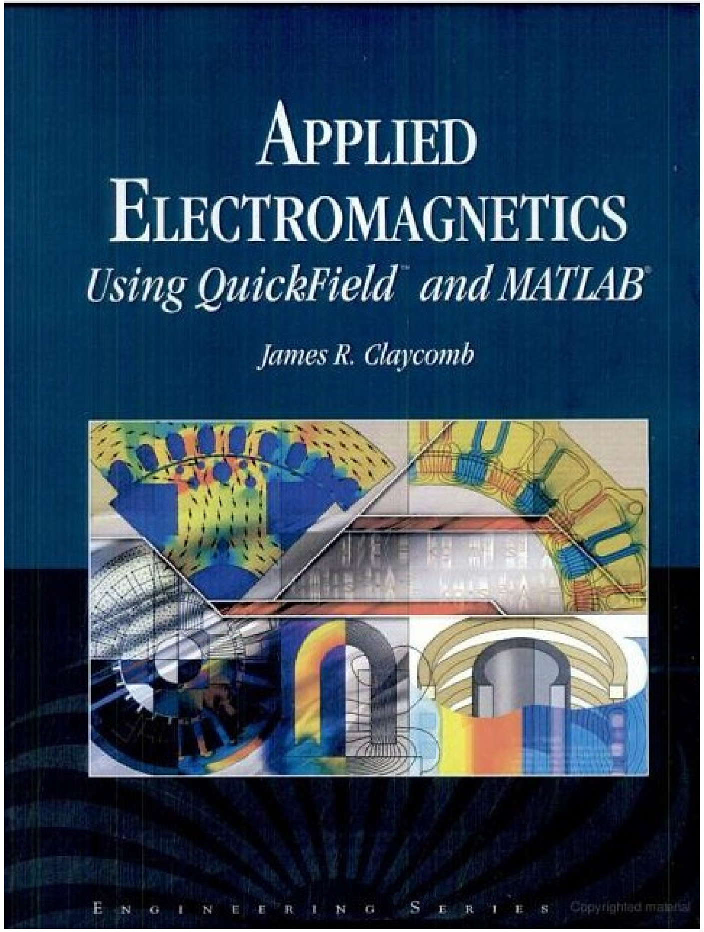
Contents and Speakers

James R. Claycomb, Ph. D.
Electromagnetic shielding simulations with QuickField

Vladimir Podnos,
Marketing & Support Director, Tera Analysis
Event Moderator

Answering questions. Presenting coming webinars.

Books by Dr. James Claycomb:



APPLIED ELECTROMAGNETICS

Using QuickField™ and MATLAB®

James R. Claycomb

ENGINEERING SERIES

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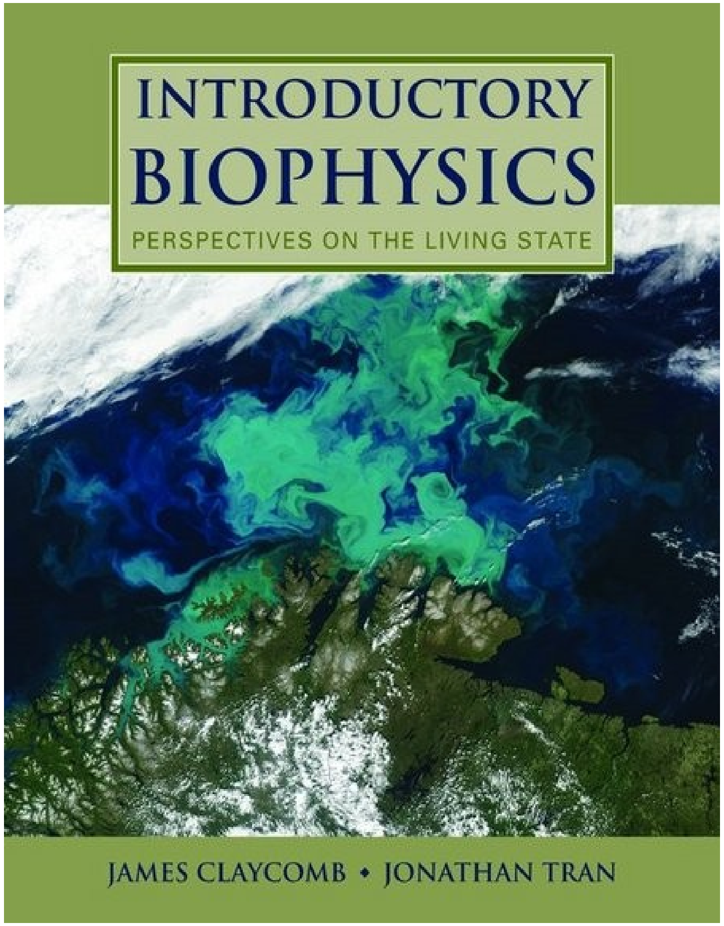


