Life could survive beneath the surface of Mars and other planets using high energy particles from space

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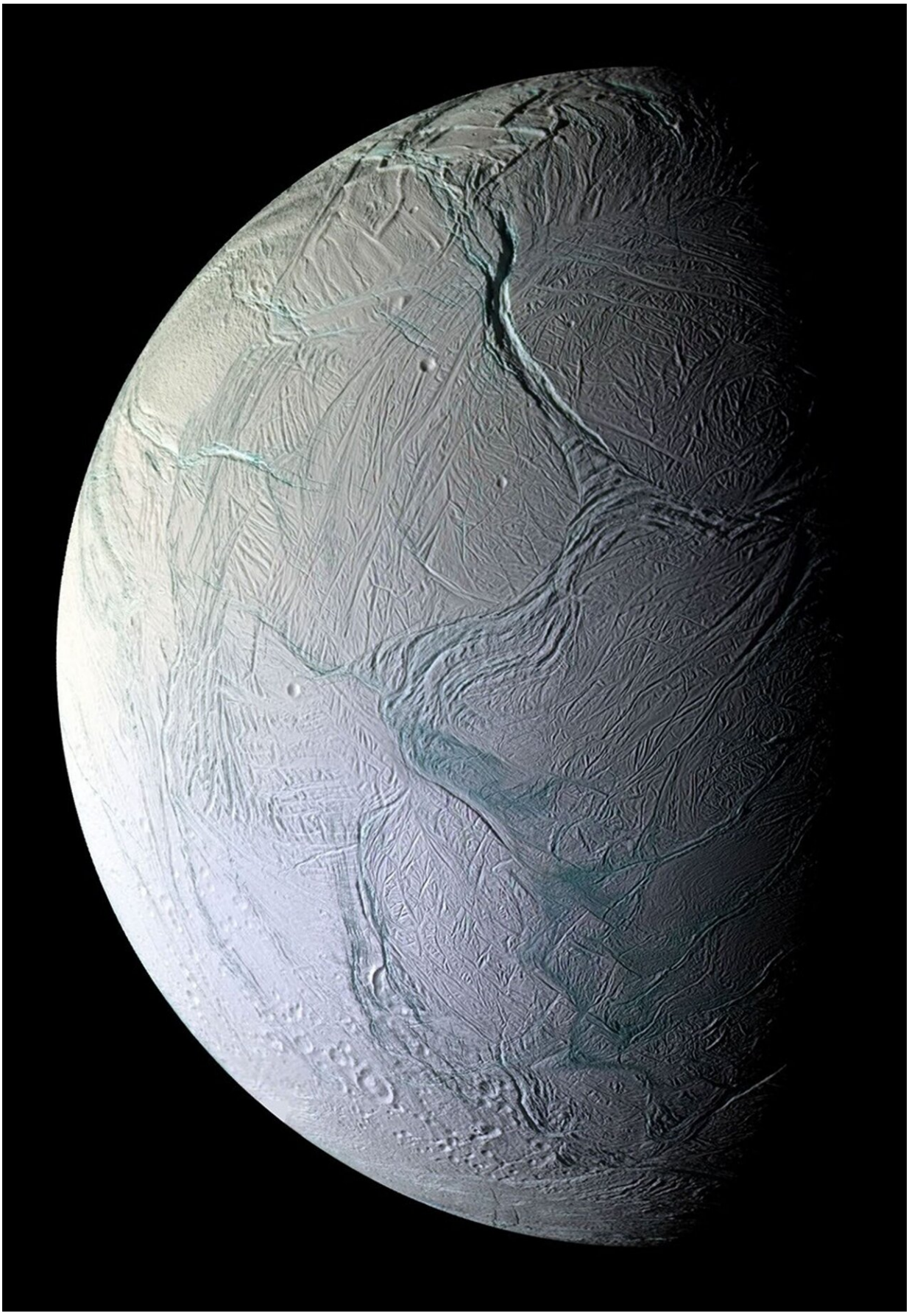


Enceladus (Saturn's moon). Credit: NASA

A new study from NYU Abu Dhabi has found that high-energy particles from space, known as cosmic rays, could create the energy needed to support life underground on planets and moons in our solar system.

