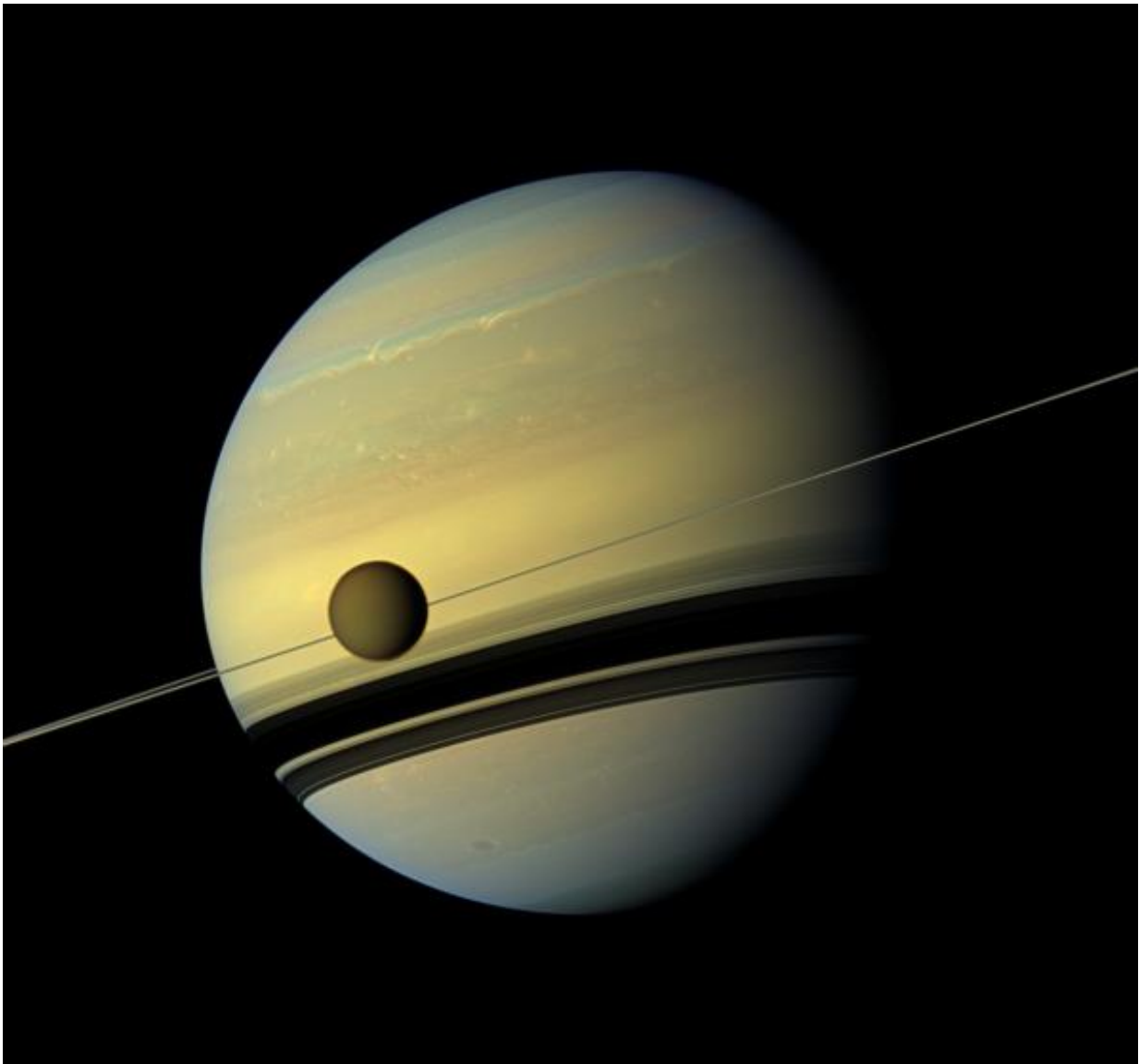


Earth's extremes point the way to extraterrestrial life

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A giant of a moon appears before a giant of a planet undergoing seasonal

changes in this natural color view of Titan and Saturn from NASA's Cassini spacecraft. Credit: NASA Jet Propulsion Laboratory

Bizarre creatures that go years without water. Others that can survive the vacuum of open space. Some of the most unusual organisms found on Earth provide insights for Washington State University planetary scientist Dirk Schulze-Makuch to predict what life could be like elsewhere in the universe.

