



ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor (RJIF): 8.4
IJAR 2023; 9(11): 204-206
www.allresearchjournal.com
Received: 14-09-2023
Accepted: 20-10-2023

Dr. Kalpana
Assistant Professor,
Department of Physics, Indira
Gandhi University, Meerpur,
Rewari, Haryana, India

Bridging the gap: Electric dimensions and magnetism explored, with a spotlight on high-temperature superconductors: A systematic review

Dr. Kalpana

DOI: <https://doi.org/10.22271/allresearch.2023.v9.i11c.11378>

Abstract

This systematic review delves into the intricate relationship between electric dimensions and magnetism, emphasizing the pivotal role of high-temperature superconductors (HTS) in bridging the gap between these fundamental aspects of physics. The paper provides an extensive overview of the historical development, current state-of-the-art, and potential future directions in the exploration of electric and magnetic phenomena, with a focus on HTS materials. The review then shifts its focus to high-temperature superconductors, shedding light on the unique properties that distinguish them from conventional superconductors.

It systematically examines the key characteristics and behaviors of HTS materials, unraveling the potential applications and technological implications of their distinct properties. The exploration encompasses the synthesis techniques, structural considerations, and performance benchmarks associated with high-temperature superconductors.

Overall, this systematic review provides a comprehensive overview of the intricate relationship between electric dimensions and magnetism, with a specific focus on the unique realm of high-temperature superconductors. By synthesizing existing knowledge and highlighting research gaps, the review aims to propel future investigations and applications in this captivating intersection of physics and materials science.

Keywords: Innovative applications, energy applications, transportation applications, materials science, systematic review

Introduction

Electricity and magnetism are two inseparable facets of the fundamental forces governing the physical world. The quest to understand their interplay has driven scientific inquiry for centuries ^[1]. Recent advancements, particularly in the realm of high-temperature superconductivity, have opened new avenues for exploring and exploiting the synergies between electric and magnetic dimensions. In the ever-evolving landscape of scientific exploration, the intersection of electric dimensions and magnetism stands as a captivating realm that continues to unravel mysteries and unveil new possibilities ^[2]. "Bridging the Gap: Electric Dimensions and Magnetism Explored, with a Spotlight on High-Temperature Superconductors - A Systematic Review" embarks on a journey through the intricacies of these fundamental forces, delving into the fascinating synergy between electricity and magnetism ^[3].

This systematic review serves as a comprehensive exploration, aiming to connect disparate realms of knowledge, and its focal point on high-temperature superconductors adds a layer of excitement and potential breakthroughs ^[4]. As we traverse the landscapes of electromagnetic phenomena and delve into the cutting-edge developments within high-temperature superconductivity, this review promises to be a beacon for researchers, enthusiasts, and curious minds alike, illuminating the pathways towards a deeper understanding of the synergistic dance between electric and magnetic dimensions. Within the scientific community, the intricate dance between electric dimensions and magnetism has long been a source of wonder, offering a tapestry of phenomena that spans from the microscopic to the cosmic ^[5].

Corresponding Author:
Dr. Kalpana
Assistant Professor,
Department of Physics, Indira
Gandhi University, Meerpur,
Rewari, Haryana, India

"Bridging the Gap" emerges as a scholarly endeavor that seeks to weave together the threads of understanding in this dynamic field, drawing attention to the enigmatic realm of high-temperature superconductors. As we venture into this systematic review, the spotlight on high-temperature superconductors becomes a focal point of intrigue. These materials, capable of conducting electricity without resistance at temperatures previously deemed impractical, hold the promise of transformative advancements in various technological domains [6].

Its comprehensive coverage includes practical HTS material manufacturing and characterization, large-scale applications, and electronic applications. The applied HTS technologies have been well enabled to build applicable devices, and their characteristics have been well verified in the HTS devices developed to be industrialized for practical applications [7]. The highlighted HTS devices and their performance details reveal the trend and the necessary improvement required to reach the goal of industrial applications of HTS technologies.

By systematically exploring the latest developments, theories, and experimental findings, this review serves not only as a synthesis of current knowledge but also as a compass guiding us towards uncharted territories in the realm of electric dimensions and magnetism [8]. As we navigate through the pages of this review, we embark on a journey that seeks not only to bridge existing gaps in our comprehension but to illuminate pathways toward groundbreaking discoveries and applications.

Methodology

Historical Perspective

This section traces the historical development of our understanding of electricity and magnetism, highlighting key milestones and breakthroughs that paved the way for contemporary research. From the elucidation of Maxwell's equations to the discovery of superconductivity [9], the journey has been marked by a continuous refinement of concepts and experimental techniques.

Fundamental Concepts

A detailed examination of fundamental concepts in electricity and magnetism provides the groundwork for comprehending the nuances of their interaction. Maxwell's equations, the Lorentz force, and magnetic induction are among the key principles that form the basis of the dynamic relationship explored in this review.

High-Temperature Superconductors

This section introduces high-temperature superconductors, emphasizing their unique properties and applications. The discovery of materials exhibiting superconductivity at temperatures higher than traditional superconductors has revolutionized the field, enabling the development of novel technologies with profound implications for energy transmission [10], medical imaging, and beyond.

