CREWED VENUS FLYBY: PRECURSOR TO MARS. K. D. Runyon[1], N. R. Izenberg[1], R. L. McNutt[1], C. E. Bradburne[1], M. Shelhamer[2]. [1]Johns Hopkins University Applied Physics Laboratory, Laurel, MD, USA (kirby.runyon@jhuapl.edu), [2]Johns Hopkins University Institutes of Medicine, Baltimore, MD, USA.

Introduction: Humans' first planetary foray out of the Earth-Moon system may well be on a flyby exploration mission of Venus. Not only would such a mission provide exploration and science opportunities at and on Venus, but would also serve as needed deep space practice for the first humans-to-Mars mission. This is a separate consideration from Venus flybys on the way to Mars in the same mission.

Communications Latency: On or orbiting Mars, astronauts will experience telecommunications latency with Earth due to the finite speed of light. The round-trip light travel time between Earth and Mars ranges from 6.4 minutes to 44 minutes, making real-time conversations impossible. For Venus, the same metric ranges from 4.6 minutes to 28 minutes (calculated via data from Wolfram|Alpha): comparable to the Mars case. A human Venus mission will give practice for dealing with this communications latency while providing a compelling exploration destination other than empty space such as a Lagrange point. In analog simulations, EVA crew have found that the equivalent of text messaging seems the best way to communicate with such a latency (Abercromby et al., 2013).

Crew Health: Information is currently lacking on the physiological and cognitive effects of long duration spaceflight outside Earth's magnetosphere on mission scenarios lacking a quick Earth-return capability. While a human Venus flyby mission would be shorter than even a human Mars flyby mission, it would not afford the opportunity to return to Earth at any time, unlike LEO and lunar missions. With the telecommunications latency, such a mission would provide emotional stressors and the opportunity to characterize and mitigate them for longer Mars missions.

Accessibility and Radiation: Venus, on average, is much closer to Earth (1.12 AU) than Mars (1.69 AU), allows for shorter overall mission durations (thus simplifying crew logistics and time in space) and has more frequent planetary alignments than Mars of every 19 versus 26 months. A human Venus flyby mission would take less than a year—shorter than some missions to the International Space Station—and yet still emulate a deep space transit with radiation levels and isolation challenges comparable to Mars transit.

Crewed Venus flyby missions enable multiple mission scenarios. All of these scenarios "kill two birds with one stone:" accomplishing human exploration and planetary science objectives for their own sake but also serving as test beds for more distant and longer-term human Mars missions. Specifically having a crew present en route, during, and after Venus flyby enables several mission architectures, including, but not necessarily limited to:

- Large, potentially modular probes or constellations launched in pieces and assembled by crew en route to Venus. Mission concepts includes cubesat – or larger – constellations [Majid et al., 2013], or probes launched in pieces in multiple SLS launches with final assembly en route to Venus,
- Real-Time Telemetry and human-in-the-loop probes actively guided in the Venus environment by human crew during the days or weeks around closest approach, where light-speed communication delays are minimal. These mission concepts include guide-able aerial platforms [Lee et al., Ashish et al] to surface rovers [Landis et al., 2003],
- Fast sample return from the Venus atmosphere, rendezvousing with the departing spacecraft instead of transiting to Earth. [Sweetser et al., 2014].

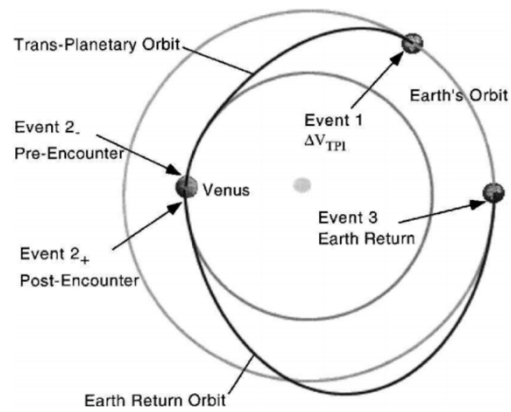

Fig. 2 Mission profile illustration (EVE).

Figure: Earth-Venus-Earth (EVE) mission (Crain et al., 2000)

Conclusion: A human Venus flyby simultaneously addresses human exploration and planetary science goals in addition to serving as an intermediate step to the longer range goals of a human Mars mission.

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