CHARACTERIZING DISORDER IN 2-DIMENSIONAL SUPERCONDUCTORS

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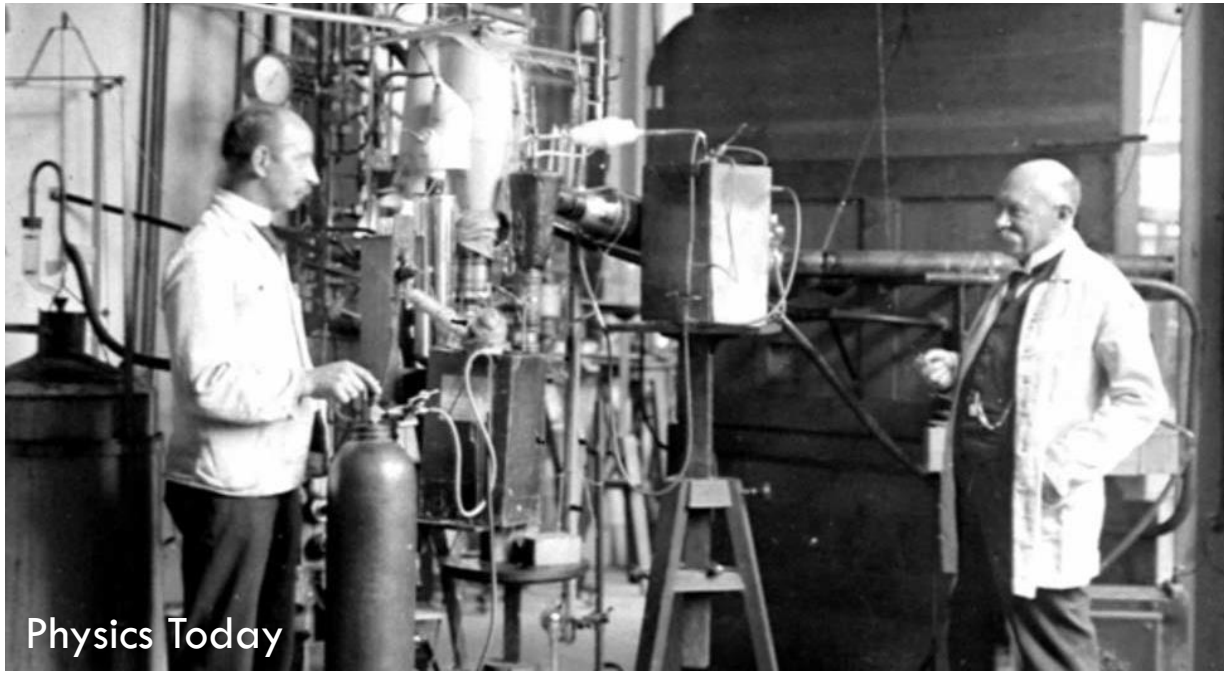
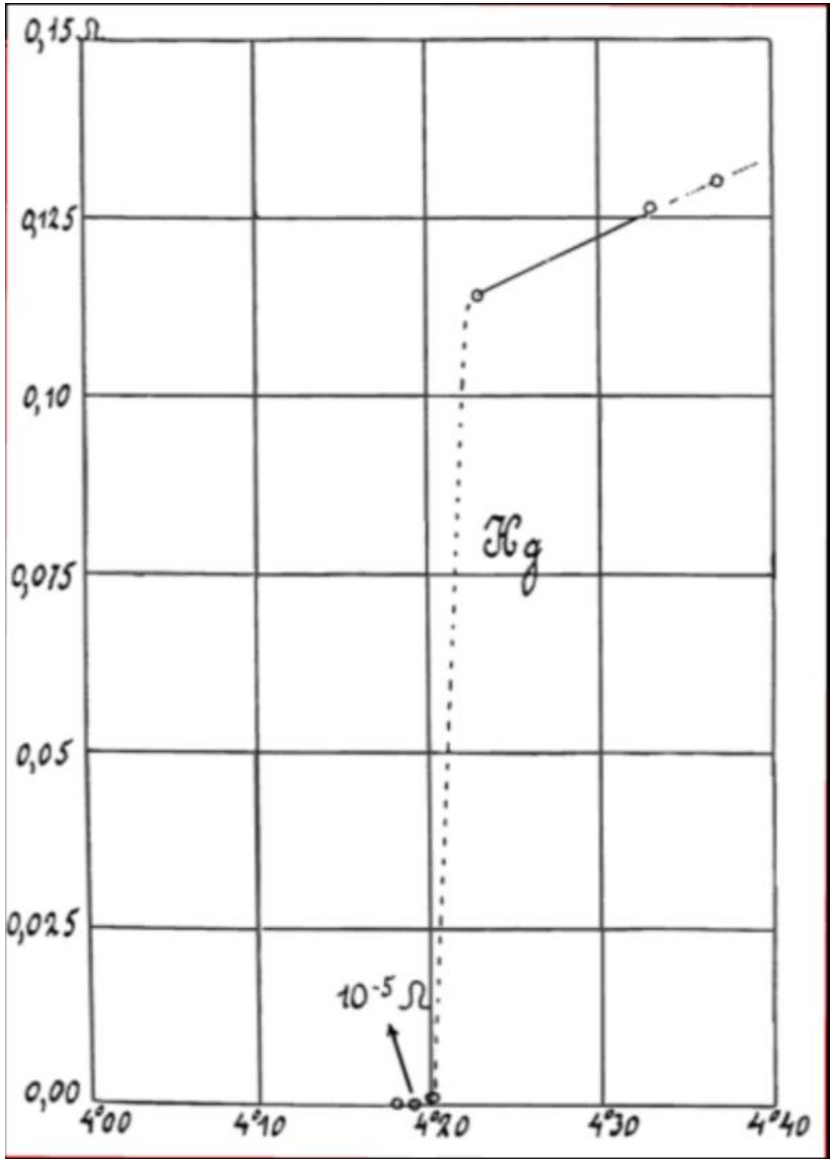
Superconductivity

