

Conversations on space debris

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Since the beginning of the era of space exploration in 1957, artificial objects have been left behind in the near-Earth environment. At velocities of 10 km s^{-1} , even small objects pose a significant risk to human activity in outer space. This debris population continues to grow due to ground launches, loss of external parts from space ships, and uncontrollable collisions between objects. The reason to present such research at a conference called “Biomath” is a surprising similarity to the mathematical modeling of spatially structured biological populations that are subject to birth and death processes, diffusion, as well as inter-species interactions. In the first part, we propose a diffusion-collision model for the evolution of debris density in Low-Earth Orbit (LEO, 200 - 2000 km altitude) and its dependence on ground-launch policy. We parametrize this model and test it against data from publicly available object catalogs to examine timescales for uncontrolled growth. In the second part, we will report on some ongoing work to elucidate the somewhat cryptic title.

References

- [1] A. Okubo, *Diffusion and Ecological Problems: Mathematical Models*, Springer Verlag, Berlin, New York, 1980
- [2] J. Jurkiewicz, P. Hinow, A population dynamics approach to the distribution of space debris in Low Earth Orbit, *Comm. Appl. Math. Comput.*, **6**:340-353 (2024) arxiv.org/abs/2210.16179