It's Real!

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By observing the transit of a planet across the face of a distant star, astronomers prove that planets exist outside our solar system.

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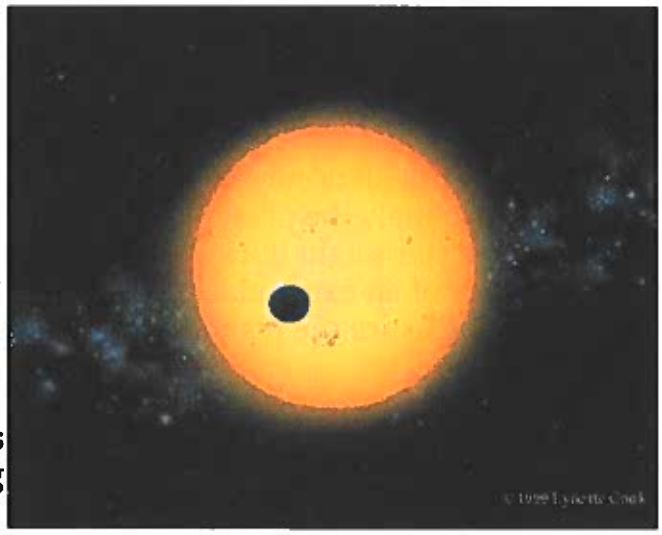


November 14, 1999: Last Friday, a team led by Greg Henry (Tenn. State) and Geoff Marcy (UC Berkeley) announced the discovery of a shadow of a planet crossing a distant star. Little known HD 209458, a Sun-like star 150 light-years away, had been suspected of harboring planets from a slight wobble found in its motion. Henry et al. now find that this wobble exactly corresponds to a planet crossing the face of the star, creating the slight dimming effect of a partial eclipse. The astronomers were then able to make a ground breaking estimate of the mass and radius of the extra-solar planet, which they find to have about two-thirds the mass of Jupiter but about 60 percent larger radius.

Above: Artist Lynette Cook's depiction of a planetary eclipse in the HD 209458 system. Copyright 1999, Lynette Cook, all rights reserved. [more information; see also NASA/Goddard's Astronomy Picture of the Day]

"This is the first independent confirmation of a planet discovered through changes in a star's radial velocity and demonstrates that our indirect evidence for planets really is due to planets," said Geoffrey Marcy, a professor of astronomy at the University of California, Berkeley.

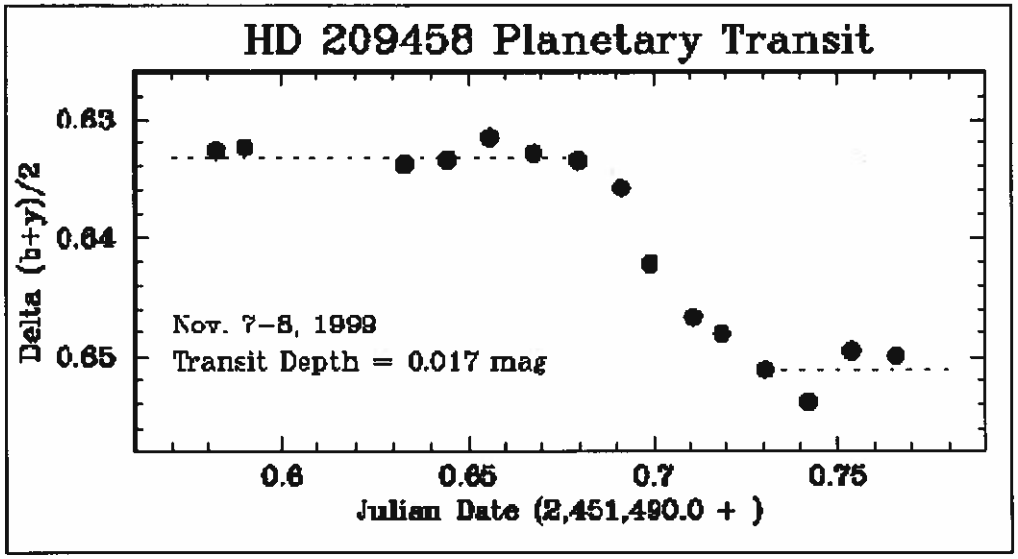
Marcy and his colleagues, Paul Butler of the Department of Terrestrial Magnetism at the Carnegie Institution of Washington in Washington, D.C., and Steve Vogt of UC Santa Cruz and Lick Observatory, first detected a wobble in the star called HD 209458 on Nov. 5. Ascribing the wobble to a nearby planet, they were able to estimate its orbit and approximate mass.