Kamerlingh Onnes, 1911

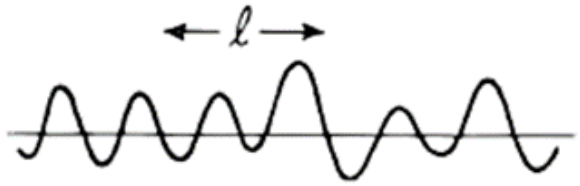




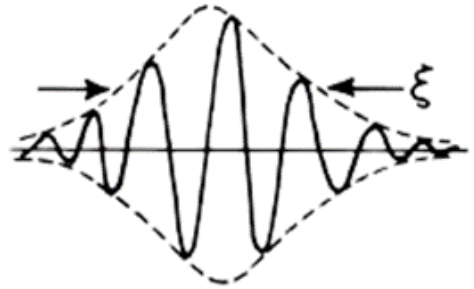
Superconductivity and disorder

Disorder can be anything that affects the electronic wavefunction.

Weak disorder

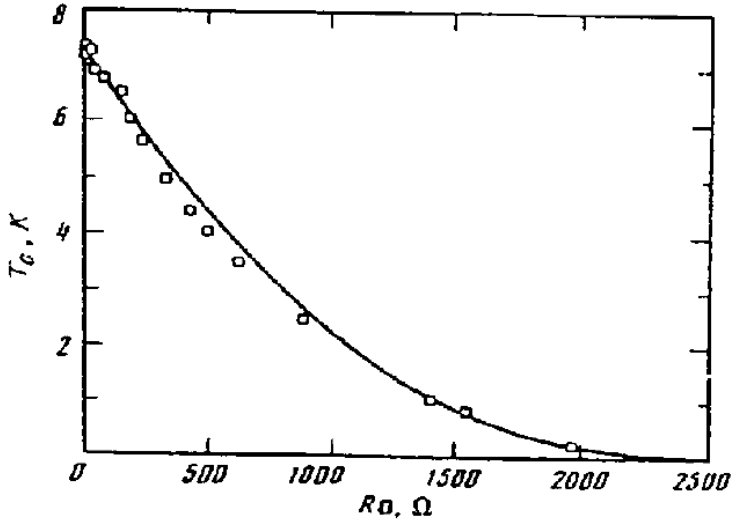


Strong disorder



P. A. Lee and T. V. Ramakrishnan, *Rev. Mod. Phys.* **57** 287 (1985)

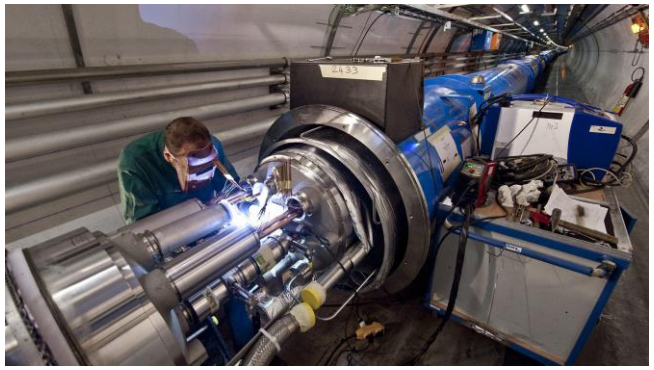
Disorder can suppress superconductivity.



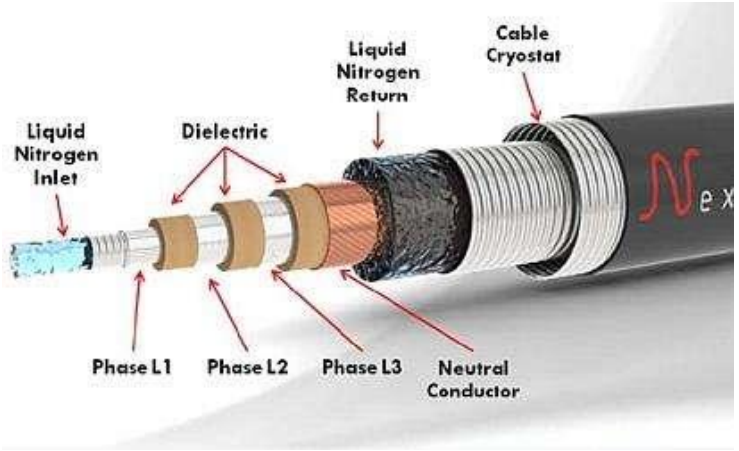
Graybeal, J. and Beasley, M. Phys. Rev. B, 29, 4167 (1984)

