Europa exploration: challenges and solutions

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Europa Exploration Background: Post-Galileo exploration of Europa presents a number of major technical challenges. Accomplishing the science objectives recommended by the NRC Decadal Survey and COMPLEX requires a more complex mission than a repeat of Voyager or Galileo-style flybys. In turn, this translates to a requirement to not only get into Jupiter orbit, but to orbit Europa itself and survive and operate within Jupiter's trapped radiation environment for long enough to achieve the major objectives.

Solutions: In this paper, we argue that recent investments in technology and research, particularly in the areas of radiation tolerant electronics and complex mission design, have now put us in a position to develop a Europa exploration concept in the flagship mission class that relies on demonstrated technologies and achieves the high level science objectives: 1. *Mass and Trip Time:* Utilizing indirect, Earth gravity assist, trajectories increases the available dry mass to $\sim$ 2000 kg (for delta-V EGA) - $\sim$3000 kg (for Venus EEGA). Trips times range from 4.5 to 8 yrs to Jupiter. The mass made available can be used to increase the science payload ($\sim$150 - 200 kg), increase available power, increase data taking lifetime, and enable the use of existing radiation hard electronic technologies. *2. Radiation Tolerant Electronics:* A significant program of radiation hard technology development has been done by NASA. The necessary radiation-tolerant elements are now ready for flight. 3. *Science Mission:* The science mission would last approximately two years, with a Jupiter system science phase of $\sim$1.5 yr and a 90 day nominal orbital mission at Europa, with some significant probability of functioning much longer. *4. Planetary Protection:* The ultimate fate of an orbiter will be impact with Europa. Planetary protection requirements will be met by radiation sterilization during the primary mission for most external and unshielded internal surfaces, combined with pre-launch sterilization of shielded components.

Summary: We conclude that a flagship class Europa mission can now be developed relying on existing technologies, having significantly more capability and returning considerably more science data than previous conventional propulsion mission concepts.

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