

## Talk about enceladus geography



Enceladus's geography is both complex and dynamic, shaped by an icy surface and significant geological activity. It has a highly reflective crust, primarily made of water ice, which makes it one of the brightest objects in the solar system. The moon's most fascinating feature is its south polar region, where "tiger stripe" fractures release plumes of water vapor, ice particles, and organic materials into space. These geysers suggest a subsurface ocean beneath the icy shell, potentially warmed by tidal forces from Saturn, which keeps the water in a liquid state.

## why does water mean life



Water is essential for life as we know it because it serves as a solvent, allowing molecules to interact and participate in chemical reactions crucial for biological processes. In liquid water, molecules can move freely, enabling complex chemistry, nutrient transport, and the formation of cell structures. Water also has unique thermal properties, which help regulate temperature in living organisms. On worlds like Enceladus, the presence of liquid water suggests the potential for similar chemical interactions, creating a possible habitat for microbial life.

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Digital Twin Instrument for Optimised Filter Selection: We will discuss the newly developed digital model of the instrument, which creates a framework for comparing and selecting various bandpass filters and sensor geometries. Strategically chosen filter profiles will facilitate the determination of black body emission curves, allowing for precise temperature measurements with a goal of improving constraints on global thermal emission due to tidal heating. The suitability of different filter profiles for NASA's science goals will be discussed.-  
Figure 1: Fractures at Enceladus' South Pole - Cassini's CIRS compared to Enceladus Thermal Mapper Warm fractures at Enceladus' South Pole vary in temperature along their length. (Left) One of the highest resolution thermal maps captured by Cassini. [2] (Right) Artistic impression: Orbiting at 150 km, ETM's ground track would be 31 km, and it would be capable of resolving 80 m features at nadir. References: [1] Howett, C. J. A., Spencer, J. R., Pearl, J., and Segura, M. (2011) J. Geophys. Res., 116, E03003. [2] NASA/JPL/GSFC/SWRI/SSI (2010) "Zooming in on heat at Baghdad Sulcus", Cassini-Huygens, <https://saturn.jpl.nasa.gov/> Summarize

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A new digital twin instrument model is being developed to optimize filter selection and sensor geometry for thermal analysis. This model enables comparison of bandpass filters to enhance blackbody emission curve measurements, ultimately refining temperature data related to Enceladus's thermal emissions from tidal heating. The study examines the efficacy of different filter profiles in meeting NASA's science objectives. Cassini data shows variations in temperature along Enceladus's south pole fractures, with the Enceladus Thermal Mapper (ETM) planned to provide high-resolution mapping for detailed thermal analysis.

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## What is oxford's ETM



Oxford's Enceladus Thermal Mapper (ETM) is a thermal imaging instrument designed to study Enceladus, one of Saturn's moons. This high-resolution instrument will map surface temperatures to better understand the moon's geological activity, especially its "tiger stripe" fractures at the south pole, which emit plumes from a subsurface ocean. By collecting data across multiple thermal bands, ETM aims to monitor temperature changes, assess tidal heating effects, and help identify regions potentially suitable for life.

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## How did the Cassini spacecraft gravity measurements



The Cassini spacecraft used gravity measurements to study Enceladus by tracking subtle changes in its own trajectory as it flew past the moon. These changes were detected as variations in the spacecraft's radio signals back to Earth, which allowed scientists to measure the gravitational pull of different regions on Enceladus. This data revealed that Enceladus likely has a global subsurface ocean beneath its icy crust, as the gravity field showed anomalies consistent with a liquid layer that affects the moon's density and structure.

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## how might low gravity affect us



Low gravity affects the human body in several ways. Muscles and bones weaken because they aren't needed to support body weight as they are on Earth. Without regular use, bones lose density, leading to increased risk of fractures. Additionally, bodily fluids shift toward the head, which can affect vision and cause facial swelling. The inner ear, which controls balance, becomes less reliable, affecting coordination. Extended periods in low gravity also alter the cardiovascular system, which adapts to reduced workload, potentially causing issues upon return to Earth's gravity.

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how would a vehicle combat low gravity adaptation on Enceladus



To handle Enceladus's low gravity, a vehicle could incorporate several design strategies to ensure stability and controlled movement. Wider, lightweight wheels or tracks with spikes would provide extra grip on icy surfaces, preventing sliding or bouncing. Adjustable ballast systems, which could add slight weight, would help keep the vehicle grounded. Additionally, small thrusters or gyroscopes could maintain stability, aiding precise navigation, especially on uneven terrain around the "tiger stripe" fractures. These adaptations would enhance the vehicle's ability to explore effectively in the moon's low-gravity environment.

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possible sources of power on Enceladus



Potential power sources for a vehicle on Enceladus would need to function in extremely cold and low-light conditions. Here are some options:

1. **Radioisotope Thermoelectric Generators (RTGs):** RTGs convert heat from decaying radioactive isotopes into electricity, making them reliable and long-lasting, ideal for Enceladus's harsh environment.
2. **Solar Panels with High-Efficiency Cells:** While sunlight is limited, advanced solar panels could still gather energy during short daylight periods, especially if coupled with efficient energy storage systems.
3. **Fuel Cells:** Using stored hydrogen and oxygen, fuel cells could generate power as needed, providing a controlled energy source.
4. **Tidal or Geothermal Power:** Although challenging to implement, future missions might consider tapping into tidal forces or internal heat sources if they can be accessed through the surface ice.

These options, especially RTGs, are currently the most feasible for sustaining long-term missions on Enceladus.

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