Signs of planet detected around sun’s nearest neighbor star

Proxima Centauri companion orbits in habitable zone

By
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A WORLD NEXT DOOR  Proxima Centauri casts a reddish glow over the surface of Proxima b (illustrated), the closest exoplanet to Earth, while two companion stars, Alpha Centauri A and B, appear as bright pinpricks of light.

M. Kornmesser/ESO

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Earth might have a kindred planet orbiting the star next door. A world at least 1.3 times as massive as Earth appears to orbit the closest star to the sun: Proxima Centauri, a dim red orb about 4.2 light-years away.

Dubbed Proxima b, the planet is cozied up to its star, needing just 11.2 days to complete one orbit. But despite the proximity to its star — just 5 percent of the distance from Earth to the sun — Proxima b is potentially habitable. Its temperature is just right for liquid water to flow on its surface, Guillem Anglada-Escudé, an astronomer at Queen Mary University of London, and colleagues report in the August 25 Nature. That makes Proxima b the closest known world outside our solar system where life might exist.

“It’s an incredible discovery — it’s almost a gift,” says David Kipping, an astronomer at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass. With Proxima b, researchers might now have their best chance at characterizing the atmosphere of an Earthlike world in another solar system and probing for hints of life elsewhere in the galaxy.

Going the distance
Proxima Centauri is part of a triple star system (above, shown to scale) just over four light-years from the sun. Its two companions, Alpha Centauri AB, lie about 0.24 light-years from their dim neighbor.

Proxima Centauri, which lies in the southern constellation Centaurus, is a runt of a star. Temperatures at the surface run about 2,800 degrees Celsius cooler than our sun, giving Proxima a feeble, ruddy glow. The star is much closer in size to Jupiter than the sun, and even though it’s relatively close to Earth, Proxima is invisible to the naked eye — it wasn’t discovered until 1915. Part of a triple star system known as Alpha Centauri, it’s not clear whether Proxima is gravitationally bound to its brighter companions (taking hundreds of thousands of years to complete one orbit around both) or just passing by.

The Alpha Centauri system is no stranger to claims of exoplanets. In 2012, astronomers reported in Nature that the star Alpha Centauri B hosts a planet roughly as massive as Earth, though too warm to be habitable (SN: 11/3/12, p. 5). Other researchers are skeptical; a 2015 report in Monthly Notices of the Royal Astronomical Society Letters, for example, found no evidence for the planet. The claim for Proxima b appears to be much stronger.

Anglada-Escudé and colleagues found their quarry by looking for a minute wobble in the speed of Proxima Centauri, the sign of a gravitational tug from the orbiting planet. An intensive two-month observing campaign in early 2016 using two telescopes in Chile — the European Southern Observatory’s 3.6-meter and Very Large telescopes — confirmed earlier suspicions of a planet.

“It’s not clear if the planet will be Earthlike,” Anglada-Escudé says. Not much is known about Proxima b, such as its size or what its atmosphere is like. Even its mass is just a minimum estimate. Without knowing how the planet’s orbit is tilted relative to us, the researchers can say only that Proxima b is no lighter than 1.3 Earths — it could be heavier and have more in common with Neptune than Earth.

Even though it’s just one star away, “we will likely have to wait a long time in order to learn anything more about the planet,” says Heather Knutson, a planetary scientist at Caltech.

Story continues after graphic

Tell tale tug
Proxima Centauri’s speed relative to the sun oscillates by a few kilometers per hour, which indicates that a planet at least 1.3 times as massive as Earth is orbiting and tugging on the star. Red dots are measured velocities; the blue curve is a fit of orbital motion to the data.

The best bet, says Knutson, is to hope that the planet, when viewed from Earth, passes in front of Proxima Centauri, allowing starlight to filter through the planet’s atmosphere. Molecules in the atmosphere would betray their presence by absorbing specific wavelengths of light. Substances such as oxygen, methane and carbon dioxide are widely considered to be chemical markers of life.

If the planet does cross in front of the star, NASA’s James Webb Space Telescope, scheduled to launch in late 2018, should be able to characterize its atmosphere, says Mark Clampin, an astrophysicist at NASA’s Goddard Space Flight Center in Greenbelt, Md. Hundreds of hours of telescope time would need to be dedicated to the task. “It will be an extremely challenging observation, but not impossible,” he says.