Applications of superconductors

Superconducting magnets
- Particle accelerators
- MRI

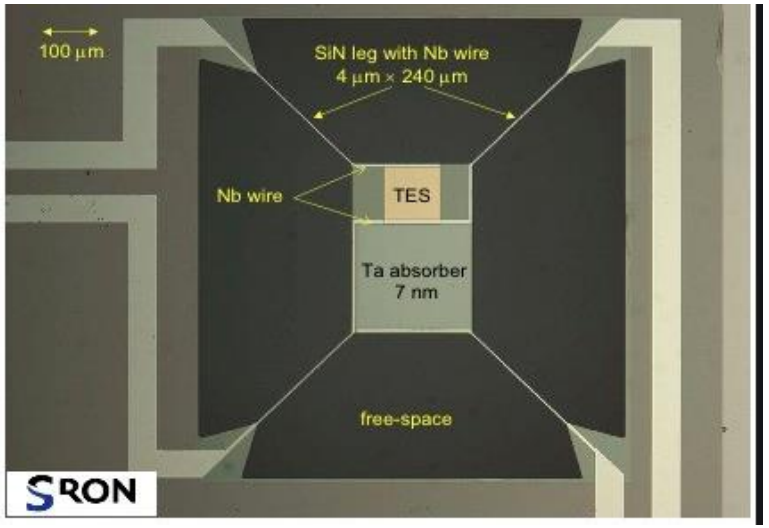


Transmission lines

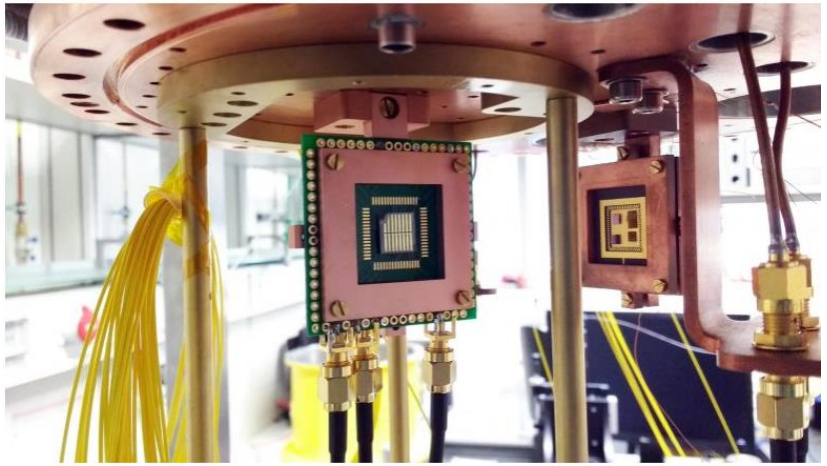


Transportation

Particle sensors



Quantum computing



Applications of superconductors

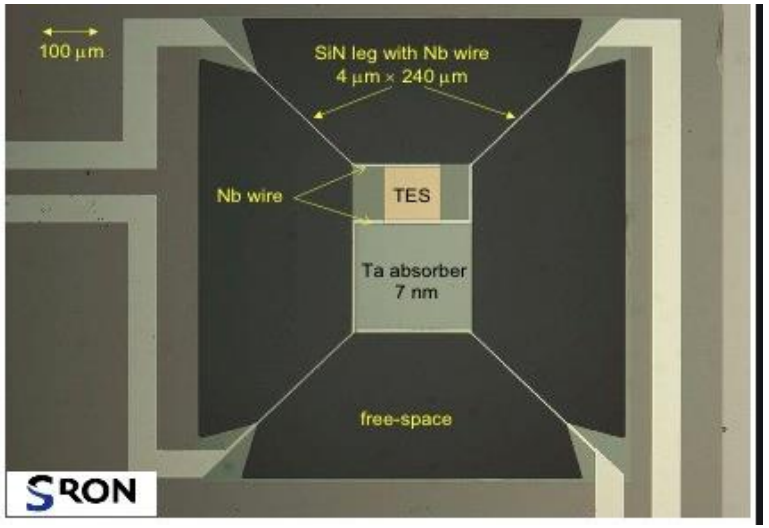
As technology advances, superconducting devices are progressively getting smaller, currently operating at the 2D scale and mesoscale.

→ Enhanced effect of fluctuations and disorder due to stronger electronic interactions which affect device performance.

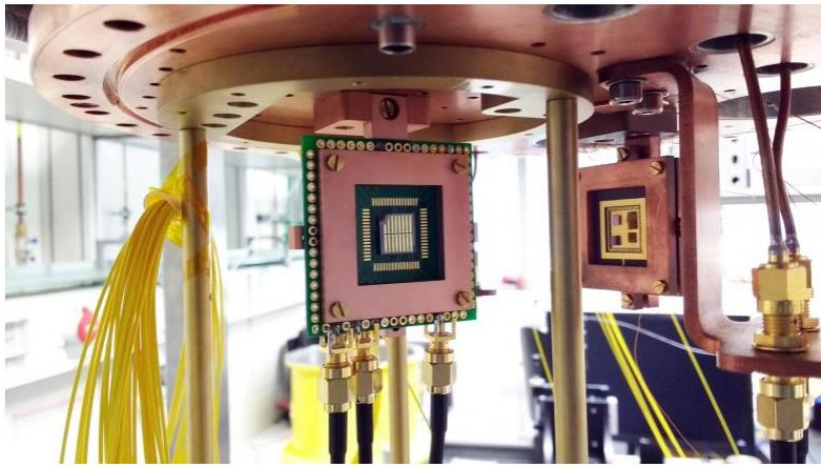
Understand, characterize and control effect of perturbations on superconductivity at mesoscopic and 2D scale.

