Demonstrating Superconductivity Using YBCO Superconductor and Neodymium Magnets

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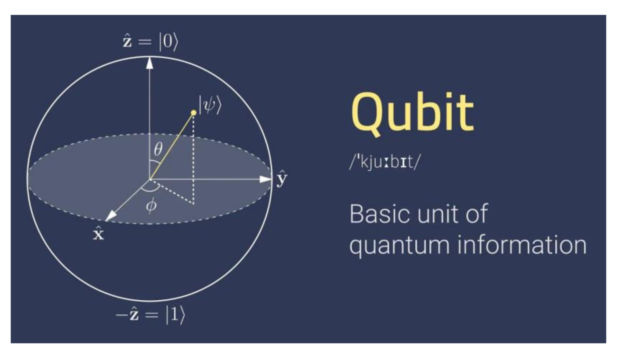
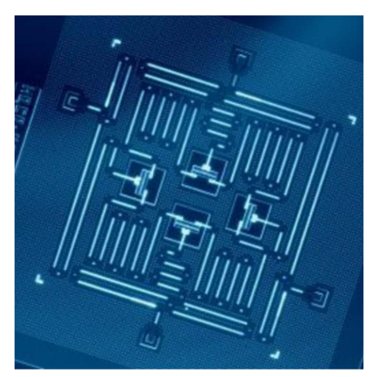
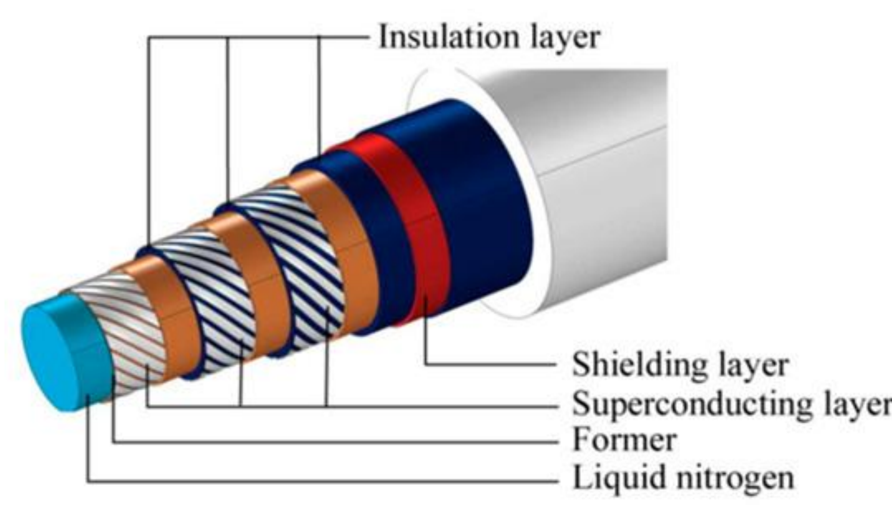
iQuISE

Motivation

- **Maglev trains** using superconducting magnetic levitation
- Study of **quantum entanglement** and entangled particles
- Low-loss **power transmission** with superconducting cables
- **Ultra-high field MRI** (Magnetic Resonance Imaging)

