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# Using modified laws to explain high-temperature superconductivity in YBCO Compounds

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**Abstract**
Superconducting materials payes attention of scientists for its important roles in generation of powerful magnetic field and electric energy beside transportation and magnetic resonance imaging (MRI).in this work potential dependent special relativity was used to define the electric resistance. The material becomes a superconductor when the electric and magnetic field compared become extremely large compared to the rest mass energy. The critical temperature was found to be directly proportional to the field potential. Strong mechanical pressure can also convert materials to a super conductors provided that it exceeds the rest mass energy in the absence of fields. The critical temperature is found to be directly proportional to the applied pressure.
Fortunately the results obtained are in agreement with the experimental works specially for high temperature supercoductors Like YBCO.

**Keywords:** YBCO, special relativity, Critical temperature, electric resistance

## Introduction

H.K.Onnes discovered something capable of carrying current without any resistance when it is cooled down below a certain critical temperature of the order of few Kelvin [1].

Superconductivity is as set of physical properties observed in certain materials where electrical resistance vanished and magnetic flux fields are expelled from the material.

Any material exhibiting these properties is a superconductor. Unlike and ordinary metallic conductor, whose resistance decreases gradually as its temperature lowered, even down to near. A absolute Zero, superconductor has a characteristic critical temperature below which the resistance drops a abruptly to zero [2, 3].

Superconductivity is a phenomenon occurring in certain materials at extremely low temperatures, characterized by exactly zero electrical resistance and the exclusion of the interior magnetic field (the Meissner Effect).

"Conventional" superconductivity is described by Bardeen-Cooper-Schrieffer (BCS) theory in normal metals the electrons have character as fermions, while in superconducting state they form "Cooper pairs" and have character like bosons [4, 5].

In 1986 Bednorz and Müller reported the discovery of the first or high temperature cuprate superconductors, also called high temperature superconductor (HTSC) [6].

Unconventional superconductivities are a properties of some doped cuprates, obtained by the carriers of charge into the highly correlated antiferromagnetic insulating state chemically [7].

High-temperature superconductors (HTSC) have become one of the most important materials studied in solid-state physics, are mainly related to cuprates. These materials strongly depend on the presence of copper oxide [8].

YBCO Cuprate superconductors, Yttrium is a transition element symbolized by the letter Y and located in the 3rd group of the periodic table with atomic number of 39 and atomic mass number of 89,906. Many compounds (or alloys) formed by yttrium have superconducting properties [9].

Properties of yttrium are not affected much by means of its relocation with various rare surfaced elements with high moments. On the other hand, partial relocation of copper in YBCO alloys with third transition metal ions has a substantial effect on its transition properties [10].

The main problem of this study is to understand the behavior of high-temperature superconductors (HTS).

The second issue lies in identifying an appropriate theory, which is essential for studying electrical parameters such as resistivity, also critical temperature for YBCO HTS This requires modifications to the existing law.

To develop suitable modifications of physic theories for copper pair. The study will also describe the behavior of YBCO high-temperature superconductors (HTS) during these transformations, and expression the critical temperature of superconductivity for YBCO compounds.

Multiple approaches will be explored to explain zero resistance and critical temperature of YBCO by applying several modified laws.

**Superconducting model based on string theory and Newtonian laws**

The resistance *R* is defined as

$$R = \frac{E}{I} \quad (1)$$

The total energy is given according to the special relativity (sr) by:

$$E = mc^2 \quad (2)$$

Thus the resistance becomes:

$$R = \frac{mc^2}{nevA} \quad (3)$$

With n, v, A standing for the charge density speed and cross sectional area.

For the relativistic mass $m$ potential dependent model gives [11]:

$$m = \frac{m_0}{\sqrt{1+\frac{2Q}{c^2}-\frac{v^2}{c^2}}} \;, v \ll c \;,\; m = \frac{m_0}{\sqrt{1+\frac{2Q}{c^2}}} \;, Q = -Q_i \;, m = \frac{m_0}{\sqrt{1-\frac{2Q_i}{c^2}}} \quad (4)$$

Thus, the mass $m$ become

$$E = mc^2, \quad m = \frac{m_0}{\sqrt{\frac{mc^2-2mQ_i}{mc^2}}} = \frac{m_0\sqrt{E}}{\sqrt{E-2V_i}} \quad (5)$$

$$E - 2V_i < 0 \;\;, E - 2V = -c_0 \quad (6)$$

$$m = \frac{m_0\sqrt{E}}{i\sqrt{c_0}} = -i\frac{m_0\sqrt{E}}{\sqrt{c_0}} \quad (7)$$

$$R = \;\; R_r + R_i = \; i\frac{m_0\sqrt{E}}{neA\sqrt{c_0}} \qquad R_r = 0 \quad \neq \quad (8)$$

If one consider slow moving electrons as in the most common cases the mass is almost equal to the rest mass. Since the electron has very small rest mass, thus upon applying very strong magnetic or electric field, the material can become a superconductor according to equations (6, 7 and 8).

