James Webb Space Telescope confirms its first exoplanet

January 11 2023

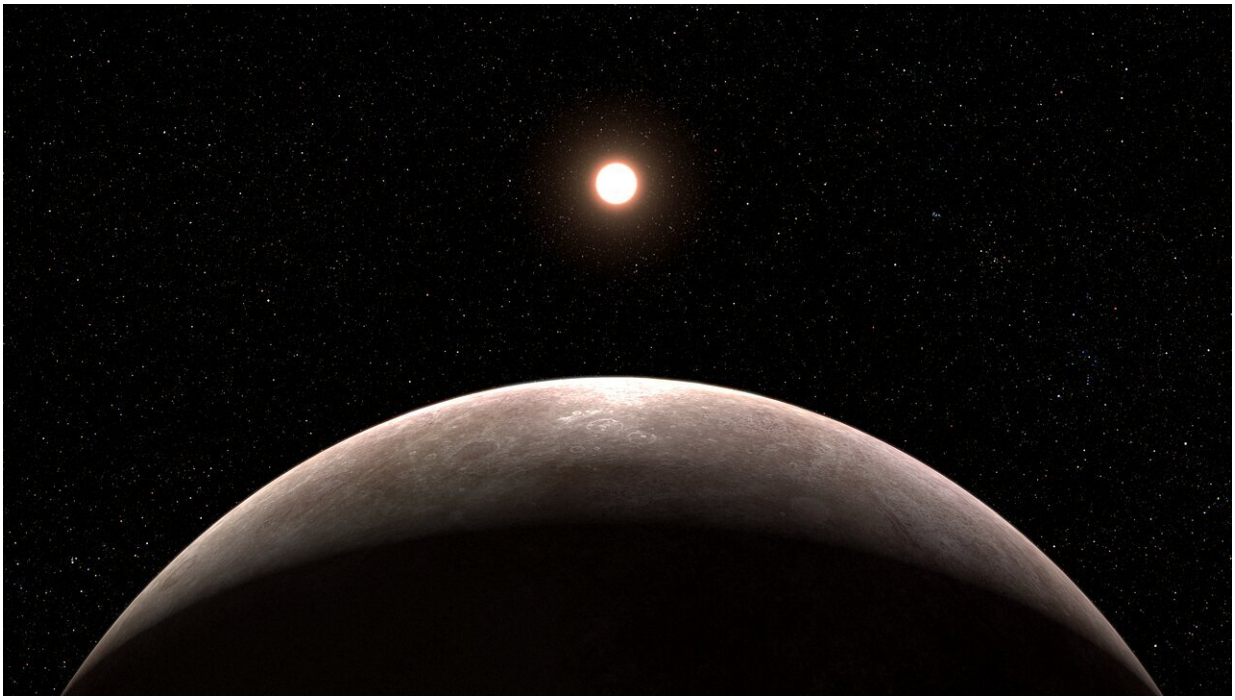


Illustration of a planet and its star on a black background. The planet is large, in the foreground at the center, and the star is smaller, in the background and also at the center. The planet is rocky. The top quarter of the planet (the side facing the star) is lit, while the rest is in shadow. The star is bright yellowish-white, with no clear features. Credit: NASA, ESA, CSA, L. Hustak (STScI)

Researchers have confirmed the presence of an exoplanet, a planet that orbits another star, using the NASA/ESA/CSA James Webb Space

Telescope for the first time. Formally classified as LHS 475 b, the planet is almost exactly the same size as our own, clocking in at 99% of Earth's diameter.

The research team is led by Kevin Stevenson and Jacob Lustig-Yaeger, both of the Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland. The team chose to observe this target with Webb after carefully reviewing data from NASA's Transiting Exoplanet Survey Satellite (TESS) which hinted at the planet's existence.

Webb's Near-Infrared Spectrograph (NIRSpec) captured the planet easily and clearly with only two transit observations. "There is no question that the planet is there. Webb's pristine data validate it," said Lustig-Yaeger. "The fact that it is also a small, rocky planet is impressive for the observatory," Stevenson added.

"These first observational results from an Earth-sized, rocky planet open the door to many future possibilities for studying rocky planet atmospheres with Webb," agreed Mark Clampin, Astrophysics Division director at NASA Headquarters in Washington. "Webb is bringing us closer and closer to a new understanding of Earth-like worlds outside the solar system, and the mission is only just getting started."

