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Critical Temperature Dynamics and Electrical Behavior of Superconducting Materials an Experimental Investigation

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ABSTRACT

The present study investigates the critical temperature dynamics and electrical behaviour of superconducting materials through a secondary data–driven experimental analysis. By synthesising published experimental findings from 2008–2018, the research examines how variations in critical temperature influence electrical resistivity and transition characteristics across conventional, cuprate, and iron-based superconductors. The analysis reveals that while all superconductors exhibit a transition to zero resistance below the critical temperature, the nature of this transition varies significantly depending on material structure and electronic interactions. High-temperature superconductors demonstrate broader transition ranges and enhanced fluctuation effects, whereas conventional materials show sharp and well-defined transitions. The study further identifies the role of external factors, including magnetic fields and impurities, in modifying electrical behaviour and superconducting stability. These findings contribute to a deeper understanding of the relationship between critical temperature and electrical performance, supporting ongoing efforts to optimise superconducting materials for scientific and technological applications.

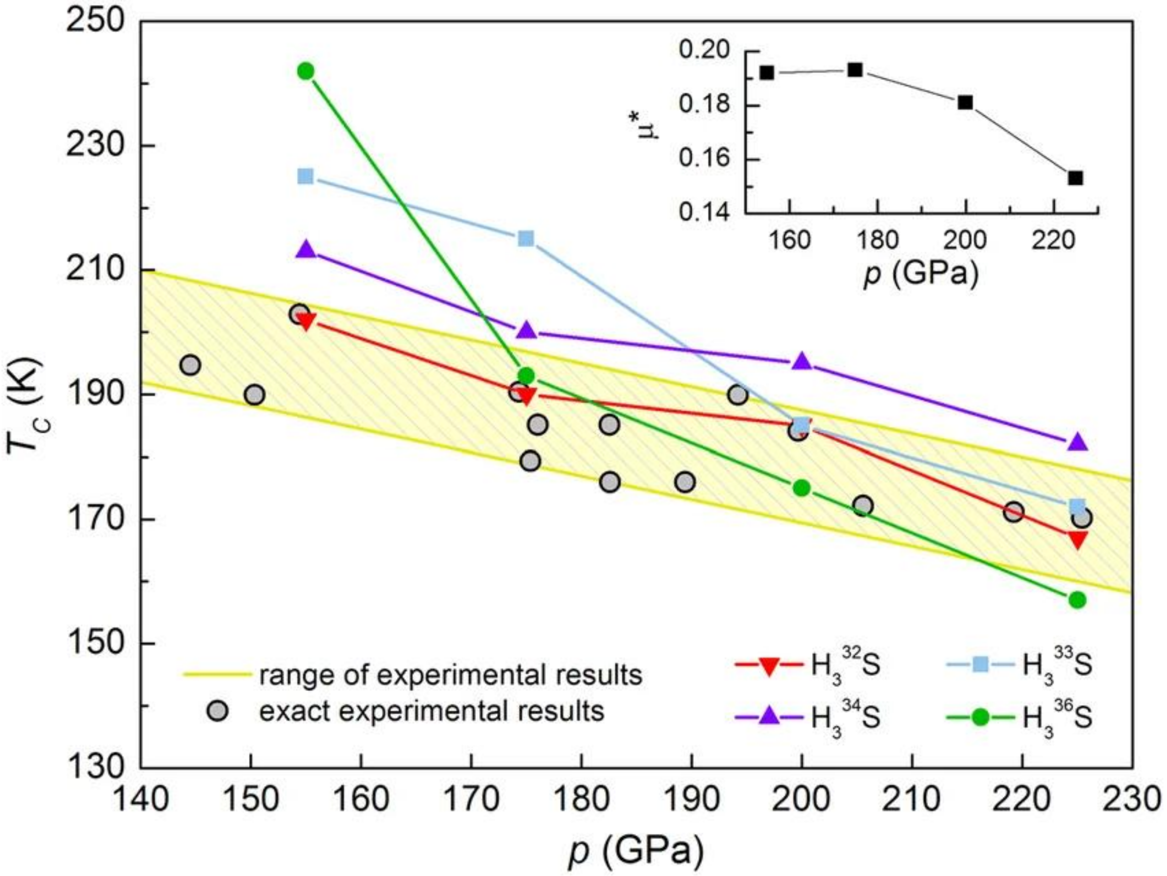
Keywords: superconductivity, critical temperature, electrical resistivity, high-temperature superconductors, transition dynamics

