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Gaps and Pseudogaps across the inhomogeneous superconductor to paired insulator transition[1]

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The mechanism for the disorder-tuned superconductor to insulator transition (SIT) in thin films and the nature of the resulting insulator are still debated, despite decades of research. We use quantum Monte Carlo simulations [1] that treat, on an equal footing, inhomogeneous amplitude variations and phase fluctuations, and go beyond our earlier Bogoliubov-deGennes analysis [2]. We gain new microscopic insights into the SIT, compare our theory with experiments [3] and make testable predictions for local spectroscopic probes. The energy gap in the single-particle density of states survives across the transition, but coherence peaks exist only in the superconducting state. A characteristic pseudogap persists above the critical disorder and critical temperature, in contrast to conventional theories. Surprisingly, the insulator has signatures of pairing with a two-particle gap scale that vanishes at the superconductor–insulator transition, despite a robust single-particle gap. The impact of rare regions on the gaps will also be discussed. In collaboration with K. Bouadim, Y.L.Loh and N. Trivedi.

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[3] B. Sacepe et al., Nature Comm. 1, 140 (2010); Nature Phys. 7, 239 (2011); M. Mondal et al., Phys. Rev. Lett. 106, 047001 (2011).

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