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A Fractal Model for the Capacitance of Lunar Dust and Lunar Dust Aggregates

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Lunar dust grains and dust aggregates exhibit clumping, with an uneven mass distribution, as well as features that span many spatial scales. It has been observed that these aggregates display an almost fractal repetition of geometry with scale. Furthermore, lunar dust grains typically have sharp protrusions and jagged features that result from the lack of aeolian weathering (as opposed to space weathering) on the Moon. A perfectly spherical geometry, frequently used as a model for lunar dust grains, has none of these characteristics (although a sphere may be a reasonable proxy for the very smallest grains and some glasses).

We present a fractal model for a lunar dust grain or aggregate of grains that reproduces (1) the irregular clumpy nature of lunar dust, (2) the presence of sharp points, and (3) dust features that span multiple scale lengths. We calculate the capacitance of the fractal lunar dust analytically assuming fixed dust mass (i.e. volume) for an arbitrary number of fractal levels and compare the capacitance to that of a non-fractal object with the same volume, surface area, and characteristic width. The fractal capacitance is larger than that of the

equivalent non-fractal object suggesting that for a given potential, electrostatic forces on lunar dust grains and aggregates are greater than one might infer from assuming dust grains are spherical. Consequently, electrostatic transport of lunar dust grains, for example lofting, appears more plausible than might be inferred by calculations based on less realistic assumptions about dust shape and associated capacitance.