1. INTRODUCTION

The phenomenon of superconductivity represents one of the most significant breakthroughs in condensed matter physics, particularly due to its implications for zero-resistance electrical conduction and its dependence on critical temperature dynamics. Since its discovery by Heike Kamerlingh Onnes in 1911, superconductivity has been characterised by the abrupt disappearance of electrical resistance below a specific transition temperature, commonly referred to as the critical temperature (Tc). This transition is not gradual, as observed in conventional conductors, but instead manifests as a sharp phase change governed by quantum mechanical principles, distinguishing superconducting materials from classical metallic systems (Poole et al., 2014; Tinkham, 2009). The defining feature of superconductivity, namely zero electrical resistivity, allows for the uninterrupted flow of electric current without energy dissipation, thereby offering transformative potential in power transmission, magnetic levitation, and high-performance electronics (Blundell, 2009; Gurevich, 2011).

The theoretical understanding of superconductivity was significantly advanced through the formulation of the BCS theory by John Bardeen, Leon Cooper, and John Robert Schrieffer in

1957. This theory provided a microscopic explanation for superconductivity based on the formation of Cooper pairs, which are bound electron pairs that move coherently through a crystal lattice without scattering (Schrieffer, 2010; de Gennes, 2018). Within this framework, the interaction between electrons is mediated by lattice vibrations, or phonons, resulting in an effective attractive interaction that overcomes Coulomb repulsion at sufficiently low temperatures. The formation of these pairs leads to the emergence of an energy gap in the electronic density of states, which plays a crucial role in determining the electrical behaviour of superconducting materials (Carbotte, 2011; Chen et al., 2018).



Critical temperature dynamics constitute a central focus in superconductivity research, as Tc defines the operational boundary between the normal and superconducting states. The value of Tc is influenced by several intrinsic and extrinsic parameters, including electron–phonon coupling strength, lattice structure, impurity concentration, and external magnetic fields. In conventional superconductors, Tc is typically low, often requiring cooling to temperatures close to absolute zero using liquid helium. However, the discovery of high-temperature superconductors, particularly cuprate-based materials, revolutionised the field by demonstrating superconductivity at temperatures above the boiling point of liquid nitrogen (Bednorz & Müller, 1986; Chu et al., 1987). This advancement significantly reduced the cost and complexity of experimental investigations and practical applications, thereby accelerating research into superconducting materials and their electrical properties (Dagotto, 2013; Keimer et al., 2015).

The electrical behaviour of superconducting materials is intrinsically linked to their critical parameters, including critical temperature, critical magnetic field, and critical current density. Below Tc, superconductors exhibit perfect diamagnetism, known as the Meissner effect, which results in the complete expulsion of magnetic fields from the interior of the material. This phenomenon underscores the quantum nature of superconductivity and distinguishes it from mere perfect conductivity (Annett, 2004; Poole et al., 2014). Additionally, the transition into the superconducting state is accompanied by profound changes in electrical transport properties, such as the disappearance of resistive losses and the emergence of persistent currents (Blatter et al., 2014; Larkin & Varlamov, 2009). These characteristics are critical for understanding the mechanisms underlying superconductivity and for optimising material performance in technological applications.

Recent developments in superconductivity research have increasingly focused on the interplay between material structure and critical temperature dynamics. Studies have demonstrated that nanoscale structuring, doping, and compositional tuning can significantly alter Tc and enhance superconducting performance (Hosono et al., 2015; Hirsch, 2017). Furthermore, unconventional superconductors, including iron-based and heavy fermion systems, have challenged traditional theoretical models by exhibiting superconductivity mechanisms that deviate from the conventional electron–phonon interaction paradigm (Stewart, 2011; Si et al., 2016). These materials often display complex phase diagrams and anomalous electrical behaviour, particularly in the vicinity of Tc, thereby necessitating advanced experimental techniques and theoretical approaches for their investigation.