NASA's discovery last month of 500 new planets near the constellations Lyra and Cygnus, in the Milky Way Galaxy, touched off a storm of speculation about alien life. In a recent article in the journal *Life*, Schulze-Makuch draws upon what is known about Earth's most extreme lifeforms and the environments of Mars and Titan, Saturn's moon, to paint a clearer picture of what life on other planets could be like. His work was supported by the European Research Council.

"If you don't explore the various options of what life may be like in the universe, you won't know what to look for when you go out to find it," said Schulze-Makuch, a professor in the WSU School of the Environment.

"We do not propose that these organisms exist but like to point out that their existence would be consistent with physical and chemical laws, as well as biology," he said.

For example, on Earth, a species of beetle called bombardier excretes an explosive mix of hydrogen peroxide and other chemicals to ward off predators.

"On other planets, under gravity conditions similar to those present on

Mars, a bombardier beetle-like alien could excrete a similar reaction to propel itself as much as 300 meters into the air," Schulze-Makuch said.

While explorers to Mars might find creatures similar to those on Earth, life on a Titan-like planet would require a completely novel biochemistry. Such a discovery would be a landmark scientific achievement with profound implications.

Life on Mars

Earth life, with its unique biochemical toolset, could feasibly survive on a Mars-like planet with a few novel adaptations.



This is the landing site on Mars of Viking Lander 2, which operated on the planet surface for 1,316 days and was turned off in 1980 when its batteries failed. Credit: Mary A. Dale-Bannister, Washington University in St. Louis

First, organisms would need a way to get [water](#) in an environment that is akin to a drier and much colder version of Chile's Atacama Desert. A possible adaptation would be to use a water-hydrogen peroxide mixture rather than water as an intracellular liquid, Schulze-Makuch said.

Hydrogen peroxide is a natural antifreeze that would help microorganisms survive frigid Martian winters. It is also hygroscopic, meaning it naturally attracts water molecules from the atmosphere.

During the daytime, plant-like microorganisms on a Martian-like surface could photosynthesize hydrogen peroxide. At night, when the atmosphere is relatively humid, they could use their stored [hydrogen peroxide](#) to scavenge water from the atmosphere, similar to how microbial communities in the Atacama use the moisture that salt brine extracts from the air to stay alive.

Schulze-Makuch speculates that a larger, more complex alien creature, maybe resembling Earth's bombardier beetle, could use these microorganisms as a source of food and water. To move from one isolated patch of life-sustaining microorganisms to another, it could use rocket propulsion.

Life on Titan

Due to its greater distance from the Sun, Titan is much colder than Earth. Its surface temperature is on average -290 degrees F. Additionally, there is no liquid water on the surface nor [carbon dioxide](#) in the atmosphere. The two chemical components are essential for life as we know it.

If life does exist on Titan or a Titan-like planet elsewhere in the universe, it uses something other than water as an intracellular liquid. One possibility is a liquid hydrocarbon like methane or ethane. Non-water based lifeforms could feasibly live in the liquid methane and ethane lakes and seas that make up a large portion of Titan's surface, just as organisms on Earth live in water, Schulze-Makuch said.

Such hypothetical creatures would take in hydrogen in place of oxygen

and react it with high energy acetylene in the atmosphere to produce methane instead of carbon dioxide.

Due to their frigid environment, these organisms would have huge (by Earth standards) and very slowly metabolizing cells. The slow rate of metabolism would mean evolution and aging would occur much slower than on Earth, possibly raising the life span of individual organisms significantly.

"On Earth, we have only scratched the surface of the physiological options various organisms have. But what we do know is astounding," Schulze-Makuch said. "The possibilities of life elsewhere in the universe are even more staggering.

"Only the discovery of extraterrestrial [life](#) and a second biosphere will allow us to test these hypotheses," he said, "which would be one of the grandest achievements of our species."

Provided by Washington State University

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