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Scientific Motivation and Requirements for Future Space Astronomy and Solar System Science Missions (2)

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AUGMENTING NASA EUROPA CLIPPER BY A SMALL PROBE: EUROPA TOMOGRAPHY PROBE (ETP) MISSION CONCEPT

Abstract

Jupiter's moon Europa is widely accepted as one of the most promising environment in the solar system able to sustain extra terrestrial habitability. Compelling evidence for the existence of a subsurface ocean was provided by the magnetic measurements of the Galileo spacecraft. The NASA JPL Europa Clipper mission is scheduled for launch in the 2020s. Because of the harsh Jovian radiation environment and budget limitations, the initial concept of an orbiter was abandoned and the spacecraft will perform only multiple flybys of the moon. Although Clipper will investigate the surface and subsurface properties with a powerful suite of instruments, the new mission profile is not favourable to the investigation of Europa's the deep interior structure. The Clipper project is considering an extra mass of about 250 kg to carry an additional flight element. We propose to augment the mission by including a small spacecraft, the Europa Tomography Probe (ETP), to be deployed on a polar orbit around Europa with a life-time of a few months. ETP will carry a magnetometer and a transponder for inter-satellite link. By exploiting the magnetic induction effect from Jupiter, the magnetometer will measure the Europa's magnetic polarizability, thus providing information on the thickness and conductivity of the internal salty ocean. The ETP transponder will establish a two-way relay link during each flyby, used to transfer telemetry data and to enable range rate measurements onboard Clipper. This configuration minimizes the required power onboard ETP and provides high quality Doppler observables using a simple ultra-stable oscillator hosted on Clipper. The limiting noise in Doppler measurements will be the frequency stability of ETP and relay electronics. Doppler data allow the determination of Europa's static gravity field to high resolution and its variable part due to eccentricity tides (Love number k_2). Furthermore, Doppler observables will constrain the Clipper position relative to Europa at a level of a few meters. The precise positioning of the main spacecraft with respect to Europa and the altimetric measurements from the radar REASON can be exploited to measure the tidal displacement (Love number h_2) of the outer icy shell. Together, magnetic

field, gravity, and possibly altimetric, measurements will place strong constraints on the deep interior structure of Europa and provide a good determination of the ice shell thickness and ocean depth. Despite the simplicity of the proposed configuration, ETP could considerably enhance the overall scientific return of Clipper.