CUTTING EDGE

Our experts examine the hottest new research

There's something in the air

Looking for out of kilter exoplanet atmospheres may be the key to finding life on other planets

▲ **Water is critical to the survival of life as we know it; this paper reinforces the idea that it has a huge effect on a planet's atmosphere**

It is a centuries old question: how is it possible, from a distance of hundreds of lightyears, to find life on another planet? The starting point might be to look for the things that all life has in common, and the authors of this month's paper, led by Joshua Krissansen-Totton of the University of Washington in Seattle, begin with the idea that what ties all life together is waste. Specifically, waste gases produced by even simple life forms, present in a planet's atmosphere as a long-lasting trace of what's going on underneath.

This is not a new idea, but with telescopes now under construction that might actually be able to measure the composition of a planet's atmosphere, it may well be one whose time has come. Previous work is old enough that we didn't even know the composition of our own Solar System's planets in detail when it was done, whereas now researchers can draw on in situ observations such as those made by the Curiosity rover at Mars.

So how do you identify an atmosphere that's been affected by life? The idea is that you might look for anything out of equilibrium: left alone for long enough, a system of chemicals will evolve towards a mixture whose composition can be predicted. Any source of chemicals – like belching bacteria – will stand out as a disruption of this mixture.

The trouble is there are other processes to consider. Sunlight, for example, can break up molecules in the atmosphere, leading to further reactions. Indeed, the energy provided by the Sun is enough to drive the chemistry in Earth's atmosphere permanently away from equilibrium, even if there was no life. What the researchers do, however, is measure how far away from equilibrium each planet and moon in their study is.

They look at Earth, Mars, Venus, Jupiter, Uranus and Titan, and if this is to be an effective means of detecting life on exoplanets then you would expect Earth to stand out. When the results are first presented, our planet doesn't stand out at all – the strong influence of the Sun on Mars's thin atmosphere, for one, creates a much larger impression than life does on Earth's air.

Writing off the technique is premature, though, for the researchers check their numbers again but this time include the effect of the oceans. The presence of liquid water fundamentally changes the chemistry of the atmosphere, and when this is included then the effect of the Earth's biosphere is obvious. In particular, the failure of oxygen and nitrogen to react is the smoking gun; without life, both would nearly vanish in two hundred million years or so. That sounds like

> "How do you spot an atmosphere affected by life? Look for anything out of equilibrium"

a long time, but geologically it's fast. Life on Earth has been affecting the atmosphere for billions of years, and it seems that in all that time it may have been signalling its presence to alien astronomers.

Before we rush to the telescope, there is much work still to do. Applying the technique does require knowing, from some independent measurements, that oceans are present, but there are ideas about how to do that. Probably the biggest hole is that the work doesn't include reactions that take place between solid rock and atmospheric gases, which complicate things even more. This is a great start, though, and a fascinating modern look at some of astrobiology's beginnings.

CHRIS LINTOTT is an astrophysicist and co-presenter of *The Sky at Night* on BBC TV. He is also the director of the Zooniverse project.

CHRIS LINTOTT was reading…
On detecting biospheres from thermodynamic disequilibrium in planetary atmospheres by Joshua Krissansen-Totton, David S Bergsman and David C Catling
Read it online at http://arxiv.org/abs/1503.08249

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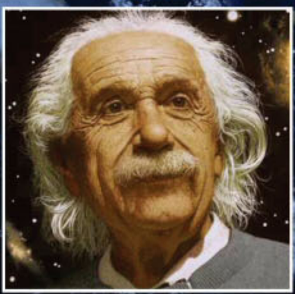

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