Superfluid disorder in quantum solids

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Abstract:

I will briefly review old ideas on how can superfluidity occur in a crystalline solid, briefly mention a theorem that any supersolid in continuous space must be in the incommensurate state and have gapless vacancies and/or interstitials. In He-4 vacanices and interstitials are gapped, and thus ideal crystals are insulating. I will present path-integral Monte Carlo data to prove that. To explain recent experiments on the non-classical moment of inertia of He-4 solids one has to consider various types of disorder. I will show examples of superfluid defects in lattice and helium systems, and discuss which of them are likely to be present in experimental samples. Finally, I will discuss the "ultimate" superfluid disordered state---a helium superglass. We find it to be remarkably stable at low temperatures and elevated pressures.