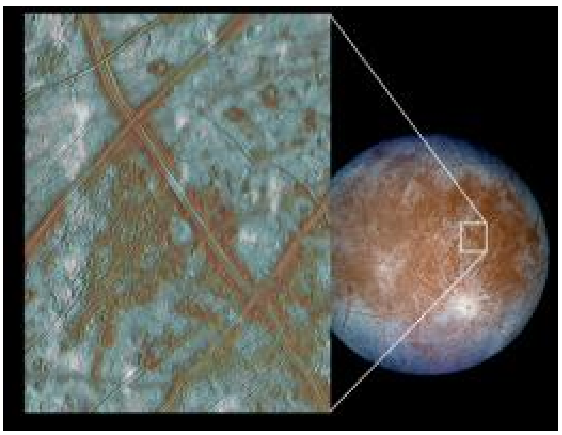
How deep must life hide to be safe on Europa?

March 29 2012, By Nola Taylor Redd



Comet C/1995 O1 Hale-Bopp, which shone in the night sky in 1997. Long period comets such as Hale-Bopp were once deemed to be the primary impact hazard to Earth. Credit: ESO

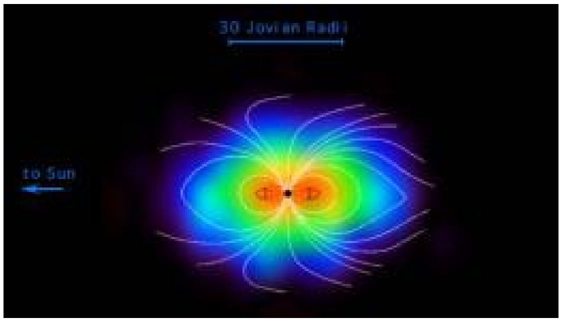
Jupiter's icy moon is subject to constant and significant blasts of radiation. A new experiment attempts to determine how deep life must lay beneath the crust in order to survive. This will be important for future missions looking for life on Europa.

Considered one of the best potential sources for extraterrestrial life in the solar system, Europa may hide life in the ocean deep beneath the moon's icy crust. Some organisms could even travel to the surface through cracks and instabilities in the crust. But radiation from Jupiter's magnetosphere constantly douses the tiny moon and could annihilate life at shallow depths, making it difficult to detect with an orbiter or lander. A group of scientists are seeking to experimentally determine just how deep organic life needs to hide on Europa in order to avoid being destroyed.

Jupiter's magnetosphere bombards the moons with high energy electrons in the megaelectron volt (MeV) range. But most of the scientific data on how high energy radiation affects organics has focused on the medical field, where studies sought to determine how chemotherapy affects the human body. That research focuses on water, the body's primary component.

"Simple theories of how deep the electrons go are only known for very high energy electrons," said Murthy Gudipati, of the Jet Propulsion Laboratory, California Institute of Technology, whose research focuses on electrons bombarding ice instead.

"Even in the megaelectron volt range, we do not have any laboratory data that has been measured on ices containing organic matter, which is really important for astrobiology."



Jupiter's magnetosphere, as captured by NASA's Cassini spacecraft. The magnetic field lines, sketched over the image, rotate with the planet, sweeping over its moons and subjecting them to massive doses of radiation that could be fatal to any organisms near the surface. Credit: NASA/JPL/Johns Hopkins

University Applied Physics Laboratory

The power of electrons

Gudipati and his team placed organic detector molecules behind ice of varying thickness, then fired an electron gun at them. They measured not only how deeply the electrons themselves traveled, but also the penetration of the photons knocked loose by the electrons -- a secondary effect that other experiments did not track.

"Those photons can penetrate far deeper and cause damage to organic matter," Gudipati said.

