Physics AT QUEENS COLLEGE

Colloquium Notice

Salvatore Torquato

Princeton University

Hyperuniform States of Matter and Their Novel Characteristics

Hyperuniformity is a new type of long-range order that encompasses all perfect crystals, perfect quasicrystals, and some exotic disordered states of matter. Disordered hyperuniform many-particle systems [1,2] can be regarded to be new states of disordered matter in that they behave more like crystals or quasicrystals in the manner in which they suppress large-scale density fluctuations, and yet are also like liquids and glasses because they are statistically isotropic structures with no Bragg peaks. Thus, these special correlated disordered materials possess a "hidden order" that is not apparent on large length scales. A variety of groups have found that disordered hyperuniform materials possess desirable photonic and electronic bandgap properties. More recently, we have shown that they possess nearly optimal transport and elastic properties. I will review the salient ideas behind the hyperuniformity concept and procedures to design a variety of different disordered hyperuniform materials as well as their corresponding physical properties, including novel transport, mechanical, electromagnetic and elastodynamic characteristics [3,4,5]. It has been a numerical and experimental challenge to create very large samples that are hyperuniform with high fidelity. I will discuss recent progress that we have made in this direction [6] and its implications for novel physical properties.

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. G. Zhang, F. H. Stillinger, and S. Torquato, "Transport, Geometrical, and Topological Properties of Stealthy Disordered Hyperuniform Two-phase Systems," J. Chem. Phys., 145, 244109 (2016).
4. S. Torquato and D. Chen, "Multifunctional Hyperuniform Cellular Networks: Optimality, Anisotropy and Disorder," Multifunctional Materials, 1, 015001 (2018).
5. J. Kim and S. Torquato, Multifunctional Composites for Elastic and Electromagnetic Wave Propagation, Proc. Nat. Acad. Sci., 117, 8764 (2020).
6. J. Kim and S. Torquato, "New Tessellation-Based Procedure to Design Perfectly Hyperuniform Disordered Dispersions for Materials Discovery, Acta Materialia, 68, 143 (2019).

Monday
April 5, 2021
Starts at 12:15 PM
zoom.us