X. Yu
NZIAS

Localization of disordered bosons and magnets in random fields

Abstract: In this talk I will present some recent progresses on scarcely studied issue of spatial localization of finite energy excitations in disordered bosonic systems. We contrast this many body problem with the well-studied localization of non-interacting fermions, and develop a new perturbative technique, which allows us to analyze the strongly localized regime in general, and to approach the magnetic ordering transition in the limit of highly connected lattices (high dimensions). We focus on the differences between bosonic systems with Ising and XY symmetry (hard-core bosons in particular), whose physical properties and quantum phase transitions are surprisingly distinct. For 1d Ising chains, we find non-analytic behavior of the localization length as a function of energy at $\omega = 0$, $\xi^{-1}(\omega) = \xi^{-1}(0) + A|\omega|^{\alpha}$, with α vanishing at criticality. This contrasts with the much smoother behavior predicted for XY magnets. We use these results to approach the ordering transition on Bethe lattices of large connectivity K, which mimic the limit of high dimensionality. In both models, in the paramagnetic phase with uniform disorder, the localization length is found to have a local maximum at $\omega = 0$. For the Ising model, we find activated scaling at the phase transition, in agreement with infinite randomness studies. In the Ising model long range order is found to arise due to a delocalization and condensation initiated at $\omega = 0$, without a closing mobility gap. We find that Ising systems establish order on much sparser (fractal) subgraphs than XY models. These results are summarized in the preprint http://arxiv.org/abs/1306.2664 (accepted by Annals of Physics).