Model system: Superconducting island arrays

Particle sensors

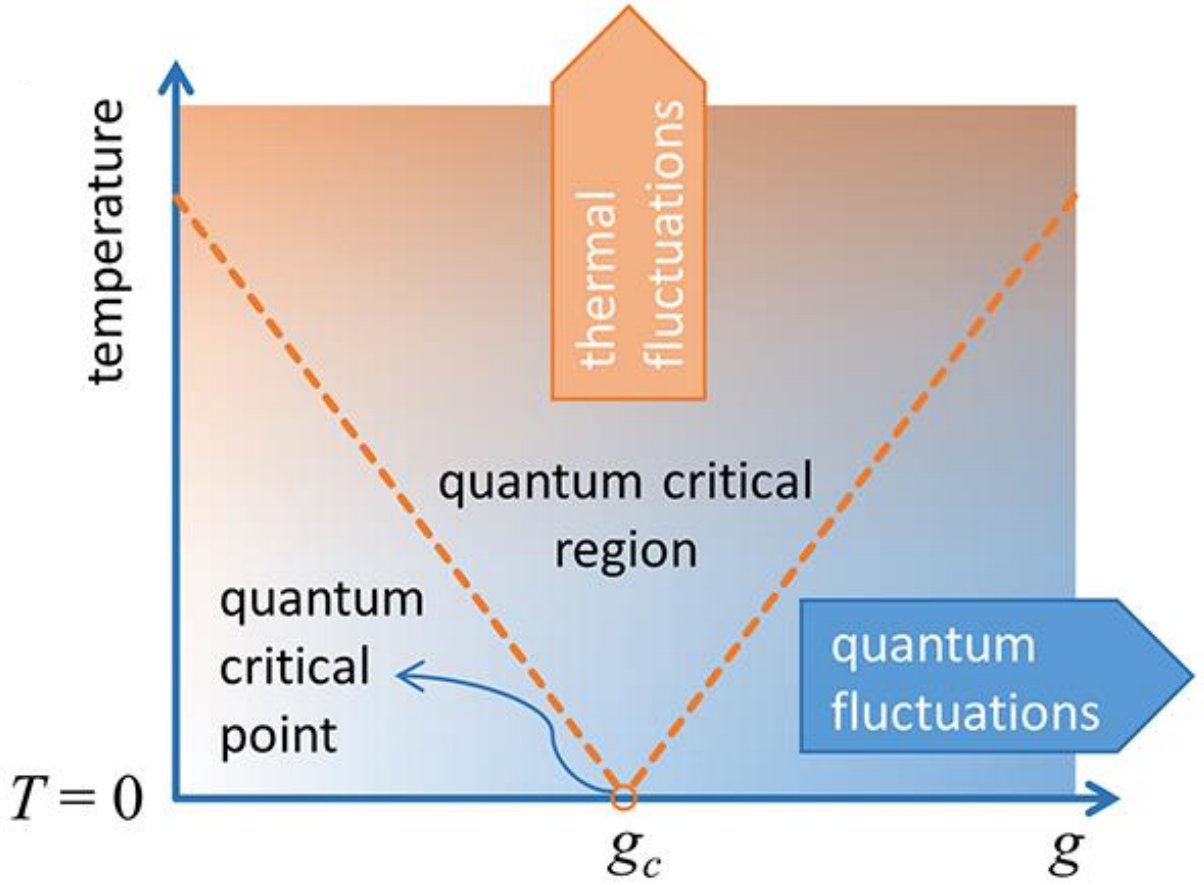


Quantum computing



Quantum phase transitions (QPT)

