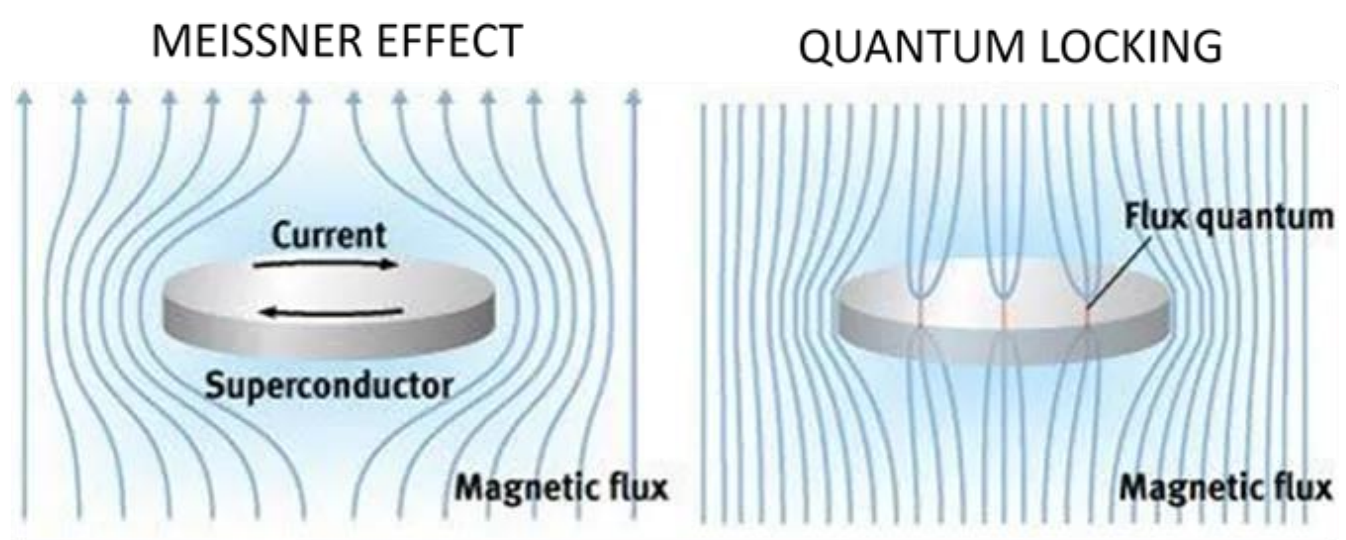
Superconductor Levitation through Quantum Locking

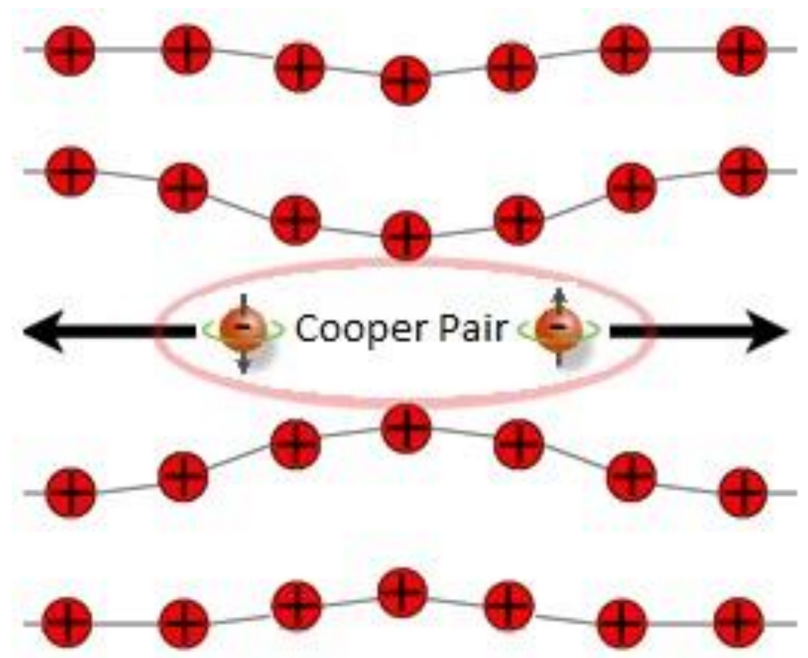
Brody Droste[1], Kai Plank[1], Skanda Rao[2], Sameer Selvakumar[1], Patrick Shaw[1], Anand Thiagarajan[1]

[1] Bellaire High School,
[2] MIT

Theory of Superconductivity

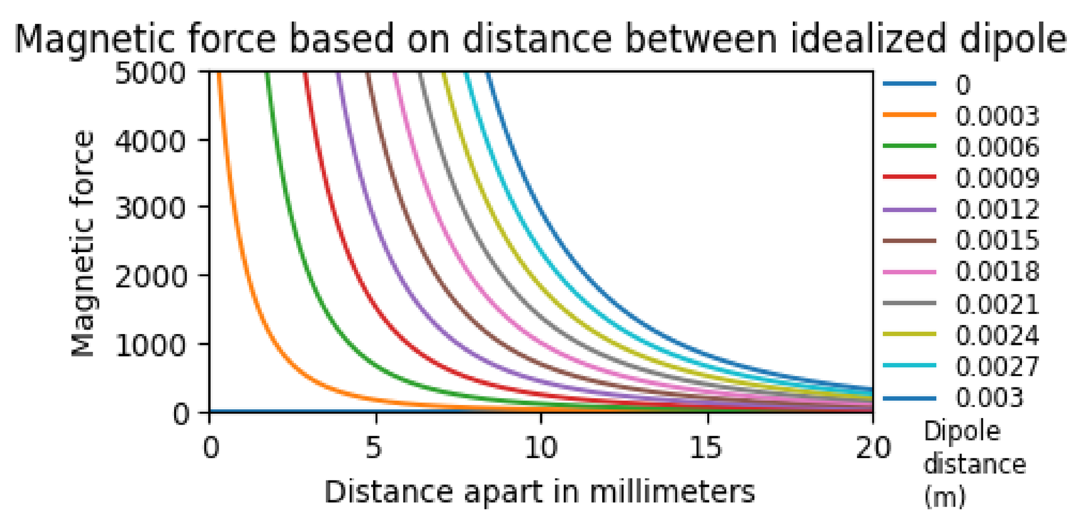
- Superconductivity - the property of a material to conduct current without electrical resistance
- Cooper Pairs are pairs of electrons with opposite momenta that bind at very low temperatures whose movement has no collisions and therefore no heat or resistance generated.
- Flux tubes are small imperfections and defects in a superconductor through which magnetic flux lines penetrate that become "pinned," locking the superconductor in place in the magnetic field
- When the magnetic field becomes strong enough, enough flux tubes form that the magnetic field simply passes through and superconductivity stops