As with all new planets they detect, the team immediately brought it to the attention of collaborator Greg Henry, an astronomer at the Tennessee State University Center of Excellence in Information Systems in Nashville. He conducts research with several automatic telescopes at Fairborn Observatory, a non-profit research foundation located in the Patagonia Mountains of southern Arizona.

Henry turned one of his automatic telescopes on the star at the time Marcy and Butler predicted the planet would cross the face of the star if the planet's orbital plane were lucky enough to carry it between Earth and the star. Until now, none of the 18 other extrasolar planets Marcy and Butler have discovered has had its orbital plane oriented edge-on to Earth so that the planet could be seen to transit the star, nor have any of the other planets discovered by other researchers.

However, on Nov. 7, Henry observed a 1.7 percent dip in the star's brightness. Because the planet orbits its star once every 3.523 days, he plans to repeat his observations on Sunday, Nov. 14.

"This planetary transit occurred at exactly the time predicted from Marcy's observations, confirming absolutely the presence of a companion," Henry said. "The amount of dimming of the star's light during the transit also gives us the first-ever measure of the size and density of an extrasolar planet. We've essentially seen the shadow of the planet and used it to measure the planet's size."



Above: Greg Henry's photometry data showing ingress of the planet orbiting HD 209458 onto the stellar disk. Quoting from IAU Circular #7307 (11-12-99):

"G.W.Henry, Tennessee State University, G.Marcy, U.C. Berkeley, R.P.Butler, Dept. of Terrestrial Magnetism, and S.S.Vogt, UCO Lick Observatory report that HD 209458 (G0V) exhibits sinusoidal velocity variations with semi-amplitude of 81 m/s, indicating presence of a companion with Msini = 0.63 Jupiter masses and an orbital period of 3.523 d.

Photometry reveals a transit ingress at JD 2451490.70 with depth of 0.017 mag, consistent with the transit time predicted from the velocities. Further measurements of transits and velocities would be valuable. The next three predicted times of ingress occur at UT times: 15 Nov 6:19, 18 Nov 18:53, 22 Nov 7:28, all times uncertain by 1 hour.

If correct, the inferred mass is 0.63 Mjup and radius is 1.6 Rjup, implying a density of 0.21 g/cc."

The star HD 209458 is 47 parsecs (153 light years or 1.4 million billion kilometers or 895,000 billion miles) away in the constellation of Pegasus, and is about the same age, color and size as our own Sun. It is very near the star, 51 Pegasi, around which the first extrasolar planet was discovered in 1995.

With the orbital plane of the planet known, the astronomers for the first time could determine precisely the mass of the planet and, from the size of the planet measured during transit, its density.

Interestingly, while the planet's mass is only 63 percent of Jupiter's mass, its radius is 60 percent bigger than that of Jupiter. This fits with theories that predict a bloated planet when, as here, the planet is very close to the star.

The density, about 0.2 grams per cubic centimeter, means it is a gas giant like Jupiter. However, such gas giants could not have formed at the distance this planet is from its star.

"This supports the theory that extrasolar planets very near their star did not form where they are, but formed farther out and migrated inward," Henry said.

Various groups around the world have been searching for planets by looking for dimming of stars, or as Marcy says, "staring at the sky and seeing if any star blinks." To date, none of these searches has turned up a new planet.

"With this one, everything hangs together," Marcy said. "This is what we've been waiting for."

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