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Point-to-Set as a measure of Correlations during Unjamming in Granular Systems

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There is evidence indicating that the unjamming of frictionless, soft grain packings occurs at a critrical point, however, no correlation function associated with a diverging, static length scale has been identified. To better understand the nature of this transition, we consider the soft grain packing problem as a constraint satisfaction problem [1]. Jammed configurations are mechanically stable packings with non-zero pressure. Contact forces on each grain therefore satisfy the equations of mechanical equilibrium, which are a set of local constraints, as well as a global constraint from the pressure. In general when jammed, there are more contact forces than constraints, so that an ensemble of force networks exists [2] which satisfy the constraints. These force networks make up a high-dimensional solution space that shrinks to a point at the unjamming transition, suggesting that the unjamming transition can be considered an entropy vanishing transition. We explore a new type of "point-to-set" correlation function which has been used to identify non-obvious length scales in other constraint satisfaction problems [3], and show that it exhibits a diverging length scale. We compare and contrast this length scale with the well established "isostatic length" of Wyart et. al [4].

[1] F. Krzakala and J. Kurchan, PRE 76, 021122 (2007)
[2] J.H. Snoeijer et. al, PRE 70, 061306 (2004)
[3] A. Montanari and G. Semerjain, Journal of Stat. Phys, 125, 1 (2006)
[4] M. Wyart et. al, PRE 72, 051306 (2005)