Superconductivity
An Introductory E-book for High School Students

Shawn Liner[1], Juana Moreno[2], Mark Jarrell[2], Phillip Sprunger[2], David Young[2], Les Butler[2]

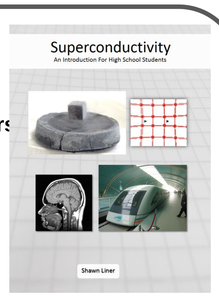
[1]Parkview Baptist School , [2]LSU

LA-SiGMA
Louisiana Alliance for Simulation-Guided Materials Applications

Abstract

High school students are often more curious about advanced science topics than the material currently in their science curriculum. High School teachers would love to feed that curiosity. However, due to curriculum demands teachers don't have class time to indulge those questions. And, while knowledgeable about their subject matter teachers, may not have knowledge of advanced or new science topics. Often this sends students to websites written by and for scientists with advanced degrees. Students get over their heads quickly and give up. Our goal is to present advanced science topics (specifically superconductivity) in a way that will allow them to learn a good background, while still maintaining their interest.

Goals



- **Cheap - We want it available to students and teachers**
- **Readily Available – easy to get and cross platform**
- **High School Level – our target audience**
- **Informative – teach them something**
- **Motivational – leave them with an interest in more**
- **Multimedia – hold their attention better with demos**
- **Interactive – allow them to touch and interact**
- **Editable – allow it to be updated in the future**
- **Structured – students have learned a healthy disrespect for websites**

Proposed Solution

Publish an interactive multimedia e-book with Habitat on Inkling.com.

Inkling is available as a tablet app for apple, android and Microsoft products, as well as being available through web browser access. Epub versions can also be created for use on non-multimedia reading devices. The structure is maintained as a book and updates are pushed automatically. Inkling stores the files so they will be readily available and no new storage location has to be created.

Tasks

Courtesy Lewis Hine via Wikimedia Commons

- **Learn about superconductors**
- **Create an outline of the content.**
  How much should we include to educate, but still keep them interested.
- **Create Graphics, images, and videos.**
  We wanted to own as much of the material as possible.
- **Create and find demos to include in the material.**

Topics

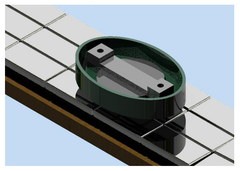
- **Electrical and Magnetic properties of superconductors along with some review of basic electrical and magnetic properties**
- **A survey of superconducting limitations. This helps prevent misinformation and promotes curiosity about overcoming those limitations**
- **Superconducting technology. A survey of where the technology is currently being used. Students are amazed that their life is impacted by these topics now.**
- **Theory. Placed last to maintain interest. Students who are genuinely curious will continue to read without chasing off the casual interest before they learn something.**

Demo
Maglev Train Model

A track is created from rare earth magnets and a "train" is 3D printed to hold the superconductor and a reservoir of liquid nitrogen. This allows for alonger demo. Long term plan calls for an oval track to be built.

Levitating Disk on Track

Design of "train"

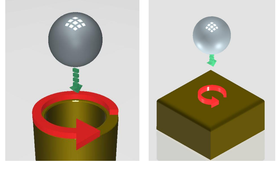


Model of oval Track with "Train"

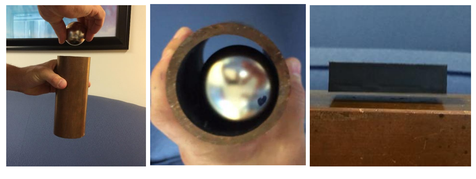
3D printed "Train"

Demo
Lenz Law

We included a demo of Lenz's law to help students understand levitation. The pictures include bubbles to explain the concept and the video includes a voice-over to help students see the important parts of the demo.



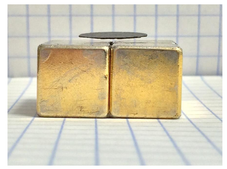
Illustrations created in Autodesk Inventor to show the current being created as the magnet falls.



Freeze-frames of the two parts of a video demonstration. The spherical magnet is dropped through the copper pipe to show it falling slowly. Then a bar magnet is dropped onto a copper plate. It is visibly slowed by the induced magnetic field.

Demo
Levitation

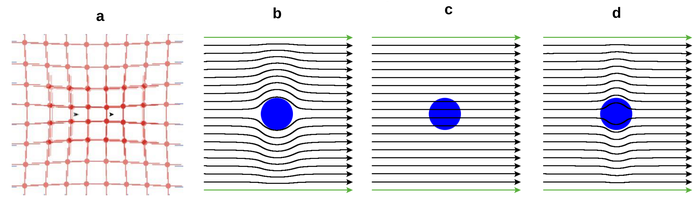
Video Demos are included of both a superconducting caused levitation and that of pyrolytic graphite. The latter was included to show that the property was not specific to superconductors.



Freeze-frames of the two parts of a video demonstration. The left shows pyrolytic graphite levitating above strong magnets. The right shows the standard demo of a magnet levitating above a superconducting disk.

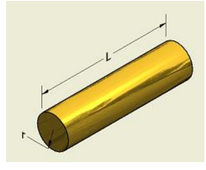
Graphics For Theory

Every attempt was made to "own" as much of the content, images, videos, and illustrations as possible.

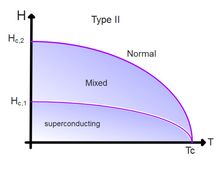


These four images were captured from simulations created in netlogo (a turtle based programing language.)
a) Two arrows represent electrons forming a Cooper Pair.
b) A superconductor expelling magnetic flux.
c) A non diamagnetic material allowing the
d) A Superconductor in a pinning state.

a



b



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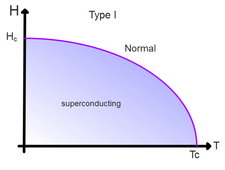

a) A simple diagram of a wire created to discuss causes of resistance
b) Type II critical magnetic field as a function of temperature.
c) Type I critical magnetic field as a function of temperature.

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