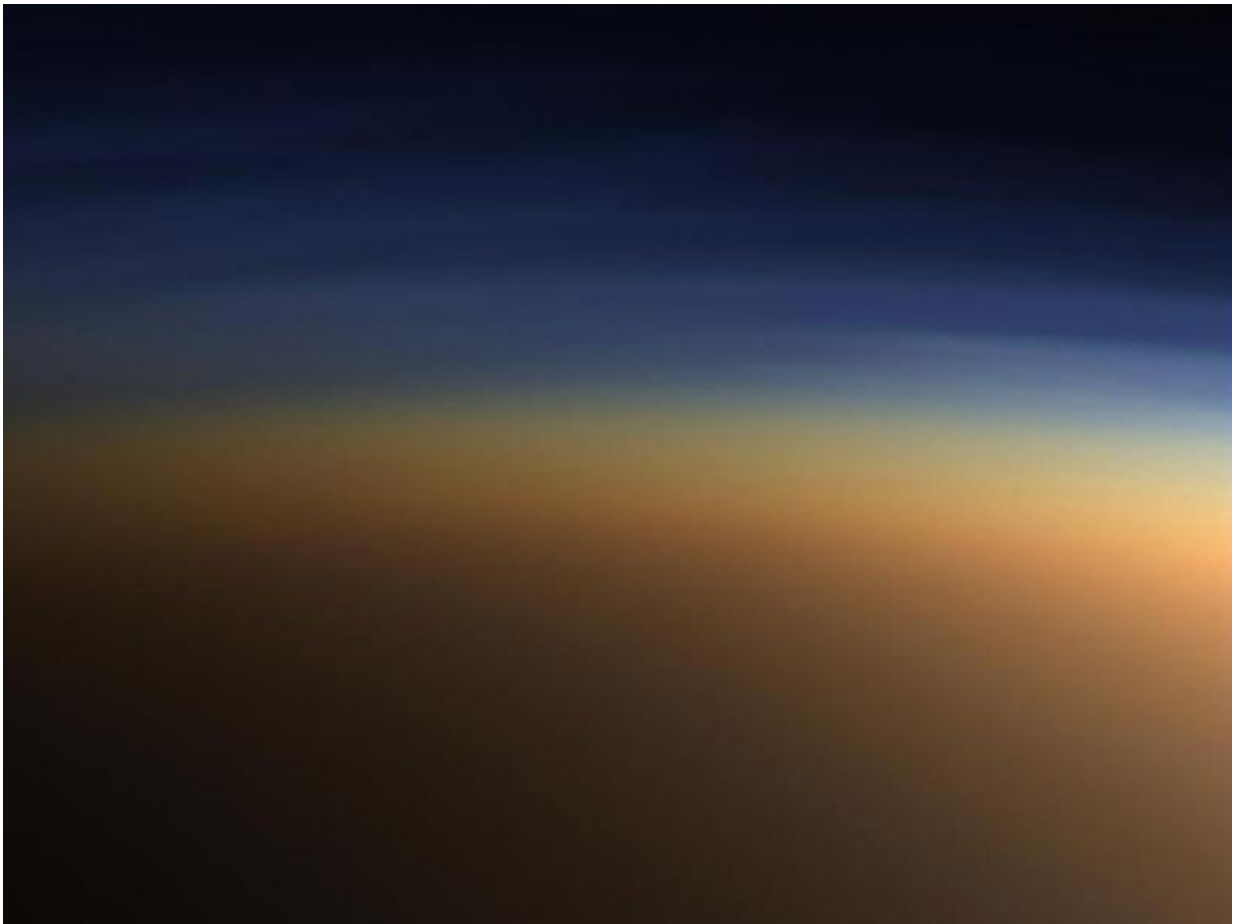


# Has Cassini found a universal driver for prebiotic chemistry at Titan?

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Credit: University College London

An important type of molecule that helps produce complex organic

material has been detected within Titan's hazy upper atmosphere by a UCL-led team as part of the international Cassini-Huygens mission.