Scientists can also estimate the planet’s size by measuring how much light the planet blocks. The size combined with the mass would let researchers determine the density of Proxima b and figure out if the planet is puffy like Jupiter or rocky like Earth.
Kipping has already been monitoring Proxima Centauri with the Canadian MOST satellite, looking for a periodic dip in light caused by the planet partially blocking its sun. There’s only a 1.5 percent chance, however, that the planet lines up just-so with the star. And if it does line up, the inherent variability in Proxima Centauri’s light will make any drop in brightness from the planet hard to detect.

Without a fortuitous alignment, “things get much more difficult,” Knutson says. Astronomers would have to rely on light coming from the planet — either an intrinsic infrared glow or visible light reflected from its sun. James Webb might be able to barely sense infrared light emanating from Proxima b, but it could be a decade or more before any other observatory is up to the challenge (SN: 4/30/16, p. 32). And even then, there are no guarantees. “It’s going to be very difficult to characterize the planet without sending a probe there,” Kipping says.

Breakthrough Starshot, a group funded by Russian entrepreneur Yuri Milner, wants to do just that. In April the group announced a plan to put $100 million toward developing technology that would send a fleet of nanocraft — robotic probes weighing just a few grams — toward Alpha Centauri, nudging them along with an Earth-based 100 gigawatt laser. Accelerating to roughly 20 percent the speed of light, the armada would arrive at Alpha Centauri about 20 years after launch. In comparison, the fastest spacecraft ever to leave Earth — the New Horizons mission to Pluto — would need roughly 90,000 years to complete the journey, traveling at its current speed of about 52,000 kilometers per hour.

“The discovery is likely to energize the project,” says Harvard University astrophysicist Avi Loeb, chairman of Breakthrough’s advisory committee. “A spacecraft equipped with a camera and various filters could take color images of the planet and infer whether it is green (harboring life as we know it), blue (with water oceans on its surface) or just brown (dry rock).”

If anything is alive on Proxima b, it’s probably quite different from anything on Earth. Photosynthesizing organisms would have to deal with a faint, cool star that emits mostly infrared light. Proxima Centauri is also known for exuberant flares, which would buffet any orbiting planets with bursts of ultraviolet radiation and X-rays. “Conditions on such a planet would be very interesting for life,” says Lisa Kaltenegger, an astrophysicist at Cornell University.

*Story continues after image*
IN THE ZONE The orbit of Proxima b, a planet with mild temperatures, is much smaller than Mercury’s (illustrated). Because Proxima Centauri is so cool, its habitable zone (green) cozies up to the star.

M. Kornmesser, G. Coleman/ESO

Given such an alien environment, life might show its presence in unusual ways. Kaltenegger, along with Cornell astronomer Jack O'Malley-James, proposes looking for biofluorescence, a glow from organisms triggered by ultraviolet light, in the wake of stellar
flares. Critters on Proxima b could have evolved biofluorescence as protection, taking harmful UV radiation and transforming it into more palatable visible light — a flicker that might be detectable from an Earth-based telescope. “The idea that we could spot a glow seems to be right out of a [science fiction] novel,” says Kaltenegger, whose proposal appears online August 24 at arXiv.org.

That’s assuming anything could survive on the planet. If Earth were placed in the same orbit as Proxima b, it would be stripped of its protective ozone roughly three times per Earth year, Kipping says. “That’s kind of bad,” he says. That rate doesn’t give the atmosphere time to recover, “but it’s not a showstopper,” he adds. A strong planetary magnetic field or a dense atmosphere might be able to withstand the blows. And if life has taken shelter underground or underwater — or is impervious to a lack of oxygen — it might still survive.

Whether or not critters crawl on Proxima b, the discovery of the planet “could really usher new energy into the search for other nearby worlds,” says Margaret Turnbull, an astronomer with the SETI Institute and based in Madison, Wis. Most exoplanets are hundreds to thousands of light-years away. But little is known about the possible planet families huddled up to the stars nearest to us. “I’d love to see interstellar travel,” says Turnbull. “To really inspire that kind of effort, we need interesting destinations like this.”

Citations


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