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Characterizing the Structure and Properties of Hyperuniform-Inspired Network Metamaterials



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Abstract: A significant body of work over the last several years has focused on the design and fabrication of network-based materials generated from the spatial tessellation of disordered hyperuniform point patterns and their physical properties. Disordered hyperuniform systems (including point patterns, two-phase materials, and networks) are characterized by an unusually strong suppression of large-wavelength density fluctuations compared to those in typical disordered systems. Many studies have demonstrated that disordered hyperuniform materials exhibit a wide range of desirable physical properties---as do materials based on the tessellations of hyperuniform point patterns---including nearly-optimal elastic moduli and isotropic photonic bandgaps. Despite the desirable physical properties that network materials based on tessellations of hyperuniform point patterns exhibit, I show that networks generated in this way have a limited capacity to inherit the hyperuniformity of the point pattern they are generated from and show ways we can make networks strongly hyperuniform by weighting the network edges. Moreover, I discuss the effect of disorder in networks on the spectrum of the differential Laplacian operator on network structures, which can be related to heat and wave transport. In particular, I show that the structures that lead to large gaps in the eigenvalue spectrum differ from the structures one might expect based on the heterogeneous materials literature. These results offer insight into how to design network materials with tailored physical properties.

Wednesday, November 18 | 2:00pm-3:15pm | Science Hall 126 & Zoom

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