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Dear Editors,

We are submitting our manuscript entitled “Direct Measurement of Force Configurational Entropy in Jamming” for consideration as a letter in Physical Review Letters.

While ordinary thermodynamics connects bulk material properties to an underlying statistical mechanics, no such underlying statistical mechanics is known for athermal granular materials. Numerous attempts have been made to create a thermodynamics using temperature analogues such as the angoricity and compactivity. While these quantities have been shown to be measurable and useful, none have been explicitly linked to a microscopic entropy, and as such have not been shown to be physically meaningful. Just as the Sackur-Tetrode equation links discrete quantum states of the ideal gas to the entropy and thus the temperature, we link discrete configurational states of force networks in a granular material to the entropy and thus the angoricity. From this we derive a first principles prediction for angoricity as a function of pressure, which we confirm using the method of overlapping histograms, concretely linking the bulk nature of angoricity with the microscopic multiplicity of the Force Network Ensemble.

This work is important because it connects thermodynamic approaches to granular materials with an underlying statistical mechanics, contributing to a complete statistical mechanical description of granular materials. Angoricity is placed on a firm footing as a thermodynamic quantity that controls the behavior of overjammed systems.

Thank you for your time and your consideration.

Sincerely,

James D. Sartor

Eric I. Corwin