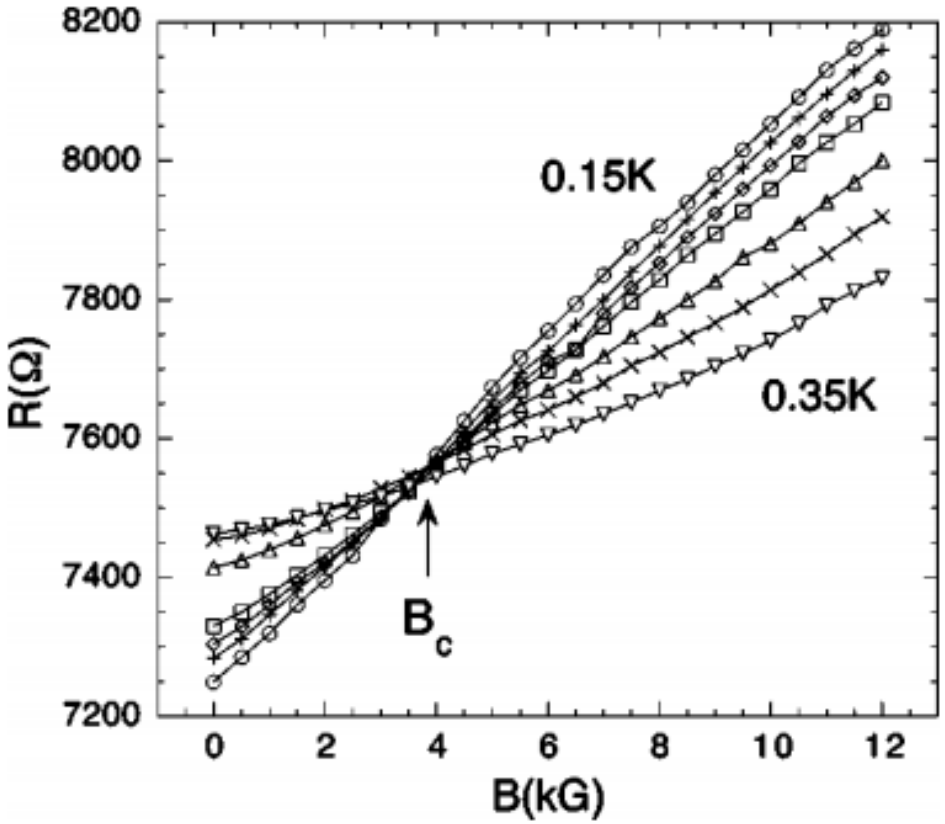
In this work, we'll study an occurrence of a quantum phase transition
→ Superconductor-Metal-Insulator transition (SMIT)