INTRODUCTORY BIOPHYSICS

PERSPECTIVES ON THE LIVING STATE

JAMES CLAYCOMB • JONATHAN TRAN

QuickField for Electromagnetic Shielding Applications

James R. Claycomb
Department of Mathematics and Physics,
Houston Baptist University
UH –Texas Center for Superconductivity

QuickField for Electromagnetic Shielding Applications

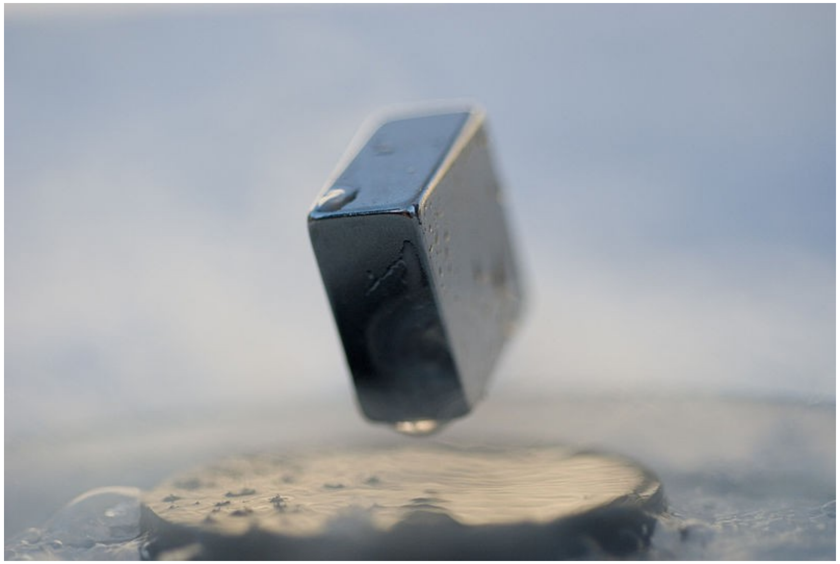
- Shielding curves for conducting and permeable (iron) enclosures
- Highly permeable (mumetal) shields
  - axial and transverse fields
- Superconducting shields
  - axial and transverse fields
- Combination superconducting and mumetal shields
- Magnetically shielded rooms
  - Single layer (copper)
  - Multi layer (copper + mumetal)
  - Doors and outlets
- Electromagnetic pulses
- Containing stray magnetic fields

