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Undergraduate Research in Non-equilibrium Systems

(Physics / Arts and Science)

Because of their tabletop nature, it is pedagodically straightforward to involve undergraduate research students in experiments in non-equilibrium systems. Equilibrium thermodynamics has been fundamental to the understanding of physics, chemistry and biology for more than a century. However, there are more processes in nature that occur out of equilibrium, or on the way toward equilibrium that are not currently understood. The advent of the computer and computer-controlled imaging systems have made it possible for physics students, even at the undergraduate level to make significant contributions to the broader science community and the collective understanding of non-equilbrium systems. This is because even the most basic of systems do not have exact solutions and many applications from the handling of dry pharmaceuticals to the contents of grain silos rely on solutions that are simply engineered on a case-by-case basis.

The PI is adept at involving undergraduate physics students in referee-journal research that has previously been published in *Physical Review Letters*, the hallmark journal in the physics community. It is not simply that the undergraduate student is a minor player in the research investigation. The PI has significant experience in tailoring research projects that are fundamental to the larger physics community but simultaneously accessible to the skills and ability of an undergraduate physics student.

This proposal focuses on three systems to expand the understanding of the solid-fluid transition (the avalanching) of granular materials. The research will be conducted by three associated undergraduate students, one paired with each of the three projects, to develop an overall model to understand the fundamental transition of materials from conditions of equilibrium to non-equilibrium. The systems will employ digital imaging and MRI imaging to examine the sub-critical (before avalanche) and super-critical (during avalanche) conditions within granular materials.