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Introduction: As part of the exploration strategy laid out in the Solar System Exploration Roadmap, NASA plans to start the Outer Planets/Solar Probe Project in FY '00. The first three missions address key issues in both planetary exploration and the Sun-Earth connection disciplines. They are Europa Orbiter (EO), Pluto/Kuiper Express (PKE), and Solar Probe (SP). All require challenging new technologies and the ability to operate in deep space and at Jupiter (gravity assists from Jupiter are part of the PKE and SP missions). Use of common management and design approaches, avionics, and mission software is planned to reduce the costs of the three missions.

Rationale and Objectives: The rationale driving future exploration of Jupiter's satellite Europa derives from the possibility that Europa had, and may still have, an extensive liquid water ocean beneath its icy surface. Theoretical calculations and the advent of the first spacecraft data from the Voyager 1 and 2 flybys (in 1979) first raised this possibility. More recent data from Galileo include high-resolution images of the surface, spectral mapping, gravity and magnetic measurements. Analyses of these data have ruled out post-Voyager models involving only thin ice shells. They are consistent the conclusions that a liquid ocean once existed on Europa and that the current surface is geologically youthful, increasing the likelihood that a liquid layer may still exist [1,2,3]. It is unlikely however that Galileo data alone can resolve the question of whether there is a subsurface ocean today. The presence or absence of an extensive liquid layer is obviously a key to Europa's potential interest for prebiotic chemistry or even current biological activity as well as for strategies for future exploration. The Campaign Strategy Working Group for Prebiotic Chemistry in the Outer Solar System recommended that an orbital mission that could address these issues be considered as the next step in Europa exploration. A Science Definition Team (SDT) was formed to advise on investigation and mission strategies that could meet these goals.

The Europa Orbiter Science Definition Team recommended three "1A" objectives for the proposed Europa Orbiter mission. These are underlain by the desire to determine whether an ocean exists and to characterize the surface and sub-surface sufficiently to guide further exploratory missions:

1A Science Objectives

- Determine the presence or absence of a subsurface ocean
- Characterize the three-dimensional distribution of any subsurface liquid water and its overlying ice layers
- Understand the formation of surface features, including sites of recent or current activity, and identify candidate landing sites of future lander missions.

The SDT also identified secondary, "1B" objectives for the mission:

1B Science Objectives

- Characterize the surface composition, especially compounds of interest to prebiotic chemistry
- Map the distribution of important constituents on the surface
- Characterize the radiation environment in order to reduce uncertainties for future missions, especially landers

Investigations: In assessing experiments that could meet these objectives, the SDT suggested a strawman package of geodetic measurements, including gravity and altimetry, remote sensing mapping of the surface, and an ice-penetrating radar. It gave high priority to determining the tidal response of Europa through the geodetic measurements as potentially the best way of establishing definitively the existence of a liquid layer (rigid solid-body diurnal tides should be ~ 1m in amplitude compared with ~30 m for the liquid layer case). High-resolution mapping is required to understand the recent geologic history of the surface and to search for potential landing sites for future missions., The SDT felt that an ice-penetrating radar may provide the best method for characterizing the upper layers of the ice and searching for significant geophysical interfaces. Although there are large uncertainties in the electrical and scattering properties of ice on Europa, such a radar might sound the crust over a range of kilometers depth, possibly detecting the ice/water interface if it exists. The SDT noted that other experiments or groups of experiments could well be proposed that would address the 1A objectives.

Mission: A draft Announcement of Opportunity was released in January, '99 for comments, and selection of investigations for EO is expected in the Fall of '99. The Europa orbiter mission as currently designed uses a direct trajectory to Jupiter. The current planned launches are EO in 2003, PKE in 2004 and SP in 2007, although the launch order will be evaluated again in the next year and changed if critical technology milestones for EO cannot be met for the 2003 opportunity. Arriving at Jupiter in 2006, it first will go into Jupiter orbit and then achieve Europa orbit after a satellite "tour" lasting about 1-2 years, which reduces the propulsion requirement for entering Europa orbit. The prime orbital mission would last about one month, limited primarily by the high particle radiation dose expected at Europa (total dose estimated at 4 Mrad behind 100mils of Al). A high-inclination orbit with an average altitude of 100-300 km is planned, facilitating both geodetic and mapping objectives [4,5].

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Acknowledgements: This work was done at the Jet Propulsion Laboratory, California Institute of Technology under a contract from NASA.