Highly permeable magnetic shields

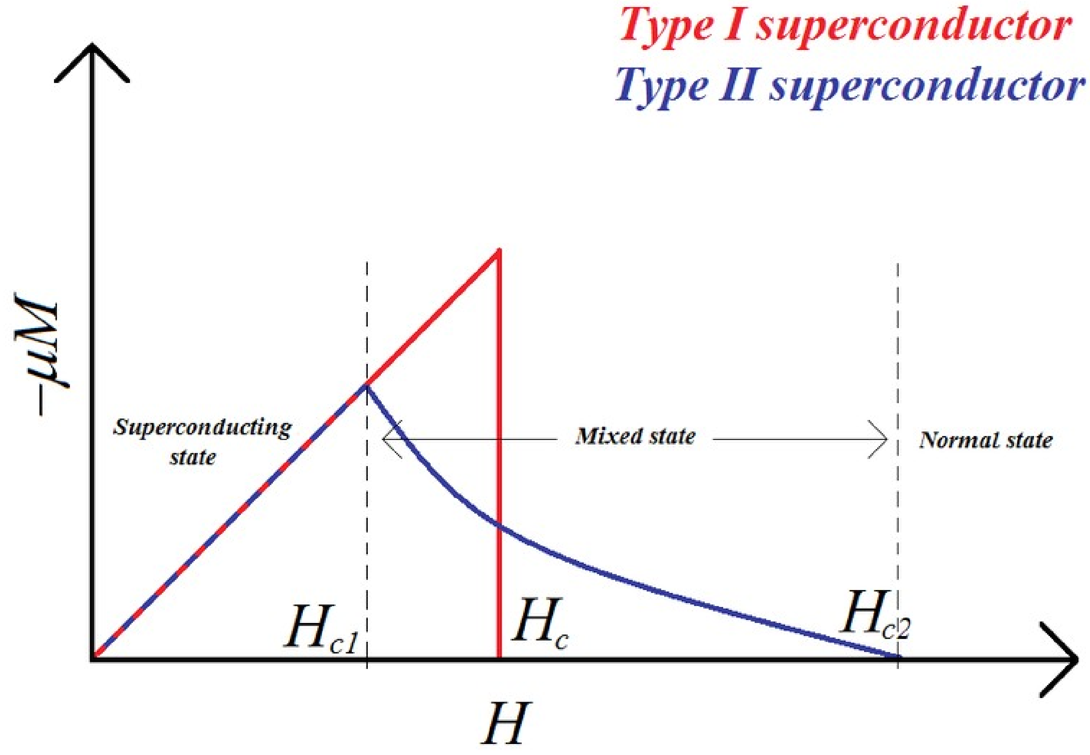
Mumetal is a nickel-iron alloy with composition (~75% nickel, ~ 15% iron, plus copper and molybdenum) relative permeability μ ranges between 10^4 - 10^5

Superconducting magnetic shields

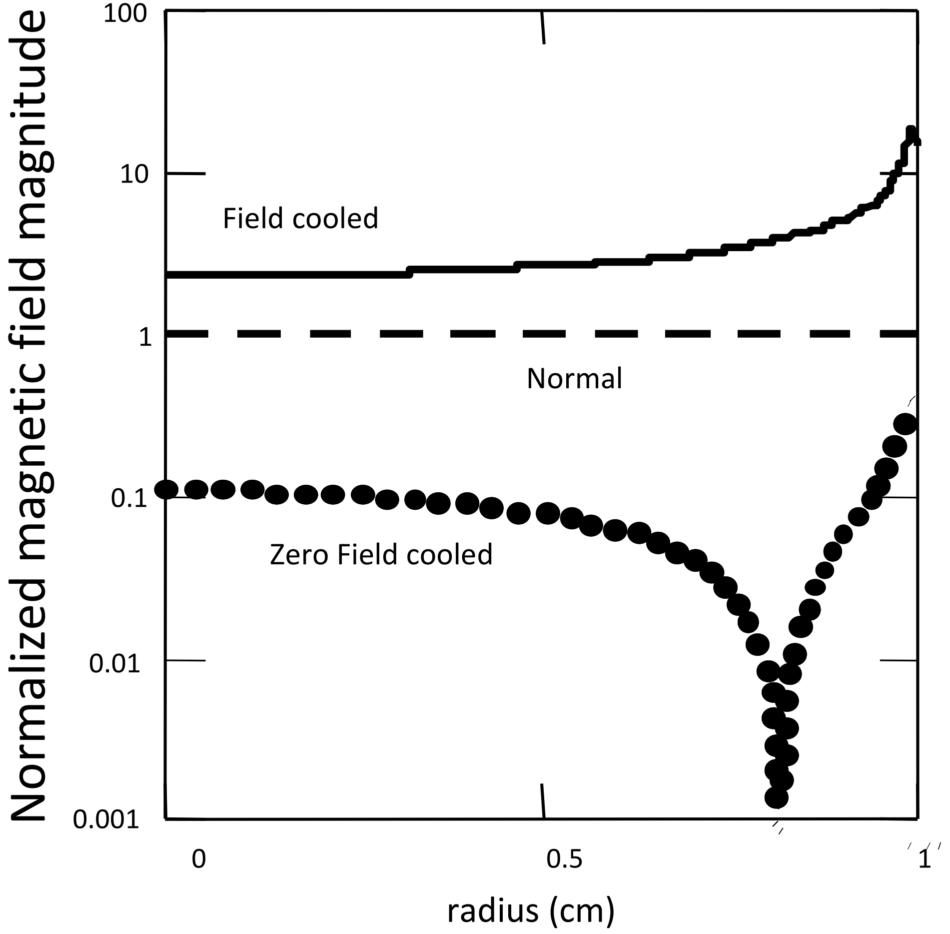
- Zero electrical resistivity below a critical transition temperature
  - External magnetic fields are expelled from superconductors (Meissner effect).

