Weekly Concept Breakthroughs

Essential Question

How does technology lead to discoveries?

Go Digital!

NASA, ESA, S. Beckwith (STScI), and The Hubble Heritage Team (STScI/AURA)

BREAKTHROUGH DISCOVERIES

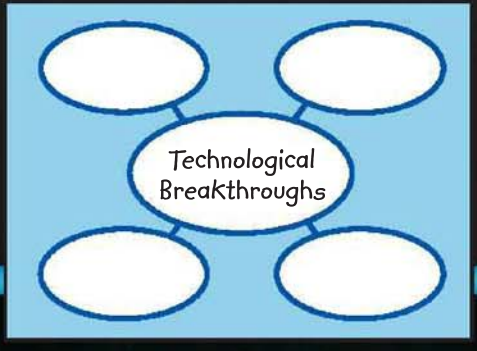
This stunning photograph of the Whirlpool Galaxy was taken by the Advanced Camera for Surveys aboard NASA's Hubble Space Telescope.

- By studying such images, astronomers have confirmed that the galaxy's curving spiral arms are long trails of stars and gas laced with dust. They have also discovered that stars in the blue regions form as hydrogen gas is compressed in the pink regions.

Deciphering the structure of a galaxy 23 million light-years away has truly been a breakthrough.

Talk About It

Write words you have learned about the ways technology leads to breakthroughs. Then talk with a partner about why learning about the Whirlpool Galaxy is significant.



Vocabulary

Use the picture and the sentences to talk with a partner about each word.

colleagues

Janell works with many **colleagues** at her company.

How are the meanings of the words colleagues and coworkers related?

conservatively

Estimating **conservatively**, this roast will serve eight people, but possibly more.

What is an antonym of conservatively?

deduction

The doctor's **deduction** is that her symptoms are just a cold.

What is a synonym for deduction?

drones

On some summer days, the sound of lawnmowers **drones** for hours.

Name something else you know that drones.

galaxy

The Milky Way **galaxy** is a system containing billions of stars.

Where is a galaxy located?

sustain

Healthy snacks will **sustain** us if we get hungry on our hike.

What else do people need to sustain themselves?

ultimately

After working hard all semester, Magda **ultimately** passed the final exam.

Describe a goal that you ultimately reached after trying for a while.

verify

There are many reasons why documents might be checked to **verify** your identity.

Who might need to verify a person's identity?

