ASTRONOMY

Venus's Rare Sun Crossing May Aid Search for Exoplanets

It's the last call. Early next month, skywatchers will get their second—and final—chance this century to observe a rare mini-eclipse in which Venus crosses in front of the sun. As seen from Earth on 5–6 June, the silhouette of Venus, as big as a large sunspot, will adorn the sun's orange disk with a fleeting beauty mark. Venus's passages, or transits, occur in pairs spaced 8 years apart every 105 or 122 years. The next transit isn't until 2117.

In past centuries, astronomers and explorers including Captain James Cook observed transits to measure the scale of the solar system. Next month, several scientists plan to study the phenomenon as a benchmark to refine models of exoplanets that pass in front of suns light-years beyond our own.

On the brink. In images of the 2004 transit recorded by a ground-based telescope in South Africa, Venus crawls toward the edge of the solar disk—the most fruitful place for scientific observations.

At the time of Venus's last passage, in 2004, astronomers had detected the transits of only two exoplanets, both the size of Jupiter, by measuring the tiny drop in starlight as the giant orbs crossed in front of their parent stars. Now, thanks largely to NASA's dedicated Kepler spacecraft, they have spotted more than 1000 transiting exoplanets. Kepler researchers say they are on the verge of finding exoplanets the size of Earth or Venus orbiting their stars at comparable distances.

But how can astronomers tell a potentially habitable, water-rich exo-Earth from a hazy and hot exo-Venus? Haze may itself provide a way to distinguish the two types of planets, and clues may come from studying the Venus transit at several different wavelengths, or colors, says Thomas Widemann of the Observatory of Paris in Meudon, France. In 2004, scientists observed the transit in white light, he says. This time, Widemann and colleagues will have nine portable 10-centimeter telescopes at sites including Japan, China, Australia, and Hawaii—some of the best places to view the entire transit (http://venustex.oca.eu). Each telescope will observe the transit through a variety of color filters.

The team will focus on the aureole, a thin arc or halo of light that surrounds the black disk of Venus for about 25 minutes just before and again after the planet crosses the face of the sun, a trip that takes about 6.5 hours. The ring is caused by sunlight refracted through the planet's dense upper atmosphere, and the intensity of the ring depends on the density and composition of Venus's atmosphere, including the presence of a haze layer. "Being able to detect the signature of a haze layer like the one on Venus would tell a lot" about the atmosphere of an exoplanet and shed light on whether the orb has the right stuff for life, Widemann says. Because light absorption by clouds or hazes can hide the presence of biomarkers such as ozone and water vapor, it's critical to know whether an exoplanet has a significant haze layer, he adds.

"We consider that 2004 was essentially a test, as nobody alive had seen a Venus transit before," says Paolo Tanga of the Lagrange Laboratory of the Observatory of the Côte d'Azur in Nice, France. "In 2012, we are ready for a more detailed characterization, thanks to better models and to the observations previously done in 2004."

One newcomer to transit studies, the Hubble Space Telescope, will attempt to emulate what the Venus transit would look like if it were taking place in a distant solar system. Hubble's optics are too sensitive to stare directly at the sun; instead, it will observe how the transit appears in sunlight reflected off Earth's moon. Because different components of Venus's atmosphere absorb different amounts of light at particular wavelengths, the slight drop in sunlight as Venus travels across the solar disk should vary across the spectrum, says Jean-Michel Désert of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts, a member of the Hubble project. If it works, the technique—called transmission spectroscopy—could help future missions identify the atmospheric constituents of transiting exoplanets.

"Because we know the atmosphere of Venus, we know what we will have to find with our technique," Désert says. "If our technique fails to retrieve the atmospheric composition of Venus, then we will have to reconsider the [validity of the] method."

Other scientists will use the transit to explore an enduring puzzle about Venus's atmosphere: its superfast rotation. The upper atmosphere rotates around the planet in just 4 days, compared to the 243 days it takes for the planet to spin on its axis.

During the transit, ground-based telescopes trained on the aureole will team up with the European Space Agency's Venus Express spacecraft, launched a year after the 2004 transit, to determine whether temperature fluctuations in the atmosphere vary with time or latitude. That information may offer clues about how solar heating and some kind of atmospheric instability may drive the fast rotation, Widemann says. Another recently launched craft, NASA's Solar Dynamics Observatory, will record the sharpest images of the transit to measure the sun's diameter to unprecedented accuracy.

Even after Venus makes its final passage across the sun this century as observed from Earth, astronomer Glenn Schneider of the University of Arizona, Tucson, hopes to take more data. As seen from Jupiter, Venus will pass in front of the sun on 20 September. Schneider has requested that Hubble attempt to observe that transit by recording the reflected sunlight from the giant planet. Schneider won't know until 15 June if his proposal will get the green light.

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