Exoplanets: tantalising search for life beyond the solar system

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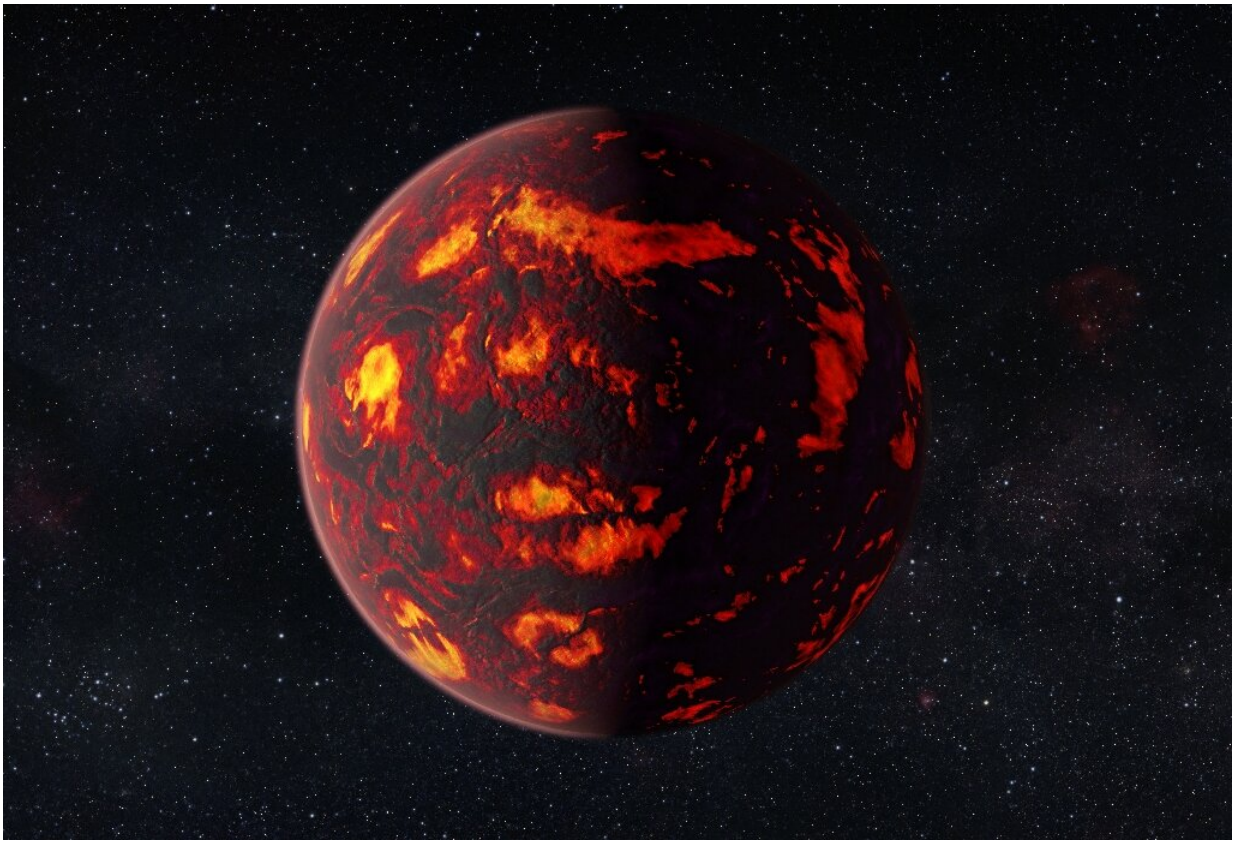

An artist's impression of the exoplanet 55 Cancri e, a so-called Super Earth in a solar system some 40 light years away from Earth.

This year's Nobel Prize for Physics honoured Michel Mayor and Didier Queloz, Swiss astronomers who proved the existence of a planet orbiting

a star far beyond the Earth's solar system.

Their find set off a series of so-called exoplanet discoveries, often with features that are nothing like the nine planets circling our sun.

Here is a backgrounder on the search for far-away planets that could support some form of life—though not necessarily as we now understand it.