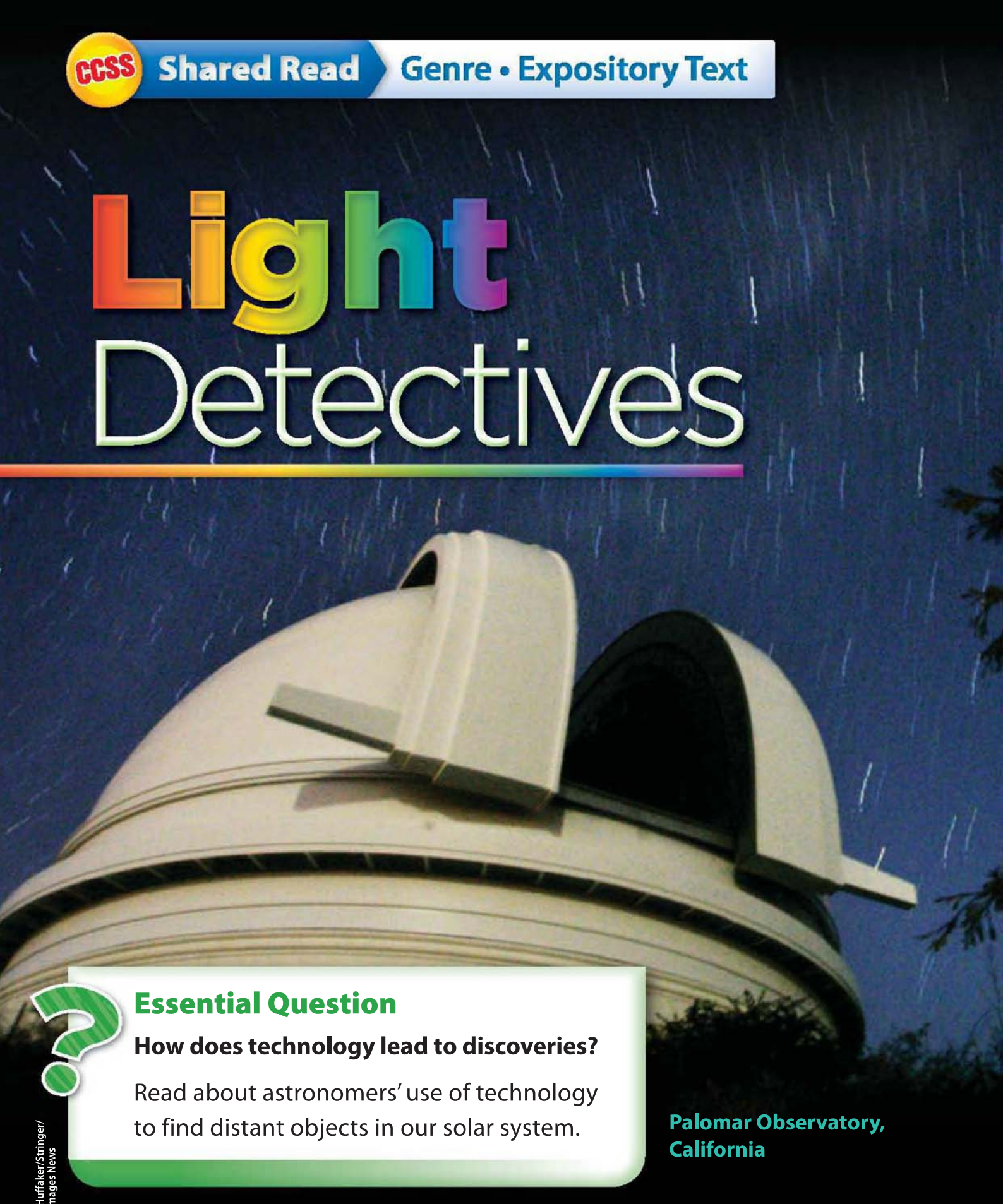
Your Turn

Pick three words. Write three questions for your partner to answer.

Go Digital! *Use the online visual glossary*

CCSS Shared Read | Genre • Expository Text

Light Detectives



Essential Question

How does technology lead to discoveries?

Read about astronomers' use of technology to find distant objects in our solar system.

Palomar Observatory, California

Sandy Huffaker/Stringer/Getty Images News

Astronomers use a number of technologies to analyze the light that we see reflected off the most distant objects in our solar system. These scientists often serve as "light detectives" who collect celestial clues using a variety of precision tools.

Discovering Pluto

In the 1920s, astronomers noticed something strange. The outer planets seemed to be affected by an unexplained force. Was there another planet out there with gravitational pull strong enough to tug on Uranus and Neptune? To find this object, a young scientist named Clyde Tombaugh perfected an innovative method for searching the sky.

Using a new telescope at the Lowell Observatory in Arizona, Tombaugh took wide-angle photographs of slivers of the night sky. He then viewed these images in a machine called a blink comparator. This tool was a type of microscope that superimposed two images of the exact same area taken at different times, placing one on top of the other. It blinked so rapidly back and forth between the two images that Tombaugh could see whether any objects changed position from the first time period to the next. As the months passed, Tombaugh estimated he had scanned more than a million stars. His painstaking research finally paid off in February of 1930 when he discovered Pluto and its orbital movement.

Scanning the Kuiper Belt

After Tombaugh's discovery, astronomers became more interested in the outer reaches of our solar system. In 1992, they identified a disk-like region extending up to 9.3 billion miles from the sun and named it the Kuiper Belt, after Gerard Kuiper who had theorized the existence of such a region. Estimates suggested that there were about 70,000 large, icy objects in the Kuiper Belt. Were some even larger than Pluto?

To answer this question, astronomer Michael Brown and his colleagues followed a procedure similar to the method designed by Tombaugh. But they took advantage of new technology to make their search easier and more effective. Like Tombaugh, Brown's team takes repeated images using a telescope. Every three hours, a digital camera mounted on the Samuel Oschin Telescope at the Palomar Observatory in California snaps a picture of the night sky. A microwave link allows robots to control both the telescope and its camera. These robots follow a pre-programmed routine that moves the telescope and takes pictures. This automated system drones through the night while the astronomers sleep.

