

wknd lifestyle

Where is everyone?

We've been searching for decades, but haven't found so much as a microbe in space yet. Could it be that we're early; that life simply has not evolved yet in the neighbourhood? Are we doing it all wrong? Is there a bustling universe of sentient beings out there, waiting for us to catch on? Humans are now beginning to build technology that could make the difference in our quest for alien life. We have a growing understanding of what to look for. We're getting better at sending probes to nearby planets, which could tell us more about where and how to search. What might we find? Why does it matter? Take a look

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There's a space-age joke about a man who has lost the keys to his car. He keeps looking beneath the nearest lamppost. Asked why, he replies: "It's where the light is."

For millennia, we have gazed up at the stars, haunted by the question: Are we alone? Our means of answering that question have remained frustratingly limited.

To extend the metaphor of the joke, we've been looking where the light is; where we are. Unlike in the joke, though, we aren't even sure the keys exist. (Though we're reasonably sure they should.)

We don't know where the street leads, what's in the next district, or indeed how we got to the lamppost to begin with.

It's a muddle.

Are we now set to take the leap that could help us un-muddle it? We have the technology to see further. We have a clearer understanding of what to look for.

The James Webb Space Telescope (JWST), built by the space agencies of the US, Europe and Canada), itself revolutionary, is already being overtaken by planned space telescopes that will have mirrors far larger than its 6.5-metre one.

Back on Earth, we are using lab simulations and computer simulations to help narrow the list of biosignatures to look for and conditions that could indicate life, either surviving or long-extinct.

"We started to reach for other stars in 1995 and we now know that there are 200 billion Sun-like stars in our galaxy alone, shining with billions and billions of possibilities," says Lisa Kaltenegger, an Austrian astro-

physicist and astrobiologist, founding director of the Carl Sagan Institute at Cornell University, and author of *Alien Earths: The Science for Planet Hunting in the Cosmos* (2024). "At this point, it would be a bigger surprise to learn that there isn't life out there, than to learn there is."

What might such life look like?

In *The Hitchhiker's Guide to the Galaxy*, that marvellous, whimsical series of novels by Douglas Adams, it turns out that the universe is a bustling place full of bureaucracy, power struggles, infrastructure nightmares, broken hearts, disappointments, restaurants and spaceships. Everyone's just surprised Earth hasn't figured this out.

In the scientific world, this is called the zoo hypothesis, and it pairs well with the Fermi paradox (posed by the physicist Enrico Fermi in 1950). The paradox goes like this: Given how much of the universe there is, it is highly probable that intelligent life (other than ours) exists, and yet there has been absolutely no evidence of it visible to us.

The zoo hypothesis has it that the life out there is simply waiting for this remote tribe to catch up, staying out of sight meanwhile, like zookeepers in a wildlife preserve.

Could this be why we're still "alone"? There are three other intriguing theories to touch upon, while we're at it.

1) This is all a simulation, and the intelligent life we seek is actually running the program we're in. (It's a bit out there, but there is serious money being poured into research to prove that this is true. Arguments for this theory involve the idea that "nothing can move faster than time" indicates the presence of a processor with a finite capacity. Are we in a sort of Matrix? Intriguingly, there is no way to disprove the theory.)

2) Life is an aberration, sort of like the fungus on the bread in the fridge. It wasn't meant to exist. It occurred somehow, will eventually run its course, and then, well, the universe's many rotating fridge shelves will all be sterile once again.

3) We're early. We somehow jumped the gun, and now we're here alone. We think

we're looking, but what we're really doing is waiting. Eventually, the rest of the universe will spring to life. Someone will zip past what was once our home, now an icy dwarf, and think: "No point stopping there. There's clearly nothing to see." Speculation aside...

What signs are we scanning for?

The US National Aeronautics and Space Administration (NASA) has a definition that serves as a guiding framework in the search: Life is defined as "a self-sustaining chemical system capable of Darwinian evolution".

From having no idea where to look (beyond a vague notion that life likely exists in a planetary Goldilocks zone something like our own), we are at the point where we now know that is only one possibility.

What seems like a frozen tundra planet now could, with the right biosignatures in its atmosphere, hint that it once held life. We are using telescopes, spectroscopes and a range of instruments and algorithms to analyse gas signatures in exoplanet atmospheres, looking for such signs.

