

## THROUGH THE EUROPEAN ICE: ADVANCED LANDER MISSION OPTIONS

Stephen Trowell and James Wild, University of Leicester  
Caltech Summer Undergraduate Fellows, Department of  
Physics, University of Leicester, United Kingdom; and  
Joan Horvath, Jack Jones, Elizabeth Johnson, and James  
Cutts, Jet Propulsion Laboratory, California Institute  
of Technology, Pasadena CA

A variety of options for missions to visit Europa and study it in depth are being discussed. A first reconnaissance may be made with an orbiter only. However, detailed examination of any water-ice ocean, particularly to determine the possible existence of biochemical materials, will require landing on and perhaps melting down through the ice itself to directly explore the European ocean.

A first mission to Europa will attempt to determine whether or not this liquid water exists. A currently-contemplated orbiter-only mission could be significantly enhanced by the addition of a small lander to make complementary measurements on the European surface. Such a lander would most likely contain seismic instruments and a mass spectrometer. This paper will cover high-level design of such a lander, including mass and power requirements and description of key technological developments required for a near-term launch.

Assuming this first mission determined it likely that liquid water did indeed exist, a more sophisticated lander package would be appropriate. In order to make quantitative measurements of the subsurface structure and environment of Europa, a vehicle capable of penetrating the surface ice layer by melting through it is proposed. This vehicle, dubbed a "cryobot" will be designed to carry a small deployable, tethered submersible (a "hydrobot") equipped with a suitable complement of instruments. This paper will describe strawman designs of this advanced lander as well and will discuss the many opportunities and challenges in creating such spacecraft. Work in progress at both Leicester and JPL to further determine cryobot feasibility through numerical modeling and mechanical prototyping will be described.