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Space

Asteroid has all ingredients for life

We're learning more about the potential importance of asteroids to life on Earth, and there may be even more discoveries to come, report **Leah Crane** and **Jonathan O'Callaghan**

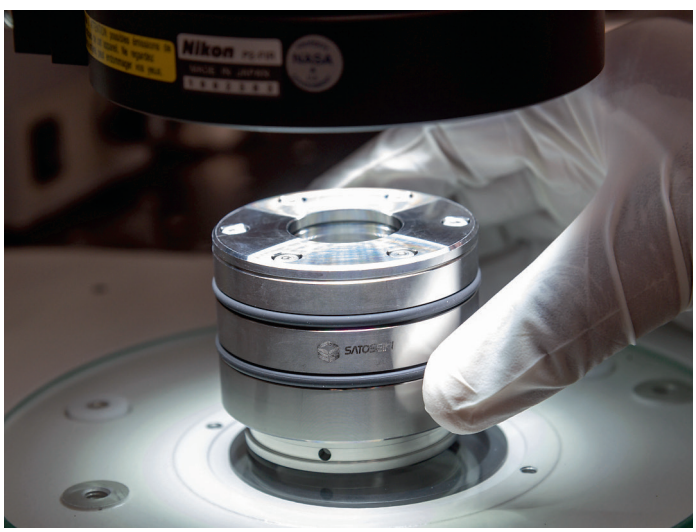
ALL five of the main ingredients for DNA and RNA have been found in samples from the asteroid Ryugu. This strengthens the idea that asteroids may have brought the ingredients for the first living organisms to Earth long ago. Meanwhile, a flyby in three years' time offers the chance to learn more about these celestial bodies.

Japan's Hayabusa 2 spacecraft visited Ryugu in 2018, where it shot two projectiles – one small and one large – into the surface of the asteroid and collected the resulting debris.

Yasuhiro Oba at Hokkaido University in Japan and his colleagues examined two samples, one from the asteroid's surface and one comprised of subsurface materials excavated by the projectiles. In both, the team found all five primary nucleobases, which are the compounds that make up the nucleic acids DNA and RNA when combined with sugars and phosphoric acid (*Nature Astronomy*, doi.org/hbsrz8).

Nucleobases have been found in samples from the asteroid Bennu and in meteorites, too. The team did find different abundances of the nucleobases among the various samples, though, which hints that these compounds might be useful for tracing asteroids and meteorites back to the parent bodies they broke off from in the distant past, as well as understanding the evolution of those parent bodies over time.

If asteroids all over the solar system are full of the building blocks of DNA, they could have brought those to Earth billions of years ago and helped kick-start the development of life.



ROBERT MARKOWITZ/NASA-JOHNSON SPACE CENTER

Samples from the asteroid Ryugu were collected by a Japanese spacecraft in 2018

"It is very likely that more complex organic molecules like nucleic acids are formed on asteroids"

It is even possible that Ryugu and other asteroids have DNA and RNA on them, not just their components. "It is very likely that more complex organic molecules like nucleic acids are formed on asteroids," says Oba.

Another asteroid we could soon learn more about is Apophis. On 13 April 2029, the asteroid, which is about 400 metres across, will pass just 32,000 kilometres away from Earth. Multiple spacecraft from the US, Europe, Japan and China are planning to study the asteroid before, during and after the flyby.

US company ExLabs has announced that its mothership spacecraft, called ApophisExL, passed a key review phase ahead of a planned launch in 2028. It will carry up to 10 spacecraft and instruments from different customers, including a lander from Japan's Chiba Institute of Technology. ExLabs will deploy this lander, which is the size of a shoebox, from 400 metres above Apophis. It will descend at about 10 centimetres a second, gently touching down on the surface after an hour, with a camera taking images.

The European-Japanese mission, called Ramses (Rapid Apophis Mission for Space Safety), will also include a lander, says Patrick Michel at Côte d'Azur University, the mission's project scientist. It will touch down a few days before the flyby and will use a seismometer to measure any landslides caused by Earth's gravitational tug – and could even record the touchdowns of landers from ExLabs. ▮

Interstellar comet has water unlike any in our solar system

While we have found the five primary nucleobases that make up DNA and RNA on the asteroid Ryugu (see main story), the interstellar comet 3I/ATLAS contains water and carbon molecules at levels never before seen in our solar system.

Astronomers have been tracking 3I/ATLAS since it entered our solar system last year. Now, Martin Cordiner at NASA's Goddard Space Flight Center in Maryland and his colleagues have found that its levels of deuterium – a form of hydrogen with an extra neutron – are at least 10 times higher than in any comet we have seen before (arXiv, doi.org/qv52).

Deuterium naturally exists in small amounts in Earth's oceans, but the levels in 3I/ATLAS are more than 40 times higher.

Cordiner and his colleagues also found relatively low levels of carbon-13, a form of carbon with an extra neutron that is typically produced after stars have exploded in a supernova (arXiv, doi.org/qv53).

Low levels of carbon-13, which have also been found in young star-forming clouds, point to 3I/ATLAS forming at a time in the galaxy's history when there weren't as many polluting supernovae.

This suggests the comet must have formed around a star system around 10 billion to 12 billion years old, more than twice as old as the sun, says Cordiner. AW