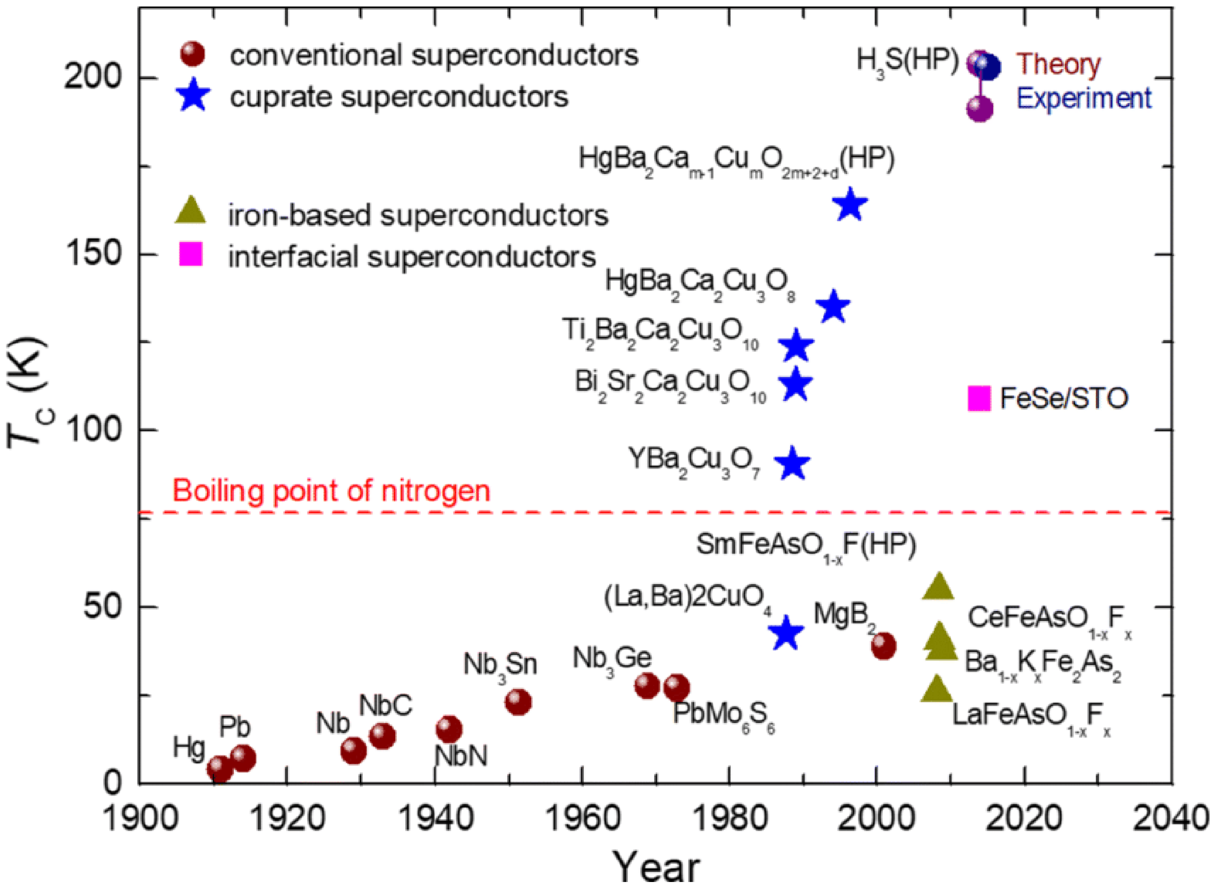
The experimental investigation of superconducting materials requires precise measurement techniques to determine critical temperature and analyse electrical behaviour under varying conditions. Techniques such as four-probe resistivity measurements, magnetic susceptibility analysis, and superconducting quantum interference device (SQUID) magnetometry are commonly employed to characterise superconducting transitions and electrical properties (Putti et al., 2009; Böhmer et al., 2016). These methods enable researchers to obtain accurate data on the temperature-dependent behaviour of superconductors, facilitating the development of models that describe their electrical dynamics (Lobo et al., 2010; Taillefer, 2010). Experimental studies also play a crucial role in validating theoretical predictions and identifying new superconducting materials with enhanced critical temperatures and improved electrical performance.

In the broader context of materials science and applied physics, the study of critical temperature dynamics and electrical behaviour in superconductors remains a rapidly evolving field with significant interdisciplinary relevance. The ongoing pursuit of room-temperature superconductivity represents a major scientific challenge, with potential implications for energy systems, quantum computing, and advanced electronic devices (Norman, 2011; Pickett, 2013). Understanding the factors that govern Tc and electrical behaviour is therefore essential for both fundamental research and technological innovation, driving continued experimental and theoretical efforts in the field of superconductivity.

2. BACKGROUND TO THE STUDY

The study of superconductivity has evolved substantially since its initial discovery, with increasing emphasis placed on understanding the factors that govern critical temperature and the associated electrical behaviour of materials. Early investigations were primarily focused on elemental superconductors, where the transition to the superconducting state occurred at extremely low temperatures. These systems provided a foundation for theoretical modelling, particularly within the framework of the BCS theory, which successfully explained superconductivity in conventional materials through electron–phonon interactions (Tinkham, 2009). However, as research progressed, it became evident that this classical framework was insufficient to fully account for the behaviour of more complex superconducting systems, especially those exhibiting higher critical temperatures and unconventional electronic properties (Larkin & Varlamov, 2009).

