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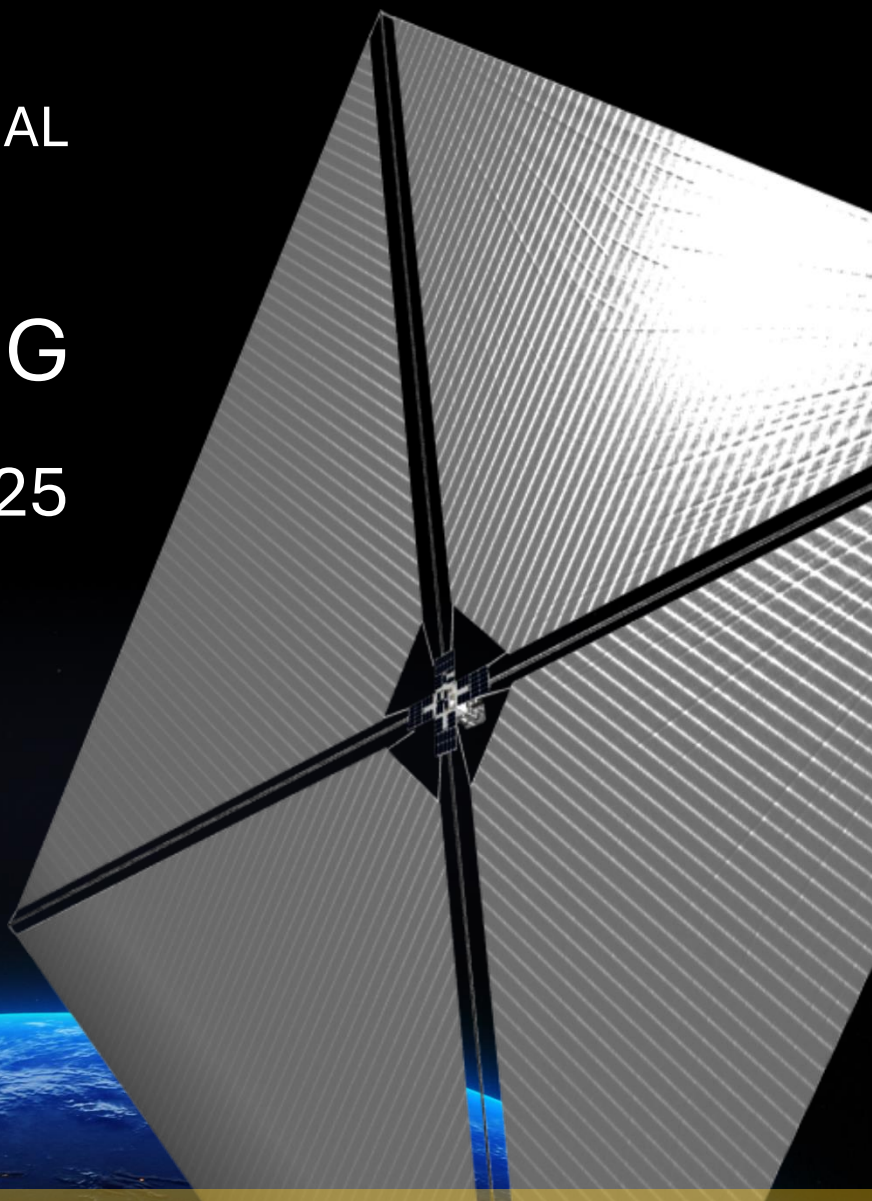

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Long-Term Performance Of Solar Sail Materials At L1 For Planetary Sunshade Applications

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The objective of this research is to evaluate the long-term performance of solar-sail satellite materials, focusing on their optical and mechanical resilience under space conditions near the photo-gravitational L1 point of the Sun-Earth/Moon center of mass, within the framework of the restricted three-body problem. The photo-gravitational force has a significant influence on the dynamics, in addition to gravitational forces. At L1, the solar sail would be exposed to direct sunlight for an extended period which can lead to high thermal loading that can degrade the optical properties of the sail materials.

To mitigate this, materials and coatings must exhibit high thermal stability and minimal thermal expansion to prevent misalignments or structural distortions. Additionally, solar sails are exposed to intense UV and gamma radiation and corpuscular parts of solar radiation: electrons, protons, and helium ions. These particles can degrade the optical properties of materials sensitive to radiation. Gamma and UV resistant materials and radiation-hardened communication and navigation systems are critical in these conditions.

This study is conducted within the framework of a planetary sunshade program, a space-based solar geoengineering strategy aimed at mitigating climate change by reducing the oncoming electromagnetic part of solar radiation. The program envisions deploying a swarm of solar-sail satellites around L1 to cast a partial shadow on Earth over an extended period.

Key aspects of this research include the structural analysis of solar sail deployment, thermal stability assessments, and the numerical modeling of thermal desorption techniques in multi-layered material designs to enhance durability and scalability for long-duration missions. The findings contribute to the advancement of planetary sunshade systems as a scalable and robust solution for global climate mitigation.

References

[1] Ancona, E., & Kezerashvili, R. (2016). Temperature restrictions for materials used in aerospace industry for the near-Sun orbits. Acta Astronautica.
[2] Ancona, E., & Kezerashvili, R. (2018). Extrasolar Space Exploration by a Solar Sail Accelerated via Thermal Desorption of Coating. Advances in Space Research.
[3] Matonti, C, L., Scantamburlo, E. & Romano, M. (2023). New Families of Halo Orbits about the Photo-Gravitational Equilibrium between Sun and the Earth–Moon System for Planetary Sunshade Missions. 74th International Astronautical Congress.
[4] Chesley, B., Matonti, C. L., Sonty, S. S., Gutowska, M., & Romano, M. (2023). A Conceptual Framework for Climate Change Mitigation Actions Employing In-Space Geoengineering. 74th International Astronautical Congress.
[5] Matonti, C. L., Coco, M., Governale, G., Wilk, L., Shimazaki, T., Krantz, E., Pushparaj, N., Mao, H., Tibert, G., Cappelletti, C., Romano, M., Fuglesang, C., Chesley, B. (2024). Roadmap toward a Planetary Sunshade for Space-based Solar Geoengineering. 75th International Astronautical Congress.