Oschin Telescope, Palomar Observatory

Instead of using a blink comparator, Brown's team sends the images to a bank of ten computers at the California Institute of Technology (CIT). The computers superimpose images taken at different times and identify objects that are possibly moving. Then the team analyzes the data to try to verify the movement. Most of the time, the objects identified are not breathtaking discoveries. They are simply the result of flaws in the telescope's camera. But sometimes, the computers do track down moving objects. Airplanes, satellites, and asteroids have been flagged by the system. And in 2003, the team discovered a bright shape that was moving more slowly than anything documented in our solar system. Could this be the object tugging on Uranus and Neptune?

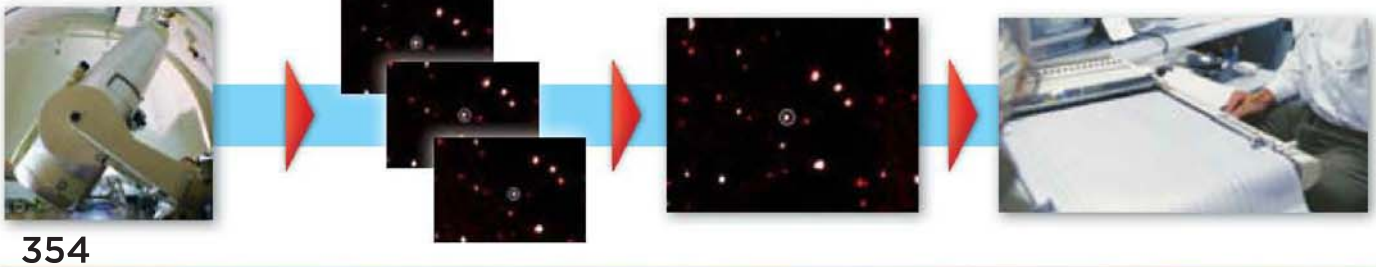
(bkgd) Kim Westerskov/Photographer's Choice/Getty Images; (t) Sandy Huffaker/Stringer/Getty Images News; (b, l to r) Samuel Oschin Telescope/Palomar Observatory/Handout/Reuters/Corbis; Caltech/Handout/Getty Images News/Getty Images; Keith Brofsky/Photodisc/Getty Images

1 A 161-megapixel camera mounted on the telescope.

2 Multiple images of the night sky.

3 CIT computers superimpose images.

4 Astronomers Mike Brown, Chad Trujillo, and David Rabinowitz analyze data.



Combining New Data with Old

The super-slow speed of this object, which was eventually named Eris, posed a problem. Brown calculated that Eris takes 560 years to orbit the sun. So it would take many years to collect enough data confirming the deduction that Eris affects planetary orbits. Rather than waiting, Brown decided to check photos taken by other astronomers. Luckily, Eris appeared in photographs taken as early as 1950. By combining these images with contemporary data, the team developed a more complete view of Eris's size and movements.

Relative sizes of Earth, the Moon, Pluto, and Eris

The team originally estimated that Eris was 25 to 40 percent more massive than Pluto. But when they used pictures taken by the Hubble Space Telescope to confirm this hypothesis, they found out they were wrong. Eris is only slightly larger than Pluto. The overestimate was the result of Eris's extremely reflective surface. The bright, reflected light gives the impression that Eris is more substantial than it really is. Brown suggests that an atmosphere of frozen nitrogen causes Eris's high level of reflection.

As a result of Brown's discovery, astronomers reconsidered the definition of a planet. Ultimately, both Pluto and Eris were classified as "dwarf planets," rather than planets. But discoveries in the Kuiper Belt continue to sustain great interest. Conservatively, astronomers predict that new technology will allow them to identify several more dwarf planets in the Kuiper Belt. The information gained from their investigations will enrich our understanding of distant objects in other parts of the galaxy as well.

NASA

Make Connections

Talk about the technology that astronomers have used to investigate distant objects in our solar system. **ESSENTIAL QUESTION**

Describe a time when using a tool (a ruler, calculator, camera, etc.) to test a hypothesis helped you answer a question. **TEXT TO SELF**