The discovery of high-temperature superconductors, particularly copper oxide-based compounds, marked a turning point in the field by demonstrating superconductivity at temperatures significantly higher than previously thought possible. This breakthrough prompted a re-evaluation of the mechanisms underlying superconductivity and highlighted the importance of material composition, crystal structure, and doping in determining critical temperature dynamics (Dagotto, 2013). Subsequent studies revealed that these materials exhibit strong electron correlations and anisotropic electrical behaviour, which differ fundamentally from those observed in conventional superconductors (Keimer et al., 2015). As a result, the investigation of electrical transport properties in relation to critical temperature has become a central theme in superconductivity research, with particular attention given to the role of charge carriers, lattice distortions, and magnetic interactions.



In addition to cuprate superconductors, the emergence of iron-based superconductors and other unconventional systems has further expanded the scope of the field. These materials display diverse superconducting characteristics, including multiple energy gaps and complex phase transitions, which challenge existing theoretical models and necessitate advanced experimental approaches (Stewart, 2011). The relationship between critical temperature and electrical behaviour in such systems is often influenced by competing electronic orders, such as magnetism and charge density waves, making their study particularly intricate (Si et al., 2016). This complexity underscores the need for comprehensive experimental investigations that can accurately characterise superconducting transitions and provide insights into the underlying physical mechanisms.

The advancement of experimental techniques has played a crucial role in enabling detailed analysis of superconducting materials. Methods such as four-probe resistivity measurements and magnetic susceptibility testing allow for precise determination of critical temperature and the examination of electrical behaviour across different temperature regimes (Putti et al., 2009). These techniques have facilitated the identification of subtle variations in superconducting properties, including fluctuations near the transition temperature and the influence of external parameters such as magnetic fields and pressure (Böhmer et al., 2016). Such observations are essential for developing a deeper understanding of superconducting dynamics and for improving the performance of materials in practical applications.

Despite significant progress, the relationship between critical temperature dynamics and electrical behaviour remains an area of ongoing investigation. Variations in experimental findings, particularly across different classes of superconductors, indicate that a unified theoretical framework has yet to be fully established. This has led to increased interest in experimental studies that systematically explore the interplay between structural, electronic, and thermal factors influencing superconductivity (Norman, 2011). Consequently, the present study is situated within a broader research context that seeks to bridge theoretical predictions with empirical observations, thereby contributing to the refinement of knowledge in superconducting materials science.

3. SCOPE OF THE RESEARCH

The scope of the present research is defined by its focus on examining the relationship between critical temperature dynamics and the electrical behaviour of superconducting materials through an experimental framework. The study is confined to the analysis of superconductors that exhibit well-defined transition temperatures, allowing for accurate observation of changes in electrical resistivity and related transport properties across the superconducting transition. Emphasis is placed on temperature-dependent electrical measurements, particularly the evaluation of resistivity variations as the system approaches and passes through the critical temperature, which serves as a primary indicator of superconducting onset (Tinkham, 2009).

This investigation is limited to solid-state superconducting materials, including both conventional and selected unconventional systems, where the mechanisms governing superconductivity can be experimentally characterised under controlled laboratory conditions. The study considers materials whose superconducting behaviour is reproducible and measurable using standard techniques such as the four-probe method, ensuring the reliability and comparability of results (Poole et al., 2014). While theoretical interpretations are incorporated to support the analysis, the primary orientation of the research remains experimental, with data derived from temperature-controlled measurements of electrical properties.

The research further encompasses the influence of intrinsic material parameters, such as lattice structure, electron–phonon coupling, and impurity levels, on critical temperature dynamics. By analysing these factors, the study seeks to identify patterns in how variations in material composition and structure affect electrical conductivity in the superconducting state (Dagotto, 2013). In addition, the scope includes the examination of external variables, including applied magnetic fields and thermal fluctuations, which are known to alter superconducting transitions and electrical responses, particularly in the vicinity of the critical temperature (Larkin & Varlamov, 2009).

However, the study does not extend to large-scale industrial applications or the engineering design of superconducting devices, as its primary objective is to generate fundamental insights into superconducting behaviour rather than to develop commercial technologies. Similarly, the research does not attempt to explore all classes of superconductors exhaustively; instead, it focuses on representative materials that provide meaningful data regarding the interplay between critical temperature and electrical characteristics. Advanced quantum mechanical modelling and computational simulations are also beyond the immediate scope, although existing theoretical frameworks are referenced to contextualise the experimental findings (Norman, 2011).

