Evolution of Cometary Dust Particles to the Orbit of the Earth: Particle Size, Shape, and Mutual Collisions

*Hongu Yang, Masateru Ishiguro[1]

1. Seoul National University

In this study, we numerically investigated the orbital evolution of cometary dust particles, with special consideration of the initial size–frequency distribution (SFD) and different evolutionary tracks according to the initial orbit and particle shape. We found that close encounters with planets (mostly Jupiter) are the dominating factor determining the orbital evolution of dust particles. Therefore, the lifetimes of cometary dust particles (~250,000 yr) are shorter than the Poynting–Robertson lifetime, and only a small fraction of large cometary dust particles can be transferred into orbits with small semimajor axis. The exceptions are dust particles from 2P/Encke and, potentially, active asteroids that have little interaction with Jupiter. We also found that the effects of dust shape, mass density, and SFD were not critical in the total mass supply rate to the interplanetary dust particle (IDP) cloud complex when these quantities are confined by observations of zodiacal light brightness and SFD around the Earth's orbit. When we incorporate a population of fluffy aggregates discovered in the Earth's stratosphere and the coma of 67P/Churyumov–Gerasimenko within the initial ejection, the initial SFD measured at the comae of comets (67P and 81P/Wild 2) can produce the observed SFD around the Earth's orbit. Considering the above effects, we derived the probability of mutual collisions among dust particles within the IDP cloud for the first time in a direct manner via numerical simulation and concluded that mutual collisions can mostly be ignored.

Keywords: Interplanetary dust particles, dynamical evolution, size frequency distribution, dust ejection