In Inas [9] seminal paper, she utilized fluid mechanics to find a new expression for the total energy.

**According to her model the energy E is given by**

$$E = K.E + P_T + P_m + V \quad (9)$$

Where the thermal pressure per unit volume excreted by the fluid is given by

$$P_T = \frac{1}{3}nkT \quad (10)$$

*K,T* stands for Boltzmann constant and kelvin temperature respectively, the mechanical pressure and potential are denoted by Pm and V respectively. One can express the energy conservation of one particle using the relations

$$E = nE_P \;,\; P_T = nP_{PT} \;,\; P_m = nP_{Pm}$$

$$V = nV_P \;,\; K.E = nK.E_P \quad (11)$$

According to equation (9) for no applied field and for very low temperature as in the case of a supercoductor is

$nkT< P_m$ (12)

Where,

$P_m = nkT_c$ (13)

Thus for

T<Tc (14)

Thus according to equations (5, 6, and 7) the material can become a super conductor for very high applied mechanical pressure.

The conditions of the critical temperature can be obtained upon applying the very strong field in equation (6) when the thermal pressure is included and the mechanical pressure is absent. In his case the resistance vanishes and the material become a super conductor, when the potential becomes extremely large compared to the thermal pressure, i.e.

p<V (15)

nkT<V (16)

**One can easily suggested that**

$V=nkT_c$ (17)

**Thus for superconducting state**

T<Tc (18)

**Discussion**

The electric resistance is defined in terms of the relativistic energy in equations (1, 2). According to equation (6) when the potential exceeds the rest mass energy the material becomes a super conductor. The critical temperature can be obtained in equations (17, 18) when treating the energy consisting of thermal pressure beside the field potential according to equations (9, 10).

The mechanical pressure can also cause the material to become a super conductor. According to equations (9, 10), in the absence of field potential, the resistance vanishes and the material becomes a super conductor when the mechanical pressure becomes extremely large compared to the rest mass energy and the thermal pressure as shown by equations (12, 13, 14). The critical temperature is directly proportional to the mechanical pressure as shown in equation (13).

## Conclusion

The electric resistance is defined in terms of the relativistic energy using potential dependent special relativity. The conditions for superconductor was found to take place for very strong electric and magnetic field compared to the rest mass energy. The critical temperature is directly proportional to the field potential. Applying very strong mechanical pressure can also convert materials to super conductors provided that it exceeds the rest mass energy in the absence of fields. The critical temperature is found to be directly proportional to the applied pressure.

## Reference


1. Pal S. Superconductivity macroscopic quantum mechanics [Term Paper]. Kolkata: IISER; 2012.
2. Combescot R. Superconductivity: an introduction. Cambridge: Cambridge University Press; 2022. ISBN: 9781108428415.
3. Fossheim K, Sudbø A. Superconductivity: physics and applications. Chichester: John Wiley & Sons; 2005. ISBN: 9780470026434.
4. Fujita S, Godoy S. Quantum statistical theory of superconductivity. Dordrecht: Kluwer Academic Publishers; 2012. ISBN: 0306470683.
5. Fujita S, Godoy S. Theory of high temperature superconductivity. London: Springer; 2001. ISBN: 1402001495.
6. Wu MK, Ashburn JR, Torng C, Hor PH, Meng RL, Gao L, *et al*. Superconductivity at 93 K in a new mixed-phase Y-Ba-Cu-O compound system at ambient pressure. Phys Rev Lett. 1987;58(9):908-910.
7. Hott R, Wolf T. Cuprate high temperature superconductor. Karlsruhe: Karlsruher Institut für Technologie, Institut für Festkörperphysik; 2015. DOI: 10.1002/3527600434.
8. Mishonov TM. On the theory of high-temperature superconductivity from electronic structure to fluctuational properties and electrodynamic behavior [Ph.D. Dissertation]. Sofia: University of Sofia; 2007.
9. Balbag MZ, Özbaş Ö, Cenik MI. Physical properties of superconductor compound containing yttrium. AKU J Sci. 2008;8(1).
10. Balbağ MZ, Özbaş Ö, Cenik MI. Yitriyum içeren süperiletken bileşiklerin fiziksel özellikleri. Afyon Kocatepe Univ Fen Müh Bilim Derg. 2001;8(1):79-90.
11. Dirar M, *et al*. Neutrino speed can exceed the speed of light within the framework of the generalized special relativity and Savickas model. Nat Sci; 2013, p. 5.