

Prospects for Extraterrestrial Life on 'Exomoons'

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Surprisingly, the best candidates for harboring life beyond Earth in our Solar System aren't planets, but worlds that orbit the largest planets, Jupiter and Saturn. Why? The requirements of life on Earth include liquid water, a stable source of energy, and a supply of nutrients. We know of at least three moons (Jupiter's moon, Europa and Saturn's moons, Enceladus and Titan) that contain liquids, heat, and nutrients. Since these worlds lie beyond the habitable zone in our Solar System, where liquid surface water might exist, they could be habitable only below their frozen surfaces.¹ The discovery of well over 1,000 exoplanets (planets orbiting stars other than the Sun) during the past 20 years raises the question, how many of these exoplanets are orbited by natural satellites (aka 'exomoons') that might be habitable or even inhabited?

Moons have different contributions to their energy budgets that affect habitability, such as eclipses by their host planets, reflected sunlight and heat from their planets, and tidal heating, which can dramatically impact a moon's climate and geology. The most likely candidates for habitable exomoons would be worlds at least as massive as Mars orbiting very large gas giant planets in their star's habitable zone, where liquid water could exist on the surface of the exomoon. The minimum mass of a habitable exomoon is set by the requirements that the exomoon could gravitationally retain a substantial atmosphere and generate a magnetic field to shield the planet from harmful cosmic rays. Although there are no gas giant planets in the Sun's habitable zone, many giant exoplanets have been discovered in the habitable zone of other stars. In fact, citizen scientists participating in the highly successful *Planet Hunters*² project have made some of these discoveries. As remarkable as it may sound, the detection of large exomoons (comparable in size or larger than Ganymede, the most massive moon in our Solar System) is within the capability of planned survey missions, as well as the current Kepler mission.

Readers may recall that the 2009 James Cameron film *Avatar* took place on an inhabited exomoon orbiting a hypothetical gas giant in the Alpha Centauri star system. Once again, science fiction may prove prophetic as we learn more about the environments of other planetary systems... but I wouldn't bet on the floating mountains!

For those of you who live in the Chicagoland area: Planetary Scientist, Jesuit, and winner of the 2104 Carl Sagan Medal, Brother Guy Consolmagno, will present a public lecture at the Adler Planetarium on November 18, 2014, where he will also sign copies of his new book, *Would You Baptize an Extraterrestrial?... and Other Questions from the Astronomers' In-box at the Vatican Observatory* (coauthored with Fr. Paul Mueller, SJ). The book will be released on October 7, 2014. Check out this interesting interview with the book's coauthors: <http://americamagazine.org/content/all-things/%E2%80%98would-you-baptize-extraterrestrial%E2%80%99-author-qa-vatican-astronomers-guy>

¹ Heller, R. et al. 2014, *Formation, Habitability, and Detection of Extrasolar Moons*, *Astrobiology*, Vol. 14, No. 9, DOI: 10.1089/ast.2014.1147

² <http://www.planethunters.org/>