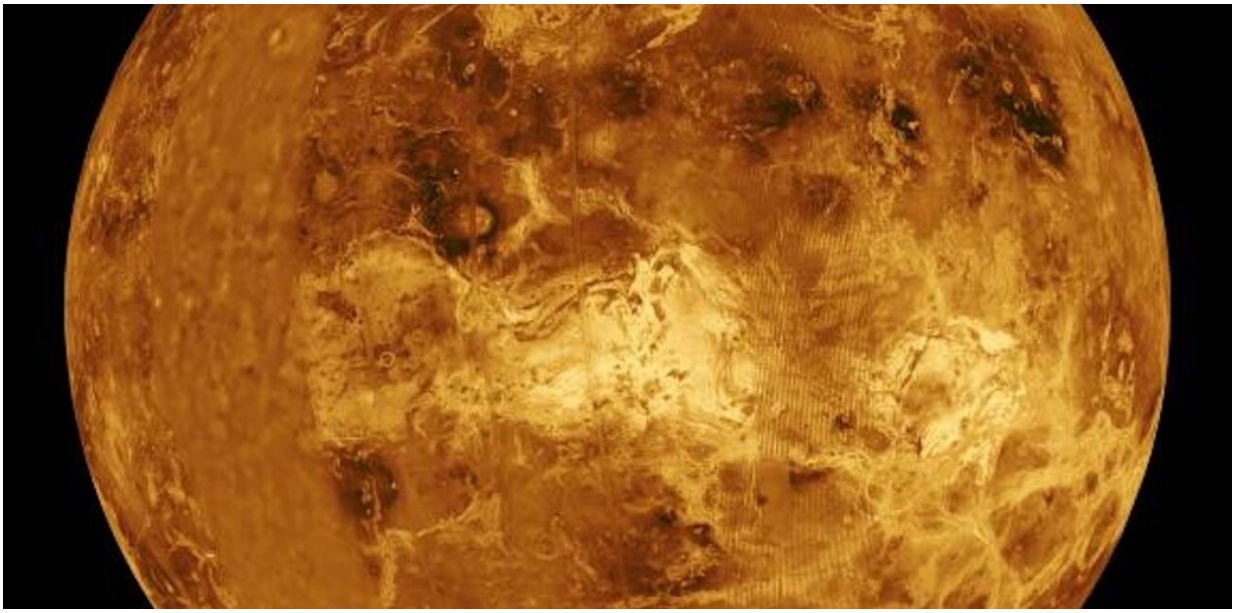
How to prove you've discovered alien life: New research offers a guide

September 12 2023, by Peter Vickers and Sean McMahon



In 2021, scientists thought they had discovered phosphine in the clouds of Venus. Credit: NASA

In the past few decades, several phenomena have led to excited speculation in the scientific community that they might indeed be indications that there is extraterrestrial life. It will no doubt happen again.

Recently, two very different examples sparked excitement. In 2017, it

was the mystery interstellar object 'Oumuamua. And in 2021, it was the possible discovery of the gas phosphine in the clouds of Venus.

In both cases, it seemed possible that the phenomenon indicated some kind of extraterrestrial biological source. Notably, physicist Avi Loeb from Harvard University argued in favor of the oddly shaped 'Oumuamua being an alien spaceship.

And phosphine in the atmosphere of a rocky planet is proposed to be a strong signature for life, as it is continuously produced by microbes on Earth.

These are just two of the latest cases of a long list of examples of such initially promising phenomena. But although a few of the examples are still controversial, most have turned out to have other explanations (it wasn't aliens).

So how can we be sure we've come to the right conclusion for something as subtle as the presence of a certain gas or a strange looking space rock? In our new paper published in the journal *Astrobiology*, we have proposed a technique for reliably evaluating such evidence.

The word "possible" is strange, with a rather unfortunate degree of flexibility. There's a sense in which it is possible that I'll meet King Charles III today, but at the same time it is extraordinarily unlikely.

Many shouts of: "It might be aliens!" should be interpreted in this (strained) sense. By contrast, we often use the word "might" to express something that has high probability, as in "it might snow today."

The concept of possibility incorporates these extremes, and everything in-between. Newspapers might capitalize on this flexibility with a cheeky headline that appears to indicate that something is a bit more exciting