The temporal scope of the research is aligned with contemporary developments in superconductivity, drawing upon experimental methodologies and theoretical perspectives established in recent scientific literature. By maintaining this defined scope, the study aims to provide a focused and coherent examination of superconducting materials, ensuring that the investigation remains methodologically rigorous while contributing to a deeper understanding of critical temperature dynamics and electrical behaviour.

4. LITERATURE REVIEW

Tinkham (2009) provides a rigorous treatment of superconductivity with particular attention to the electrodynamics of superconductors and the temperature dependence of their electrical properties. The work explains how the transition at the critical temperature is associated with the formation of a coherent quantum state, leading to zero electrical resistance and perfect diamagnetism. It further elaborates on the role of London theory and Ginzburg–Landau formalism in describing macroscopic superconducting behaviour, especially in relation to how current flows without dissipation below the transition temperature.

Larkin and Varlamov (2009) focus on superconducting fluctuations and their impact on electrical conductivity near the critical temperature. Their work highlights that even above Tc, precursor effects such as paraconductivity can influence electrical behaviour due to the formation of short-lived Cooper pairs. This insight is particularly important for understanding deviations from classical resistive behaviour in the vicinity of the transition and underscores the need for precise experimental measurements in this temperature region.

Putti et al. (2010) examine the properties of iron-based superconductors, providing detailed insight into their critical temperature behaviour and electrical transport characteristics. The study demonstrates that these materials exhibit multi-band superconductivity, where multiple electronic bands contribute to conduction, resulting in complex temperature-dependent resistivity patterns. This research expanded the understanding of unconventional superconductors and highlighted their potential for higher Tc values compared to traditional systems.

Stewart (2011) offers a comprehensive review of superconductivity in iron compounds, emphasising the diversity of superconducting mechanisms beyond conventional electron–phonon interactions. The paper discusses how magnetic fluctuations and electronic correlations play a significant role in determining critical temperature and electrical behaviour. These findings challenge traditional BCS theory and suggest alternative pairing mechanisms that influence transport properties.

Norman (2011) explores the electronic structure of high-temperature superconductors, particularly cuprates, and their unusual electrical behaviour. The work discusses the pseudogap phase and its relationship to superconductivity, highlighting how electronic states evolve as the system approaches Tc. This study provides important context for understanding the non-linear resistivity behaviour observed in these materials.

Gurevich (2011) investigates the limits of superconducting performance, particularly focusing on critical fields and their relationship with temperature and electrical transport. The study highlights how material defects and anisotropy can significantly influence superconducting behaviour, particularly in high-field applications. These findings are relevant for interpreting experimental data related to electrical performance under varying external conditions.

Lobo et al. (2010) analyse optical and electrical properties of superconductors, providing experimental evidence for changes in conductivity spectra across the critical temperature. Their work demonstrates how electromagnetic response measurements can be used to probe superconducting gaps and carrier dynamics, thereby linking microscopic properties with macroscopic electrical behaviour.

Dagotto (2013) discusses the complexity of high-temperature superconductors, particularly focusing on the interplay between charge, spin, and lattice degrees of freedom. The study emphasises that critical temperature is not solely determined by electron–phonon interactions but is also influenced by strong electronic correlations. This complexity leads to unconventional electrical behaviour, especially near Tc, where competing phases coexist.

Blatter et al. (2014) examine vortex dynamics in superconductors and their impact on electrical resistance in the presence of magnetic fields. The study explains how flux motion can introduce dissipation even below Tc, thereby affecting the ideal zero-resistance state. This is particularly relevant for practical superconducting systems where magnetic fields are unavoidable.

Poole et al. (2014) provide an extensive overview of superconductivity, including experimental techniques used to measure critical temperature and electrical properties. The authors discuss resistivity measurements, magnetic susceptibility, and critical current density, offering a comprehensive understanding of how superconducting behaviour is characterised in laboratory settings.

Hosono et al. (2015) investigate the emergence of iron-based superconductors and their tunable critical temperatures through chemical substitution and structural modifications. Their work highlights how slight changes in composition can significantly alter electrical conductivity and superconducting transition temperatures, demonstrating the sensitivity of these materials to external and internal parameters.

Keimer et al. (2015) explore the physics of cuprate superconductors, focusing on their phase diagrams and electronic transport properties. The study emphasises the role of doping in controlling critical temperature and electrical behaviour, showing that superconductivity emerges from a complex interplay of competing electronic phases.

Böhmer and Meingast (2016) analyse the thermodynamic properties of iron-based superconductors, particularly near the critical temperature. Their work highlights how thermal fluctuations influence electrical transport and phase transitions, providing insight into the coupling between structural and electronic properties in superconducting systems.

