Circle of Life

Which solar systems are more likely to harbor extraterrestrials? Those with lots of planets that make circular orbits.

If intelligent life is out there, it probably resides in a solar system with many planets. The more planets a star has, a recent study found, the more circular the orbits tend to be. Because planets on circular orbits do not move toward or away from their star, their climates may be stable enough to foster advanced life.

Our own solar system fits that pattern. The sun has eight or nine planets.
Ellipticity in History

Like any planet on an elliptical path, Mercury comes closest to the sun once every orbital period, but the position of the closest point changes faster than Newton's law of gravity predicted—convincing some 19th-century astronomers that a planet they named Vulcan was pulling Mercury off course. In fact, its proximity to the sun accentuates the (then unknown) effects of general relativity, which helped to confirm Einstein's theory.

—K.C.

Jack Lissauer, a planetary scientist at the NASA Ames Research Center, notes that the newfound correlation makes sense because planets on circular orbits do not interfere much with one another. A planet on an elongated path, on the other hand, can "mess up the orbits of the other planets and kick them out [of the system]," Limbach says.

These planetary road hogs do not make good abodes themselves. When near their sun, they fry; when far away, they freeze. Thus, intelligent beings are more likely to prosper on planets with circular orbits. Such beings would see many other worlds orbiting their star, just as we do—and may even bicker over which ones are truly planets.

—Ken Croswell

SOURCE: UNDERSTANDING ELLIPSE RELATIONSHIP AND THE SOLAR SYSTEM
COSMIC TARGET

Bull's-eye! The gas giant Jupiter looks like a target circle in this composite photo that depicts the planet's south pole. While no spacecraft has ever traveled directly under the planet, NASA's Cassini probe shot 18 photos of the pole while en route to Saturn, and the Cassini imaging team stitched them together. In reality, it's an impossible view since half the planet should always be covered in shadow. At the upper left lies the Great Red Spot, a major storm that has lasted for centuries. In addition, features as small as 75 miles across are visible throughout. — ERNEST MASTROIANI PHOTO BY NASA/JPL, SPACE SCIENCE INSTITUTE
Many small, frozen worlds seem to have warm underground oceans, making the search for alien life more exciting — and more confusing.

BY COREY S. POWELL

"Follow the water." That's been a guiding principle in the modern search for extraterrestrial life, based on the overwhelming evidence that all living things on Earth — no matter how exotic or extreme — require water to survive. For the past two decades, this emphasis on water has focused attention on Mars, where NASA has intently sought evidence of ancient rivers or modern trickles. Each eroded pebble and layer of sediment there has been heralded as an important clue.

Lately, though, the celestial dowsing process has been pointing in a sharply different direction, away from the majestic deserts of the Red Planet and toward a motley assortment of small, frozen bodies. The shift began in the late 1990s, when the Galileo spacecraft gathered evidence that Jupiter's moon Europa has a thick layer of water beneath its icy crust. No need to mince words: "Thick layer of water" is another way of saying "a vast, global ocean," one that just happens to be sequestered underground (or rather, under ice). Europa may hide twice as much water as all Earth's oceans put together.

Any thought that Europa was an anomaly soon evaporated with the discovery of geysers on Enceladus, a 300-mile-wide satellite of Saturn. Then the, er, floodgates opened as scientists began reporting evidence of water sloshing around inside Jupiter's moon Ganymede, Saturn's Titan and Mimas, and perhaps Neptune's Triton. There may be water layers inside Pluto and the dwarf planet Ceres, too.

"Instead of being the exception, maybe it's normal to have an ocean in an icy body," says Louise Prockter, a Europa expert at Johns Hopkins University. "And there are so many icy bodies we haven't even looked at yet."

Taken together, the evidence suggests that little ice worlds contain much, perhaps most, of the warm, wet real estate in the solar system. That epiphany inevitably leads to a pair of captivating questions. Could organisms really eke out a living in the eternal darkness of a subterranean ocean? And if so, does that mean our Mars-obsessed space program has been diligently looking for life in all the wrong places?

EUROPA UNION

As soon as I mention life, Prockter pauses and offers a gentle but firm disclaimer that she is not looking for...
“bugs” on Europa. “I’ve been horribly misquoted in the past,” she sighs.