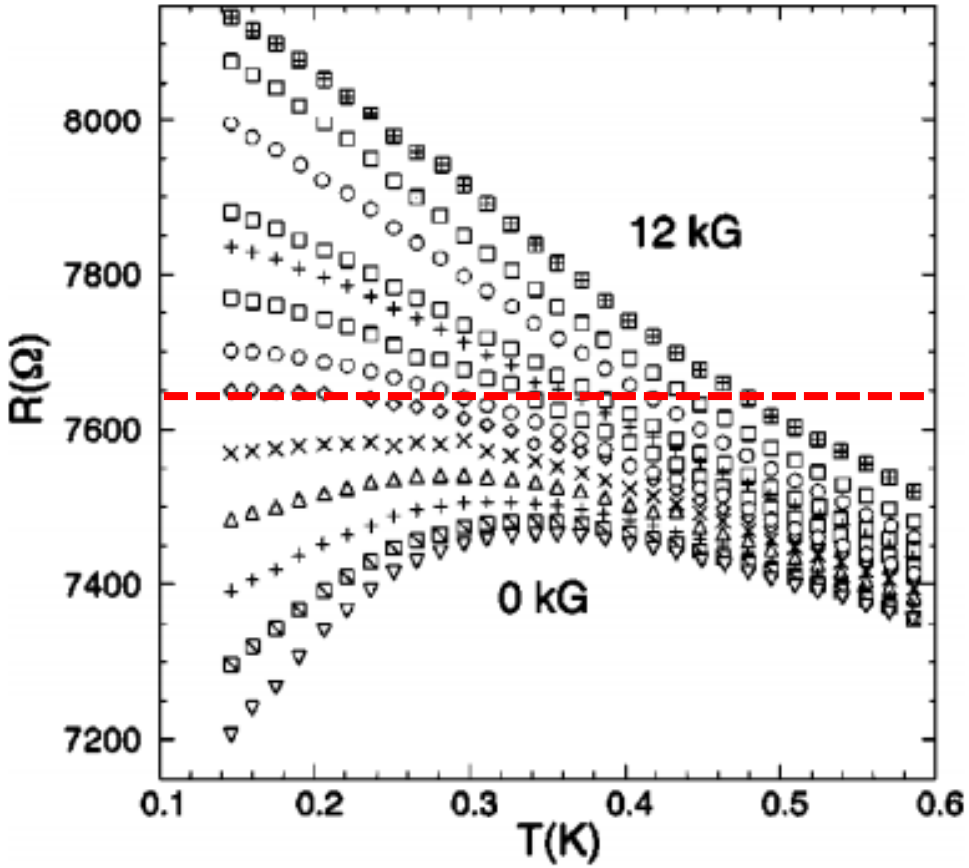
M. Klanisek, *Viewpoint: A Critical Test of Quantum Criticality.* Retrieved from https://physics.aps.org/articles/v7/74

Experimental signatures of a superconductor-insulator transition (SIT)

