

Scientist sheds light on Titan's mysterious atmosphere

January 23 2019



This unprocessed image of Saturn's moon Titan was captured by NASA's Cassini spacecraft during its final close flyby of the hazy, planet-sized moon on April 21, 2017. Credit: NASA/JPL-Caltech/Space Science Institute

A new Southwest Research Institute study tackles one of the greatest mysteries about Titan, one of Saturn's moons: the origin of its thick, nitrogen-rich atmosphere. The study posits that one key to Titan's mysterious atmosphere is the "cooking" of organic material in the moon's interior.

"Titan is a very interesting [moon](#) because it has this very thick [atmosphere](#), which makes it unique among moons in our [solar system](#)," said Dr. Kelly Miller, research scientist in SwRI's Space Science and Engineering Division and lead author of the study. "It is also the only body in the solar system, other than Earth, that has large quantities of liquid on the surface. Titan, however, has liquid hydrocarbons instead of water. A lot of organic chemistry is no doubt happening on Titan, so it's an undeniable source of curiosity."

The atmosphere of Saturn's largest moon is extremely dense, even thicker than Earth's atmosphere, and is comprised mainly of nitrogen gas.

"Because Titan is the only moon in our solar system with a substantial atmosphere, scientists have wondered for a long time what its source was," she said. "The main theory has been that ammonia ice from comets was converted, by impacts or photochemistry, into nitrogen to form Titan's atmosphere. While that may still be an important process, it neglects the effects of what we now know is a very substantial portion of comets: complex organic material."

Another odd aspect of Titan's atmosphere is that it's also about 5 percent methane, which reacts quickly (by astrophysical standards) to form organics that gradually fall to the surface. As a result, the atmospheric methane would either have to be replenished somehow or this current

period of time is simply a unique era for Titan.

Miller's investigation was spurred by data from the Rosetta spacecraft, a European Space Agency probe that studied the distant comet 67P/Churyumov-Gerasimenko with NASA participation and delivered the surprising discovery that the [comet](#) was roughly half ice, a quarter rock and a quarter organic material.

"Comets and primitive bodies in the outer solar system are really interesting because they're thought to be leftover building blocks of the solar system," she said. "Those small bodies could be incorporated into larger bodies, like Titan, and the dense, organic-rich rocky material could be found in its core."

To study the Titan mystery, Miller combined existing data from organic material found in meteorites with previous thermal models of the moon's interior to see how much gaseous material could be produced and whether it was comparable to the atmosphere now. Following the standard rule of, "If you cook something, it will produce gases," Miller found that approximately half of the nitrogen atmosphere, and potentially all of the methane, could result from the "cooking" of these organics that were incorporated into Titan at its very beginning.

Miller's study will appear online in *The Astrophysical Journal* on January 22.

More information: *Astrophysical Journal* (2019). [DOI: 10.3847/1538-4357/aaf561](https://doi.org/10.3847/1538-4357/aaf561)

Provided by Southwest Research Institute

Citation: Scientist sheds light on Titan's mysterious atmosphere (2019, January 23) retrieved 16 April 2024 from <https://phys.org/news/2019-01-scientist-titan-mysterious-atmosphere.html>

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