

Europa: The First Destination in the quest of Extraterrestrial Life

Speaking of the search for extraterrestrial life, the celestial body currently under the spotlight is one of the Galilean Moons, namely Europa. Who would have thought that even a small moon could potentially harbour life? That's the wonder of our universe, after all. If we didn't periodically investigate it, we would never learn about it. In this blog, we will be discussing this natural satellite of Jupiter, its mythological story, its features, the space missions and research conducted regarding this celestial body, and what its future fate might be.



Image Credit: Wikipedia

Journey to the stars with us as we cast our gaze upon Europa, a celestial marvel nestled among the Galilean Moons of Jupiter. Though it may be the most petite in that heavenly quartet, Europa stands



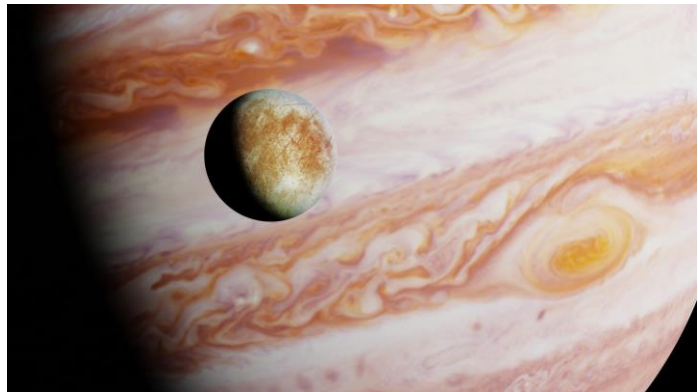
Image Credit: Wikipedia

proudly as the sixth-largest moon in our solar system, a testament to its grandeur. Its size rivals that of our lunar neighbour, yet its story is one of cosmic serendipity and mythological romance. Discovered by the visionary astronomers Galileo Galilei and Simon Marius on a winter's night in 1610, this icy orb was once known simply as Jupiter II. But fate, and a dash of scholarly rivalry, bestowed upon it a name rich with ancient allure—Europa, named for a Phoenician princess of Greek lore.

Characteristics

Enter the cosmic arena where Jupiter's mysterious moon Europa is doing a heavenly waltz around it. This moon, which is made of silicate rock and has a shimmering water-ice crust, suggests that it might have an iron-nickel core. Its atmosphere is as thin as a whisper against the vastness of space, a thin layer of oxygen. View the surface of Europa, a young face with hardly any impact craters visible, a white-beige tapestry furnished with light streaks. Europa is the smoothest sphere in the solar system; its immaculate exterior prompts the question of whether there is an ocean beneath it, a secret domain that may perhaps harbour extraterrestrial life.

A single revolution around its massive partner takes Europa roughly 3.5 Earth days to complete. Europa, perpetually trapped in a tidal embrace with its parent planet, creates a Sub Jovian point in the sky where Jupiter watches over us from the zenith, a permanent, menacing presence. A world of wonder is revealed by this dance between gravity and light, a moon that may hold the secrets to extraterrestrial life.



Europa with Jupiter
Image Credit: JPL (NASA)

Digging the Past

The myth of Europa sparkles in the fabric of tales that covers our night sky, telling the story of celestial destiny and divine love. Europa was once a princess of the Phoenician Kingdom, so beautiful that people travelled great distances to see her brilliance. Zeus, the king of gods, saw her on a fateful day on the seashore. He was struck by an arrow of eternal attraction, which was actually a plot of his own devising involving Cupid, the god of love. Transforming into a majestic white bull by his shape-shifting prowess, Zeus mingled with the herd overseen by Europa's father.



Image Credit: Wikipedia

Amongst the bulls, one stood out with a calmness and regality that captivated Europa. Little did she know, this was Zeus in disguise. Their mutual affection blossomed, and together they fled across the sea to Crete, where Zeus revealed his true form and crowned Europa as the queen of the land. These moonlit dreams of a god and a mortal are captured in paradise above. Since one of Jupiter's moons is similar to Europa in relation to Zeus. The moon Europa, named after their fabled love by astronomer Simon Marius, presently orbits Jupiter as a continual reminder of the romance that once transcended the boundaries of Earth and Olympus.



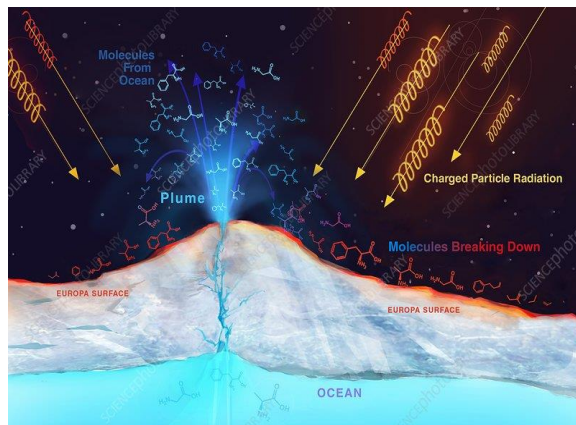
What's the deal with Europa?

