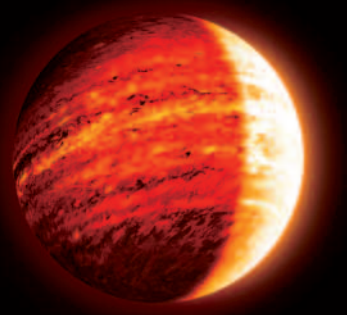


ROBERT NAEYE

The Exoplanet and the Amateurs

Backyard observers help pin down a distant world's nature.

AN INTERNATIONAL NETWORK of astronomers has announced one of the most impressive discoveries ever made that involves amateurs. The group has found an extrasolar planet that periodically transits (crosses) the face of its host star. Better yet, this object is unlike any of the 28 other known transiting exoplanets, and follow-up observations will yield precious insights into the diversity of planets throughout our galaxy.

The planet orbits 8th-magnitude HD 17156, a Sun-like star located 250 light-years away in northern Cassiopeia. Dubbed HD 17156b, this find smashes not one, but two records for transiting exoplanets. It goes around its star every 21.2 days, much longer than the previous record holder at 5.66 days. It also has by far the most highly elongated orbit, with an eccentricity of 0.67.

"This planet is definitely a major breakthrough," says Greg Laughlin (University of California, Santa Cruz), whose Transit Search observer network made the discovery. "It's our first discovery of a transit. And the planet, with its long period and high eccentricity, is unique."

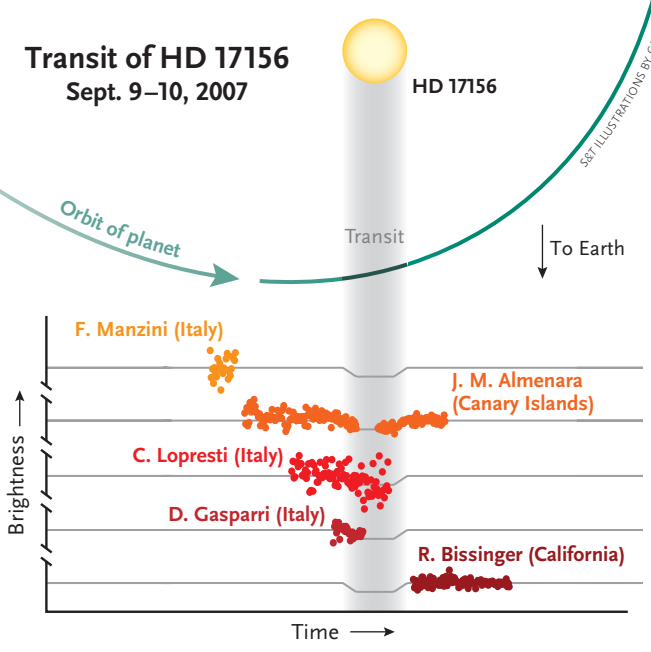
"This is a fantastic, historic discovery," adds exoplanet researcher Sara Seager (MIT). "First, it enables us to study a planet very different than the 'normal' hot Jupiters, almost all of which are on circular orbits of less than 4 days. This discovery is also historic because amateurs helped detect the transits."

PLANETARY ROTISSERIE ***Above:*** **The "hot Jupiter" around HD 17156 orbits so close to its parent star — ranging between 5 and 23 million miles — and absorbs so much stellar heat that its nightside glows, as depicted in this artist's concept.** ***Right:*** **Professional and amateur observations using CCD photometers detected the minute drop in brightness caused when HD 17156b passed in front of the star on the night of September 9, 2007.**

First Sightings

A team led by Debra Fischer (San Francisco State University) first found the planet in early 2007 using the tried-and-true "wobble" method. That is, the astronomers looked for small motion-induced shifts in the host star's spectral lines caused by the gravitational tugs of an orbiting companion. Then, to find out whether the planet transits its star, Laughlin organized an international campaign to observe HD 17156.

On the night of September 9th, Italian amateur astronomers Claudio Lopresti and Daniele Gasparri used modest commercial telescopes and CCD cameras to catch the initial telltale dip in starlight caused by the planet



SKY ILLUSTRATIONS BY CASEY REED

passing in front of the star and blocking some of its light. Unfortunately, clouds intervened, and they were unable to observe the entire transit.

