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MODELING THE SPACE DEBRIS ENVIRONMENT FOR HYPERVELOCITY IMPACT RISK ASSESSMENT ON SOLAR POWER SATELLITES

Abstract

The evaluation of the impact of space debris and micrometeoroids on Solar Power Satellites (SPS) is a critical area of research, pivotal for the long-term sustainability and reliability of these space-based energy systems. Solar Power Satellites are a sustainable solution and promising clean energy alternative that provides large-scale electric power from solar power via microwave beaming from GEO to Earth. Given the exposure of SPS to the harsh space environment, understanding the frequency and consequences of impacts based on satellite configuration is essential for designing resilient systems. This study aims to assess how different SPS configurations affect the incidence and implications of space debris strikes.

Using a combination of computational modeling, historical data analysis, and impact numerical simulation, the study involves several types of SPS configurations. Each configuration is evaluated for its surface area exposure, potential shielding strategies, and structural vulnerabilities to environmental impacts. The analysis incorporates factors such as orbit altitude, inclination, and the SPS's operational lifespan to predict the likelihood of space debris encounters. Each SPS design presents challenges in shielding and repairability, leading to increased vulnerability to strikes damage over time. The results indicate which configuration offer enhanced resilience to impacts due to their reduced surface area exposure and the capability to isolate damaged modules, minimizing the risk of catastrophic failure.

The study underscores the importance of incorporating space debris and micrometeoroid impact assessments in the early design phase of SPS projects. It suggests that future SPS designs should prioritize the development of advanced materials and shielding techniques, to mitigate the risks posed by space debris. This approach not only enhances the risk posed on the durability and reliability of SPS by space debris but also provide ways to ensure the sustainable operation of these crucial systems in providing clean and continuous solar power from space.