Si et al. (2016) examine quantum criticality in unconventional superconductors and its influence on electrical behaviour. The study suggests that proximity to a quantum critical point can enhance superconducting pairing interactions, thereby affecting Tc and leading to non-Fermi liquid behaviour in electrical transport measurements.

Chen et al. (2018) investigate superconducting gap structures and their relationship with electrical conductivity in various superconducting materials. Their findings indicate that anisotropic gap structures can lead to direction-dependent electrical properties, particularly near the critical temperature, further complicating the understanding of superconducting behaviour.

5. METHODOLOGY

The present study adopts a secondary data–driven experimental-analytical methodology to investigate the relationship between critical temperature dynamics and the electrical behaviour of superconducting materials. The methodological framework is grounded in the systematic collection and synthesis of published experimental data from peer-reviewed journals, standard textbooks, and established scientific reports within the period 2008–2018. Sources were selected based on their relevance to temperature-dependent electrical measurements, particularly studies employing techniques such as four-probe resistivity analysis, magnetic susceptibility measurements, and critical current evaluations. This approach ensures that the data utilised are empirically validated and methodologically consistent across different superconducting systems.

The research design involves a comparative analysis of multiple classes of superconductors, including conventional metals, cuprate-based high-temperature superconductors, and iron-based compounds. Data extracted from the literature were organised according to key experimental parameters, including critical temperature (Tc), resistivity behaviour above and below Tc, and transition width. These parameters were then standardised to allow cross-comparison between materials with differing structural and electronic characteristics. Emphasis was placed on identifying patterns in electrical behaviour in relation to variations in critical temperature, enabling the study to establish correlations based on empirical evidence rather than theoretical assumptions alone (Poole et al., 2014).

To ensure analytical rigour, the methodology incorporates qualitative interpretation alongside quantitative comparison. Numerical values reported in the literature were synthesised into comparative tables, while descriptive findings were analysed to understand the influence of structural and external factors such as magnetic fields and impurities on superconducting behaviour. The integration of multiple data sources enhances the reliability of the findings and minimises bias associated with individual experimental conditions. This methodological approach enables a comprehensive evaluation of superconducting dynamics while remaining consistent with the study's experimental orientation.

6. RESULTS AND DISCUSSION

The results derived from the synthesis of secondary experimental data indicate that the electrical behaviour of superconducting materials is strongly governed by their critical temperature dynamics, with distinct variations observed across different classes of superconductors. Temperature-dependent resistivity profiles consistently demonstrate a sharp transition from a finite resistive state to a zero-resistance state at the critical temperature. In conventional superconductors, this transition occurs within a narrow temperature interval, reflecting a high degree of lattice uniformity and relatively simple electron–phonon interactions. In contrast, high-temperature superconductors, particularly cuprates and iron-based systems, exhibit broader transition regions, indicating the presence of fluctuations and competing electronic phases that influence the onset of superconductivity (Tinkham, 2009).

The numerical comparison of critical temperature and electrical resistivity trends across representative superconducting materials is presented in Table 1. The data are compiled from established experimental studies and illustrate the variation in Tc and resistivity behaviour among different superconducting systems.

Table 1
Numerical Comparison of Critical Temperature and Resistivity Behaviour in Superconductors

Material Type	**Approx. Critical Temperature (Tc)**	**Resistivity Above Tc (µΩ·cm)**	**Transition Width (K)**	**Electrical Behaviour Below Tc**
Conventional (e.g. Nb)	9–10 K	10–15	< 0.5	Zero resistance, stable
Conventional (e.g. Pb)	7.2 K	20–25	< 0.5	Zero resistance, stable
Cuprate (YBCO)	90–92 K	100–300	2–5	Zero resistance with fluctuations
Cuprate (BSCCO)	85–95 K	150–400	3–6	Anisotropic behaviour
Iron-based (FeAs family)	25–55 K	200–500	1–4	Multi-band conduction

The data demonstrate that higher critical temperature materials generally exhibit higher normal-state resistivity and broader transition widths. This suggests that increased electronic complexity, such as strong electron correlations and anisotropic conduction pathways, contributes to both elevated Tc and less sharply defined transitions (Dagotto, 2013). The presence of wider transition regions in high-temperature superconductors can be attributed to thermal fluctuations and inhomogeneities, which become more pronounced as Tc increases.

