

# Earth-mass planet found orbiting the nearest star

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A planet with mass similar to that of the Earth has been found orbiting  $\alpha$  Centauri B, our closest interstellar neighbor. It was found by the European Southern Observatory's (ESO) 3.6 meter telescope at La Silla, Chile using the HARPS spectrograph. The results were published in the October 17 edition of *Nature*. While the newly found body is not in the habitable zone of its parent star, it does provide another step in the search for Earth-like worlds.

The idea of other planets orbiting other stars was first postulated in the sixteenth century by the Italian philosopher Giordano Bruno, a supporter of Copernicus's heliocentric view of the solar system. Isaac Newton concurred with this two centuries later when he wrote in the conclusion to the *Principia* that, if other stellar systems were similar to ours, that "they will all be constructed according to a similar design."

The earliest claims on exoplanet discovery were made in the 19th century. Astronomers from institutions as varied as the East India Company and the University of Chicago made claims that the binary star 70 Ophiuchi had a planet around it, with an orbital period of 36 years. Subsequent research showed that the orbital dynamics put forth would be highly unstable, and any claims of a planet in that system have been seen as erroneous.

Two planets orbiting the pulsar PSR 1257+12 are taken to be the first confirmations of exoplanets. Astronomers believe that the planets formed out of the remnants of the supernova that created the pulsar or are the rocky cores of gas giants that survived the death of their star. The first extrasolar planet (exoplanet) orbiting a solar-type star was found in 1995.

Since then, more than 840 planets, including multi-planetary systems, have been identified. The planets found include ones smaller in size and mass

than the Earth. 2,300 more exoplanet candidates, detected by the Kepler spacecraft, are awaiting confirmation.

Finding exoplanets is a challenge. Planets emit no light of their own and most always reside near a star, thus being *extremely* hard to detect directly (although work on that is ongoing). Instead, astronomers detect planets indirectly by closely observing the motion of the stars and their light output.

Two primary ways of finding exoplanets currently exist: the radial-velocity method, which looks at how the velocity of a star changes because of the gravitational interaction with an orbiting planet; and the transit method, which finds small reductions in the star's brightness as planets pass in front of the star.

Both methods are powerful, more so when combined, as they are complementary. The first method finds the mass of the exoplanet, the second finds its physical size. These measurements also take time, needing at least four orbits of the planet for confirmation, meaning it would take four years for an observer in another star system to find Earth.

The planet, named  $\alpha$  Centauri Bb, was found using the High Accuracy Radial Velocity Planet Searcher (HARPS) spectrograph, using the radial-velocity method above. Researchers observed the color of the light coming from  $\alpha$  Centauri B, and the slight changes, the Doppler shifts, in that color to infer a change in the velocity of the star as it traveled through the Milky Way that would only occur if it had an orbiting planet.

Finding the signal of  $\alpha$  Centauri Bb in the data was challenging. There was noise from the instruments, the rotation of the target star, long-term sunspot activity on the star, light from  $\alpha$  Centauri B's companion  $\alpha$  Centauri A, the extremely weak signal of the planet itself—all of these variables and more were considered

and dealt with before a clear signal of an Earth-mass planet orbiting ? Centauri B emerged.

The measurements were taken three times a night almost every night over the course of four years, with a total of 459 observations made. This has resulted in the most precise radial-velocity measurement ever recorded, finding motion just above the detection threshold.

An exoplanet being found next to our closest stellar neighbor, a scant 4.3 light years (more than 40 trillion kilometers), shows the potential for further scientific investigation. It is known that the planet is not Earth-like. It is too close to its parent star, making a complete orbit around the star in only 3.2 days, and thus far too hot for human habitation.

However, the star's proximity to us, and brightness allows for a potential characterization of the precise chemical composition of any atmosphere the exoplanet may have. This star system was in fact a target star for the Terrestrial Planet Finder (TPF), which had a mission goal of investigating exoplanetary atmospheres. The mission was cancelled by NASA in 2011 due to budget cuts imposed by the Obama administration.

Perhaps what is most interesting about the discovery of ? Centauri Bb is the high probability of another planet orbiting ? Centauri B. Recent papers studying exoplanetary systems have found that low-mass planets are more often found in multi-planetary systems, leading researchers to suspect that if one Earth-mass planet is orbiting ? Centauri Bb, there might be another. Perhaps this second planet would be in ? Centauri B's habitable zone.

The search for exoplanets has faced budget cuts in recent years. As mentioned above, the TPF mission was cancelled in 2011. The Space Interferometry Mission (SIM), which had a primary goal of finding exoplanets orbiting in a star's habitable zone, was cancelled by NASA in 2010. The planning for the European Space Agency's Darwin mission was ended in 2007, which had similar mission goals. It was ended because the funding did not exist to explore the technology necessary to make the mission possible.

A multitude of ideas for future study of exoplanets exist. One such concept is Antoine Labeyrie's "hypertelescope." This would involve a multitude of space-based telescopes in an extremely precise

spherical array pointing at a target. It would be a new breed of telescope, taking existing technology to a much higher level of precision, potentially revealing surface features of Earth-like worlds around other suns. Only the profit motive, based in capitalism, prevents such ambitious projects from furthering humanity's understanding of the universe.

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