Superconductivity. Discovered 100 years ago, continues to fascinate and attract the interest of scientists and non-scientists all around the globe. Being the only quantum phenomena visible to the naked eye, it offers a unique window to quantum mechanics.

Now you can touch it as well. The 'Quantum Levitation' variety of kits offer a unique opportunity to witness true levitation and feel the quantum locking forces.

Designed for Science Education. Our kits were specially designed for large audience demonstrations.

⚠ WARNING!

The **"Quantum Levitation"** experiment uses extremely strong neodymium magnets. These magnets, if not handled carefully, can cause serious injury. Keep the magnets away from magnetic materials and far from sensitive electronics.

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 only 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 nearly 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 dissipates energy. The pinning is achieved through defects in the crystalline structure of the superconductor usually resulting from grain boundaries or impurities.

QUANTUM LEVITATION

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A truly Quantum experience

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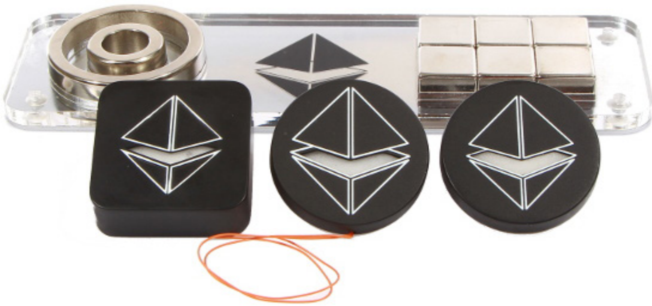


Meissner effect

The Meissner effect describes the expulsion of magneic 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 (falls aside). Try to force it a few more millimeters into the field and see how it levitates while still wobbling around.

Conclusions: In the Meissner state the superconductor is diamagnetic, it has an opposite magnetization. It therefore exhibits unstable magnetic repulsion, like two repelling magnets.

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. Briefly 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 including upside down.

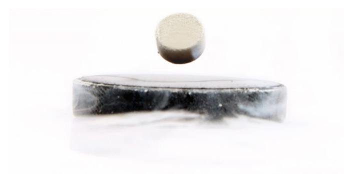
Conclusions: The superconductor is ‘locked’ in space. The flux pinning force keeps the levitator stable in 3D (unlike two repelling magnets).

Frictionless motion

After seeing the locking its time to further explore its properties.

Experiment: Lock the levitator above the pair of ring magnets. It will rotate freely around the axis of the magnets but will be locked in any other direction. Shift the superconductor sideways to emphasize that it rotates around the magnet axis and not around its center.

Conclusions: The superconductor moves freely as long as the magnetic field inside it (magnetic flux) stays the same.



Quantum locking / Frictionless motion [2]

Experiment: put the levitator in liquid nitrogen facing down (superconductor side up) Push a small disc magnet close to the superconductor. The magnet will stable levitate above the surface. It can be rotated around its axis in a frictionless motion.