Imagine a world where the potential for life whispers from beneath a shell of ice, where the dance of cosmic forces crafts an environment unlike any other. This is Europa, Jupiter's moon, akin to Saturn's Enceladus, both celestial bodies that tantalize us with the possibility of hidden organisms. The secret lies in their cryovolcanic activities and tidal flexing, geological ballets that could nurture life in the dark depths below.

Tidal Heating is also known as Tidal Flexing. Based on orbital mechanics, when two objects rotate and one lighter object revolves around a heavier object (e.g., the Earth revolves around the Sun), it must eventually follow a circular path rather than an elliptic path, which is referred to as Tidal Circularization. However, this is not the case for celestial bodies, as Kepler's rule for planetary motion asserts that celestial bodies always follow an elliptic route, which has been confirmed. Hence to avoid tidal circularization the lighter body revolving around the heavier body produces a certain amount of heat within its core. (This is like the resistance to follow a circular path, and this resistance can be seen in the form of heat energy in the core or interiors of the celestial body). In addition to this, as the celestial bodies also rotate about their axis, heat energy is also produced for this reason as well. Through these phenomena, Heat energy is produced among the celestial bodies which is called Tidal Heating.

The Heat Produced within the surface of Europa warms up the particles present in the core or within the surface. The water vapor particles present within the surface are warmed up to 0°C (273K) and the water vapor comes up in liquid phase and freezes as solid ice on the surface as it reaches 0°C . Thus, explaining the icy surface of the Europa. The Process of Vapours reaching the surface slowly will create a path for the particles to travel through the core. Sometimes, the high pressure due to heat produced in the core causes vapours to reach the surface with higher velocities thus causing vapours to burst out of the icy surface, along with some ice particles present around the vents to go along with the vapours.

Addition to this, Europa is enveloped by a tenuous atmosphere predominantly composed of oxygen. Unlike Earth, where oxygen is generated biologically via photosynthesis, Europa's oxygen arises from a non-biological process known as radiolysis. This process entails the dissociation of water vapor molecules into oxygen and hydrogen when exposed to intense radiation. Europa's icy surface, when traversing through Jupiter's powerful magnetosphere, encounters charged particles. These particles bombard the surface, leading to the release of hydrogen atoms from their vapor state. Due to hydrogen's lightweight, it escapes into space, leaving behind oxygen atoms. These residual oxygen atoms accumulate to form the moon's thin atmosphere. The creation of this atmosphere is a complex phenomenon, involving intricate mathematical and physical interactions beneath Europa's icy crust.



Space Missions

There is a long history of investigation of Europa, one of Jupiter's fascinating moons. Pioneer 10 and 11 offered the first low-resolution photos of its surface in 1973 and 1974. Later, more precise images of Europa's frozen landscape were provided by the Voyager 2 mission. With the launch of the Galileo Space Probe in 1995, a thorough investigation of the Galilean Moons was initiated, greatly expanding our knowledge of Europa and its siblings. More recently, the European Space Agency's JUICE mission, which was launched in 2023, briefly touched down on Europa, however its main objective was Ganymede, which is expected to reach the Jovian system by July 2031.



Image Credit: NASA (Artistic Impression of Pioneer Mission)



Image Credit: JPL (NASA) (Artistic Impression of Europa Clipper)

NASA's Europa Clipper mission, which is devoted entirely to studying Europa, is set to launch in October, marking a momentous occasion. The Europa Clipper, in contrast to conventional orbiters, will circle Jupiter and conduct 45 low-altitude flybys of Europa in order to collect comprehensive data. Due to its frozen surface, which is marked by tall, sharp ice spikes, landing on Europa presents significant hurdles that would be impossible to overcome with existing technology.

Conclusion

The ongoing research in the quest for extraterrestrial life may not have yielded the breakthroughs we often hope for as laypeople. However, it has underscored a compelling notion: Earth is not the sole celestial body with the potential to harbour life. There are numerous other entities within our Solar System alone. Expanding our perspective to our Galaxy, the Local Group, and the entire Universe, it seems less likely that we are alone in the vast cosmos. With our current limited knowledge, we cannot definitively say we are not alone. Yet, science demands evidence; without concrete proof, any claim remains theoretical. At this moment, in the absence of evidence of life beyond Earth, we might stand alone. The future, however, is unwritten. Only through relentless research and space missions can we hope to find answers to this profound question.

By, Vishnuthirtha SH
(Stargazing Expert)