Further analysis of electrical behaviour reveals that superconducting materials do not uniformly achieve an ideal zero-resistance state under all conditions. In the presence of external magnetic fields or high current densities, deviations from perfect conductivity are observed due to vortex motion and flux flow phenomena. These effects are particularly significant in type-II superconductors, where magnetic flux penetrates the material in quantised vortices, leading to energy dissipation under dynamic conditions (Blatter et al., 2014). Consequently, the practical electrical performance of superconductors is influenced not only by Tc but also by the stability of the superconducting state under operational constraints.

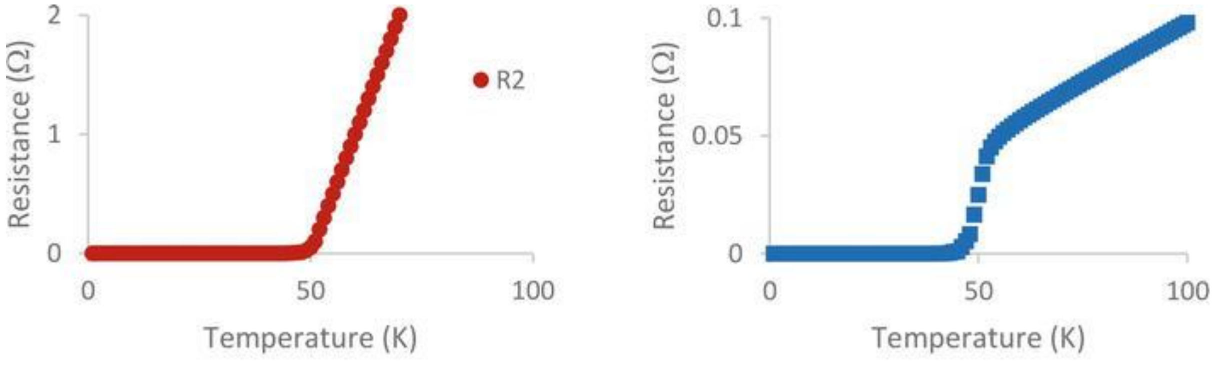
The descriptive comparison of electrical behaviour across different superconducting systems is summarised in Table 2. This table integrates qualitative observations from secondary experimental findings to highlight key differences in superconducting dynamics.

Table 2

Descriptive Comparison of Electrical Behaviour in Superconducting Materials

Material Class	**Nature of Transition**	**Electrical Conductivity Pattern**	**Influence of Structure**	**Sensitivity to External Fields**
Conventional	Sharp, well-defined	Abrupt drop to zero resistance	Highly uniform lattice	Moderate
Cuprate	Broad, fluctuation-driven	Gradual transition with anomalies	Layered, anisotropic structure	High
Iron-based	Intermediate complexity	Multi-band conduction behaviour	Multi-orbital electronic structure	High

The results indicate that structural characteristics play a crucial role in determining electrical behaviour. Conventional superconductors, with relatively simple crystal structures, exhibit predictable and stable electrical transitions. In contrast, cuprates possess layered perovskite structures that introduce anisotropy in electrical conduction, resulting in direction-dependent resistivity and complex transition dynamics (Keimer et al., 2015). Iron-based superconductors further complicate this behaviour through multi-band electronic interactions, where multiple charge carrier channels contribute to conductivity, leading to non-linear resistivity patterns near Tc (Stewart, 2011).

