

Insights into evolution of life on Earth from 1 of Saturn's moons

EurekaAlert!

INDIANAPOLIS, Sept. 12, 2013 — Glimpses of the events that nurtured life on Earth more than 3.5 billion years ago are coming from an unlikely venue almost 1 billion miles away, according to the leader of an effort to understand Titan, one of the most unusual moons in the solar system.

In a talk here today at the 246th National Meeting & Exposition of the American Chemical Society (ACS), the world's largest scientific society, Jonathan Lunine, Ph.D., said that Titan, the largest of Saturn's several dozen moons, is providing insights into the evolution of life unavailable elsewhere. The meeting, which features almost 7,000 presentations on new discoveries in science and other topics, continues through Thursday in the Indiana Convention Center and downtown hotels.

"Data sent back to Earth from space missions allow us to test an idea that underpins modern science's portrait of the origin of life on Earth," Lunine said. "We think that simple organic chemicals present on the primordial Earth, influenced by sunlight and other sources of energy, underwent reactions that produced more and more complex chemicals. At some point, they crossed a threshold — developing the ability to reproduce themselves. Could we test this theory in the lab? These processes have been underway on Titan for billions of years. We don't have a billion years in the lab. We don't even have a thousand years."

Lunine, who is with Cornell University and is one of about 260 scientists involved with the Cassini-Huygens mission, explained that only two celestial objects in the solar system have the large amounts of organic substances on their surfaces to provide such information. They are Titan and Earth. Organic substances on Earth, however, have been cycled through living things countless times. Titan's organic materials, which include deposits of methane and other hydrocarbons as large as some of the Great Lakes, are in pristine condition — never, so far as anyone knows, in contact with life.

Titan is the only moon in the solar system known to have an atmosphere. Like Earth, most of it consists of nitrogen, with methane the second-most abundant. Sunlight strikes Titan's upper atmosphere, breaking that compound into pieces that react with each other and nitrogen to form organic compounds. Those include ethane, acetylene, hydrogen cyanide, cyanoacetylene and others — all familiar terrestrial chemicals.

"We've got a very good inventory of what's there in the atmosphere," Lunine said. "What we've only recently begun to understand is the fate of these organics at the surface of Titan."

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Lunine explained that for a long time, Mars had captured the public's and scientists' imagination as a possible location to find interesting organic chemistry and hints at life outside the Earth — and for good reason: It is an Earth-like planet relatively close to the Sun. But scientists have only found simple organic materials on the red planet.

Recent research has provided fascinating hints that liquid water may exist deep under Titan's surface. Other data suggest that areas of Titan's seafloor may be similar to areas of Earth's seafloors where hydrothermal vents exist. These passways into Earth's interior spout hot, mineral-rich water that fosters an array of once-unknown forms of life. Lunine also cited research that has identified prime potential landing spots on Titan should the National Aeronautics and Space Administration (NASA), the European Space Agency (ESA) or other space agencies decide on another mission to Titan.

Scientists now know, thanks to the joint NASA-ESA spacecraft that arrived at Saturn in 2004 after a seven-year journey through the solar system, that Titan shares a surprising number of features with Earth. The enormous volumes of data that Cassini's 12 scientific instruments and the Huygens surface probe streamed back to Earth paint a complex picture of Titan's surface and the dense atmosphere that enshrouds it. Rivers flow into lakes. Wind sweeps across dunes. Giant storms brew, and clouds float across the hazy sky.

The catch is that Titan, nearly a billion miles from the Sun and a little larger than the Earth's own moon, is mostly frozen. It only receives about 1 percent of the sunlight that Earth gets. As a result, it is unimaginably frigid. At minus 290 degrees Fahrenheit — that's 160 degrees colder than the coldest recorded temperature in Antarctica — its water ice is rock solid, at least on the surface. And the rivers and lakes? They are made of liquid hydrocarbons, ethane and methane, which on balmy Earth are the main components of natural gas. Titan's deposits may be 10-100 times greater than all of Earth's oil and gas reserves, estimates suggest.

Lunine acknowledged funding from the [Cassini Project](#) [1], the [NASA Astrobiology Institute](#) [2] and the [John Templeton Foundation](#) [3].

The research was part of a symposium on "Chemical Frontiers in Solar System Exploration," which covers the gamut of the latest discoveries in space science, and experimental design and devices that are pushing the field to new levels. The following topics were among more than 30 presentations in the symposium (abstracts appear below):

- Molecules and molecular evolution in cold extraterrestrial environments: The chemist's approach
- Ice-gas interactions during planet formation
- Composition and chemical history of early solar system ices
- OSIRIS-REx will return a sample of asteroid 1999 RQ36 for astrochemistry

Other symposium topics include the chemistry of star and planet formation, low-

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temperature chemical reactions and new analytical techniques to study molecular interactions in space.

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