Testing the Viability of Directed-Energy Interstellar Exploration

D. Shen [1], P. Wu [1], O. Hsu [1], A. Pandey [1], A. Giri [1], D. Sotsaikich [1], A. Li [1], B. Yi [1], W. Sharpless [1], V. Khurana [1], D. Mai [1], R. Yuh [1], D. Deng [1], J. Mang, E. Stednitz [1], Z. Yun [1], J. Rothman [2], P. Lubin [2], T. Brashears [1]

[1] Space Technologies at Cal, UC Berkeley, Berkeley, CA, USA
[2] UC Santa Barbara, Santa Barbara, CA, USA

Abstract

Current research in electronics manufacturing by UCSB's Experimental Cosmology Group is enabling the development of satellites the size of a single wafer (WaferSats). When coupled with directed energy systems, such WaferSats offer the possibility of space exploration at 0.25c. Space Technologies at Cal is developing a scientific payload scheduled for launch on a Blue Origin rocket to provide further groundwork for the eventual launch of such WaferSats. By conducting microgravity research regarding laser ablation of asteroids, revival of C. elegans, and WaferSat laser communication, we work towards proving the viability of directed energy systems in propelling WaferSats carrying live passengers into interstellar space and provide novel data regarding the use of directed-energy systems in mitigating existential threats from asteroids.

Laser Ablation

Since the 1980s, near-Earth objects have become of high interest due to their potential danger to humanity. Research has shown that directed energy in the form of lasers is a feasible method of deflecting earthbound asteroid threats. However, empirical research in this field has been limited by the presence of gravity on earth. Using a 10 W thermal laser, a sample of representative asteroid material (basalt) will be ablated for approximately 30 seconds in a microgravity environment. A thermal imaging system will capture video of the ablation spot to compare the plume to numerical simulations and empirical data gathered in ground-based labs.

***C. elegans* revival**

Caenorhabditis elegans are nematode worms that grow up to 1 mm long. Aside from being a model organism in developmental biology, they also possess the ability to enter into a state of suspended animation when cooled to temperatures below -70 °C. While in this state, they can be kept for decades and subsequently revived with no side effects. Combined with their extremely small size, *C. elegans* are thus a prime astronaut candidate for long-duration interstellar missions. We will revive *C. elegans* in microgravity and observe their behavior and development to determine their viability as interstellar passengers aboard future deep space missions. Such work opens the field towards potentially seeding distant planets with earth-based lifeforms.

WaferSat Laser Communication

Interstellar spacecraft must be lightweight due to fuel restrains on long-duration missions. To this end, a satellite printed on a single silicon wafer would be the lightest possible spacecraft that still offers a sensor array to allow for data collection. Two WaferSats will utilize laser communication to send messages across the 2U payload space. We aim to prove the ability of WaferSats to function under typical launch conditions and promote to further development of ultralight satellites.

Conclusions

We provide scientific data from several microgravity experiments that lays the groundwork for advances in several different fields, including interstellar travel, planetary defense, and sending life beyond the stars.

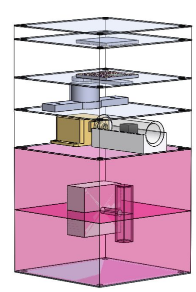

Figure 1: Render of microgravity payload