SUPERCONDUCTIVITY

Superconductivity is a quantum phenomenon of zero electrical resistance. It was discovered in 1911 by a dutch physicist named Kamerlingh Onnes. Superconductivity occurs only below a certain critical temperature(Tc). Metals such as aluminum, lead, tin become superconductors at temperatures close to the absolute zero (-273.15C, - 459.67F).

In 1986 a new family of superconductors was discovered having a much higher Tc, close and even higher than the boiling temperature of liquid nitrogen (-196.15C,-321.07F).

MEISSNER EFFECT

The expulsion of magnetic field from a superconductor is an intrinsic property of any superconductor. Below a certain magnetic field the superconductor expels all the magnetic flux. It does that by driving currents near its surface. These currents produce a magnetic field within the bulk that cancels the external field.

FLUX PINNING

In some cases the magnetic flux becomes locked or "pinned" inside a superconductor. Flux pinning is desirable in high - temperature ceramic superconductors to prevent flux movements which introduce a resistance and dissipate energy. The pinning is achieved through defects in the crystalline structure of the superconductor usually resulting from grain boundaries or impurities.

QUANTUM EXPERIENCE

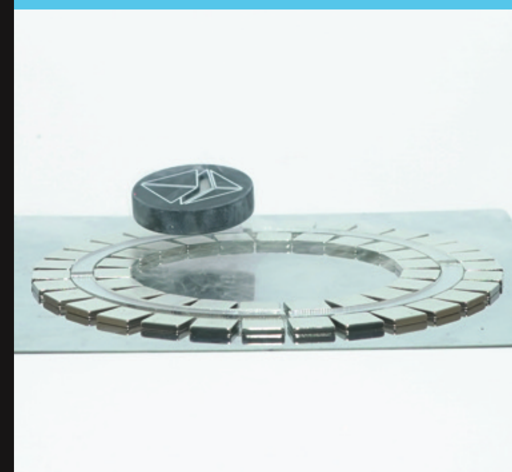
⚠ WARNING!

This contains strong neodymium magnets. If swallowed or not handled carefully, can cause serious injury. Keep magnets away from magnetic materials and sensitive electronics.

ASSEMBLY VIDEO

SUPERCONDUCTIVITY LEVITATION KIT

QUANTUM EXPERIENCE



EXPERIMENTS

MEISSNER EFFECT

The Meissner effect describes the expulsion of magnetic flux from the superconductor.

Experiment: Soak the levitator in liquid nitrogen, logo face down. Take a small magnet and gently lower it towards the levitator, ~3cm above. Let it go. See how it is repelled (jumps away). Try to force the magnet a few more millimetres further towards the magnet and see how it levitates but strongly wobbles around.

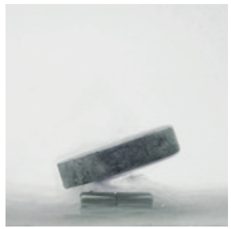
Conclusions: In the Meissner state the superconductor is a perfect diamagnet - it has a magnetization opposite in sign and equal in magnitude to the surrounding magnetic field. It therefore exhibits an unstable magnetic repulsion, like two repelling magnets.

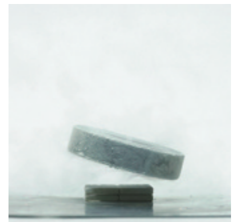
FLUX PINNING, QUANTUM LOCKING

The locking is the key to understanding **Quantum Levitation**. Show how the superconductor is frozen in space close to the magnets.

Experiment: Take the cooled superconductor and place it above the magnetic setup. The superconductor is "locked" in midair. Try to move it in all directions and feel the resistance due to the pinning force.

Show that the superconductor can be placed in any orientation even upside down (suspended below the magnets).

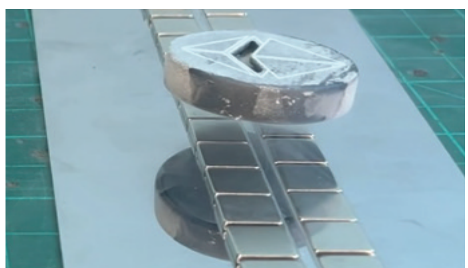




Conclusions: The superconductor is 'locked' in space. The flux pinning force keeps the levitator stable in 3D (unlike the unstable Meissner repulsion).

HOVERBOARD - FRICTIONLESS MOTION

Build a straight track by placing the magnets on the steel sheet.



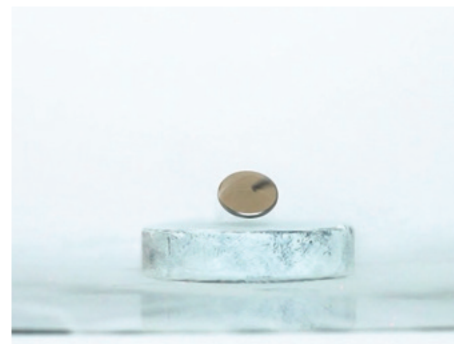
Put the magnets such that adjacent magnets side-by-side attract each other (opposite orientations) and repel each other along the track. Try to push the magnet pairs as close as possible along the track.

Observe – The Superconductor is locked on the track BUT can freely move along the straight line.

HOVERBOARD - FRICTIONLESS MOTION [2]

Build a similar track BUT with a spacer between the two magnet rows. The attracting magnet in each pairs will be pulled towards one another which will help keep the spacer in place.

Observe: The Superconductor levitates slightly higher. Try to Draw the field lines in both cases and explain the different behaviors due to the magnetic field.



Now you're ready to design the best hoverboard track!