From macro to micro and back: How material microstructure influences macro-scale behavior in avalanching systems

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This project focuses on the systems that show avalanching behavior, or so-called intermittent dynamics. The basic system that will be studied involves a collection of soft particles whose interactions are modeled using discrete element/molecular dynamics type of simulations. These systems form mesoscale features, called force or interaction networks whose size is large compared to particle scale, but small compared to the scale of the system. These networks will be analyzed using a combination of topology based methods, as well via standard statistical mechanics - based approaches. One direction of the planned research involves development of machine learning type of algorithms that may have predictive capabilities. Another direction includes development of effective stochastic methods that could be used for the purpose of understanding mathematical basis for intermittent type of behavior. The project will be carried out as a joint effort with the experimental group at Duke University, theoretical groups at Rutgers University and University of Oklahoma, and a computational/modeling group based in Argentina. The participating student will be expected to work and communicate with the researchers from both groups, including travel for work and study visits. The research itself will involve further development of existing computational routines, analytical work on appropriate continuum stochastic models, and collaborative projects with other members of the research group.
Support: ARO Grant (current); NSF Grant (pending)