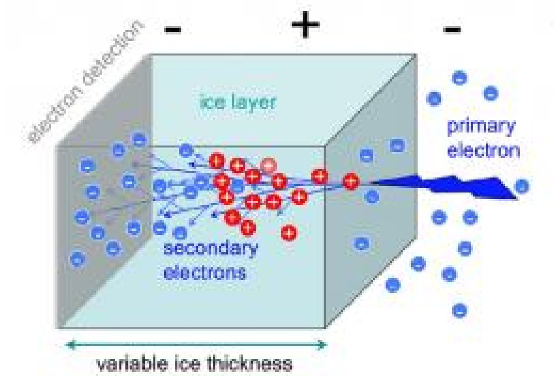
He paralleled the process with standing a person behind a wall, and speaking at different frequencies while changing the thickness of the barrier.

Except, of course, the frequencies studied here can kill organic molecules, rather than converse with them.

Wes Patterson, a planetary scientist at Johns Hopkins University, compared the effects of Jupiter's radiation to the radiation humans might experience.

"There's a reason why lab techs wear lead vests when giving X-rays," he said. "Exposure over a short time may not do too much to you, but if you're constantly exposed to radiation, it will harm the body."

He reiterated the importance of the research's experimentation with ice, rather than water, calling it "a vital first step."



As radiation shoot into the ice, they collide with molecules, knocking free a second wave of electrons that can be as damaging as the first. The team measured how far these dangerous particles traveled and their effect on organic matter. Credit: NASA/JPL

Step by step

The team focused on low energy electron radiation, up to ten thousand times less than the height of damage pumped out by Jupiter. In this range, the depth the electrons travel is directly related to the strength of the radiation.

They projected three scenarios as the bombardment increases in strength. Two take into account potential changes that may come with depth; at stronger energies, the electrons could do more or less damage, which the team has calculated. However, if the results remain the same at higher energy levels following normal behavior, radiation of 100 MeV will penetrate between 60 to 80 centimeters (23 to 32 inches).

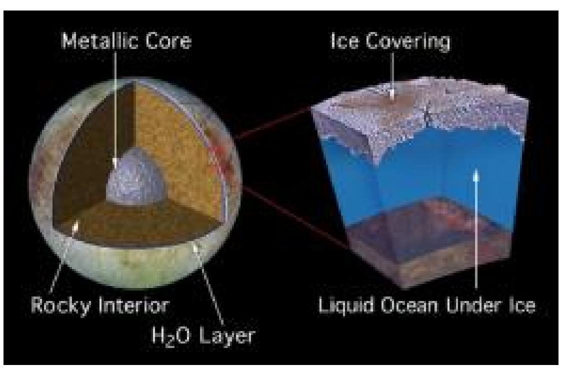
This may not sound like it would be a problem, but if a lander sent to Europa digs only two feet into a highly radiated area of the crust in search of life, it most likely wouldn't find any because electrons should have destroyed any organics in that region.

The team plans to extend their study on the effects of increased radiation energy incrementally. One reason for the gradual extension is because not all of Europa experiences the same exposure.

Jupiter's magnetosphere rotates with the planet, about every ten hours, while it takes 85 hours for the moon to orbit Jupiter. Consequently, the magnetosphere constantly overtakes the moon, exposing the back side, or trailing hemisphere, to more radiation than the front. The equatorial region of the trailing side takes more damage than its poles.

"We need to understand how that depth varies with location," Patterson said.

That's something Gudipati hopes to achieve.



Jupiter's icy moon, Europa, may contain a liquid ocean beneath its icy crust. Credit: NASA/JPL

"We need to do step-by-step lab studies covering as much of the region as possible that is pertinent for Europa," he said.

Eventually, he hopes to run experiments at energy ranges comparable to Jupiter's magnetic field, though he noted that each step will grow more expensive. But when it comes to preparing a mission to the icy moon, the cost of insufficient knowledge could be higher.

"If we are investing millions or billions [in a mission to Europa], then it is worth investing half a million to a million dollars to get this full range covered," he said.

Patterson agreed. "This looks like a really great start on something that would be important for future consideration for landing on Europa, and even for trying to understand what we could observe from orbit."

These experiments should help create realistic goals for potential missions to Europa.

Without them, finding organic molecules on the icy moon could be far more challenging.

Gudipati said, "If we do not know how deep to dig through lab simulations, we will be tossing a coin."

Source: Astrobio.net

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