

“Disordered Classical Ground States”

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There is no fundamental reason why classical ground states (many-particle configurations with minimal total energy per particle) cannot be aperiodic or disordered. We provide rigorous evidence for the counterintuitive existence of disordered ground states using two different approaches. The first employs the control of collective density variables for certain pairwise interactions [1]. The second uses the venerable hard-sphere model, which has been of great utility in fundamentally understanding the nature of the liquid state, glasses, and crystals. In particular, we show that the densest hard-sphere packings in sufficiently high dimensions in Euclidean spaces may be disordered rather than periodic, implying the existence of disordered ground states for some continuous short-ranged pair potentials [2]. Sphere packings in high dimensions are relevant to the optimal way of sending digital signals over a noisy channel.

1. R. D. Batten, F. H. Stillinger and S. Torquato “Classical Disordered Ground States: Super-Ideal Gases, and Stealth and Equi-Luminous Materials,” *J. Appl. Phys.* **104**, 033504 (2008).
2. S. Torquato and F. H. Stillinger, ”New Conjectural Lower Bounds on the Optimal Density of Sphere Packings,” *Experimental Math.*, **15**, 307 (2006).