What's an exoplanet?

Any planet outside our solar system is considered an exoplanet.

Although their existence had long been theorised in both research labs and in popular culture—think "Star Wars"—until 1995 no one had been able to prove one existed.

By setting their telescopic sights on the Sun-like star 51 Pegasi, part of the Pegasus constellation, Mayor and Queloz found it was wobbling—the light it emitted was blue as it moved toward them and red as it moved away.

That proved something was circling the star, even though they couldn't see it directly, being some 50 light years from Earth.

Nonetheless they could confirm the planet was gaseous and as big as Jupiter, yet very close to its star—it had a four-day orbit—and very hot, confounding theories on what types of celestial bodies would revolve where.

"We thought other systems would be similar to our own," Ulf Danielsson of the Nobel Committee for Physics said in presenting the award Tuesday.

"We were wrong."

How many are out there?

Today there are 4,057 confirmed exoplanets, according to the NASA Exoplanet Archive, and at least as many likely candidates.

The vast majority are far bigger than those of our solar system: there are more than a thousand so-called ice giants, around 1,000 gas giants, and "super Earths" with masses many times higher than the rock we call home.

There are only around 350 smaller terrestrial planets with Earth-like mass, and of those only a handful in a "temperate" zone that would allow for the presence of liquid water—the key ingredient for life as we know it.

But these are just the planets scientists have detected: several studies have estimated that there could be a trillion exoplanets in our galaxy alone.

Ultimately, there could be as many exoplanets in the universe as there are stars.

A view of the southern skies over the ESO 3.6-metre telescope at the La Silla Observatory in Chile with images of the stars Proxima Centauri (lower-right) and the double star Alpha Centauri AB (lower-left) from the NASA/ESA Hubble Space Telescope

How to find them?

There are several ways to find planets that cannot be directly observed, often because the light from their suns is so bright, relatively speaking, that it blocks out smaller objects nearby.

WOBBLE WATCHING - This involves looking for changes in the colour spectrum emitted by a star due to the gravitational pull of one or more invisible planets.

If these patterns are regular and cyclical, corresponding to a tiny wobble in the star, chances are they are caused by a planet. Nearly 18 percent of exoplanets have been found this way.

SHADOW SEARCHING - When a planet passes directly between its star and an observer—an astronomer peering through a telescope, or a satellite in space—it dims the star's light by a tiny but measurable amount.

This "transit" method has been the most successful so far—NASA's Kepler spacecraft used it to find thousands of candidate planets from 2009 to 2013, and around 80 percent of all exoplanets have been found this way.

More recently, NASA's TESS satellite was launched in 2018, able to analyse much brighter stars for smaller planets, and the European CHEOPS satellite, which aims to better analyse known exoplanets, is set for launch in the coming weeks.

PICTURE PRODUCING - Snapping a picture of an exoplanet in front of its star is akin to trying to photograph a microscopic speck of dust on a glowing lightbulb. But by removing the blinding glare of the star, astronomers can capture an image, a method called direct imaging.

Only just more than one percent of distant planets have been detected this way.

BEAM BENDING - In this technique, light from a distant star is bent and focused by gravity as an orbiting planet passes between the star and Earth.

Called gravitational micro-lensing, the gravity of the planet and star focus light rays of the distant planet on an observer in the same way that a magnifying glass focuses the sun's light onto a tiny, bright spot. Only a handful of exoplanets have been found using this method.

What conditions might support life?

Of the exoplanets found to date, only a handful are in a "temperate" zone in relation to their star: not so hot that water evaporates, not so cold that it freezes solid.

Life on Earth is also unimaginable without an atmosphere, containing in our case the oxygen organisms need to survive. An atmosphere also protects animal species in particular from damaging high-energy radiation from a star's ultraviolet and X-rays.

But without a definitive understanding as to how life emerged on Earth, it is possible that living creatures elsewhere in the universe could survive and thrive in gases, chemicals or temperatures that would be lethal for us.

Scientists are now evaluating potential chemical combinations that might indicate alien life—which might be nothing like we know it.