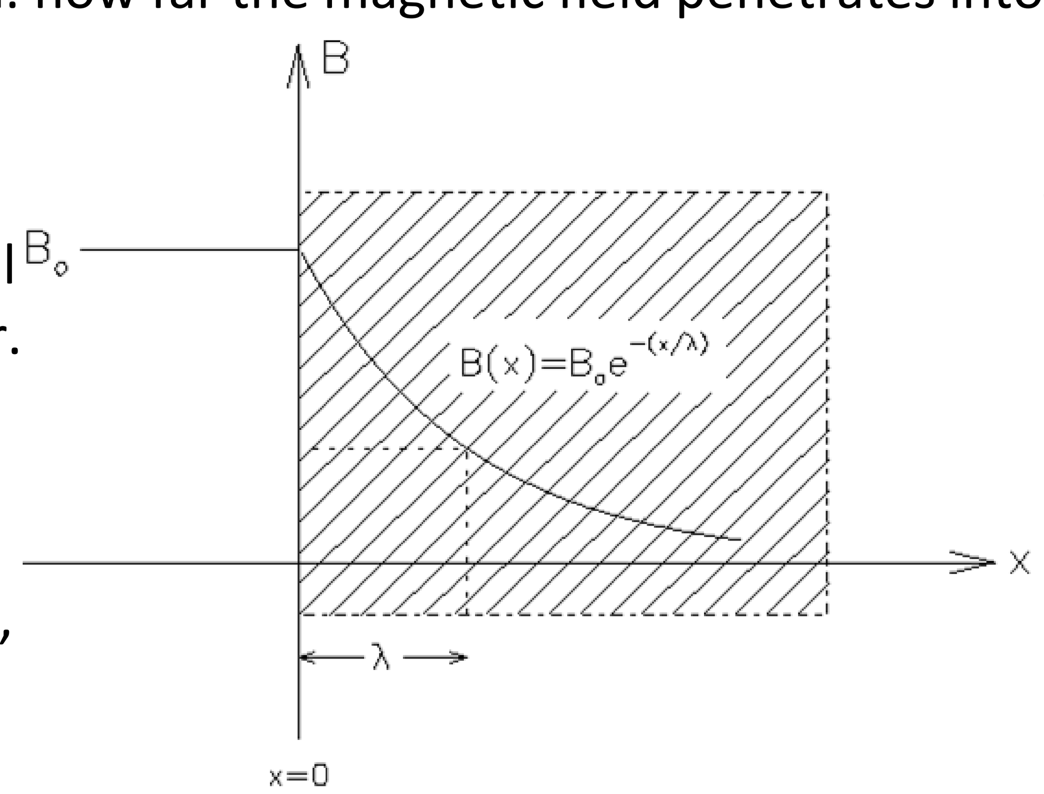


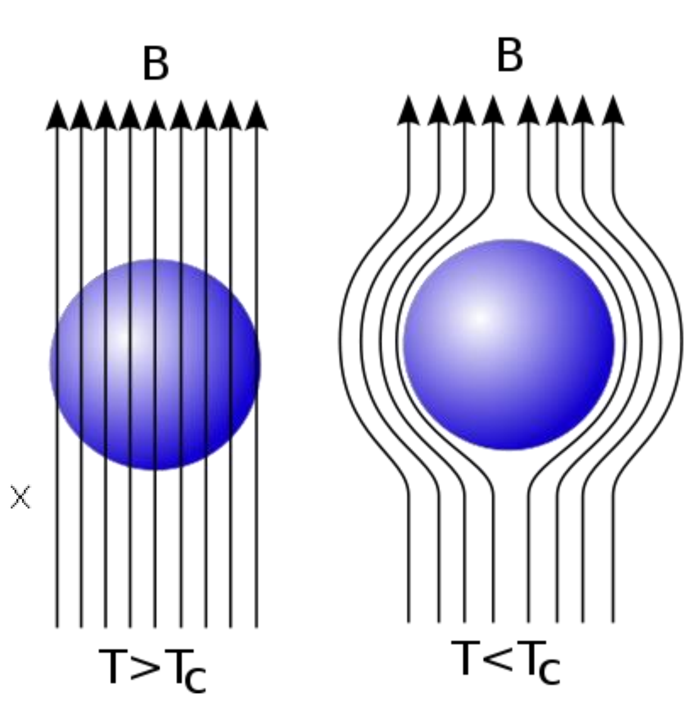


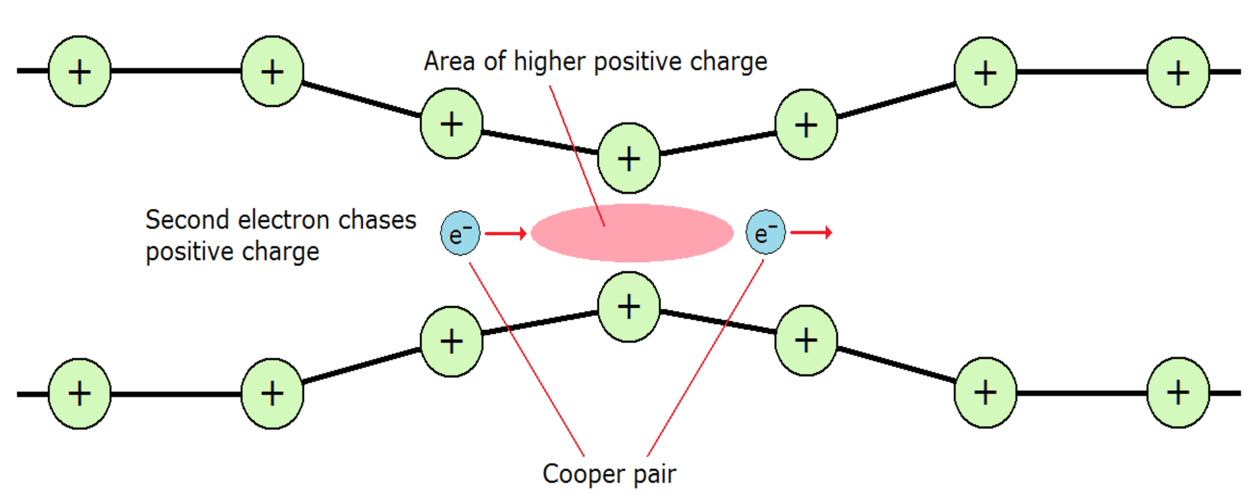


Physics Principles

- Superconductors have unique physical properties that include conducting currents with essentially **no electrical resistance** ($V = IR$) and **repelling magnetic fields**: the **Meissner effect**
- The magnetic field inside of the superconductor decays exponentially as a function of the **London penetration depth**: how far the magnetic field penetrates into the material
- Certain materials have a temperature known as a **critical temperature**, at which that specific material becomes a superconductor. These temperatures are usually extremely cold, in our case ~86°K (~-187°C)
- At these low temperatures, the random motion of superconducting particles decreases significantly so **Cooper pairs** can form
- The metal's lattice of cations becomes greatly influenced and attracted by passing electrons, creating locations of high positive charge which **attract entangled electrons** to those areas