Crossing point of curves at set temperatures

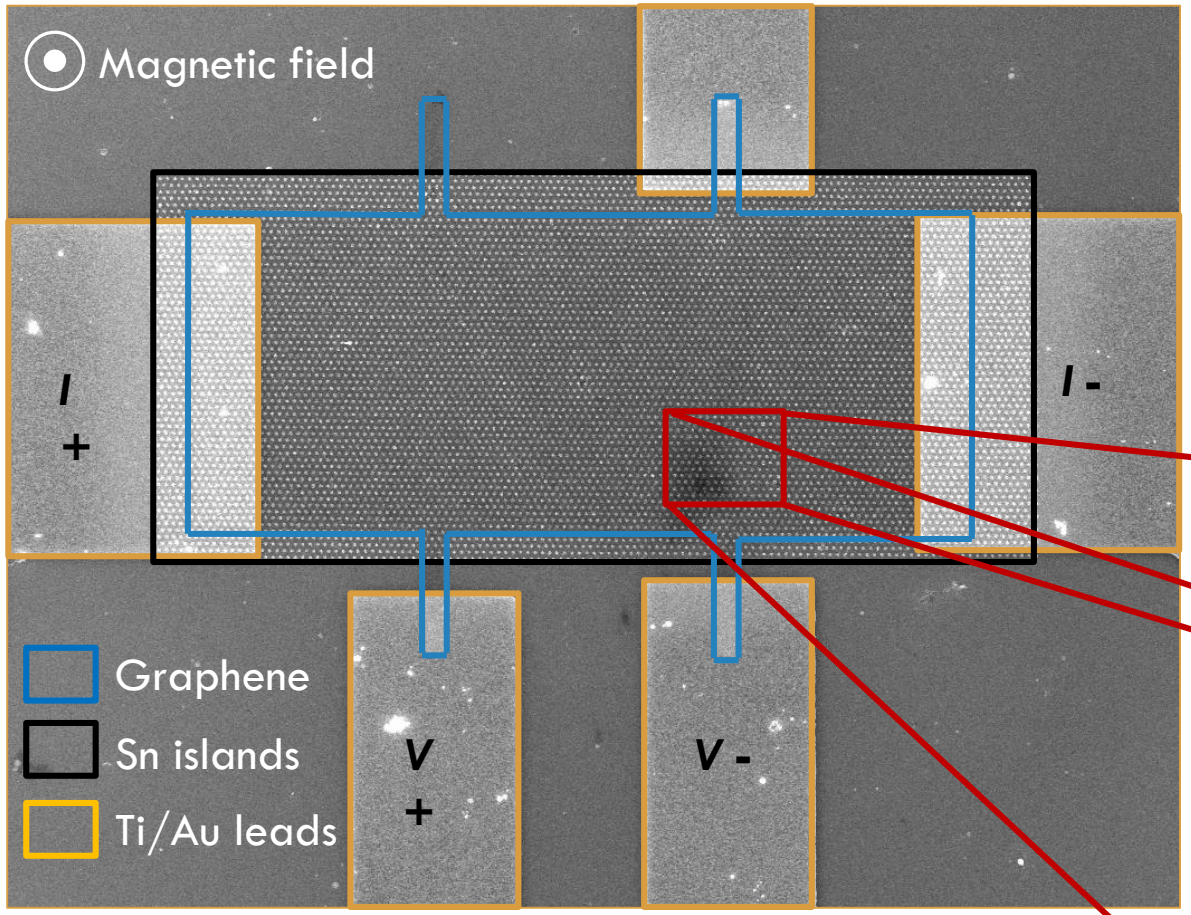


Upturn in resistance as $T \rightarrow 0$



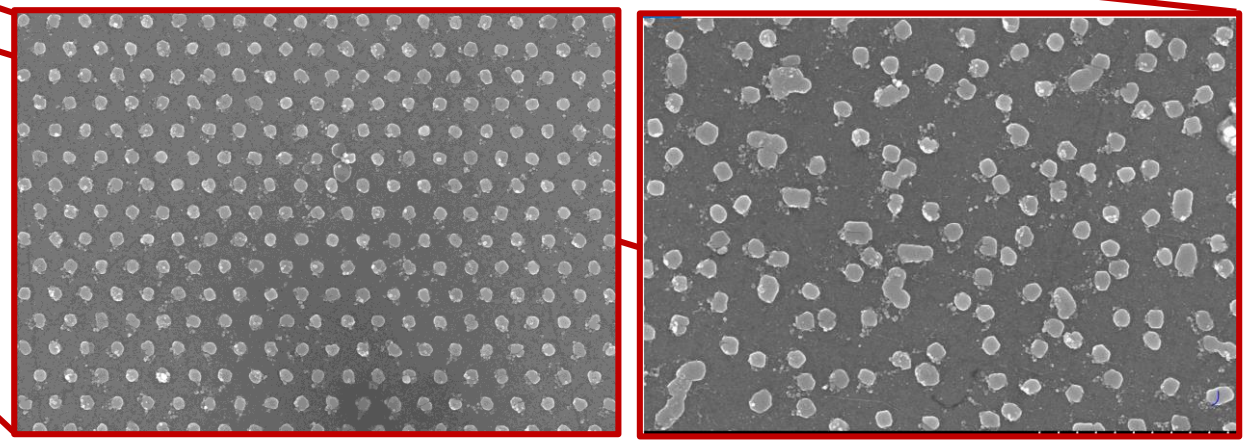
To study effects of disorder on quantum phase transitions

