Electrostatic Dust Levitation Near Asteroid Itokawa

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A plasma sheath is created when the solar wind and solar UV radiation interact with the surface of airless planetary bodies, such as the Moon and asteroids. It has been hypothesized that, due to the low gravity of these bodies (as much as 5 orders of magnitude smaller than Earth's gravity), small dust grains may levitate in the plasma sheaths. Observational evidence for planetary dust levitation is weak: Surveyor horizon glow observations from the Moon have been attributed to zodiacal light after re-analysis. and levitation is one of several possible explanations for the 'dust ponds' on the asteroid Eros. However, electrostatic dust levitation has been observed in the lab. Additionally, we have shown that dust levitation is possible (and that stable levitation can occur) near asteroids using numerical simulations with simplified asteroid shape and plasma models.

The plasma environment near the surface of an asteroid depends strongly on the asteroid's shape. We have created a treecode-based 2D plasma model. This model is able to simulate the plasma environment (including photoelectron emission) about realistic asteroid shapes. Specifically, we have modeled the plasma environment about the asteroid Itokawa's equator. Coupling the plasma model with the shape-derived gravity field and a model of solar radiation pressure, we have developed a highly accurate representation of the near-surface environment. We have identified locations and dust grain sizes, both in the sunlit and plasma wake regions, where levitation may be possible. Additionally, we will present a comparison of our predictions for levitation in the sunlit region of Itokawa with predictions generated using simplified plasma and spherical gravity models. Finally, we will discuss the stability of levitation in various regions of Itokawa and the potential for global dust transport.