Quantum Magnetic Levitation

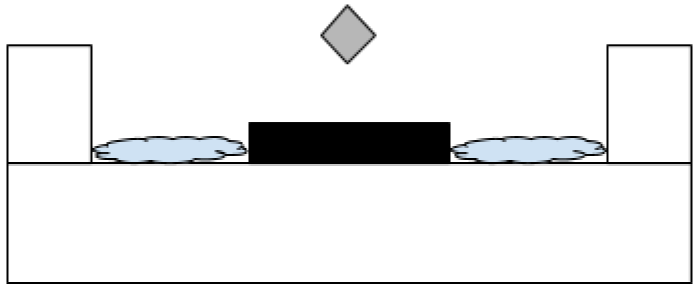

Figure 1: Graphic of magnet levitating above superconductor in basin of liquid nitrogen in styrofoam container.

Introduction

A quantum magnetic levitation model is a fun way to display the effects of bringing a superconductor to a temperature that is below its critical temperature. A superconductor is an object that has no electrical resistance and expels magnetic fields. As a result of this phenomenon, when a rare earth metal such as neodymium is placed above a chilled superconductor, the neodymium is forced to levitate over the chilled superconductor, since the superconductor forces neodymium's magnetic field to move around it. This phenomenon is known as the Meissner effect.

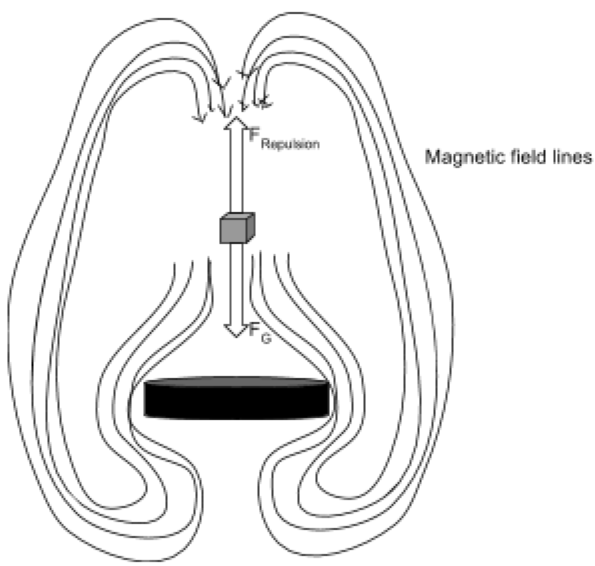

Figure 2: The Meissner effect as demonstrated by the changed magnetic field around the superconductor, balancing out the force of gravity and the force of repulsion.

Here, the superconductor acts as a magnet with the same pole causing the superconductor and neodymium to repel one another. This repulsion is what causes the neodymium to float above the chilled superconductor.

Creating the Model

Item List
Neodymium magnet
Liquid nitrogen
Styrofoam container
Yttrium barium copper oxide tablet

This model was created by cutting a small section out of a styrofoam cylinder, putting a tablet that is made of yttrium barium copper oxide (or YBCO) in the center, and adding some liquid nitrogen. A small neodymium magnet is placed on top of the YBCO tablet, and the magnetic fields of the magnet and tablet repel each other.

If the magnet is too big, the superconductor would not be powerful enough to levitate the magnet, leaving the magnet to sit atop the styrofoam cup. If the magnet is too small, the superconductor would repel against the magnet even more, making the magnet levitate at a greater height.

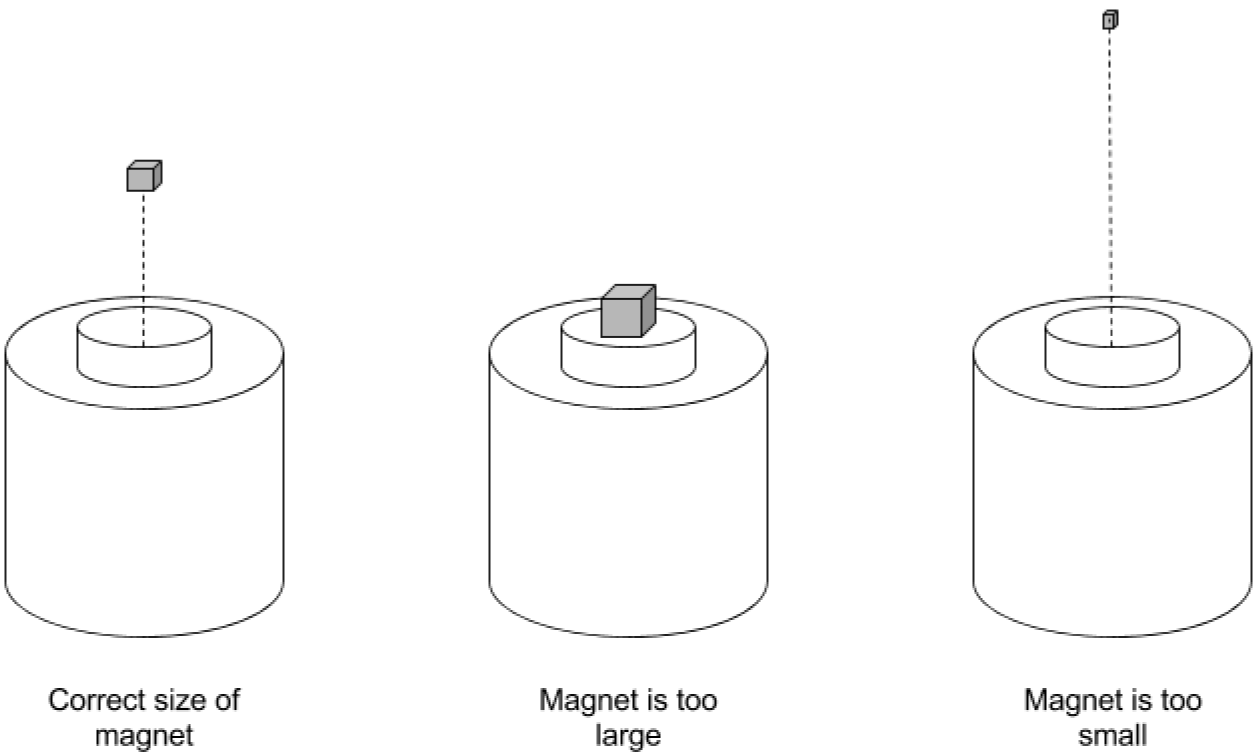

Figure 3: Illustration of magnet size versus levitation height.

https://www.scientificamerican.com/article/how-do-they-do-that-a-closer-look-at-quantum-magnetic-levitation/
http://hyperphysics.phy-astr.gsu.edu/hbase/Solids/meis.html
*All figures created by Austin Mullins and Zach Steinberg