In the vastness of space, the catch is knowing where to look — and also when.

"For almost half its 4.5-billion-year history, Earth's atmosphere showed none of the telltale signs of life we look for (a substantial combination of oxygen and methane), although life existed at least 3.5 billion years ago," says Kaltenegger.

Oxygen levels rose enough to alter the atmosphere only about 2.4 billion years ago.

"We'd need to be really lucky to find the signatures we're looking for, because we'd need to be looking in just the right place, at just the right time," she adds.

Where are we looking?

In April, a team of scientists led by Nikku Madhusudhan, an Indian-British astrophysicist with the Institute of Astronomy at University of Cambridge, detected hints of dimethyl sulfide (DMS) and dimethyl disulfide (DMDS) swirling in the atmosphere of the distant planet K2-18b.

On Earth, these gases are produced only by organic matter (such as phytoplankton).

Great excitement greeted the discovery. In an interview with Wknd, Madhusudhan pointed out that he wasn't realistically expecting the findings to lead to life forms; just to more information on what could cause such signatures. Still, the possibility of life could not be ruled out.

In July, researchers at NASA's Jet Propulsion Laboratory found that the evidence for the existence of DMS was inconclusive. The search continues.

JWST is currently studying a fascinating planetary system called Trappist-1, discovered in 2017, which contains seven Earth-sized worlds. "They circle their red star at different distances, making them the perfect Goldilocks test cases," Kaltenegger writes.

One of these planets, the fourth from its sun, Trappist-1e, is a mere 40 light years away and appears to contain signs of an atmosphere; itself a very rare sign of possible

water leading to a healthy greenhouse effect.

"A little greenhouse effect goes a long way," as Nikole Lewis, an astronomer with Cornell University, put it in a NASA statement. Further investigation is underway.

Far closer to home, two small rocky moons are being considered. Jupiter's Europa and Saturn's Enceladus have potentially habitable oceans under their ice crusts.

The European Space Agency's JUICE (Jupiter Icy Moons Explorer) mission left Earth in 2023 and will begin its flybys of Europa in 2032. NASA's Europa Clipper mission left in 2024 and is scheduled to arrive in 2030. (Both are orbiter missions; lander missions to these moons are still in the early planning stages.)

A long time ago and a galaxy far away

The orbiters and rovers make the most news, but they aren't the only ones doing the heavy lifting.

The Hubble Space Telescope, built by NASA and the European Space Agency (ESA), completed 35 years in orbit this year. It was recently used to study exoplanets Trappist-1b and Trappist-1c. (Exoplanets are planets outside our solar system.)

NASA's Kepler Space Telescope, which operated from 2009 to 2018, discovered thousands of exoplanets. Madhusudhan's discovery, in fact, was based partly on Kepler data.

NASA's Spitzer space telescope, launched in 2003, discovered Trappist-1. JWST, launched in 2021, is peering into the past.

There is plenty more to come. NASA's Nancy Grace Roman Space Telescope, set for launch in 2027, will be able to survey an area of sky 100 times larger than the Hubble Space Telescope and JWST.

A more-advanced version of JWST, NASA's Habitable Worlds Observatory, is being designed for launch in the 2040s.

ESA's proposed Large Interferometer for Exoplanets (LIFE) mission will use a constellation of artificial satellites to scan the thermal emissions for specific biosignatures.

Meanwhile, we continue to listen closely, via programs such as Breakthrough Listen, launched by Stephen Hawking in 2015, and the US-based non-profit SETI or Search for Extra-Terrestrial Intelligence.

Is the answer here at home?

Is Earth really just a "mote of dust suspended in a sunbeam," as the astronomer Carl Sagan put it? It isn't just loneliness or the eternal drive to know more that motivates the space programme. "We started looking for life elsewhere to understand how planets like Earth work," says Kaltenegger.

Each discovery tells us more about who we've been; where Earth may be headed. We could find ways to draw on resources from space, alleviate some of the strains on Earth.

There's even a chance we may find sentient life. There is after all the theory that early organic molecules that led to life on Earth were tossed here via asteroid. Which means there could be other evolutions out there.

It could also mean, of course, that we've already met one kind of alien: Us.

