Paper ID: 49488
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IAF SYMPOSIUM ON FUTURE SPACE ASTRONOMY AND SOLAR-SYSTEM SCIENCE MISSIONS (A7)
Science Goals and Drivers for Future Exoplanet, Space Astronomy, Physics, and Outer Solar System Science Missions (2)

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SCIENCE GOALS FOR FUTURE EXPLORATION OF THE HABITABILITY OF THE GASEOUS GIANT PLANETS' SATELLITES

Abstract

In the outer solar system, following in the footsteps of the Voyager missions, recent large space missions - involving international collaboration (like Galileo, Cassini-Huygens, or Juno) -, have determined with precision the properties of the dense and extended giant planets atmospheres, but also revealed among their complex satellites systems new possible habitats in icy moons with atmospheres harboring organic chemistry and water vapor, associated with internal liquid water oceans and available energy sources. Several of the satellites around Jupiter and Saturn show potential for habitable conditions [1]. Jovian moons Europa, Callisto and Ganymede are hiding, under their icy crust, undersurface liquid water oceans which, in the case of Europa, may be in direct contact with a silicate mantle floor and kept warm by tidally generated heat. Titan and Enceladus, Saturn's satellites, were found by the Cassini-Huygens mission to possess active organic chemistry with seasonal variations, unique geological features and possibly internal liquid water oceans. As revealed by Cassini, the liquid hydrocarbon lakes currently distributed mainly at polar latitudes on Titan are ideal isolated environments to look for biomarkers. If the silicate mantles of Europa and Ganymede and the liquid sources of Titan and Enceladus are geologically active as on Earth, giving rise to the equivalent of hydrothermal systems, the simultaneous presence of water, geodynamic interactions, chemical energy sources and a diversity of key chemical elements may fulfil the basic conditions for habitability. Such potential habitats can only be more thoroughly investigated with appropriate designed space missions, like ESA's L1 JUICE and NASA's Europa Clipper mission. Other mission concepts currently being studied include NASA's Dragonfly for Titan. I will discuss current and future means of exploration to answer scientific questions for these moons but also what they can teach us for our own planet.

[1] Coustenis and Encrenaz, 2013, In "Life Beyond Earth", Cambridge Univ. Press