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Space

Chemistry clues could be the key to finding extraterrestrial life

Alex Wilkins

A NEW method to recognise the chemical properties of living things could help us detect alien life even if it functions differently from life on Earth.

When searching for alien life, scientists usually rely on biosignatures – substances or patterns that can reliably indicate the presence of living organisms. Astronomers can analyse the atmospheres of faraway planets to look for molecular biosignatures. But many molecules produced by living things can also arise through geological or chemical processes in the absence of life forms.

The new test, devised by Christopher Carr at the Georgia Institute of Technology and his colleagues, is based on amino acids. Amino acids are the building blocks of proteins, complex molecules that all life on Earth depends on. However, they are relatively simple molecules and can occur in the absence of life: for example, they have been found in lunar soil and on comets.

So, rather than simply detecting amino acids, Carr and his team reasoned that measuring the reactivity of the molecules in a sample would be a more reliable indicator of living things.

"The beauty of this approach is that it's highly explainable and linked directly to physics"

In a non-living system, molecules are formed and destroyed as they react with things in their environment, like cosmic rays or other molecules, but the more reactive molecules are more likely to disappear. "If you don't have a system in place to maintain what's present, then the things that will tend to be destroyed would be those that are more reactive," says Carr. Living systems, however, will preferentially keep more reactive molecules because they require them for the chemical processes that support life, leading to a unique signature.

The reactivity of a compound is determined by the arrangement of electrons in the molecule. More reactive molecules have a smaller difference in energy between the outermost electron and the next available space that would be filled by an additional electron during a reaction.

Carr and his team calculated this difference in energy for 64 amino acids, including many that aren't used by life on Earth. Then they looked up amino acid abundances in known samples, which came from either abiotic sources, like meteorites or moon soil, or from living samples, like fungi or bacteria, and used their molecular energy calculations to map the statistical distribution of amino acid reactivities. From this, they could then assign a probability the sample was living or non-living.

Using this method on more than 200 living and non-living samples, they found it could identify life correctly 95 per cent of the time (arXiv, doi.org/qtzv). "The beauty of this approach is that it's incredibly simple," says Carr. "It's highly explainable and it's linked directly to physics."

Life, if it does exist elsewhere in the universe, is likely to be based on carbon chemistry and amino acids, and function according to the same chemical reactivity rules as life on Earth, says Carr, so this method should work for extraterrestrial life, he says.

Using the reactivity of molecules to detect life isn't a new idea, but measuring the reactivity in a statistical distribution is, says Henderson Cleaves at Howard University in Washington DC. The method could form part of a suite of life-detecting tools on future space missions. ▮

Zoology

The secret to how cats always land on their feet

WHEN falling cats turn themselves the right way up before hitting the ground, they use a hidden trick: an exceptionally flexible region of their spine.

How cats always land on their feet has been challenging scientists for over 100 years. One idea, the bend-and-twist, proposes that the cat would bend its body almost into a right angle, then turn its front half one way and the back half the other. This means the front and rear legs both arrive at the correct position at the same time.

Or the cat could rotate the front first and then the back in a tuck-and-turn. To do this, it would extend its rear legs while keeping its front legs scrunched up, and twist its front half. Then it would swap so the front legs were extended and the rear ones contracted, and twist its rear half. This would mean one pair of legs is correctly oriented before the other.

To find out what cats really do, Yasuo Higurashi at Yamaguchi University in Japan and his team examined the spines of five dead cats and twisted them to see how much each region could rotate without breaking. They focused on the thoracic spine, from the middle of the back, and the lumbar spine, from the lower back. It turned out that the thoracic spine had a range of motion three times that of the lumbar spine (*The Anatomical Record*, doi.org/qt5v).

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Cats are able to twist their bodies in mid-air, rotating their fronts before their rears

Then, they took high-speed video of two adult cats being dropped from a height of 1 metre. In both cases, the cats finished rotating their fronts tens of milliseconds before their rears.

"My general impression has been that the bend-and-twist is the most important, but this… makes me reassess a bit and give a little bit more credence to the tuck-and-turn," says Greg Gbur at the University of North Carolina at Charlotte, author of *Falling Felines and Fundamental Physics*. The highly flexible thoracic spine suggests to him the front of the cat's body might rotate more. ▮

Michael Marshall