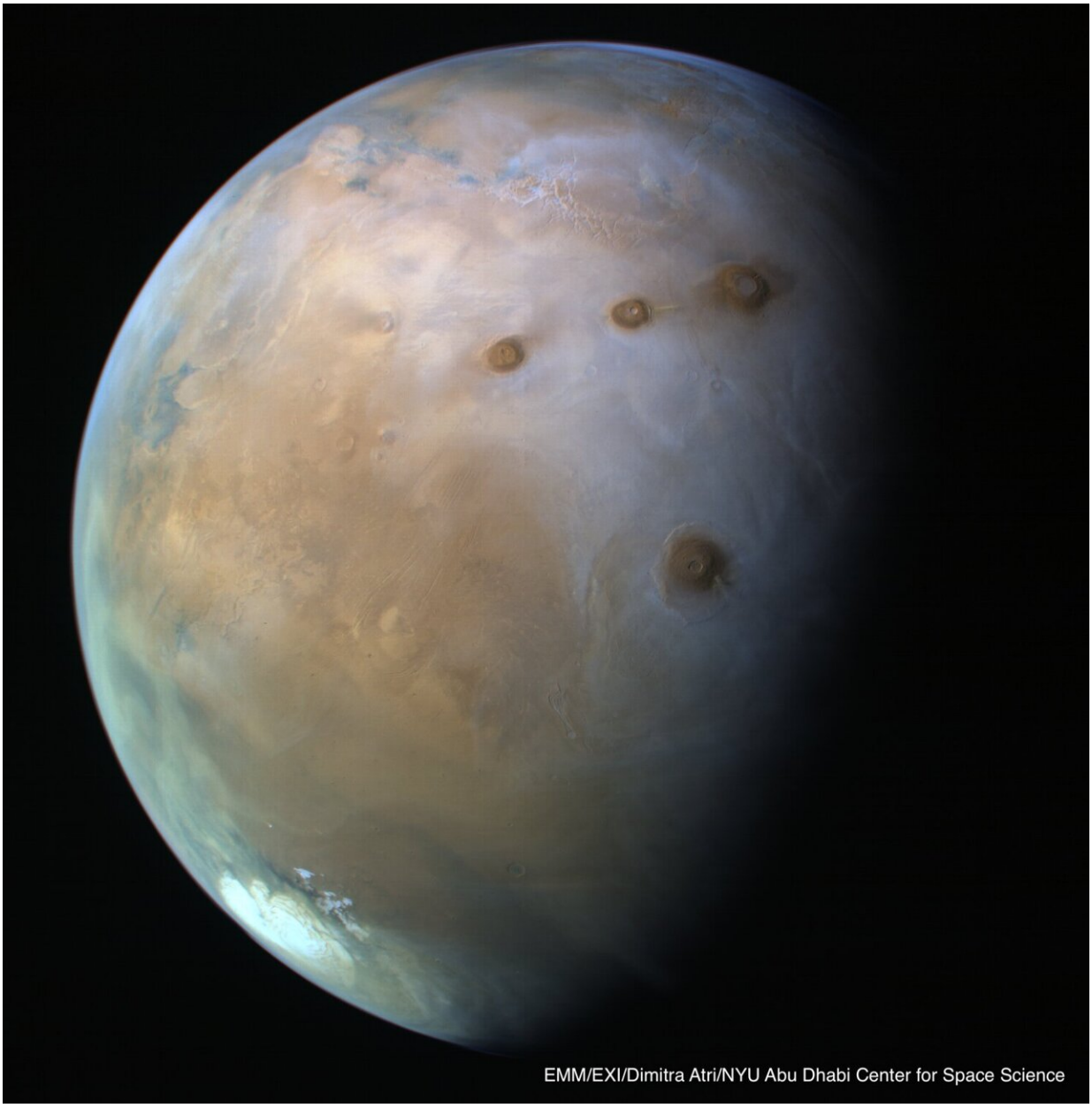
The research shows that cosmic rays may not only be harmless in certain environments, but could actually help microscopic life survive. These findings challenge the traditional view that life can only exist near sunlight or volcanic heat.

Published in the *International Journal of Astrobiology*, the study was led by the Principal Investigator of the Space Exploration Laboratory at NYUAD's Center for Astrophysics and Space Science (CASS), Dimitra Atri.

The team focused on what happens when cosmic rays hit water or ice underground. The impact breaks water molecules apart and releases tiny particles called electrons. Some bacteria on Earth can use these electrons for energy, similar to how plants use sunlight. This process is called radiolysis, and it can power life even in dark, cold environments with no sunlight.

Using computer simulations, the researchers studied how much energy this process could produce on Mars and on the icy moons of Jupiter and Saturn. These moons, which are covered in thick layers of ice, are believed to have water hidden below their surfaces. The study found that Saturn's icy moon Enceladus had the most potential to support life in this

way, followed by Mars, and then Jupiter's moon Europa.



Mars. Credit: Dimitra Atri, EMM/EXI/NYUAD/CASS

"This discovery changes the way we think about where life might exist," said Atri. "Instead of looking only for warm planets with sunlight, we can now consider places that are cold and dark, as long as they have some water beneath the surface and are exposed to cosmic rays. Life might be able to survive in more places than we ever imagined."

The study introduces a new idea called the Radiolytic Habitable Zone. Unlike the traditional "Goldilocks Zone"—the area around a star where a planet could have liquid water on its surface—this new zone focuses on places where water exists underground and can be energized by cosmic radiation. Since cosmic rays are found throughout space, this could mean there are many more places in the universe where life could exist.

The findings provide new guidance for future space missions. Instead of only looking for signs of life on the surface, scientists might also explore underground environments on Mars and the icy moons, using tools that can detect chemical energy created by cosmic radiation.

This research opens up exciting new possibilities in the search for life beyond Earth and suggests that even the darkest, coldest places in the solar system could have the right conditions for life to survive.

More information: Dimitra Atri et al, Estimating the potential of ionizing radiation-induced radiolysis for microbial metabolism on terrestrial planets and satellites with rarefied atmospheres, *International Journal of Astrobiology* (2025). DOI: 10.1017/S1473550425100025

Provided by New York University

https://phys.org/news/2025-07-life-survive-beneath-surface-mars.html