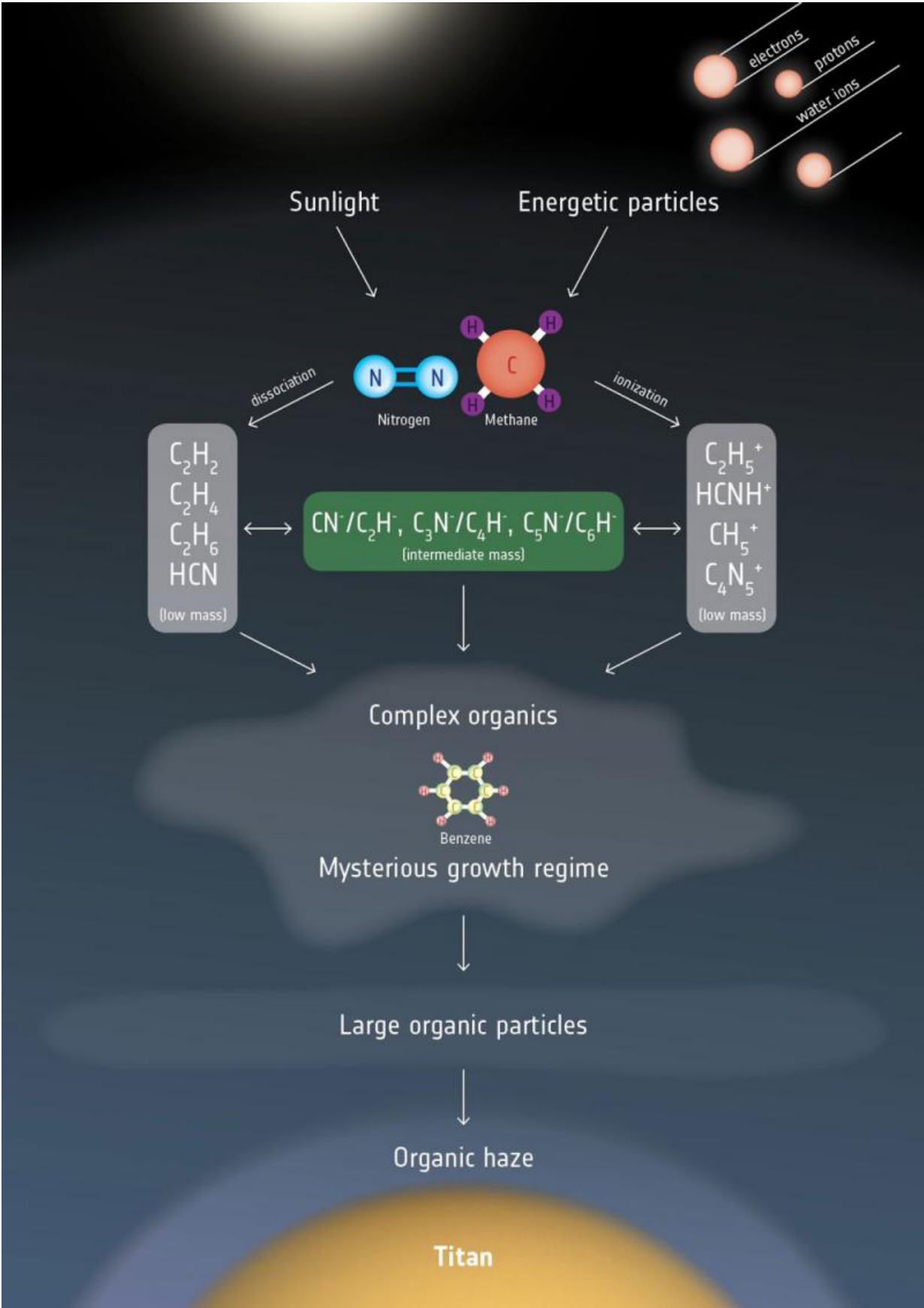
In the study, published in *Astrophysical Journal Letters*, scientists identified negatively charged [molecules](#) called 'carbon chain anions' in the [atmosphere](#) of Titan, Saturn's largest moon. These linear molecules are understood to be building blocks towards more [complex molecules](#), and may have acted as the basis for the earliest forms of life on Earth.