→ Study point disorder on tunable 2D superconducting arrays

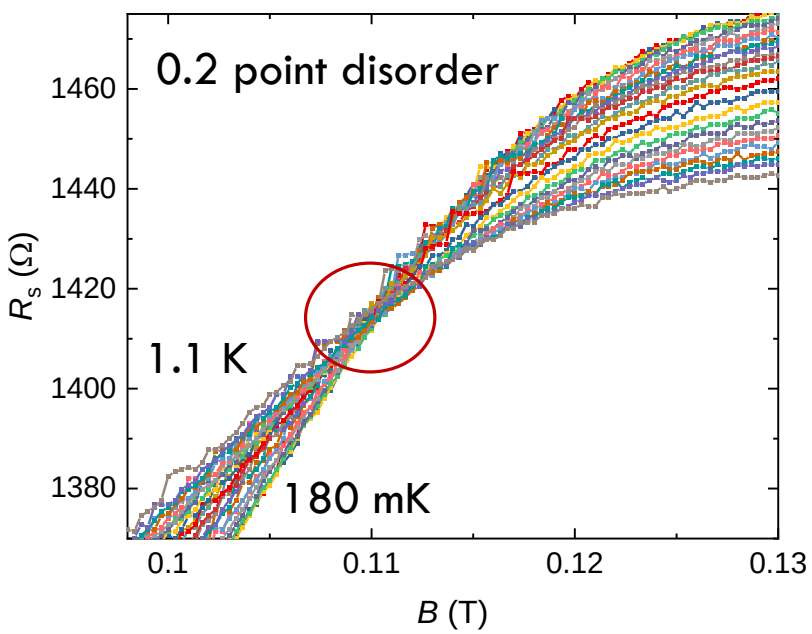


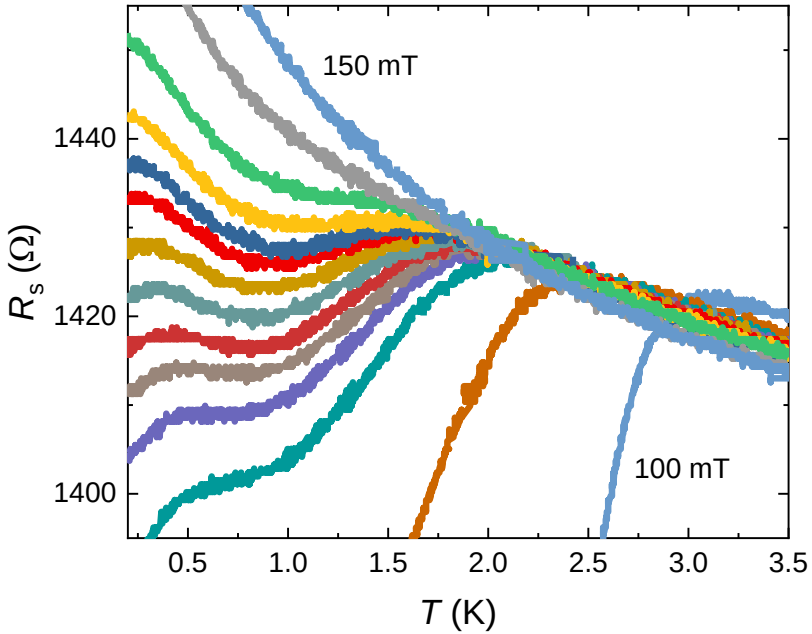
What are the effects of phase separation?

What determines a percolative transition?



Results and Conclusions





- First study of controllably tuned patterned disorder on the field driven transition.
- Presence of a magnetic field tuned QPT.
- Relevant to studies on rare-regions, Griffiths phases, percolation and multiple criticality.