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A NEW FAMILY OF PHOTOGRAVITATIONAL SUN-EARTH L1 HALO ORBITS TO ENABLE PLANETARY SUNSHADE

Abstract

The objective of this paper is to present a new family of photogravitational Sun-Earth halo orbits to enable planetary sunshade in the perspective to mitigate Earth's climate changing through a swarm of satellites, focusing the research on the swarm orbits characteristics and solar sail orientation requirements.

The Earth's climate changing is mostly due to the increasing concentration of greenhouse gas in the atmosphere, which causes the general rise of the temperatures. To mitigate this, a space-based geoengineering infrastructure has been previously proposed to reduce the oncoming solar irradiance, by setting a 'solar light umbrella' between Sun and Earth.

First, an analysis and further evaluation is developed for the two cases of constant attitude (À. Jorba 2010) and time-varying attitude (J-P. Sánchez 2015) photogravitational L1 halo orbits defined in the Sun-Earth Circular Restricted Three Body Problem (CR3BP) with Solar Radiation Pressure. Then, special orbits are here proposed (for the first time to the best knowledge of the authors) for the planetary sunshade that have a shape characterized as follows. They have a constant position along Sun-Earth angular momentum direction and a periodic motion along the two other orthogonal directions. Then, the analytical expression of the orientation history required to maintain the special orbits proposed are stated, and subsequently their existence is proven.

Furthermore, a realistic case is analyzed, for each family of orbits considered, by propagation in a high fidelity model considering a Sun-Venus-Earth-Moon-Jupiter system. In perspective, the newly proposed orbits could be used to produce a non-uniform shading on Earth.