LEVIATHAN: A STARSHIP-BASED VENUS AEROBOT FOR LOW-ALTITUDE AND SURFACE EXPLORATIONS. J. T. Vistica, Leviathan Explorations (jvistica@leviathanexplorations.com).

Introduction: SpaceX's Starship [1] presents a significant paradigm shift in planetary exploration. While optimized for a target delivery of 150 tons to Mars and high production rates, the Starship can be leveraged for other missions. For example, a customized Starship can be sent on a one-way journey to Venus to deliver a unique long-lived Aerobot for surface and low-altitude exploration that can significantly increase our knowledge of Venus.

The Leviathan-class Venus Aerobot explorer [2] is a 31-ton nuclear-powered stainless-steel helium-filled semi-autonomous superpressure balloon with a cruising altitude of 8 km capable of landing and taking off almost anywhere with a payload and systems capacity of 15 tons. The Aerobot would be a Far-term Flagship mission for the 2030's.

Mission Summary: For a rigid superpressure balloon the larger the tank size the greater the payload capacity and the potential for more scientific return. In this mission a 13 m section of Starship itself is used as the helium tank giving a lift volume of 800 m^3 for the 31-ton lift capacity at the 8 km altitude's ambient conditions. This mission would be delivered by a customized SpaceX Starship on a one-way journey.

Starship modifications. This mission is designed to take maximum advantage of reconfigured Starship components (Figure 1) allowing development costs to focus on Aerobot control systems and instrument packages.

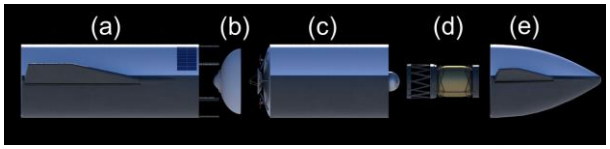

Figure 1: (a) engines and fuel tanks (50% standard size) and interstage disconnect (b) backshell with parachutes (c) Aerobot (d) cryogenic liquid helium tank (e) nose cone with interstage disconnect

Altitude Control System. An internal bladder [3] is used to provide variable altitude control. Inflating the bladder with outside air, the helium volume is compressed reducing buoyancy thus reducing altitude. This system allows the Aerobot to control its altitude and land and take off again at will.

Power. Power is provided by a 2-ton self-regulating 10 kWe Kilopower [4] fission reactor located in the helium volume providing power for heat pumps, batteries, and electronics. Output is 4 kWe at -2 km.

Helium Tank. 3300 kg of liquid helium is transported in an external cryogenic drop tank.

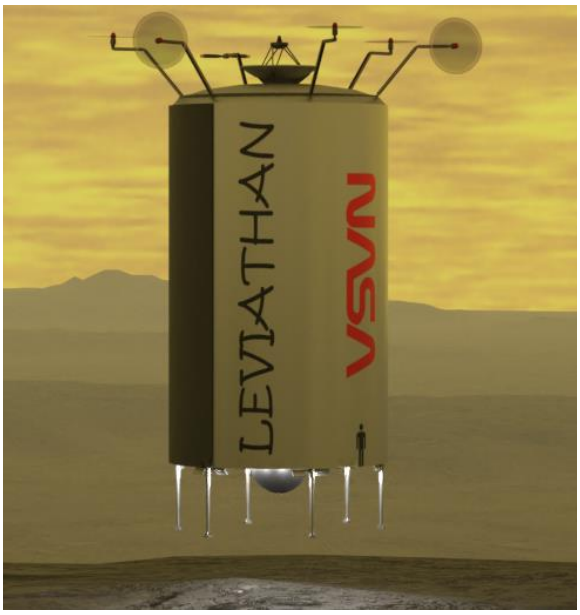

Figure 2: Aerobot landing maneuver

Aerobot specifications. (Figure 2)

- operational altitudes: -2 km to 8 km
- surface landings anywhere below 8 km
- able to circumnavigate the planet
- mission duration: possibly years
- primary transport: wind (0 to 14 kph)
- secondary transport: maneuvering propellers
- control sphere: active cooling and insulation maintains temperature for electronics

Conclusion: Previously proposed Venus landers have been limited to a single landing site and extremely limited duration. The Leviathan Aerobot could possibly operate for years and circumnavigate Venus in just 104 days using winds at 8 km but also be able to perform surface operations anywhere along its travels.

Complex surface operations for Venus have been written off as all but impossible. Not only are they possible, they could be realized in the next decade.

Venus conditions provide many challenges but also a unique opportunity to deliver a true global explorer in a Starship-based Leviathan-class Aerobot.

References:

[1] SpaceX (2021) *SpaceX Starship*. [Online].

[2] Vistica J. T. (2021) *Beyond Mars: Starship-Based Venus Explorer*. [Video]. YouTube.

[3] Loon (2021) https://loon.com. [Online].

[4] Poston D. I. et al. (2019) *Kilopower Reactors for Potential Space Exploration Missions,* NETS-2019, ANS (2019).