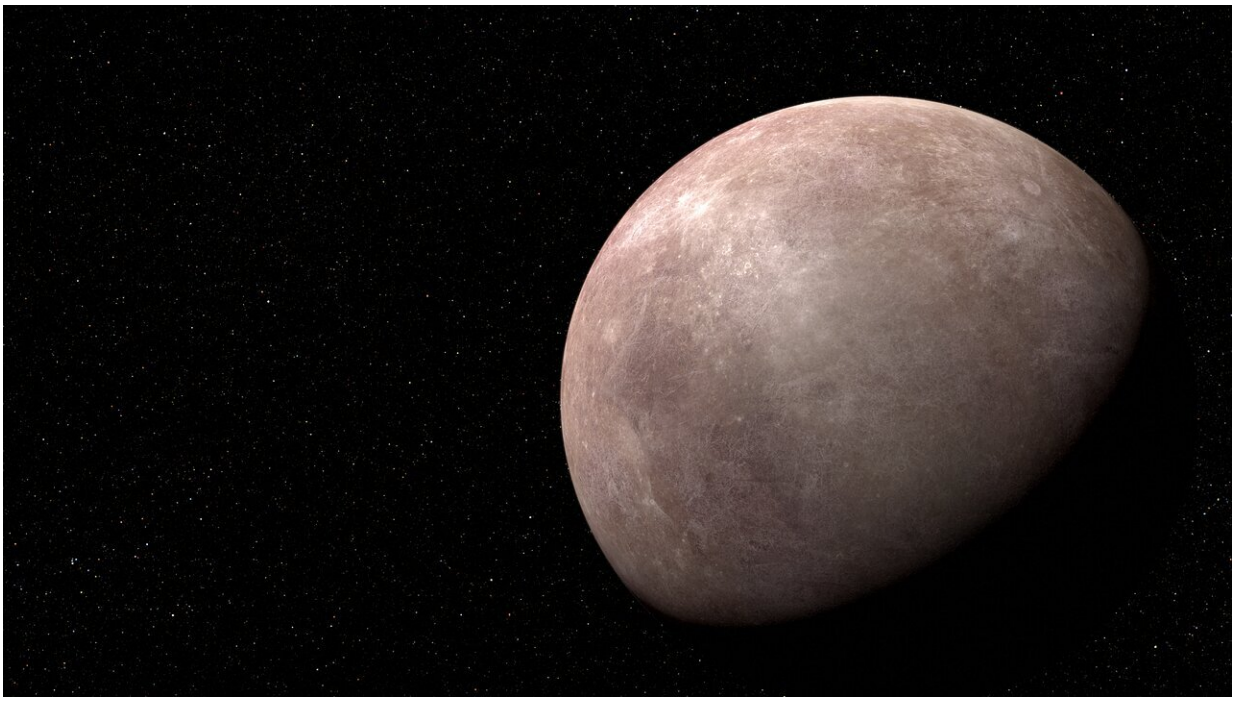


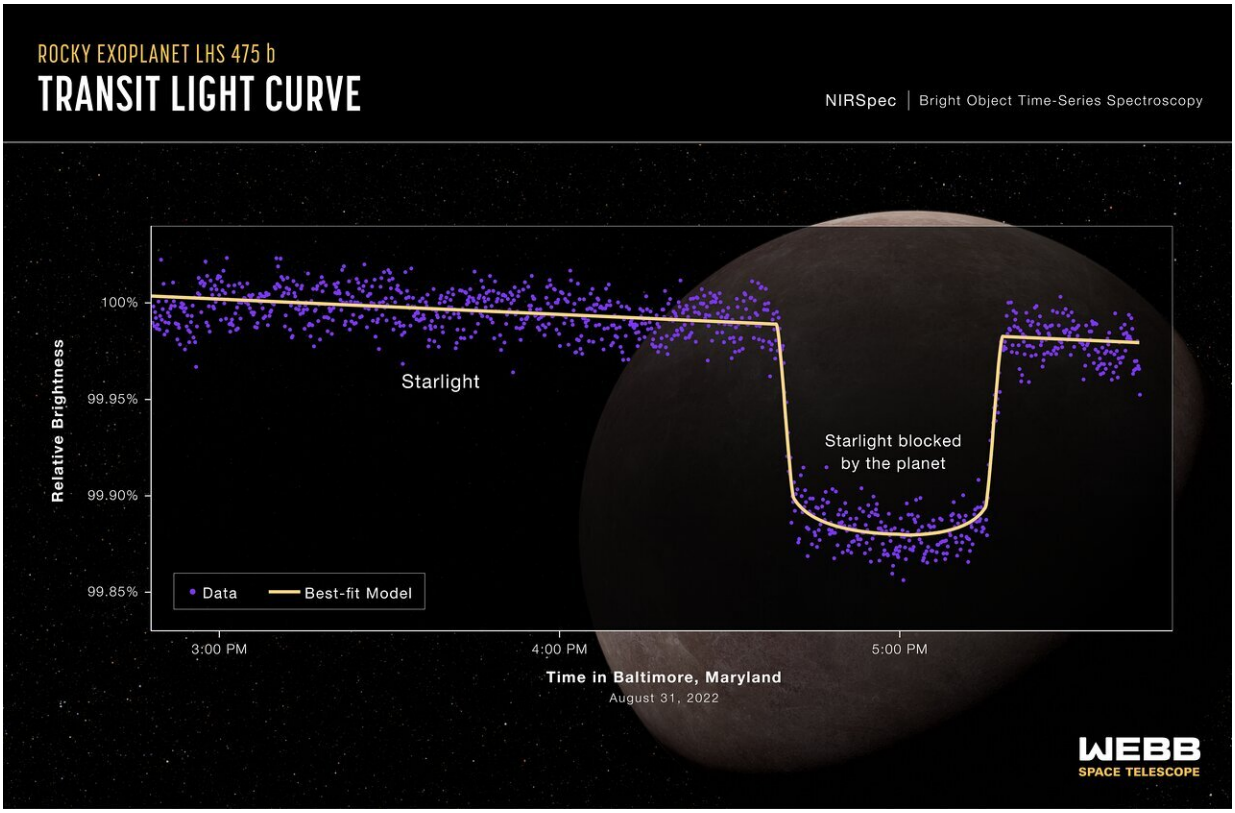
Illustration of a planet on a black background. The planet is large and rocky. Roughly two-thirds of the planet is lit, while the rest is in shadow. Credit: NASA, ESA, CSA, L. Hustak (STScI)

Among all operating telescopes, only Webb is capable of characterizing the atmospheres of Earth-sized exoplanets. The team attempted to assess what is in the planet's atmosphere by analyzing its transmission spectrum. Although the data show that this is an Earth-sized terrestrial planet, they do not yet know if it has an atmosphere.

"The observatory's data are beautiful," said Erin May, also of the Johns Hopkins University Applied Physics Laboratory. "The telescope is so sensitive that it can easily detect a range of molecules, but we can't yet draw any definitive conclusions about the planet's atmosphere."

Although the team can't conclude what is present, they can definitely say

what is not present. "There are some terrestrial-type atmospheres that we can rule out," explained Lustig-Yaeger. "It can't have a thick methane-dominated atmosphere, similar to that of Saturn's moon Titan."