Luckily, Jose Manuel Almenara Villa (Astrophysical Institute of the Canary Islands, Spain) observed almost the entire transit, which lasted 186 minutes. His 12-inch (30-cm) telescope and CCD recorded a 0.6% dip in the star's brightness.

David Charbonneau (Harvard-Smithsonian Center for Astrophysics) led the effort to observe the next transit, which took place on the night of September 30th. Several professional astronomers in the United States, as well as California amateur Don Davies, observed the transit at exactly the predicted time, confirming the discovery.

In the Exoplanetary Spotlight

Based on the gravitational tug detected in its host star, HD 17156b has a mass of 3.1 Jupiters. The amount of starlight it blocks indicates that its diameter is about 1.15 Jupiters. Theorists can breathe a sigh of relief, because the calculated average density, roughly 2.6 times the density of water (2.6 g/cm³), is in line with theoretical predictions for a gas-giant planet of such high mass. In contrast, about 30% of the known hot Jupiters are puffed up well beyond the diameter expected for a given mass.

"The professional community will lavish attention on this star because of the planet's properties," says Charbonneau. "But they are able to do so because of the huge contribution of these amateurs."

Due to its elongated orbit, the planet experiences a 26-fold variation in the amount of light received from the parent star. During each orbit, it swings to within just 5 million miles (7½ million km), which, Laughlin points out, "leads to an intense phase of heating on the hemisphere that happens to be facing the star during the 12 hours of closest approach."

"The variation in the amount of radiation from the star during this planet's orbit means that the planet will be alternately and dramatically heated and cooled by its host star," adds Seager. The planet's dayside may vary between 800°F (430°C) and 2,420°F (1,330°C) during each orbit. How much of this heat carries over to the nightside will tell much about the planet's atmosphere, if any, and the strength of its global winds.

"This should drive complex weather on the surface," says Laughlin, "and the nightside of the planet should be glowing from its own radiation." He expects that it will have a considerably cooler average temperature than other known hot Jupiters. "It lies in an interesting intermediate regime between the hot Jupiters and the Jovian planets in our solar system."

Additional Scrutiny

Future infrared observations by NASA's Spitzer Space Telescope should be able to measure how the planet's atmosphere responds to this burst of heating and how it radiates this energy. Spitzer cannot actually resolve the planet from its host star, but it can measure the system's total heat output, which will change slightly as the planet swings in close to the star and gets blasted, and then moves away and cools off.

Besides the changing distance from the star, Spitzer will see both the day and night sides of the planet at different times, which will help theorists model atmospheric circulation. Such information, in turn, will be useful for creating global climate models for hot Jupiters in general.

Fischer's colleague Geoff Marcy (University of California, Berkeley) says that their team will continue observing the star's wobble to refine the planet's orbit. Repeated transit observations could reveal small timing variations caused by gravitational perturbations from other planets in the system.

For more about the Transit Search network and details about HD 17156b, including transit predictions, visit transitsearch.org.

Laughlin plans to continue his ongoing collaboration with amateurs (*S&T:* February 2006, page 34). He concentrates on stars with planets in eccentric, long-period orbits. He further focuses on those whose planets would transit when closest to their host stars, which boosts the probability that they'll actually transit as seen from Earth.

Professionals rarely make the attempt to observe these potential transits because of the very low probability that any given planet will orbit its star aligned along our line of sight. But with an eager corps of skilled amateurs willing to tackle long-shot projects, and with dozens of additional potential targets on the waiting list, expect more discoveries in the months and years ahead. ✦

C. LOPRESTI (BOTTOM); D. GASPARRI (TOP)

ITALIAN STYLE Amateur astronomers Daniele Gasparri *(top)* of Bologna and Claudio Lopresti *(bottom)* of La Spezia provided observations that first hinted at the existence of a transiting planet around the star HD 17156.

Contributing editor ***Robert Naeye*** *is a science writer for the Astrophysics Science Division at NASA's Goddard Space Flight Center, where he writes (mostly) about gamma-ray bursts, black holes, and neutron stars.*