SCUDEM@COMAP

Student Challenge Using Differential Equations Modeling

SCUDEM X 2025
Problem A: It Is Raining Space Dust

A large number of small particles, referred to as Cosmic Dust, constantly fall on the earth's atmosphere. Cosmic dust has a wide variety of shapes and sizes, and it comes from a wide variety of sources. The sources of cosmic dust range from comets from outside the solar system to asteroids within the solar system. Some of the particles remain intact as they fall and reach the earth's surface. The size of the particles range from just a few molecules to over 0.1mm. The particles also have a wide range of velocities.

Cosmic dust is studied because it offers one way to gain insight into how matter is distributed. The variation in sources, size, and momentum may offer some clues into the various cycles that matter might undergo over time[1], but there is a great deal about the phenomena that is not understood. To better understand the phenomena cosmic dust is collected in many different ways including capturing in complex space missions. Our goal, here, is to explore how the particles found on the earth's surface can be used to help better understand the phenomena.

The path that cosmic dust takes to the earth's surface can be complex. The particles travel long distances. They also have to contend with the adverse effects of falling through the earth's atmosphere at high velocities. Your team is asked to examine and predict what might happen to small particles as they enter the earth's atmosphere. For this initial study you should make some assumptions to greatly simplify the situation, and the goal is to provide an initial estimate to what happens to different size particles with different velocities as they fall through the earth's atmosphere. Given your findings, is it possible to use an estimate of the distribution of particles of cosmic dust found within a given strata of the earth's surface from a certain time period and work backwards to estimate the distribution of cosmic particles that entered the earth's atmosphere at that time?

Bibliography

[1] Walton, C.R., Rigley, J.K., Lipp, A. et al. Cosmic dust fertilization of glacial prebiotic chemistry on early Earth. Nat Astron 8, 556–566 (2024). https://doi.org/10.1038/s41550-024-02212-z