Determining the Scientific Impact of a Geodesy Network at Enceladus

Principal Investigator: James Keane (322); Co-Investigators: Sang Park (392), Alex Berne (California Institute of Technology), Mark Simons (California Institute of Technology)

Program: FY21 R&TD Innovative Spontaneous Concepts

Objectives

We aim to develop the capability to invert for the interior structure and dynamics of Enceladus (quantified by the static and time-varying gravity field and topography) from a hypothetical geodetic network of radio beacons around Enceladus and perform the first investigation of the associated parameter space. The secondary objectives are to foster collaborations between JPL and Caltech, further the development of an early-career JPL scientist, and engage a PhD student in cutting-edge research.

Results

The primary task completed under this work was the upgrade of existing JPL capabilities (using the software package MONTE) to model tracking of multiple radio beacons orbiting Enceladus, and inverting for the gravity field. With these tools, one could consider multiple network configurations. With the successful implementation demonstrated in this Innovative Spontaneous Concept study, we now have the tools to invert these synthetic observations to determine how well the given network resolves key geophysical phenomena, which will be the subject of a future study.

Significance/Benefits to JPL and NASA

Geodesy provides one of the few ways to interrogate the hidden interiors of ocean worlds at a range of spatial and temporal scales—synergistic with seismology and electromagnetic methods. At Enceladus, it provides insight into the interior structure, composition, and heat sources—providing the environmental context needed for understanding habitability and interpreting any potential biosignatures detected there. Investment now will enable JPL to propose competitive Discovery and New Frontiers missions that explore habitability with a multi-pronged, wholistic approach—complementing and enhancing life-detection investigations. This is particularly timely, with the next round of Discovery and New Frontiers missions on the horizon, and the possibility of a dedicated Enceladus flagship class mission.

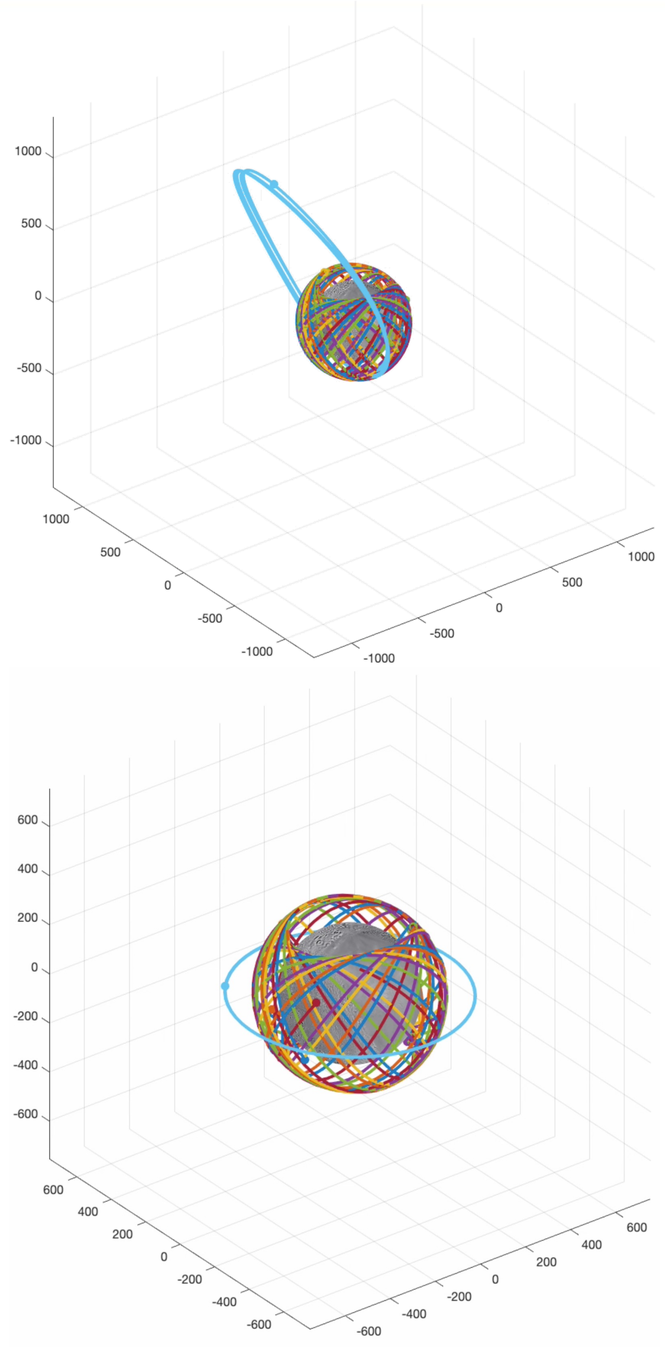

Figure: Two snapshots of the orbital configuration of 6 beacons, orbiting in stable, low-altitude inclined orbits about Enceladus, with a more distant "mothership" in a halo orbit (top) or equatorial orbit (bottom). In this study, we developed the tools to let us investigate how these configurations of radio beacons may be used to measure the gravity field (and thus interior structure) of Enceladus. Axes are in units of kilometers.

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

www.nasa.gov

PI/Task Mgr Contact
Email: James.T.Keane@jpl.nasa.gov

Clearance Number:
RPC/JPL Task Number: R21243