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Evolution of the electronic spectral function and dynamical conductivity across the disorder-tuned superconductor-insulator transition[1]

NANDINI TRIVEDI, The Ohio State University, Columbus, OH 43220

I will discuss the behavior of the single particle electronic spectral function, the bosonic (pair) spectral function $P(\omega)$, and the dynamical conductivity $\sigma(\omega)$ across the superconductor-insulator transition (SIT) calculated using quantum Monte Carlo simulations [1]. The transition is driven by tuning the charging energy relative to the Josephson coupling or by varying the degree of disorder. We identify a prominent Higgs mode in the superconductor, and characteristic energy scales in the insulator, that vanish at the transition due to enhanced quantum phase fluctuations, despite the persistence of a robust fermionic gap across the SIT [2]. Disorder leads to increased absorption at low frequencies compared to the SIT in a clean system. Disorder also expands the quantum critical region, due to a change in the universality class, with an underlying T=0 critical point. Obtaining the conductivity at the transition has been problematical because of analytic continuation of numerical data. We propose a well-defined integrated low-frequency conductivity that can be reliably estimated and discuss its universality.

[1] "Dynamical conductivity across the disorder-tuned superconductor-insulator transition," M. Swanson, Y. L. Loh, M. Randeria, and N. Trivedi, Phys. Rev. X **4**, 021007 (2014).
[2] "Single- and two-particle energy gaps across the disorder-driven superconductor-insulator transition," K. Bouadim, Y. L. Loh, M. Randeria, and N. Trivedi, Nat. Phys. **7**, 884 2011).

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