Contact Charging in Granular Materials

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***Abstract*— Charging of fine, sub-millimeter particles and the resulting clustering is important in circumstances ranging from the early stages of planet formation to industrial powders to airborne pollutants. Even in charge-neutral particle systems comprised of grains of the same dielectric material, contact charging can generate large amounts of net positive or negative charge on individual particles, resulting in long-range electrostatic forces. This talk focuses on recent work where collision events between individual particles are tracked with high-speed video and the charge on single particles can be extracted [1]. In freely falling granular streams we observe collide-and-capture events between charged particles and particle-by-particle aggregation into clusters [2]. Size-dependent contact charging is found to produce a variety of charge-stabilized "granular molecules", whose configurations can be modeled by taking many-body dielectric polarization effects into account. We briefly introduce a new approach, based on ultrasonic levitation, for studying contact charging of single particles. This method allows for measurements under a wide range of environmental conditions as well as an applied electric field, and its sensitivity makes it possible to determine the charge transferred in a single collision.**

[1] S. R. Waitukaitis and H. M. Jaeger, In situ granular charge measurement by free-fall videography, Review of Scientific Instruments 84, 025104 (2013).
[2] V. Lee, S. R. Waitukaitis, M. Z. Miskin, and H. M. Jaeger, Direct Observation of Kepler Orbits and Particle Aggregation in Charged Granular Streams, Nature Physics 11, 733-737 (2015).