## Dynamics of charged and polarized grains

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Completely identical insulator grains do charge one another upon contact and the charge difference even increases with repeated contact. Several experimental and theoretical works have provided a strong analytic foundation for charging mechanisms due to geometric or material asymmetries, but the mechanism in the case of absolutely identical grains is not at all clear. Here, we investigate the electrostatic charging of an agitated bed of identical grains using particle-based simulations, mathematical modeling, and experiments. We simulate a discrete-element model including electrical multipoles and find that infinitesimally small initial charges exponentially rapidly. We confirm the predicted can arow exponential growth in experiments using vibrated grains under microgravity, and we describe novel predicted spatiotemporal states that merit further study. Finally, we discuss how the charging dynamics emerge from the competition between the polarization and relaxation time scales.

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