Key observations to understand the internal structure of Phobos

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Observations of Phobos by many spacecraft such as Viking orbiter, Mars Global Surveyor, mars Odyssey, Mars Express, and Mars Reconnaissance Orbiter provided variety of datasets of the satellite including visible and color images, UV spectrum, global and high-resolution near IR and IR reflectance spectrum, radar reflectance, and precise orbiting parameters. However, because all of these missions have studied Phobos at distance, critical observations such as high-resolution imaging and precise gravity measurements have not been performed yet. In addition, Phobos exists in a very unique circum-Martian environment, which is significantly different from asteroids in the main belt. For example, impacts to Phobos should show the leading and trailing asymmetry due its synchronous rotation, which should also affect the deposition rates of re-impact of ejecta originated from Phobos itself. Also, the surface should have experienced space weathering due not limited to solar wind but also escape irons from Mars. Secondary impacts from Mars may contaminate the regolith of Phobos as well. Thus, understanding these processes is necessary to obtain a basic picture of surface evolution of the satellite. Important and necessary observations in the future mission would include (1) comprehensive mapping of craters and boulders, (2) study of sedimentary structures (if any) of regolith (layers) at high-resolution images, (3) high-resolution observations of geological features including grooves and depressions, (4) understanding of the degree of space weathering and its spatial distribution, and (5) a detection of dust ring on Phobos orbit.
The two distinctive color units observed on Phobos are interpreted in several ways, including an exposure of fresh internal materials over relatively weathered and totally different geological unit. In either case, their nature and understanding the surface processes would be important to derive information regarding its internal structure. Importantly, we do not know if an internal core exist or not, or even if the internal Ice exist (can vary from 0 to 60%). Also, the estimated bulk porosity can vary up to 70% and the surface materials may not represent the body. Therefore, key observations regarding the internal structure would include: (1) Detection of internal water-ice, which may be constrained by measurements of ion flux from inside, (2) Rough structure of the body in terms of gravity, (3) Shallow but precise subsurface structures including regolith thickness, contamination, layering, and the existence of base rock, which may be constrained by gradiometer observation, radar sounder, and lander’s in-situ packages for porosity and particle size, (4) Exact density value at anywhere, which may be performed by Muography instrument.

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