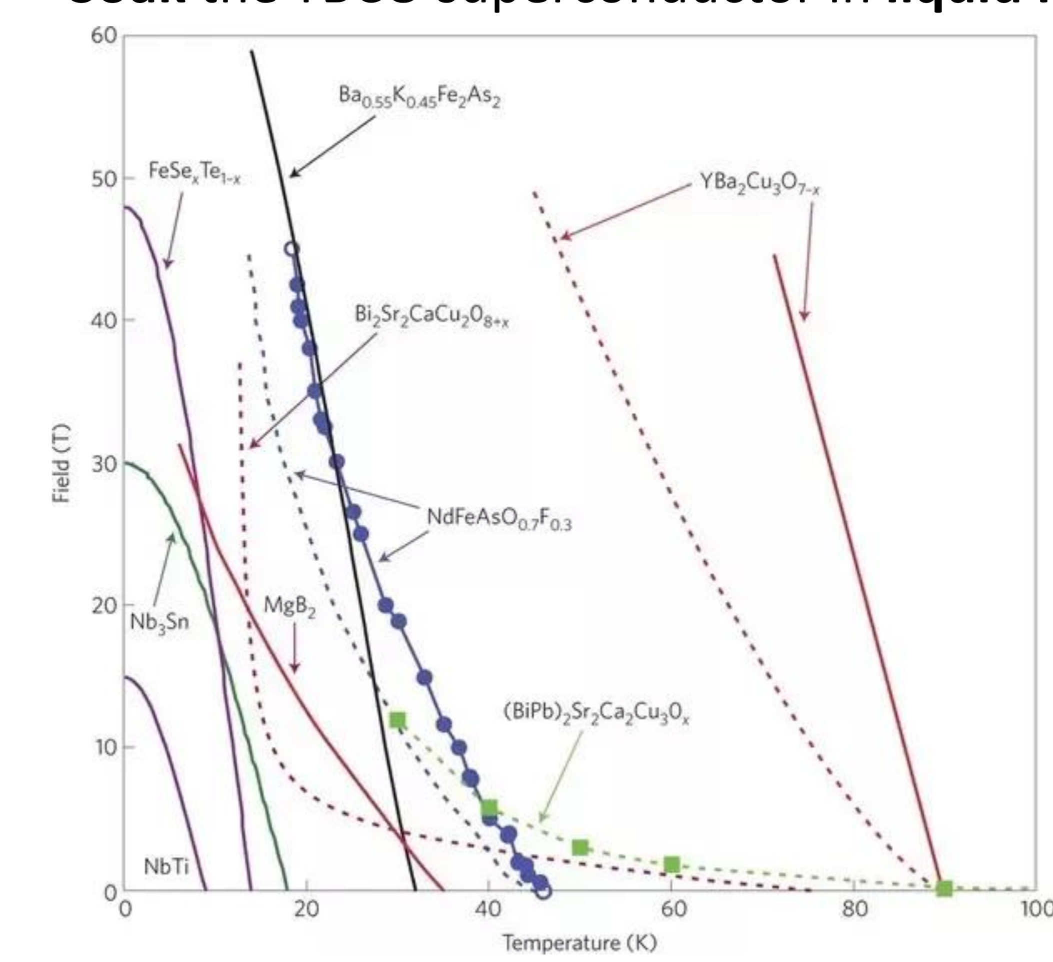


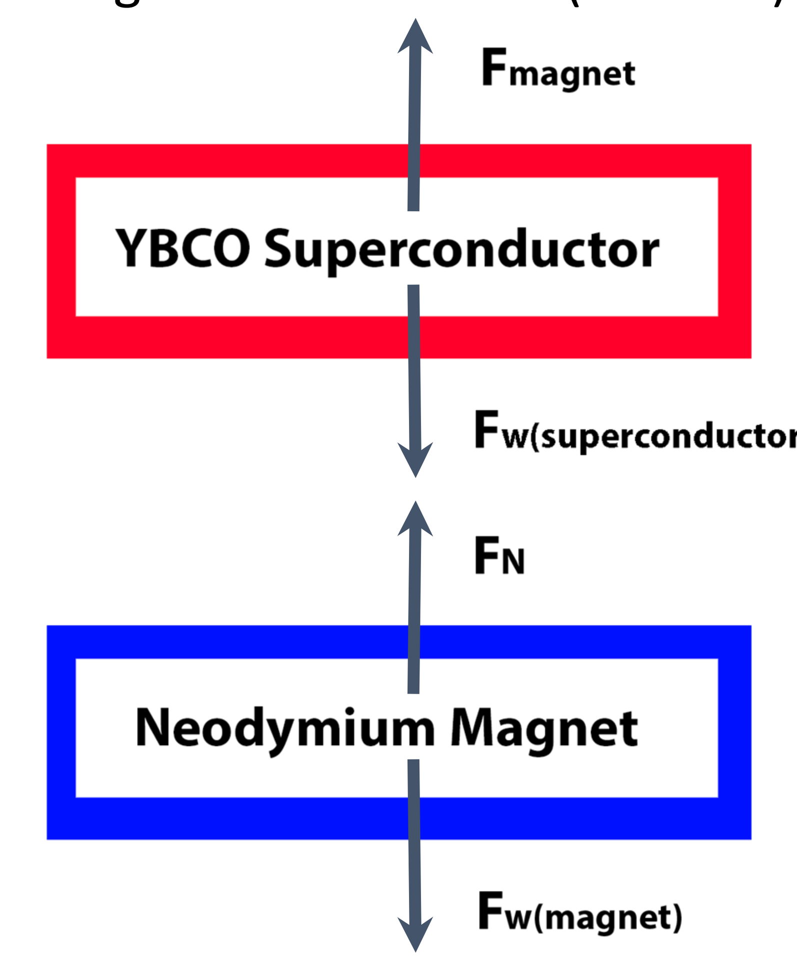




Demonstration and Procedure

- Place magnets in a **circular track shape** to create a cradle for the YBCO superconductor
- Ensure that the magnets are **facing the same charge** as the YBCO superconductor **upwards**
- **Soak** the YBCO superconductor in **liquid nitrogen**, cooling it down to ~77°K (~-196°C)





Looking Forward/State of the Art

- Power transportation with **reduced energy loss**
- High sensitivity particle detectors
- Development of **more efficient** superconducting materials
- **Higher temperature** superconductors
- Powerful electromagnets in particle accelerators

Further Experiments:

- **Determining critical temperature** for superconducting material and rate of warming
- Finding **magnetic cradle properties** that causes levitation

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