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Something in the air: The search for life on distant planets

Written by: *David C. Catling & James F. Kasting*

"…a time would come, when men should be able to stretch out their eyes…by which means they should be able to discover… every nebulous star appearing as if it were the firmament of some other world at an incomprehensible distance…that they should see planets like our Earth"- **Inaugural lecture of Christopher Wren (aged 25) as Professor of Astronomy, Gresham College, London, 1657.**

In 1657, Christopher Wren – future architect of St. Paul's Cathedral — was excited about the new technology of telescopes, which, he said, made it possible "to penetrate into the most hidden parts of nature". Unfortunately, worlds beyond our solar system remained unknown for another three-and-a-half centuries until telescopic detectors grew sufficiently sensitive and some telescopes were put into space. Only in the last decade have telescopes discovered that some stars are indeed the firmament – the heavenly skies – for Earth-like planets orbiting around them. Our galaxy contains billions of these so-called exoplanets. Today, their discovery begs an answer to an even older question of whether we're alone in the universe. Are some exoplanets inhabited?

Both of us have spent some time thinking about what makes a planet habitable. When we compare Venus, Earth and Mars, we see that an atmosphere – through composition and climate—is critical for distinguishing lifeless from inhabited worlds. It's not just distance from the Sun that matters. Under its extremely dense atmosphere, the surface of Venus is so hot that physics doesn't allow liquid water to exist. Meanwhile, Mars is a frozen desert beneath thin, wispy air. Mars is too small to have active volcanoes today, which otherwise would supply new gases to its atmosphere and make it thicker and warmer. The Earth alone has oceans and life, but it once had an atmosphere devoid of oxygen that was inhospitable to the large life forms that are all around us. Earth was once not a planet of the apes – as it is with us humans – but a planet of the microbes. And before that, Earth was lifeless.

To understand the habitability of planets, we need to know where atmospheres come from, how atmospheres remain stable, how the mixture of gases in an atmosphere changes over billions of years from the origin of a planet to its current or future state, and whether an atmosphere can provide a climate conducive to life. In short, we need to know the science of atmospheric evolution.

Part of that science is how biology affects atmospheres. For example, virtually all of the oxygen and methane in the Earth's atmosphere comes from biology. The detection of these gases on exoplanets could reveal the presence of life. In fact, humankind is on the verge of such measurements. NASA's James Webb Space Telescope (JWST) launches in 2021 and might be capable of detecting biogenic gases on the nearest exoplanets as might three enormous ground-based telescopes that will become operational in the 2020s: the European Extremely Large Telescope, the Giant Magellan Telescope, and the Thirty Meter Telescope. Meanwhile, NASA is studying giant space telescopes for the 2030s with a key goal to search for exoplanet life.

We're living in an exciting time when life could soon be discovered elsewhere. It's possible that the universe is teeming with life and most habitable exoplanets are covered in microbe-like biospheres, which drastically modify their atmospheres, but we just haven't got the technology to see this yet. The new telescopes could be as revolutionary for astrobiology in this century as the microscope was for biology in the 1600s. At that time, new optics allowed Antonie van Leeuwenhoek to discover that microbes are everywhere on this planet, and Robert Hooke coined the word 'cell'.

Of course, there are two options. The cosmos could be a great cathedral of amazing biology or it could be a sterile theatre of cold, clockwork physics and chemistry. We may find that life is so rare that Earth remains the only known living world. Either way, knowing how planetary atmospheres work and where they come from will be central to the whole upcoming endeavour of searching for exoplanet life.

–David C. Catling and James F. Kasting

Authors of **Atmospheric Evolution on Inhabited and Lifeless Worlds**, published April-May, 2017.

About the Author: *David C. Catling*

David C. Catling, University of Washington David C. Catling is a Professor in Earth and Space Sciences at the University of Washington, studying planetary surfaces, atmospheres, and habitability. He actively participates in the research of NASA's Astrobiology Institute and is the author of Astrobiology: A Very Short Introduction (2013). He has tau...

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About the Author: *James F. Kasting*

James F. Kasting is a Distinguished Professor of Geosciences at Pennsylvania State University, and an acknowledged expert on atmospheric and climate evolution. He is the author of How to Find a Habitable Planet (2010) and coauthor of the introductory textbook, The Earth System, 3rd edition (2009). Dr Kasting is a Fellow of the American Geophysical ...

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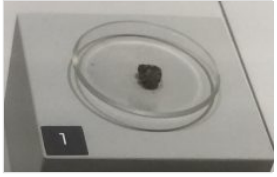

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