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Solar System Exploration including Ocean Worlds (5)

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PRIME: TACKLING CHALLENGES OF EXPLORING THE OCEAN WORLD ON EUROPA

Abstract

Probes for missions to our solar system's Ocean Worlds that penetrate their ice shells have been considered for nearly 20 years, since the time when scientific evidence strongly suggested an ocean on the moon of Jupiter called Europa. Scientific interest for these missions could explore four significant themes: 1) Geodynamics: what is the structure and dynamic state of the icy crust and ocean interface?; 2) Geochemistry: what is the chemistry of the ice and ocean?; 3) Habitability: does the Ocean World's past or present state provide the necessary environments to support life?; and 4) Life Detection: did life emerge on one of these Ocean Worlds, and does it persist today? JPL recently funded a broad look at a mission to Europa to identify the significant technology and operational challenges that have been overlooked with a sharp focus on the ice-penetration segment. The effort was named Probe using Radioisotopes for Icy Moons Exploration, or PRIME for short. A system designed to access the ocean of an icy moon is faced with technological hurdles exacerbated by severe thermal and volume constraints. This study identified challenges linked to: thermal control, the startup phase of ice penetration, communications while in the ice sheet, detecting and reaching the ocean in a programmatically-acceptable time, and detecting and avoiding in-ice hazards. A few means to overcome some of the specific challenges include options to use sonar for hazard and ice-ocean interface detection, reliable anchoring before reaching the ice/ocean interface to prevent uncontrolled descent to the ocean floor, store-and-forward communications architecture to provide a reliable two-way link, fluid loops for heat transfer to enable differential-thermal steering and non-electrical heating vehicle-wide, and pressure-balanced, oil-filled structures to minimize volume while reacting the hydrostatic pressures during descent. This paper will address the challenges and proposed solutions.