The team say the discovery of the negatively charged carbon chain anions is surprising because they are highly reactive and should not last long in Titan's atmosphere before combining with other materials. Their discovery there is completely reshaping current understanding of the hazy moon's atmosphere.

The detections were made using Cassini's plasma spectrometer, called CAPS, as Cassini flew through Titan's [upper atmosphere](#), 950–1300 km above the surface.

Interestingly, the data show that the carbon chains become depleted closer to the moon, while precursors to larger aerosol molecules undergo rapid growth. This suggests a close relationship between the two, with the carbon chains 'seeding' the larger molecules that are thought to fall down to, and deposit on, the surface.

"We have made the first unambiguous identification of carbon chain anions in a planet-like atmosphere, which we believe are a vital stepping-stone in the production line of growing bigger, and more complex organic molecules, such as the moon's large haze particles," said Ravi Desai, study lead author and PhD student at UCL.



Credit: University College London

"This is a known process in the interstellar medium – the large molecular clouds from which stars themselves form – but now we've seen it in a completely different environment, meaning it could represent a universal process for producing complex organic molecules. The question is, could it also be happening at other nitrogen-methane atmospheres like at Pluto or Triton, or at exoplanets with similar properties?"

Titan boasts a thick nitrogen and methane atmosphere with some of the most complex chemistry seen in the Solar System. It is even thought to mimic the atmosphere of early Earth, before the build-up of oxygen. As such, Titan can be seen as a planet-scale laboratory that can be studied to understand the chemical reactions that may have led to life on Earth, and that could be occurring on planets around other stars.

"The prospect of a universal pathway towards the ingredients for life has implications for what we should look for in the search for life in the Universe," said co-author Professor Andrew Coates, also from UCL and co-investigator of CAPS. "Titan presents a local example of exciting and exotic chemistry, from which we have much to learn."

In Titan's upper atmosphere, nitrogen and methane are exposed to energy from sunlight and energetic particles in Saturn's magnetosphere. These energy sources drive reactions involving nitrogen, hydrogen and carbon, which lead to more complicated prebiotic compounds.

These large molecules drift down towards the lower atmosphere, forming a thick haze of organic aerosols, and are thought to eventually

reach the surface. But the process by which simple molecules in the upper atmosphere are transformed into the complex organic haze at lower altitudes is complicated and difficult to determine. This discovery adds vital information that will help scientists understand the chemical process.

"These inspiring results from Cassini show the importance of tracing the journey from small to large chemical species in order to understand how [complex organic molecules](#) are produced in an early Earth-like atmosphere," added Dr Nicolas Altobelli, ESA's Cassini project scientist. "While we haven't detected life itself, finding complex organics not just at Titan, but also in comets and throughout the interstellar medium, we are certainly coming close to finding its precursors."

Cassini's 13-year odyssey in the Saturnian system will soon draw to a close, but future missions, such as the international James Webb Space Telescope and ESA's exoplanet mission Plato are equipped to look for this process not only in our own Solar System but elsewhere. Advanced ground-based facilities such as ALMA could also enable follow-up observations of this process at work in Titan's atmosphere, from Earth.

**More information:** R. T. Desai et al. Carbon Chain Anions and the Growth of Complex Organic Molecules in Titan's Ionosphere, *The Astrophysical Journal* (2017). [DOI: 10.3847/2041-8213/aa7851](https://doi.org/10.3847/2041-8213/aa7851)

Provided by University College London

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