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Enhancing Pinning For Vortices in Hyperuniform Substrates and Emergent Hyperuniform Vortex States MINH QUAN LE THIEN, DANIELLE MCDERMOTT, Department of Physics, Wabash College, CYNTHIA J. OLSON REICHHARDT, CHARLES REICHHARDT, Los Alamos National Laboratory —
Disordered hyperuniformity is a state which simultaneously has isotropic liquid like properties and crystalline like properties such as little variation in the density fluctuations over long distances. An open question is what possible applications could utilize properties of hyperuniformity. One of the major issues for applications of type-II superconductors is how to achieve high critical currents by preventing vortex depinning, so there is great interest in understanding which pinning site geometries will lead to the optimal vortex pinning. Using large scale computational simulations, we show that vortices in a type-II superconductor with a hyperuniform pinning arrangement exhibit enhanced pinning compared to an equal number of randomly placed pinning sites, and that the enhancement is robust over a wide range of parameters. The stronger pinning arises in the hyperuniform arrays due to the suppression of pinning density fluctuations, permitting higher pin occupancy and the reduction of weak links that lead to easy flow channeling. We also show that in general, in amorphous vortex states in the presence of either random or hyperuniform pinning arrays, the vortices themselves exhibit disordered hyperuniformity due to the repulsive nature of the vortex-vortex interactions.

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