

Characteristics of Black Holes

Lesson Plan

Grade Level: 6-8

Curriculum Focus: Astronomy

Lesson Duration: Two class periods

Student Objectives

- Understand that even though black holes all have characteristics in common, they come in three different sizes.
- Understand that each size black hole has characteristics different from the others.

Materials

- Discovery School video on *unitedstreaming: Black Holes: The Ultimate Abyss*
Search for this video by using the video title (or a portion of it) as the keyword.

Selected clips that support this lesson plan:

- X-Rays, Gravity, and the Study of Black Holes
 - White Dwarves, Supernovas, and Space Time
 - Proving the Existence of Black Holes
 - Exploring Black Holes From Within
 - Worm Holes
 - Black Holes Throughout the Galaxies
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- Library and Internet reference materials on black holes
 - A computer with Internet access

Procedures

1. Review with your students what they have learned about black holes.
2. Make sure they understand that, while black holes have characteristics in common, they differ with regard to size. Explain that black holes come in three sizes: stellar mass black holes, supermassive black holes, and mini-black holes. Explain further that particular characteristics are associated with each size.

3. Divide the class into three teams, and assign each team to research one of the black-hole types discussed above.
4. Tell students that each team will prepare a presentation based on its research, which should include the following:
 - characteristics of the type of black hole
 - lifetime of the type of black hole
 - locations (or suspected locations) of the type of black hole
 - evidence for existence of the type of black hole
5. Tell students to keep track of the sources for their facts so that they or other interested classmates can go back to those sources for further information. Encourage students to include visuals in their reports.
6. After each team has presented its report, invite students to participate in creating on the chalkboard a compare-and-contrast chart showing the similarities and differences among the three types of black holes.

Discussion Questions

1. Discuss how Newton's view of gravity differs from Einstein's view of gravity.
2. Describe how a black hole is formed from the time a massive star begins its collapse.
3. Knowing that density is defined as mass per unit volume, discuss the mathematical characteristics of a singularity (values of mass, density, volume, and radius).
4. Describe the steps involved in determining the mass of a black hole. What do you have to measure or observe in order to estimate the mass?
5. If you were observing a probe entering the event horizon of a black hole, you would see it "hovering for an eternity and destroyed in an instant." Discuss the meaning of this phrase as it applies to conditions near a black hole.
6. Discuss the objective of the Gravity Probe B satellite and its relevance to the study of gravity.

Assessment

Use the following three-point rubric to evaluate students' work during this lesson.

- 3 points: report well-researched, information clearly and logically organized, presentation interesting and lively
- 2 points: report adequately researched, information sufficiently organized, presentation dull
- 1 point: report insufficiently researched, information inadequately organized, presentation poorly prepared

Vocabulary

black hole

Definition: An object with a gravitational field so strong that light cannot escape from it. It is believed to be created in the collapse of a very massive star.

Context: Everybody has heard of black holes; no one has really seen them.

galaxy

Definition: A galaxy that is a powerful source of radio waves.

Context: Mighty jets of energized particles are blasted into space from invisible engines at the hearts of these so-called radio galaxies—further evidence that a black hole is driving the process.

gravity

Definition: A fundamental physical force that is responsible for interactions that occur because of mass. The force of gravity from an object is inversely proportional to the square of the distance away from the object.

Context: Newton reasoned that all matter in the universe has gravity.

mass

Definition: A measure of the amount of material an object contains, which causes it to have weight in a gravitational field.

Context: The more mass a body has, the more gravity.

singularity

Definition: A point or region of infinite mass density at which space and time are infinitely distorted by gravitational forces and which is thought to be the final state of matter in a black hole.

Context: The most terrifying concept of astrophysics lurks at the bottom of a black hole—the singularity—where nothing, not even light, can escape.

space-time

Definition: A system of one temporal (time) and three spatial coordinates by which any physical object or event can be located. Also called the space-time continuum.

Context: Space and time seem to be woven together to form the flexible four-dimensional fabric of the universe: so-called space-time.

supernova

Definition: The explosion of a very large star in which the star may reach a maximum intrinsic luminosity one billion times that of the sun.

Context: When a giant star switches off, it goes out with a bang. While we see the outward explosion as a supernova, this masks the implosion going on inside.

Academic Standards

National Academy of Sciences

The National Science Education Standards provide guidelines for teaching science as well as a coherent vision of what it means to be scientifically literate for students in grades K-12. To view the standards, visit <http://books.nap.edu>.

This lesson plan addresses the following science standards:

- Earth and Space Science: Origin and evolution of the universe

Mid-continent Research for Education and Learning (McREL)

McREL's Content Knowledge: A Compendium of Standards and Benchmarks for K-12 Education addresses 14 content areas. To view the standards and benchmarks, visit <http://www.mcrel.org/>.

This lesson plan addresses the following national standards:

- Science—Space Science: Understands essential ideas about the composition and structure of the universe and the Earth's place in it.
 - Science—Physical Science: Understands energy types, sources, and conversions, and their relationship to heat and temperature.
 - Science—Physical Science: Understands basic concepts about the structure and properties of matter.
 - Science—Physical Science: Understands motion and the principles that explain it.
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Support Materials

Develop custom worksheets, educational puzzles, online quizzes, and more with the free teaching tools offered on the [Discoveryschool.com](http://www.discoveryschool.com) Web site. Create and print support materials, or save them to a Custom Classroom account for future use. To learn more, visit

- <http://school.discovery.com/teachingtools/teachingtools.html>

