CLASSROOM ACTIVITY

Gravity: Making Waves

Gravity may seem elementary. But proving Einstein's theories about it is quite hard. To do so, scientists are struggling to capture gravity's most elusive hallmark: the gravitational wave. This Astro Feature focuses on research at the Laser Interferometer Gravitational-Wave Observatory (LIGO) in Livingston, LA, where scientists have constructed a sprawling facility dedicated to the detection of minute changes in spacetime caused by gravitational waves traveling from energetic events in space.

CLASS DISCUSSION

Establish Prior Knowledge

Discuss gravity with your students. What did Newton discover about gravity? What was Einstein's theory about gravity? You may want to refer them to the essay: Newton vs. Einstein vs. the Next Wave (http://www.amnh.org/sciencebulletins/content/a.f.gravity.20041101/essays/44.html) for a discussion of the two scientists' theories about gravity. (See page 2 for a description of What is a Theory?") Tell them that the video they are about to see shows scientists testing Einstein's theory of gravitational waves.

Exploration

Have students watch the video. Use the following questions to guide a class discussion.

- What are gravitational waves?
- What have scientists theorized so far about gravitational waves?
- Why is learning about gravitational waves important?
- How do scientists hope to measure gravitational waves?
- How is the study of gravitational waves helping scientists to understand the forces that shape our universe?

Wrap-Up

Use the following questions to wrap-up your discussion:

- What had Newton theorized about, but was unable to prove or provide data for?
- How did Einstein refine and further explain theories that Newton could only hypothesize about?
- How does this demonstrate the dynamic nature of scientific understanding?

The Scientific Method

Research scientists use the Scientific Method (see page three) to investigate the natural world. You can use *Gravity: Making Waves* to illustrate how scientists conduct experiments to test Einstein's theory about gravitational waves. These experiments will let them observe and measure a phenomena previously invisible to science.

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CLASSROOM ACTIVITY

Gravity: Making Waves (continued)

Extend
Students who wish to learn more can visit these related links from NASA:

NASA Puts Einstein to the Test
http://www.nasa.gov/missions/science/gpb_tests.html
LIGO isn't the only project searching for answers about gravity. See how scientists are using the satellite, Gravity Probe B, to learn about the gravity waves around our planet.

Amazing GRACE
http://www.nasa.gov/missions/solarsystem/f_grace.html
How does gravity affect our atmosphere? NASA's Gravity Recovery and Climate Experiment (GRACE) project is seeking to collect information abouton the impact of Earth's gravity about our climate systems.

Laser Interferometer Space Antenna: Education
http://lisa.jpl.nasa.gov/education.html
Explore the topic of gravity with your students through articles, games, and a science bowl quiz.

Ask a High-Energy Astronomer: Relativity
http://imagine.gsfc.nasa.gov/docs/ask_astro/relativity.html
This page features answers to commonly asked questions about space-time, gravity, and relativity.

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Scientific Process

The Scientific Method is a dynamic and open-ended process that scientists use when they investigate a question they have. It is not a series of prescribed steps that scientists follow to prove a hypothesis. Rather, it's a general plan that helps guide their investigation. And while all scientists use the Scientific Method, they might not use all the steps, or they may complete the steps in a different order. For example, a scientist might make observations and collect data about a subject that interests him or her for years before formulating a hypothesis.

DEFINING A QUESTION TO INVESTIGATE

As scientists conduct their research, they make observations and collect data. The observations and data often lead them to ask why something is the way it is. Scientists pursue answers to these questions in order to continue with their research. Once scientists have a good question to investigate, they begin to think of ways to answer it.

FORMING A HYPOTHESIS

A hypothesis is a possible answer to a question. It is based on: observations scientists make, existing theories, and information they gather from other sources. Once they have a hypothesis, scientists can begin to think about how to test it.

TESTING A HYPOTHESIS

Evidence is needed to support or disprove the hypothesis. There are several strategies for collecting evidence. Scientists can gather their data by observing the natural world, performing an experiment in a laboratory, or by running a model. Scientists decide what strategy to use, often combining strategies. Then they plan a procedure and gather their data. They make sure the procedure can be repeated, so that other scientists can evaluate their findings.

ANALYZING THE DATA

Scientists organize their data in tables, graphs, diagrams, and even photographs. If possible, they check the data by comparing it to data from other sources. They are looking for patterns that show connections between important variables in the hypothesis they are testing.

DRAWING CONCLUSIONS

Scientists must decide whether the data clearly support or do not support the hypothesis. If the results are not clear, they must rethink their procedure. If the results are clear, scientists write up their findings and results to share with others. The conclusions they draw usually present new questions for them to pursue.

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