True enough, but her work is central to addressing those existential questions: If anything lives on Europa, it probably needs a way for fresh materials to circulate from the surface down into the ocean. And if we want to find that alien life, it will be a lot easier if some stuff from the oceans migrates back up to the surface. The underlying issue, then, is whether the icy crust of Europa is dynamic and vital, or if it is more of an immobile casket. That’s where Prockter comes in.

About two years ago, she sat down with Simon Kattenhorn, a friend and colleague at the University of Idaho, and mapped out an enigmatic region where Europa’s landscape resembles a jigsaw puzzle. When the two researchers fit the pieces together, re-creating the original landscape, they found “a big hole in the middle”—a place where the original crust went missing. It almost surely ended up below the surface, shoved by the pieces’ motion, where it got recycled into the moon’s interior.

If old crust is disappearing in some places, then new crust must be forming elsewhere. That fits with other evidence that the cracks on Europa’s surface are slowly spreading, presumably pulling up stuff from below in the process. “There is material on the surface that’s quite likely ocean material,” Prockter says.

Bolstering that view, the Hubble Space Telescope recently detected large, intermittent clouds of water vapor hovering around Europa’s southern hemisphere. The strong implication is that liquid water lurks just below the surface, perhaps in glacial lakes akin to Lake Vostok in Antarctica. During local high tide, fissures in the ice crack open and water squirts out, forming a plume. That discovery parallels the current interpretation of the jets on Enceladus, driving home Prockter’s larger point: “We think of Europa as the poster child for icy satellites. If we can understand Europa, we’ll make great leaps toward understanding these other bodies.”

Europa and Enceladus seem to represent one extreme of the water worlds, places where the ice is thin and the ocean is just barely out of reach. With geothermal heat welling up from below and energetic compounds raining down from above, it’s not hard to imagine how life might gain a foothold on those moons. For Ganymede, Mimas and the rest, the liquid layer is probably locked away deeper, dimming prospects for life. Titan is a special case because it has hydrocarbon lakes on the surface in addition to a likely ocean underneath, making it a doubly liquid world that is literally awash in organic chemicals.

“There’s still a lot to be discovered on Titan; I hope there will be repeat missions, not just one,” muses Caltech’s Ed Stone. As lead scientist on the historic Voyager project, he oversaw the original reconnaissance of Titan in the 1980s. But in 2012, NASA rejected a proposed spacecraft mission to Titan’s lakes in favor of another trip to — you guessed it — Mars.

**TAKE ME TO THE OCEAN**

More broadly, the efforts to learn more about the hidden water worlds have proceeded at an agonizing half-pace. True, this year Ceres and Pluto will get robotic visitors, the
Dawn and New Horizons probes, respectively. The results should clarify those dwarf planets’ inner structures, but they’re unlikely to reveal much about life. Meanwhile, Europa, the archetype of the breed, hasn’t received a second look since Galileo’s termination 12 years ago.

The obstacles are both practical and political. Europa has the best-understood and most-accessible of the buried oceans, but even a probe on the surface would have a hard time figuring out what is happening beneath its ice.

At the same time, NASA’s obsession with Mars means little money is left over for a Europa mission — and the money needed would be substantial. Not only is Europa much farther from Earth, but it also orbits within Jupiter’s fierce radiation belts, so any probe there would need protection against destructive particle blasts. A meaningful exploration of Europa would probably cost at least $2 billion.

But wait! Help is on the way — from Congress of all places. Support there is steadily growing for the Europa Clipper, a concept that NASA has been nurturing and refining for the past few years. Proctor, who helped define the spacecraft’s scientific goals, is cautiously optimistic that this mission will really happen. NASA is currently evaluating proposals for specific instruments.

In its latest guise, the Europa Clipper would make repeated, rapid swoops past Europa before retreating to safer distances from Jupiter. Here at last is where the real answers could begin. Flying through the moon’s liquid plumes, the Clipper could map their sources and get a direct sample of Europa’s ocean, tasting for hints of biochemistry. Further ahead, some researchers envision submarines somehow breaching the European ice to take a direct look, or radiation-hardened rovers conducting life-science experiments at the edges of the geysers. But these are all distant possibilities, decades away at least.

“There might be a massive, well-developed ecosystem under the ice that we’ll never get to see — at least not anytime in the near future,” Proctor says wistfully.

It reminds me of President Kennedy’s words in 1962: “We choose to do these things not because they are easy, but because they are hard.” I’m also thinking about the Space Age lesson we’ve learned over and over since then: Each time we summon our resources and tackle the hard things, we achieve a new and deeper relationship with the universe. [1]

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