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**Cooper Pair Insulators**[1]

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One of the recent advances in the field of the Superconductor to Insulator Transition (SIT) has been the discovery and characterization of the Cooper Pair Insulator phase. This bosonic insulator, which consists of localized Cooper pairs, exhibits activated transport and a giant magneto-resistance peak. These features differ markedly from the weakly localized transport that emerges as pairs break at a "fermionic" SIT. I will describe how our experiments on films nano-patterned with a nearly triangular array of holes have enabled us to 1) distinguish bosonic insulators from fermionic insulators, 2) show that Cooper pairs, rather than quasi-particles dominate the transport in the Cooper Pair insulator phase, 3) demonstrate that very weak, sub nano-meter thickness inhomogeneities control whether a bosonic or fermionic insulator forms at an SIT and 4) reveal that Cooper pairs disintegrate rather than becoming more tightly bound deep in the localized phase. We have also developed a method, using a magnetic field, to tune flux disorder reversibly in these films. I will present our latest results on the influence of magnetic flux disorder and random gauge fields on phenomena near bosonic SITs.

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