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Transport in thin insulating films close to the Boson-Fermion Crossover J.C. JOY, X. ZHANG, S.M. HOLLEN[1], C. ZHAO[2], Department of Physics, Brown University, G. FERNANDES, J.M. XU, Division of Engineering, Brown Univeristy, J.M. VALLES, JR., Department of Physics, Brown University —
In two-dimensional systems, sufficient levels of disorder are known to localize Cooper Pairs into a phase incoherent insulating state. While many theoretical and experimental works have shown this state's existence, its ubiquity close to the disorder tuned Superconductor to Insulator transition is still an open problem. Recent experiments on nanopatterned $Pb_{0.9}Bi_{0.1}$ films have suggested a crossover from Bosonic to Fermionic transport deep in the insulating phase, indicating that the Cooper Pair Insulator (CPI) only persists to a finite level of microscopic disorder. The normal state resistance at which this crossover occurs is governed by the extent coupling constant inhomogeneities on the scale of the coherence length, which allow the formation of locally phase coherent superconducting islands in the insulating state. By tuning the scale of these inhomogeneities and examining the extent of the CPI state, we argue that the disorder tuned Superconductor to Insulator transition proceeds via pair breaking and Anderson localization of fermions when the level spacing in the islands approaches the size of the mean field gap. This work was supported by the NSF through grants No. DMR-1307290 and DMR-0907357 and by the AFRL, the ONR, and the AFOSR.

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