Strong-randomness phenomena at superfluid phase transitions

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Quenched disorder or randomness can dramatically change the properties of thermal and quantum superfluid phase transitions.

In the first part of the talk, we discuss the effects of one-dimensional (layered) disorder on the thermal phase transition of a bulk superfluid. We find an anomalously elastic "sliding" phase between the conventional normal and superfluid phases. In this intermediate phase, the stiffness parallel to the layers remains finite while the stiffness perpendicular to the random layers vanishes, and the elastic free energy exhibits anomalous scaling behavior [1].

The second part of the talk is devoted to large-scale Monte-Carlo simulations of the superfluid-insulator quantum phase transition of one-dimensional bosons with off-diagonal disorder. For weak disorder, we find the transition to be in the same universality class as the superfluid-Mott insulator transition of the clean system. The nature of the transition changes for stronger disorder. Beyond a critical disorder strength, we find nonuniversal, disorder-dependent critical behavior [2].

[1] P. Mohan, P.M. Goldbart, R. Narayanan, J. Toner and T. Vojta, Phys. Rev. Lett. 105, 085301 (2010).

[2] F. Hrahsheh and T. Vojta, Phys. Rev. Lett. 109, 265303 (2012).