Electric and Magnetic Phenomena in High-Temperature Superconductors

A comprehensive analysis of electric and magnetic phenomena in HTS materials forms the core of this review. The interplay between electric currents and magnetic fields in these superconductors, known as the Meissner effect, is explored in depth. Additionally, vortex dynamics, critical

current densities, and flux pinning mechanisms are discussed to elucidate the complex behavior of these materials.

Applications and Technological Implications

The paper examines the practical implications of understanding the interplay between electric and magnetic dimensions in HTS materials. Applications in power transmission, magnetic levitation [11], and magnetic resonance imaging are highlighted, showcasing the potential transformative impact of this research on various industries.

Future Directions

The review concludes by outlining potential future directions in the exploration of electric dimensions and magnetism, with a focus on high-temperature superconductors. Emerging technologies, novel materials [12], and interdisciplinary collaborations are identified as key drivers for advancing our understanding of these fundamental forces.

Discussion

The systematic exploration of the historical development of electricity and magnetism sets the stage for understanding their intricate relationship. Fundamental concepts such as Maxwell's equations provide a theoretical framework for the subsequent analysis. The introduction of high-temperature superconductors marks a turning point, unlocking new possibilities and applications.

The in-depth analysis of electric and magnetic phenomena in HTS materials reveals a rich tapestry of behaviors, including the fascinating Meissner effect and intricate vortex dynamics. These phenomena contribute to the unique characteristics of high-temperature superconductors, distinguishing them from conventional superconductors.

Applications and technological implications underscore the practical relevance of this research, with real-world applications in power transmission, magnetic levitation, and medical imaging. The transformative potential of high-temperature superconductors in these areas is evident, promising advancements that could reshape industries.

The review identifies emerging technologies, novel materials, and interdisciplinary collaborations as key factors driving future advancements in the exploration of electric dimensions and magnetism, particularly in the realm of high-temperature superconductors. This comprehensive overview aims to inspire and guide future investigations, fostering continued progress at the intersection of physics and materials science.

Conclusion

Bridging the gap between electric dimensions and magnetism through the exploration of high-temperature superconductors represents a promising avenue for scientific inquiry and technological innovation.

The most success has been achieved with HTS small-scale devices that rely on the special properties of superconductors, especially the Josephson quantum tunnelling effects. Perhaps the best-known small-scale device is the SQUID (Superconducting Quantum Interference Device) magnetometer.

Large-scale applications for HTS materials present a major challenge to the materials scientist. The most important applications under consideration are magnets, power

transmission cables, current leads, fault current limiters, transformers, generators, motors, and energy storage. In most of these applications, apart from fault current limiters, HTS superconductors would simply replace conventional conductors.

Applications related to magnet technology are probably among the most significant that are under research at the present time. These include magnetic energy storage, Maglev trains (relying on repulsion between magnets mounted on the train and the guide way) and magnets for MRI and other medical imaging applications.

This systematic review serves as a comprehensive resource for researchers, educators, and practitioners interested in the dynamic interplay between electric and magnetic phenomena, with a special emphasis on the unique properties of high-temperature superconductors.

References

1. Bohrdt A, Homeier L, Reinmoser C, Demler E, Grusdt F. Exploration of doped quantum magnets with ultracold atoms. *Annals of Physics*. 2021;435:168651.
2. Bussmann-Holder A, Keller H. High-temperature superconductors: underlying physics and applications. *ZeitschriftFür Naturforschung B*. 2020;75(1-2):3-14.
3. Giannetti C, Capone M, Fausti D, Fabrizio M, Parmigiani F, Mihailovic D. Ultrafast optical spectroscopy of strongly correlated materials and high-temperature superconductors: a non-equilibrium approach. *Advances in Physics*. 2016;65(2):58-238.
4. Ikram M, Raza A, Altaf S, Rafi AA, Naz M, Ali S, *et al*. High Temperature Superconductors. In *Transition Metal Compounds-Synthesis, Properties, and Application*. In tech Open; c2021.
5. Hull JR, Hanany S, Matsumura T, Johnson B, Jones T. Characterization of a high-temperature superconducting bearing for use in a cosmic microwave background polarimeter. *Superconductor Science and Technology*. 2004;18(2):S1.
6. Jin JX, Xin Y, Wang QL, He YS, Cai CB, Wang YS, *et al*. Enabling high-temperature superconducting technologies toward practical applications. *IEEE Transactions on Applied Superconductivity*. 2014;24(5):1-12.
7. Woods RC. Practical applications of high temperature superconductors. *Engineering Science & Education Journal*. 1996;5(2):51-56.
8. Portis AM. *Electrodynamics of high-temperature superconductors*. World Scientific; c1993, 48.
9. Malozemoff AP, Yeshurun Y, Krusin-Elbaum L, Worthington TK, Kronemier DC, Dinger TR, *et al*. *High Temperature Superconductors*; c1988.
10. Kalsi SS. *Applications of high temperature superconductors to electric power equipment*. John Wiley & Sons; c2011.
11. Brandt EH. Rigid levitation and suspension of high-temperature superconductors by magnets. *American Journal of Physics*. 1990;58(1):43-49.
12. Christen D, Narayan J, Schneemeyer L. *High-Temperature Superconductors: Fundamental Properties and Novel Materials Processing* (No. CONF-891119-). Pittsburgh, PA (USA); Materials Research Society; c1990.