{ BEYOND OUR ORBIT } A NEW SPIN

Space oddities: The strangest planets we've found so far

Team HT Wknd

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We've stumbled upon some strange things, amid our quest to know more and perhaps meet the neighbours. There are planets that look a lot like Earth but are blue from silica, where whipping winds send a rain of glass flying sideways; others with a core of carbon compressed into diamond; still others with so little density, one planet has been nicknamed the cotton-candy orb.

● **Dark as coal:** TrES-2b is an orb so dark, it is said to be less reflective than coal. The reason: at an estimated 1200 degrees Celsius, it is too hot to support clouds. In addition, its atmosphere is heavy with chemicals that absorb light, such as vapourised potassium and sodium. Where Earth reflects about 37% of the light it receives from the Sun, and Jupiter reflects about 52%, TrES-2b reflects less than 1%. Spotted in 2006, it has been nicknamed the planet of eternal night.

● **An orb of hot ice:** Surface temperatures hover around 500 degrees Celsius on Gliese 436b, 32 light years away. Yet its surface is made up of a kind of ice, formed under atmospheric pressure levels so high, it cannot melt. Because it is pressure rather than temperature that keeps the ice solid, the material has been nicknamed Ice X. The planet was discovered in 2004.

● **Diamond core:** Discovered in 2004 and sitting 41 light years away, the rocky planet 55 Cancri e (left) is so hot, with surface temperatures at about 2400 degrees Celsius, that its surface is believed to be a "lava ocean". Atmospheric pressure is so high, meanwhile, that some of the carbon it contains has likely been compressed into a core of diamond.

● **Cotton-candy world:** The gas giant WASP-193 b, discovered in 2023 and situated 1,181 light years from Earth, has a density so low, it has been nicknamed the "cotton-candy planet". It is about 50% bigger than Jupiter, for context, and has only 13% of that planet's mass; and Jupiter is a gas giant to begin with.

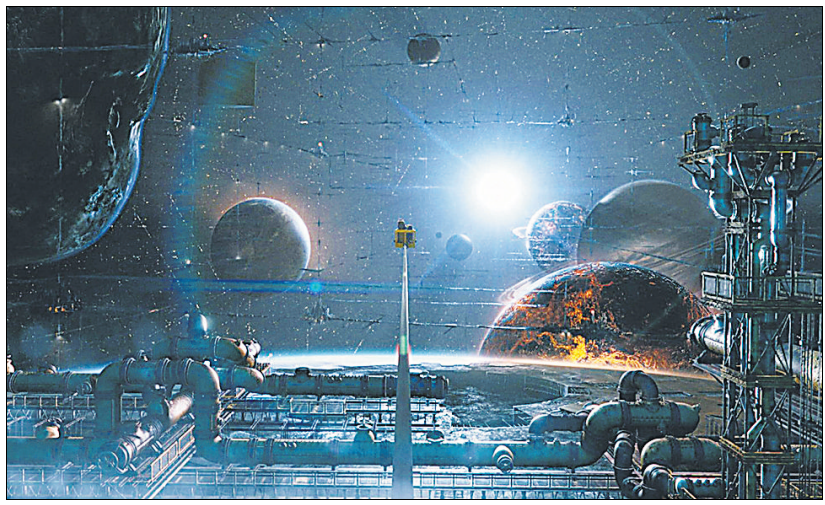
● **A rain of glass:** The blue planet HD

(Above, from extreme left) Stills from *The Hitchhiker's Guide to the Galaxy* (2005), *The Martian* (2015) and *Interstellar* (2014). A NASA rendering of the spiral galaxy NGC 1068; an image of the Curiosity lander on Mars; and a rendering of the Trappist 1 system.

IMAGES: NASA / CXC / SAO / J SCHMIDT AND N WOLK; NASA / JPL-CALTECH

(Right) The planet factory in the *Hitchhiker's Guide to the Galaxy* film (2005). Assuming there is intelligent life out there (a reasonable assumption), what might it be like? Where would we sit on the scale of such intelligence? Our search for answers continues.

(Extreme right) The little green alien from *The Simpsons*.



FROM THE ARCHIVES: Are we ready to encounter alien life, asks Nikku Madhusudhan of the Institute of Astronomy at University of Cambridge

