IAF SPACE EXPLORATION SYMPOSIUM (A3)
Solar System Exploration including Ocean Worlds (5)

Author: Prof. Antonio Genova
Sapienza University of Rome, Italy

Dr. David E. Smith
Massachusetts Institute of Technology (MIT), United States
Dr. Robin Canup
Southwest Research Institute, United States
Dr. Terry A. Hurford
National Aeronautics and Space Administration (NASA), Goddard Space Flight Center, United States
Prof. Maria T. Zuber
Massachusetts Institute of Technology (MIT), United States
Prof. Francis Nimmo
University of California, Santa Cruz (UCSC), United States
Dr. Mark Wieczorek
Observatoire de la Cote d'Azur, France
Dr. Erwan Mazarico
National Aeronautics and Space Administration (NASA), Goddard Space Flight Center, United States
Dr. Sander Goossens
University of Maryland, Baltimore County (UMBC), United States

MAGIC: A GEOPHYSICAL MISSION TO THE GALILEAN MOON CALLISTO

Abstract

The exploration of the Jovian system is one of the main science themes for future interplanetary missions. Multidisciplinary investigations of Europa, Ganymede and Callisto will be conducted by the NASA mission Europa Clipper and the ESA mission JUpiter ICy moons Explorer (JUICE). A better understanding of the interior structure of these Galilean moons is fundamental to provide evidence regarding the presence of an ocean underneath their icy shells. Our current knowledge of Callisto's interior is uncertain, due to limited resolution of the Galileo spacecraft data acquired during its flybys in the late 1990's. The JUICE mission will visit Callisto with 12 flybys (baseline tour), enabling further imaging, altimetry, magnetometer and gravity measurements, prior to going into orbit around Ganymede.

While Ganymede is a highly-evolved ice-rock moon with a differentiated interior and abundant surface evidence of internal activity, Callisto appears ancient and incompletely differentiated—perhaps largely unmodified since its formation. These characteristics make Callisto unique among all known and potential ocean worlds in its potential to reveal primordial conditions and outer satellite system origins. The thorough characterization of Callisto's surface and interior will require an orbital mission to provide highly accurate geodetic, geophysical, and multi-frequency inductive field measurements. This would provide the needed complement to the high-accuracy data set from JUICE in orbit around Ganymede.

The Magnetics, Altimetry, Gravity, and Imaging of Callisto (MAGIC) mission is conceived to address outstanding objectives regarding the properties of the moon's interior, ocean and ice shell. The science payload concept includes a framing camera, a dual fluxgate magnetometer system, and a 2-laser multi-beam altimeter. These three high heritage instruments enable high accuracy observations of the icy moon's surface and its magnetic field; the spacecraft telecommunication system additionally allows for a

dedicated gravity investigation.

After its arrival at the Jupiter system, the spacecraft will be placed in a 100-km altitude orbit to obtain the primary global datasets with the onboard instrumentation. The spacecraft is then lowered to a 50 km orbit for a primary mission phase of 12 months. The measurements collected from this low-altitude orbit will reveal Callisto's extent of internal differentiation, the thickness and density of the ice shell, and the existence and properties of a subsurface ocean. We present numerical simulations that support our expected estimates of Callisto's gravity field, and geophysical parameters that will constrain with high accuracy the properties of its internal structure and orientation.