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Water Lust: Why All the Excitement When H₂O Is Found in Space?

Mars, Europa, interstellar nebulae, and now even the moon all seem to be getting wetter with every observation. But what is it about this simple hydrogen-oxygen combo that makes it the sine qua non of finding extraterrestrial life?

By [Bruce Lieberman](#)

ELIXIR OF LIFE: Finding evidence of water in the solar system and beyond is an important signpost for the presence of life. Liquid water is a solvent, a medium and a catalyst for certain types of proteins, and essential to biological processes.
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When NASA announced last month the finding of water ice in several impact craters on [Mars](#), and either water or hydroxyl widely dispersed on the [moon](#)'s surface, the solar system became a little more familiar because it seemed a tad more hospitable to life as we know it on Earth.

But is that because the rest of the cosmos has much in common with Earth or vice versa?

[Water](#), the unique molecule that cradles and nurtures life here, is apparently common and perhaps abundant in the solar system.

Observational evidence suggests that water as a solid, liquid or gas is present at the poles of Mercury, within the thick clouds of Venus, on

[Mars](#), inside asteroids and comets, and in the atmospheres of Jupiter, Saturn, Uranus and Neptune. Scientists also have

speculated that Jupiter's moons [Europa](#), Ganymede and Callisto have vast subsurface oceans of liquid water. They have also detected through spectroscopy water frost on Pluto's moon, Charon. Of course, scientists have known that H₂O also seems to be ubiquitous beyond the solar system. They've detected it in one form or another in interstellar gas and even in such unlikely places as the atmospheres of stars. Perhaps it shouldn't be such a revelation. After all, hydrogen is the most common element in the universe, followed by helium and oxygen.

"It's not a surprise that the simple (molecules) would show up again and again," says Pamela Conrad, a planetary scientist at NASA's Jet Propulsion Laboratory (JPL) in Pasadena and part of the science team for the next-generation Mars Science Laboratory headed to the Red Planet in late 2011. "But I think its discovery on specific planets or other bodies in the solar system has a significance beyond whether or not we're surprised that it's there. It gives us permission to speculate on whether or not there is other chemistry that would be relevant to the origin or the sustenance of life."

As scientists continue their search for extraterrestrial water, it's good to be reminded why they're actually looking for it. Just what is it about water, specifically liquid water, that makes it essential for life? The short answer is that life on Earth requires it. Photosynthetic life snatches the hydrogen from water molecules to make sugars. Organisms use water to add rigidity to cells and transport nutrients. If we don't drink it, we die.

But it's the handful of intrinsic—and collectively unique—properties that explains why water is the elixir of life. Sushil Atreya, who studies the formation of planets and the evolution of their atmospheres at the University of Michigan at Ann Arbor's [Planetary Science](#) Laboratory, breaks it down this way: "Liquid water acts as a solvent, as a medium and as a catalyst for certain types of proteins, and those are three main things that allow life to flourish," he says.

Liquid water's property as a solvent, in which salts and organic compounds such as amino acids and sugars readily dissolve, is due to its dipole molecular structure. The oxygen atoms in water hold their electrons much more strongly than the hydrogen atoms do, so they accumulate a negative electrical charge. Water's hydrogen atoms, bent on the same side of the water molecule, are positively charged. The resulting structure is the reason why water molecules can break down such a wide variety of chemical species.

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"(Water) is just amazing at being able to make friends with some piece of a molecule, or some piece of an ion," JPL's Conrad says. "And that property of water is special, because more things dissolve in it than in other kinds of solvents." As a result, water is a great arbiter of chemistry that allows tremendous diversity. "When you're trying to make life, you want conditions where you can try many things...in the hopes that something will take shape," he says.

Although it's a superior solvent, water also provides an ideal medium in which chemical reactions can occur and nutrients can be easily transported, Atreya says. That includes enzymes, essential to life processes, which need water in order to do their job. "They have to be in a certain shape in order for them to act as catalysts for biochemical reactions...and water allows them to be in a certain shape," he says.

A few other properties make water the ideal medium for life: Water can remain a liquid over a wide range of temperatures, from zero degree Celsius to 100 degrees C—and even higher if dissolved salts and gases, such as ammonia, are added. (The range also varies with pressure.) Also, ice floats. Frozen water is less dense than its liquid form because "when you make a crystal, arranging atoms in an ordered repeating pattern, you just can't stack them very tightly," Conrad says. The difference in density between the solid and liquid states of water means that ice sheets can cover oceans, protecting life below. If ice sank, water would freeze from the bottom up and we'd live in a very different world. (Only a handful of other substances other than water become less dense when frozen. They include silicon, acetic acid and germanium, among others.)

This particular property of water may make life viable in places like Europa, Jupiter's ice-covered moon that scientists suspect holds a liquid water ocean below. Scientists suspect that subsurface liquid water may exist on Mars, and water ice has been seen gushing from beneath the surface of Saturn's moon, [Enceladus](#). Some scientists, meanwhile, suspect that there may be liquid water beneath the surface of Saturn's moon Titan.

Another property that shouldn't be neglected: water absorbs infrared radiation, so it can store heat and help organisms maintain temperature. Beneath Europa's icy shell, a key heat source may be the moon's rocky mantle energized by tidal forces exerted by Jupiter, which could be warming the bottom of an ocean possibly 100 kilometers deep, says Bob Pappalardo, the principal scientist at JPL for the extended Cassini mission at Saturn who is also preparing for the [next robotic exploration of Europa](#) in the mid- to late-2020s.

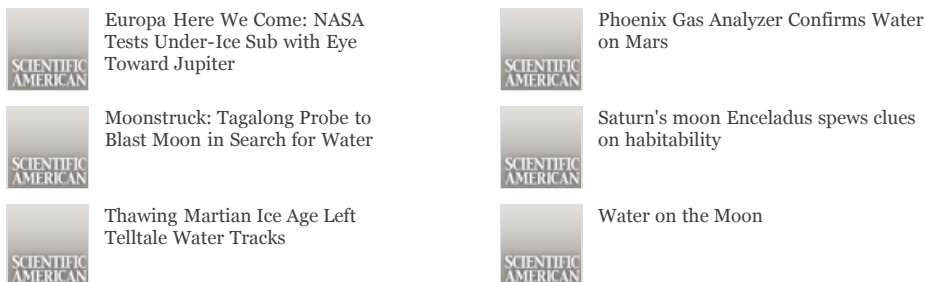
It is at those places of chemical disequilibrium, where water is in contact with Europa's hot rocky mantle, where life may thrive. Thermal vents at the bottom of Earth's oceans, where strange life forms congregate around "black smokers" that vent nutrient-rich chemicals, may be analogues for what's happening on the European ocean floor. Observations of the satellite's fractured sheath of ice and magnetometer readings from the Galileo [spacecraft](#) both suggest a salty water ocean hidden from view.

"We're pretty sure that the interior of Europa is warm and wet today," Pappalardo says. "I certainly think, when you look at those ingredients for life, that Europa rises right to the top of the places to explore."

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