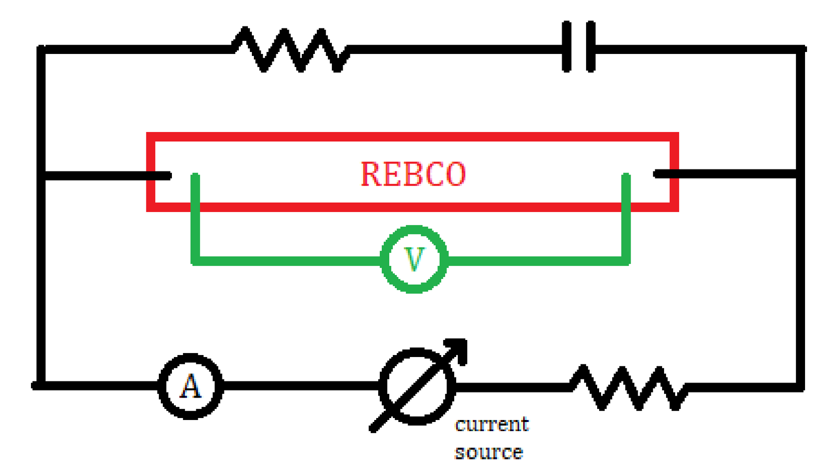
Methodology

- Materials: YBCO puck, liquid nitrogen, neodymium magnets
- By approximating the magnet as a magnetic dipole, we coded a simulation in Google Colab to give magnetic force based on the distance of the dipole and distance between magnets
- Through experimental testing we determined a distance curve for the strength of the magnets to know how field varies around floating puck
- Cooling the YBCO with LN2 puts it in a superconducting state, from which we can levitate the puck or measure its resistance



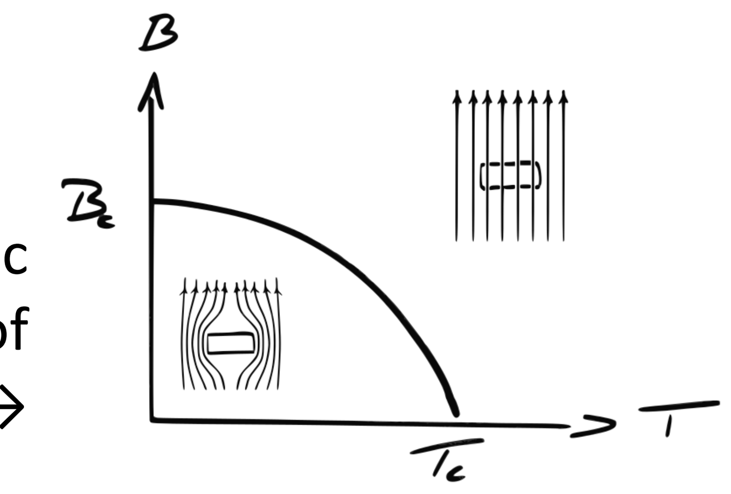
Demonstration

- Demonstration of breakdown of superconductivity with current, temperature, or magnetism



← circuit to test resistance of superconducting strip

simplified diagram of critical magnetic field vs critical temperature of superconductor→



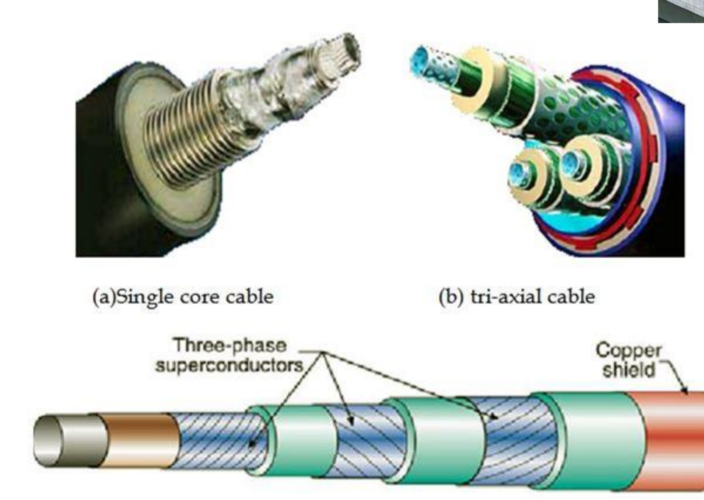
Applications

Transportation:

- Maglev trains - frictionless travel
- Spacecraft and aircraft launch - mass drivers using superconducting electromagnets

Energy:

- Generators/Transmission cables - no electrical resistance improves efficiency



References / Acknowledgements

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