OPPOSITION SURGES ON ICY AND ROCKY MOONS. B. J. Buratti, J. Bauer, and M. D. Hicks. Jet Propulsion Laboratory, California Institute of Technology (4800 Oak Grove Drive, Mailstop 183-501, Pasadena, CA 91109; bonnie.j.buratti@jpl.nasa.gov).

Introduction: Most planetary satellites exhibit a large increase in brightness as their faces become fully illuminated to an observer. This "opposition surge" occurs whether the body is rocky or icy, and it seems to occur on virtually all airless bodies. So far Umbriel [1] and asteroid 1173 Anchises [2] are the only such bodies that have been shown to lack a surge.

The classical explanation for the opposition surge is that it is due to shadow hiding: mutual shadows cast by surficial particles rapidly disappear as the surface becomes fully illuminated to the observer. With this physical explanation, the amplitude and functional form of the surge indicate important properties of the regolith, including the size and the size distribution of particles, and their compaction state [3]. These properties in turn yield important clues to the collisional history of the satellite and the existence of phenomena such as cold-trapping of volatiles, volcanic activity, and recent resurfacing.

More recently, a second type of opposition surge has been discovered that occurs at small solar phase angles (a fraction of a degree). These surges are very sharply peaked and they are not compatible with shadow–hiding mechanisms. First observed on Europa [4, 5], many more bodies have been shown to possess this sharp spike in brightness, including rocky bodies such as the Moon [6,7]. This surge has been attributed to coherent backscatter, a phenomenon in which photons following identical but reversed paths in a surface interfere constructively in the backscattering direction to increase the brightness by up to a factor of two.

Observations: An example of this second type of opposition surge is illustrated in Figure 1, which shows the solar phase curve of Triton observed from Table Mountain Observatory. Like many high albedo surfaces, Triton exhibits a very small phase coefficient (Triton's excursion in solar phase angle is limited to less than two degrees from the Earth). However, when the solar phase angle is smaller than 0.1 degree (which is not attained every year), the satellite exhibits a surge of about 15% in brightness. This phenomenon has important implications for the geometric and bolometric Bond albedos for the satellites that exhibit it.

A similar but smaller surge has been observed on the Moon [7], although the lunar solar phase is much larger for solar phase angles greater than one degree, and on Enceladus [6]. Unpublished observations of the Saturnian satellites also show a sharply peaked surge.

Modeling: Unlike shadow hiding in a loose regolith, which predominantly affects the singly scattered component of radiation, coherent backscatter is a multiple scattering phenomenon and it should be most important for high albedo surfaces such as those of icy satellites. In the visible, the theory suggests that it should be important only at very small solar phase angles [8]. Because the width of the coherent backscatter opposition surge is greater at longer wavelengths (since the path length of a photon is greater), measurements at different wavelengths are particularly valuable as diagnostic and modeling tools. It is important to separately account for and model coherent backscatter, so the component of the surge due to shadow hiding can be modeled in terms of the microtexture of the surface.

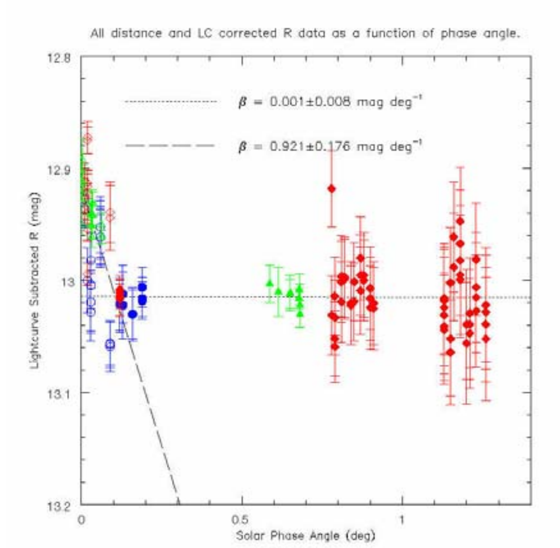

Figure 1. The solar phase curve of Triton.

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