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ROADMAP FOR AN INTERNATIONAL PLANETARY SUNSHADE (IPSS)

Abstract

Countering climate change is the most crucial challenge for humanity in the 21st century. One possibility to mitigate global warming without directly modifying the Earth's atmosphere is shading the Earth with one or several thin structures positioned at the Sun-Earth Lagrange Point L1 in an international collaboration. The technological feasibility of producing these sunshades from space resources and the logistical aspects of transfer and deployment must be assessed. In this work technologies for lunar in-situ resource utilization, manufacturing of the sunshades in space, and ways to produce solar cells for powering production facilities and sunshades were examined. Based on a possible shade design an analysis of the logistical transportation aspects was conducted including possible transfer trajectories, an innovative design for a lunar launch infrastructure, as well as an attitude and orbit control system for sunshades. The state-of-the-art of key technologies for sunshade production and operation, as well as trends for the future were applied to a roadmap proposing steps to be taken on the way towards the implementation of an International Planetary Sunshade (IPSS) system. This has shown that the trend of in-space manufacturing and international goals for lunar exploration can be utilized for accelerated sunshade development. Many technologies which are required to manufacture satellite structures in space or to operate sustainable lunar exploration are similar to those technologies required for producing sunshades in space. Capabilities to manufacture thin metallic foil and solar cells from space resources must be demonstrated. International heavy launcher capabilities combined with a lunar coilgun concept are the first step enabling continuous lunar logistic operations to efficiently build-up sunshade mega constructions. Solar sail and laser-beam-driven concepts should form the basis for energy-efficient and sustainable transport of sunshades. Based on recent achievements in superconductive materials the construction of large coils and the load-bearing capacity of the lunar coilgun must be demonstrated. However, if pursued near-term, the timeframe for technology demonstration is still feasible and first sunshades of the IPSS system could be operated by 2060. Advancing the development of sunshade production technologies not only allows for reduction of global warming, but for many other applications that would facilitate ground-breaking space operations.