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Disordered Hyperuniform Particle Packings

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The study of hyperuniform states of matter is an emerging multidisciplinary field, influencing and linking developments across the physical sciences, mathematics and biology [1,2]. A hyperuniform many-particle system in d -dimensional Euclidean space is characterized by an anomalous suppression of large-scale density fluctuations relative to those in typical disordered systems, such as liquids and amorphous solids. As such, the hyperuniformity concept generalizes the traditional notion of long-range order to include not only all perfect crystals and quasicrystals, but also exotic disordered states of matter. Disordered hyperuniform states have attracted great attention across many fields over the last two decades because they can have the character of crystals on large length scales but are isotropic like liquids. This hybrid crystal-liquid attribute endows them with unique or nearly optimal, direction-independent physical properties and robustness against defects. I will briefly review the hyperuniformity concept and then discuss a variety of different disordered particle packings that are hyperuniform [1,2,3].

1. S. Torquato and F. H. Stillinger, "Local Density Fluctuations, Hyperuniform Systems, and Order Metrics," *Phys. Rev. E*, 68, 041113 (2003).
2. S. Torquato, "Hyperuniform States of Matter," *Phys. Reports*, 745, 1 (2018).
3. S. Torquato, Perspective: "Basic Understanding of Condensed Phases of Matter via Packing Models," *J. Chem. Phys.* 149, 020901 (2018).

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