

Thermal Radiation Pressure as a Possible Mechanism for Losing Small Particles from Near-Sun Asteroids

*Yoonsoo P. Bach¹, Masateru Ishiguro¹

1. Department of Physics and Astronomy, Seoul National University

Recently space explorations of near-Earth asteroids (NEA) (25143) Itokawa, (162173) Ryugu, and (101955) Bennu have indicated a paucity of micron-sized fine-grains on the surface, which is likely different from that of larger asteroids, such as (4) Vesta and (433) Eros. Meanwhile, meteoritic samples show granular structures of size scales down to mm or even sub-micron scale. It is, therefore, expected that mechanisms including thermal fatigue or micrometeoroid impacts would supply a myriad of sub-micron to sub-mm debris particles on the asteroid surfaces. Then how have these continuously-supplied-micron-sized grains been lost from the NEA's surfaces? Among the NEAs, (3200) Phaethon has been showing recurrent activities at its perihelion, i.e., the dust cloud consisting of an effective particle radius ~ 1 micron. This is a hint that such small grains are not only being generated, but also being removed by ejection, although the ejection mechanism is unknown.

In this work, we suggest a unique idea that thermal radiation from the asteroidal regolith, viz., thermal radiation pressure (TRP), can play a dominant role in removing those small particles selectively. Our model predicts TRP is stronger at a smaller heliocentric distance while almost negligible at a distance of $> \sim 0.8$ au. It is also shown that TRP is the most effective for particles of radius $\sim 1 \mu\text{m}$. Our theoretical estimate of the size is well consistent with the previous observational studies of Phaethon's dust cloud (radius $\sim 1 \mu\text{m}$). In the JpGU 2021 meeting, we will compare our TRP model with other mechanisms such as electrostatic dust levitation and discuss the future application of this theory to Phaethon to investigate a scientific case for JAXA's DESTINY+ mission.

Keywords: Minor planets, asteroids