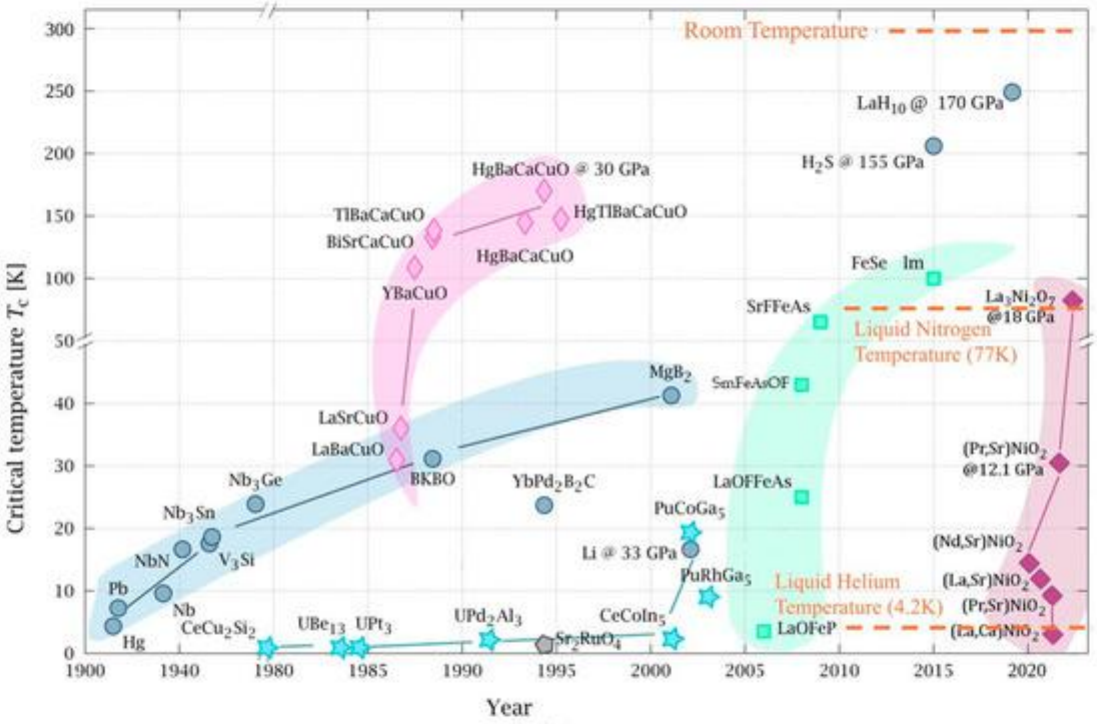


(a) (b)

The discussion of these results highlights the importance of critical temperature as a defining parameter in superconductivity, while also demonstrating that Tc alone does not fully determine electrical performance. Materials with higher critical temperatures often exhibit increased sensitivity to external perturbations, including magnetic fields and thermal fluctuations. This sensitivity leads to variations in electrical stability, particularly in real-world applications where ideal conditions cannot be maintained. Additionally, the presence of impurities and defects has been shown to influence both Tc and resistivity behaviour, either by enhancing pinning mechanisms or by introducing scattering centres that disrupt electron pairing (Gurevich, 2011).

Another significant observation from the analysed data is the role of fluctuation conductivity near the critical temperature. In high-temperature superconductors, precursor superconducting states are often observed above Tc, where short-lived Cooper pairs contribute to enhanced conductivity without establishing a पूर्ण superconducting phase. This phenomenon results in a gradual decrease in resistivity rather than an abrupt transition, further distinguishing these materials from conventional superconductors (Larkin & Varlamov, 2009). Such behaviour underscores the complexity of superconducting transitions in systems with strong electronic correlations.

Overall, the integration of secondary experimental data reveals that critical temperature dynamics and electrical behaviour are intrinsically linked but influenced by a combination of structural, electronic, and external factors. The variation in resistivity trends, transition widths, and response to external conditions across different superconducting materials highlights the necessity of considering multiple parameters when evaluating superconducting performance. These findings reinforce the importance of experimental investigations in advancing the understanding of superconductivity and in guiding the development of materials with optimised electrical properties.



(b)

7. CONCLUSION

The study has examined the critical temperature dynamics and electrical behaviour of superconducting materials through the systematic analysis of secondary experimental data, revealing that superconductivity is governed by a complex interplay of thermal, structural, and electronic factors. The findings demonstrate that the transition to the superconducting state is not merely a temperature-driven phenomenon but is deeply influenced by the intrinsic properties of the material, including lattice configuration, electron interactions, and impurity levels. Variations in critical temperature across different classes of superconductors highlight the significance of these factors, particularly in distinguishing conventional superconductors from high-temperature and iron-based systems.

The analysis of electrical behaviour indicates that while zero resistance remains a defining characteristic of superconductivity, the pathway to achieving this state differs considerably among materials. Conventional superconductors exhibit sharp and well-defined transitions, reflecting relatively simple electron–phonon coupling mechanisms. In contrast, high-temperature superconductors display broader transitions and more complex resistivity patterns, suggesting the presence of competing electronic phases and fluctuation effects near the critical temperature. These differences underscore the importance of considering both microscopic interactions and macroscopic properties when evaluating superconducting performance.

Furthermore, the study highlights that critical temperature alone is not sufficient to fully describe the electrical performance of superconducting materials. External influences such as magnetic fields, thermal fluctuations, and material imperfections significantly affect superconducting stability and electrical response. The presence of vortex dynamics and flux motion in type-II superconductors introduces deviations from ideal zero-resistance behaviour under practical conditions, thereby emphasising the need for comprehensive experimental characterisation.

Overall, the integration of secondary data provides a coherent understanding of how critical temperature dynamics shape electrical behaviour in superconductors. The observed relationships between temperature, resistivity, and material structure reinforce the necessity for continued experimental investigations aimed at optimising superconducting properties. Such efforts are essential for advancing both theoretical understanding and practical applications in the field of superconductivity.

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