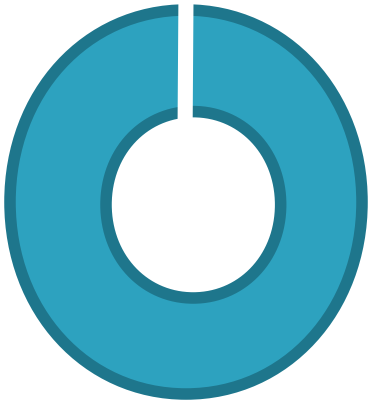


Superconducting magnetic shields

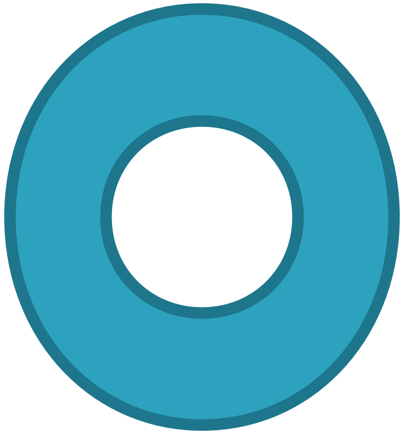


Superconducting ring shields





Flux Focuser
(normal B =0)



Continuous Ring
(FC: normal B =0)
(ZFC: A = 0)

Comparing Transverse and Longitudinal Shielding Factors for Permeable and Superconducting Tubes

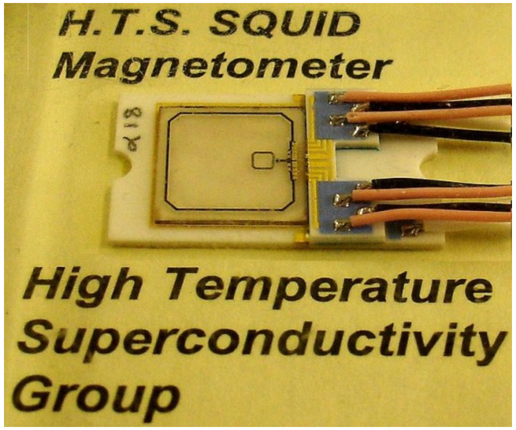
Field attenuation along the axis of a superconducting tube

$$B_{axial} \propto \exp\left(-3.832\frac{z}{a}\right) \qquad B_{trans} \propto \exp\left(-1.84\frac{z}{a}\right)$$

Field attenuation along the axis of a highly permeable tube

$$B_{axial} \propto \exp\left(-3.832\frac{z}{a}\right) \qquad B_{trans} \propto \exp\left(-3.832\frac{z}{a}\right)$$

Superconducting Shields for Biomagnetic Measurements



HTS SQUID with pickup coil

NIMH 275 channel whole –head SQUID magnetometer system (CTF MEG system), recording neuromagnetic signals with spatial and temporal resolution.

