THE STAR WITNESS

Supplemental Educational Support Materials

for Special Feature: "The James Webb Space Telescope: A Vision for the Future"

Discussion questions

Q1:
Why are telescopes placed in space?

Answer:

Student answers will vary. Some students might say that space telescopes can see objects more clearly because they are above the blurring effect of Earth's atmosphere. Other students might say that space-based infrared telescopes are important because space is the best place to do infrared astronomy. Earth's atmosphere glows brightly in infrared light, making it difficult to accurately measure light from faint celestial infrared objects.

Q2:
Why are infrared telescopes placed in space?

Answer:

Student answers should include the following ideas:

Although there are many infrared telescopes on Earth, the best place to do infrared astronomy is in space. Earth's atmosphere glows brightly in infrared light, making it difficult to accurately measure light from faint celestial infrared objects. So an infrared telescope needs to be as far away from Earth as possible and shielded from Earth's glow. The James Webb Space Telescope will be placed at the L2 point and will have a tennis court-sized sunshield to protect it from the infrared glow of the Sun and Earth.

Also, in contrast to visible light, which is blurred by Earth's atmosphere, infrared light is absorbed by many of the components of Earth's atmosphere, so it never reaches the ground. Water vapor, in particular, absorbs many wavelengths of infrared light. An astronomer, for example, would have a hard time using a ground-based infrared telescope to search for water vapor (an indication of habitability) in the atmosphere of an extrasolar planet. Most of the infrared light from that planet would not reach the telescope because the water vapor in Earth's atmosphere would absorb it.

Q3:
Why do astronomers need infrared telescopes?

Answer:

Student answers should include the following ideas:

- An infrared telescope can allow astronomers to look back at the very early universe, when the first galaxies formed. Those galaxies can only be seen in infrared light.
- Infrared light also can be used to look through dust to discover objects that cannot be seen in visible light. For example, infrared light allows astronomers to peer into clouds surrounding new stars to find emerging planets.
- An infrared telescope also may allow astronomers to look at the atmosphere of planets to detect the gases (carbon dioxide, methane, and water vapor) that signal the possibility of life.

Q4:
If you could use the James Webb Space Telescope to observe anything in the universe, what would you like to observe and/or discover? Explain why.

Answer:

Student answers will vary, but students may want to use Webb to look for the first galaxies, to study star birth and planet formation, or to look for other planets that might harbor life. There are also many discoveries to make in the area of stellar evolution, such as detecting "failed stars" (called brown dwarfs) and understanding star-forming regions in other galaxies. Students might also decide to use the telescope to look at any number of other objects not described in the reading.

Vocabulary words

Astronomer

A scientist who studies the universe and the celestial bodies residing in it, including their composition, history, location, and motion. Many of the scientists at the Space Telescope Science Institute are astronomers. Astronomers from all over the world use the Hubble Space Telescope.

Atmosphere

The layer of gases surrounding the surface of a planet, moon, or star.

Big Bang

A broadly accepted theory for the origin and evolution of our universe. The theory says that the observable universe started roughly 13.8 billion years ago from an extremely dense and incredibly hot initial state.

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Galaxy
A collection of stars, gas, and dust bound together by gravity. The smallest galaxies may contain only a few hundred thousand stars, while the largest galaxies have thousands of billions of stars. The Milky Way galaxy contains our solar system. Galaxies are classified or grouped by their shape. Round or oval galaxies are elliptical galaxies and those showing a pinwheel structure are spiral galaxies. All others are called irregular because they do not resemble elliptical or spiral galaxies.

Hubble Space Telescope (HST)
An orbiting telescope that collects light from celestial objects in visible, near-ultraviolet, and near-infrared wavelengths. The telescope's primary mirror is 2.4 meters (8 feet) wide. It orbits the Earth about every 96 minutes and is powered by sunlight collected with its two solar arrays.

Infrared (IR) Light
The part of the electromagnetic spectrum that has slightly lower energy than visible light but is not visible to the human eye. Just as there are low-pitched sounds that cannot be heard, there is low-energy light that cannot be seen. Infrared light can be detected as the heat from a fire or a light bulb.

James Webb Space Telescope (JWST)
An orbiting telescope that will collect infrared light from celestial objects. JWST is the scientific successor to the Hubble Space Telescope. Unlike Hubble, JWST will be placed approximately 930,000 miles (1,500,000 kilometers) from Earth and cannot be serviced by astronauts.

Near-Infrared
The region of the infrared spectrum that is closest to visible light. Near-infrared light has slightly longer wavelengths and slightly lower frequencies and energies than visible light.

Observatory
A structure designed and equipped for making astronomical observations. Observatories are located on Earth and in space.

Orbit
The act of traveling around a celestial body, or the path followed by an object moving around a celestial body. For example, the planets travel around, or orbit, the Sun because the Sun's gravity keeps them in their paths, or orbits.

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Primary Mirror

A large mirror in a reflecting telescope that captures light from celestial objects and focuses it toward a smaller, secondary mirror. The primary mirror in the Hubble Space Telescope measures 94.5 inches (2.4 meters) in diameter. In contrast, the James Webb Space Telescope has a primary mirror measuring 21.6 feet (6.5 meters) at its widest point.

Spitzer Space Telescope

A space-based, cryogenically-cooled observatory that collects infrared light from celestial objects. The telescope was launched in 2003 as the last of NASA's Great Observatories Program. Prior to running out of liquid helium, its cryogenic material, in May 2009, the telescope operated at a few degrees above absolute zero. In the current warm mode of operations, Spitzer can continue to operate until late in this decade, providing a science mission of 10-15 years.

Sunshield

A device on a telescope that radiates away heat and light coming from the Sun, Moon, or Earth. It is almost like an umbrella protecting the telescope from heat. The James Webb Space Telescope will have a sunshield the size of a tennis court.

Visible Light

The part of the electromagnetic spectrum that human eyes can detect; also known as the visible spectrum. The colors of the rainbow make up visible light. Blue light has more energy than red light.

Education Standards

Common Core Standards for English Language Arts

http://www.corestandards.org/ELA-Literacy/CCRA/R/

College and Career Readiness Anchor Standard for Reading

CCSS.ELA-Literacy.CCRA.R.10

Read and comprehend complex literary and informational texts independently and proficiently.

SEE MORE Hubble images and read more Star Witness news stories at **Amazing Space**, NASA's award-winning educational website for K–12 students and teachers.

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