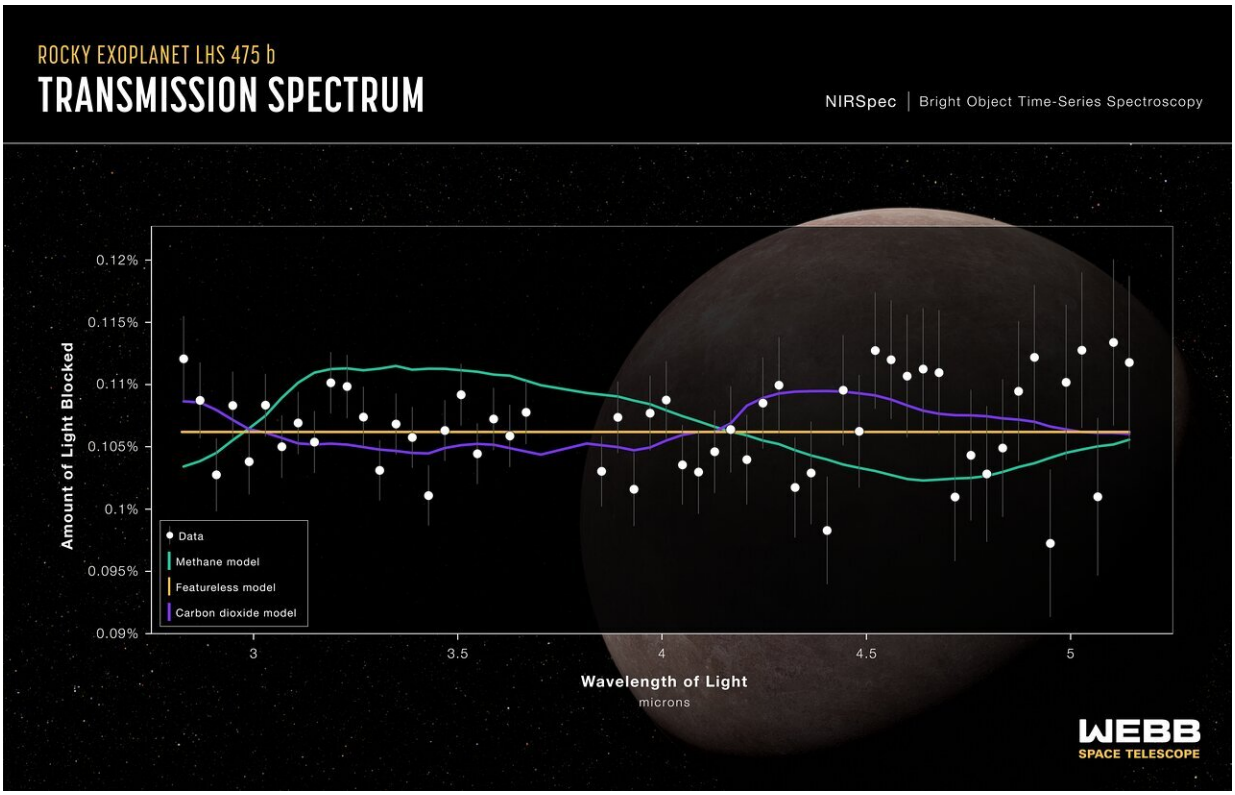


The graphic shows the change in relative brightness of the star-planet system spanning three hours. The spectrum shows that the brightness of the system remains steady until the planet begins to transit the star. It then decreases, representing when the planet is directly in front of the star. The brightness increases again when the planet is no longer blocking the star, at which point it levels out. Credit: NASA, ESA, CSA, L. Hustak (STScI), K. Stevenson, J. Lustig-Yaeger, E. May (Johns Hopkins University Applied Physics Laboratory), G. Fu (Johns Hopkins University), and S. Moran (University of Arizona)

The team also notes that while it's possible the planet has no atmosphere, there are some atmospheric compositions that have not been ruled out, such as a pure carbon dioxide atmosphere. "Counterintuitively, a 100% carbon dioxide atmosphere is so much more compact that it becomes very challenging to detect," said Lustig-Yaeger. Even more precise measurements are required for the team to distinguish a pure carbon dioxide atmosphere from no atmosphere at all. The researchers are scheduled to obtain additional spectra with further observations this summer.

Webb also revealed that the planet is a few hundred degrees warmer than Earth, so if clouds are detected it may lead the researchers to conclude that the planet is more like Venus, which has a carbon dioxide atmosphere and is perpetually shrouded in thick cloud. "We're at the forefront of studying small, rocky exoplanets," Lustig-Yaeger said. "We have barely begun scratching the surface of what their atmospheres might be like."

The researchers also confirmed that the planet completes an orbit in just two days, information that was almost instantaneously revealed by Webb's precise light curve. Although LHS 475 b is closer to its star than any planet in the solar system, its red dwarf star is less than half the temperature of the sun, so the researchers project it still could support an atmosphere.



The graphic shows the transmission spectrum of the rocky exoplanet LHS 475 b. The data points are plotted as white circles with gray error bars on a graph of the amount of light blocked in percent on the vertical axis versus wavelength of light in microns on the horizontal axis. A straight green line represents a best-fit model. A curvy red line represents a methane model, and a slightly less curvy purple line represents a carbon dioxide model. Credit: NASA, ESA, CSA, L. Hustak (STScI), K. Stevenson, J. Lustig-Yaeger, E. May (Johns Hopkins University Applied Physics Laboratory), G. Fu (Johns Hopkins University), and S. Moran (University of Arizona)

The researchers' findings have opened up the possibility of pinpointing Earth-sized planets orbiting smaller red dwarf stars. "This rocky planet confirmation highlights the precision of the mission's instruments," Stevenson said. "And it is only the first of many discoveries that it will make." Lustig-Yaeger agreed: "With this telescope, rocky exoplanets are

the new frontier."

LHS 475 b is relatively close, at only 41 light-years away, in the constellation Octans.

The team's results were presented at a press conference of the American Astronomical Society (AAS) on Wednesday January 11, 2023.

Provided by European Space Agency