Signal to Noise Improvement Ratio (SNIR)

$$SNIR = \frac{SNR_{\text{with shield}}}{SNR_{\text{without shield}}}$$

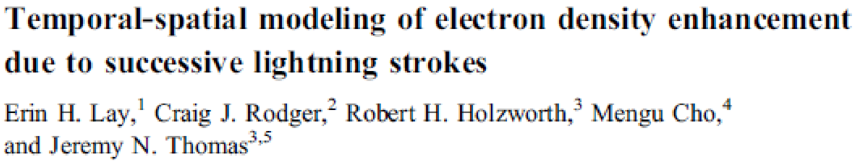
Magnetically Shielded Rooms

A room shielded from electromagnetic field (higher frequencies) in Wolfson Centre for Magnetics

Lightning Simulations

$$I(z=0,t) = Q\frac{1}{12}\frac{1}{\tau}\left(\frac{t}{\tau}\right)\exp\left(-\left(\frac{t}{\tau}\right)^{1/2}\right)$$

Cho, M., and M. J. Rycroft (1998), Computer simulation of the electric field structure and optical emission from cloud top to the ionosphere, J. Atmos. Sol. Terr. Phys., 60, 871–888.

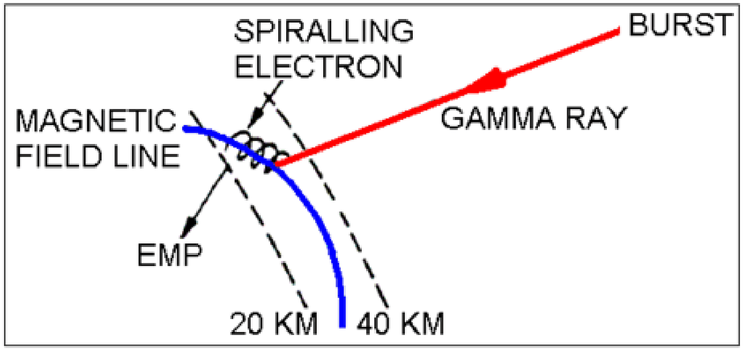


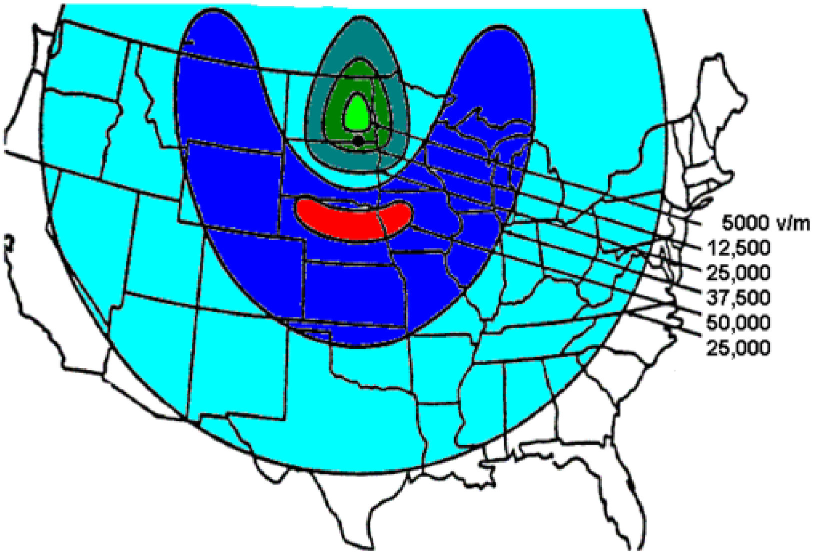
Temporal-spatial modeling of electron density enhancement due to successive lightning strokes

Erin H. Lay,[1] Craig J. Rodger,[2] Robert H. Holzworth,[3] Mengu Cho,[4] and Jeremy N. Thomas[3,5]

