars, about 100 times as many stars as there are people today on Earth. Edge to edge, the Sombrero is 60,000 light-years across, which is slightly smaller than our Milky Way.

VOCABULARY

Globular Cluster: A spherically shaped collection of up to a million old stars held together by gravity and usually found in the halo of galaxies.

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

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

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.

FAST FACTS

Constellation: Virgo

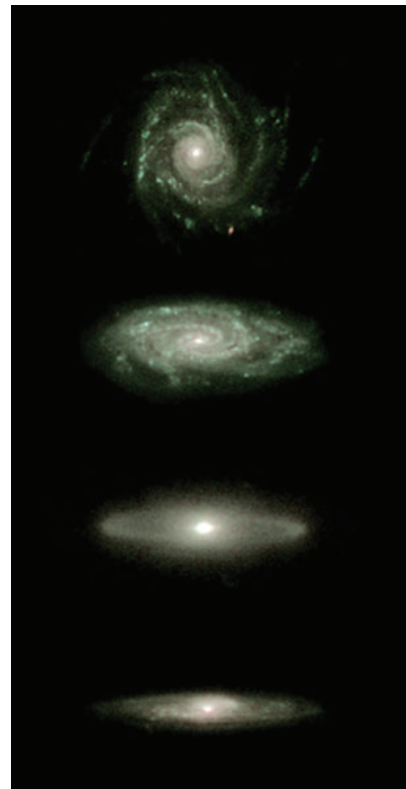
Distance from Earth: 30 million light-years

Length of galaxy: 60,000 light-years

Credit: NASA and the Hubble Heritage Team (STScI/AURA)

Looks are deceiving.

A galaxy's appearance depends on how it is tilted toward Earth. The images at right, taken from deep surveys, illustrate that galaxies look different depending on the angle at which we see them. A galaxy, when viewed from above [*right, top*], appears round. A galaxy viewed from the side, or edge-on [*right, bottom*], looks like a flat pancake. The Sombrero Galaxy [*below*] is another galaxy seen edge-on.



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.





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In Search of . . . Galaxy Orientation

Description of Classroom Activity

Using the images and text on the Sombrero Galaxy lithograph, students will compare the orientations of spiral galaxies. Not all spiral galaxies look the same, because their orientation affects their appearance. Students will conduct research to expand their comparisons, organize their materials, and present a report describing how a galaxy's orientation affects its appearance.

Grade Level

Middle – high school, grades 8 – 12

Prerequisites

The number of stars visible through a telescope is dramatically greater than can be seen with the unaided eye. Advances in technology enable scientists to collect, store, and manipulate data obtained from telescopes, as well as allow astronomers to communicate their results with others. Students should be aware that galaxies are very large collections of stars, gas, and dust held together by gravity. They should have knowledge of the basic structure of spiral galaxies — the bulge, the disk, the halo, and the spiral arms.

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. The shapes of galaxies vary — some are elliptical, others are spiral, and still others have no definite shape. The appearance of a galaxy depends on its orientation with respect to Earth; we cannot change that orientation. Galaxies are different sizes. 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, so individual stars are not likely to collide if two galaxies merge. Galaxies are so far away that they appear as fuzzy patches in the sky. Only three galaxies are visible with 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.

Purpose

The purpose of this activity is to use the images and text on the Sombrero Galaxy lithograph to explain how orientation plays a role in classifying galaxies.

Materials

- Sombrero 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>
 - Computers with Internet connection for researching
-

Instructions for the Teacher

Preparation

- Obtain a lithograph for each student.
- Bookmark or identify as favorites those Websites you want students to use for their research.

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 images on the front and back of the Sombrero Galaxy lithograph. Additional spiral images are available on the Whirlpool and Warped Galaxy lithographs. Explain that all of these galaxies are spiral galaxies. Then ask students to write down three similarities and/or differences about the galaxies in the images. Ask the students to read the information on the back of the Sombrero lithograph and to check if any of their comparisons are discussed in the text. The activity's theme should focus on a galaxy's orientation relative to Earth and how a galaxy's orientation is fixed. In addition, students can use the Internet to research their comparison statements. Provide instructions for accessing the appropriate Websites. Have students prepare a report on galaxy orientation. The report could be in the form of a slide show, a skit, a story, a Power Point presentation, or a 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 galaxies on the front and back of the Sombrero Galaxy lithograph. Write down three similarities and/or differences about the galaxies in those images. Then read the information on the back of the lithograph. Were any of your similarities and/or differences described in the text? Next, research how a galaxy's orientation affects its appearance. Your teacher will guide your search and will ask you to present a report on your research. This report could be in the form of a slide show, a skit, a story, a Power Point presentation, or whatever you feel 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>

4. 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.