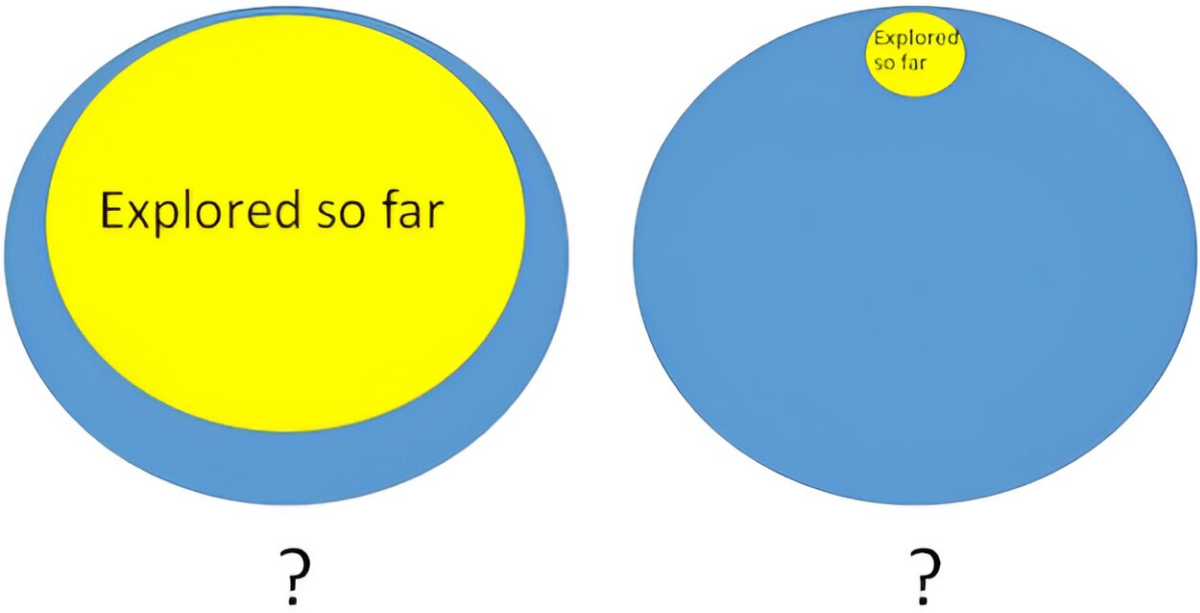
than it actually is. But the scientific world needs to express itself with rigor, transparently conveying the degree of confidence justified by the evidence.

Some would turn to Bayes' Theorem, a common statistical formula, which gives the probability (Pr) of something, given some evidence.

One could, optimistically, input the available evidence into the Bayes formula, and achieve as output a number between 0 and 1 (where 0.5 is a 50:50 chance that a signal is produced by aliens). But the Bayesian approach doesn't really help when it comes to extraterrestrial life.

For example, it requires an input for the prior probability that aliens exist. And intuitions about that vary dramatically (estimates for the number of inhabited planets in our galaxy range from one to billions).

It also requires a value for the probability of the phenomenon in question occurring naturally—not caused by aliens. For some kinds of "biosignatures" (such as a dinosaur skeleton) we know that the probability of it occurring without life is incredibly low. But for many others (say, a particular blend of gases) we don't know much at all.



How much of the relevant possibility space have we explored? Credit: Peter Vickers, CC BY-SA

Here one meets with the problem of "unconceived alternatives". Put simply: we may know too little about alternative sources of the phenomenon. Perhaps we just haven't explored the space of possible causes of the relevant phenomenon very much.

After all, humans have only carried out a limited amount of rigorous research—we don't know about every single process that could produce a certain gas in an atmosphere.

New approaches

In 2021, a Nasa-affiliated group published a paper setting out the Confidence of Life Detection (CoLD) framework, designed to solve this problem.

It recommends seven steps to verifying a discovery, from ruling out contamination to getting follow-up observations of a predicted biological signal in the same region.

Unfortunately, the problem of unconceived alternatives remains a serious challenge. Level 4 in the framework requires that "all known non-biological sources of signal" are shown to be implausible. But this only starts to mean something when the relevant space of different possibilities has been thoroughly explored.

Our new paper, published by the group Exploring Uncertainty and Risk in Contemporary Astrobiology (EURiCA), has come up with another proposal.

Or, rather, it is an idea borrowed from another context. For many years, it has been imperative for the Intergovernmental Panel on Climate Change (IPCC) to be clear on how confident they are concerning a great many propositions about climate change.

In order to express their degree of confidence, a framework has been in place for more than 20 years now, which combines the quantity and quality of the evidence with the degree to which experts agree (the degree of consensus, if any). While this has been robustly challenged, it has stood the test of time in the face of extraordinary scrutiny and the highest possible stakes.

This same framework could be used in the context of discovering extraterrestrial life. A dedicated team of experts would make a judgment based not only on their assessment of the scientific evidence (X-axis in image above), but also the extent of agreement across the community (Y-axis).

So the worst assessment would have low agreement among experts and

limited evidence while the best would have high agreement and robust evidence.

What of unconceived alternatives? The community of experts will only agree that purported evidence for life is "robust" if the relevant possibilities have been thoroughly explored. If they haven't, there's a good chance some other explanation will turn up in the long run.

Astrobiologists mustn't limit their research to the study of the signatures of life. They must also carefully investigate the possible ways that non-biological processes might mimic those same signatures.

Only when we know that, might we finally be able to say, "This time, it really could be aliens."

More information: Peter Vickers et al, Confidence of Life Detection: The Problem of Unconceived Alternatives, *Astrobiology* (2023). DOI: 10.1089/ast.2022.0084

Provided by The Conversation