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 115, A00E59, 2010

Electromagnetic Pulse (EMP)





Source: Nuclear Environment Survivability,
U. S. Army, report AD-A278230 (1994)

Starfish prime – atmospheric nuclear test 1962

Electromagnetic Pulse (EMP)

high altitude (few hundred km) nuclear detonation

Pulse component	Pulse time	Mechanism
E1	<1 μs peak - 5 ns ½ max -200 ns	Electrons from gamma ionized atoms in upper atmosphere are deviated by Earth's B-field
E2	1 μs < 1 s	Scattered gamma rays produced by neutrons
E3	10 – 100 s	Restoration of Earth's B-field displaced by nuclear blast (similar to solar flair induced geomagnetic storm)

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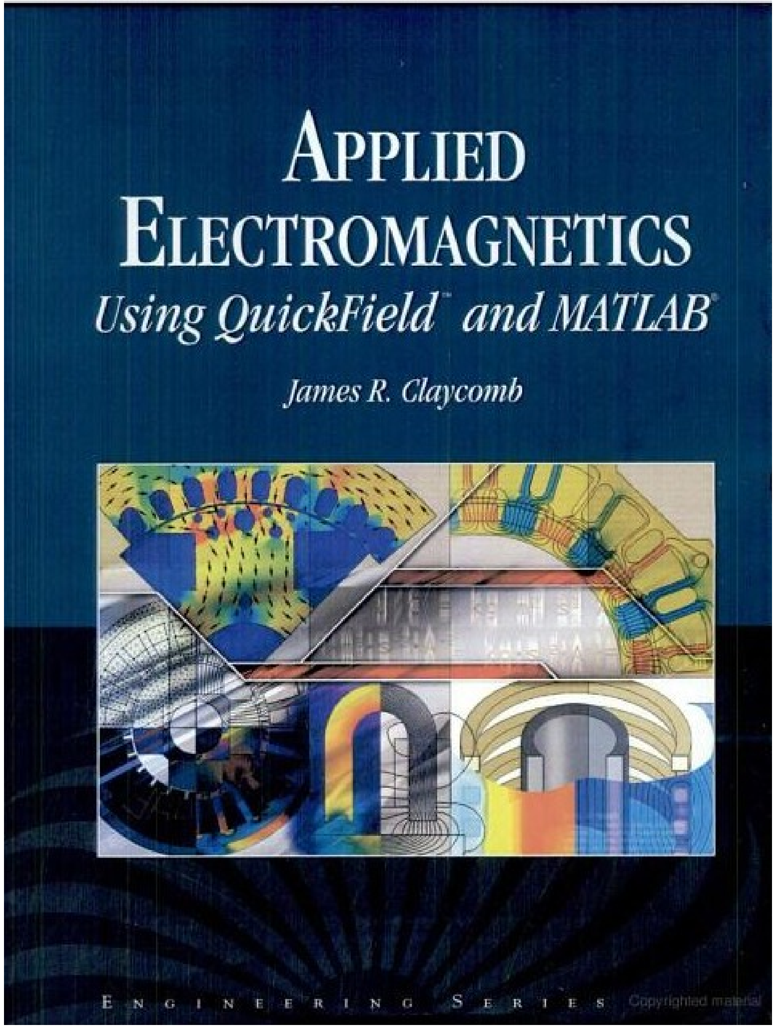

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Chapter 1: Mathematical Preliminaries
Chapter 2: Solutions to Laplace’s Equation
Chapter 3: A Walk Through QuickField
Chapter 4: Electrostatics
Chapter 5: Magnetostatics
Chapter 6: Time Harmonic Magnetics
Chapter 7: Transient Magnetics
Chapter 8: Superconductivity
Chapter 9: DC Current Flow
Chapter 10: AC Current Flow
Chapter 11: Thermal Analysis
Chapter 12: Stress Analysis
Chapter 13: Electrical Circuits

Included multiphysics coupling