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Explain the resistivity for high-temperature superconductivity on YBCO compounds using string theory and Schrödinger equation

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Abstract
Super conductors play an important role in our day life. they are widely used in generation of powerful magnetic and electrical energy, transportation and magnetic resonance imaging. This encourages to construct a new model based on the laws of fluid mechanics. In this model a new energy expression including the pressure which is related to the thermal energy was found. This expression was used to find the electric resistance. The model indicated that the resistance vanishes and the material becomes a super conductor when the temperature is less than a certain critical value. This critical temperature was found to be dependent on the internal and external fields including electric and magnetic fields. This may explain why a wide variety of materials can act as a super conductor.
Schrödinger equation was also utilized to obtain a useful expression for the resistance dependent on the wave number. The conditions for super conducting conditions indicated that the material becomes a superconductor when the temperature is less than a certain critical temperature which is dependent on the internal and external fields. using quantum laws indicated that such conditions can explain the behavior of nano materials.

Keywords: Superconductor, critical temperature, resistance, Schrödinger equation, nano materials

1. Introduction
Superconductivity is one of the major breakthrough in the history of Physics. In the year 1911 just after the refrigeration technique via liquid helium has emerged, 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. Initially it was done with Mercury. Later people started tend metals beyond certain low temperature are capable of being superconductor. The year 1933 came with another surprise; Meissner and Oschenfeld observed superconductors are capable of expelling magnetic fields. Within 1950's and 1960's a complete and satisfactory theory of classical superconductor had been revolutionized with the emergence Landau-Gingburg effective theory and most celebrated microscopic theory of superconductor given by Bardeen, Cooper, Schreifer (BCS) in 1957 [1].
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 behave as fermions, while in superconducting state they form "Cooper pairs" and behave like bosons [2, 3].
High temperature superconductivity is a property of some doped cuprates, obtained by the introduction of charge carriers into the highly correlated antiferromagnetic insulating state chemically. Actually, understanding of the origin of high temperature superconductivity and that of the nature of the doped antiferromagnetic Mott insulators are closely associated. The strong correlations play important role in understanding the high T_c superconductivity.
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. Although superconducting parameters for yttrium element could not be determined in normal state, superconductivity is more under high pressure or in thin films of compounds it

forms.
Superconducting properties of yttrium are not affected much by means of its replacement 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.
Transition temperature is less affected by the replacement of 1-2-3 ceramic superconductors of cadmium. This temperature is arranged form 89 K to 93,5 K. [4, 5].
Although many aspects of the superconductivity in HTS are similar to those in the conventional superconductors (e.g. quasi particle pairs and persistent currents brought about by a net attractive electron-electron interaction), there are also many important differences [6, 7]. For example, conventional superconductivity arise in normal state metals which follow Landau-Fermi liquid theory with well-defined propagating degrees of freedom (phonons). Hence, the pairing interaction responsible for superconductivity (the electron-phonon interaction) is well-known and fully described by the BCS theory. HTS on the other hand, where the propagating degrees of freedom are unknown, as is then the pairing mechanism. Therefore, there is currently no theory which can describe HTS from first principles [8, 9].
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.
The study will also describe the behavior of high-temperature superconductors (HTS) in YBCO during the physics laws [10].
The research will be explored to explain zero resistance by applying several modified Beside This work include two models, to explain superconductors behavior, one is based on fluid mechanics and the other is based on Schrödinger equation. This followed by discussion and conclusion.

String theory and Newtonian laws for superconductors
The equation of motion the electron having velocity v and affected by a field of potential V and pressure P is given by:

$$m\frac{dv}{dt} = F - \nabla P \quad (1)$$

Where the force F is defined to be:

$$F = -\nabla V \quad (2)$$

For the velocity, we have:

$$m\frac{dv}{dx}.\frac{dx}{dt} = -\frac{\partial v}{-\partial x} - \frac{\partial p}{\partial x} \quad = \quad mv\frac{dv}{dx} = -\frac{\partial v}{-\partial x} - \frac{\partial p}{\partial x} \quad (3)$$

Integrating the equation:

$$\int mvdv + \int dv + \int dp = c = E \quad (4)$$

The total energy is thus given by:

$$E = \frac{1}{2}mv^2 + V + P \quad , \quad v = \sqrt{\frac{2}{m}}\sqrt{(\mathrm{E - V - P})} \quad (5)$$

For a negative pressure which is a pressure exerted on the particle such that it is equal to the kinetic energy, When the potential is V_o. In this case

$E = V_o$ (6)

When the electron is accelerated by the potential V it follows that

$$eV = \frac{1}{2}mv^2 \quad , \quad V = \frac{mv^2}{2e} \quad (7)$$

Thus according to the definition of the resistance and equation (6) the resistance is given by:

$$R = \frac{V}{I} = \frac{mv^2}{2e(nevA)} \quad (8)$$

$$v = \sqrt{\frac{2}{m}}\sqrt{(\mathrm{E - V - p})} \quad (9)$$

The velocity and the resistance become imaginary when

$$(E - V - p) < 0 \, , (E - V - p) = -c^{\circ} \quad (10)$$

This requires

V+P-E>0 (11)

If the energy stands for the rest mass energy or equal to the potential V_o such that they are small and if the electron is treated as surrounded by a fluid gas the thermal pressure becomes negative.
Using the ideal gas law for pressure:

P = nkT (12)

Thus equation (10) becomes

V-Vo-nkT>0, V-Vo>nkT (13)

Define the critical temperature Tc to satisfy

V-Vo=nkTc (14)

Thus the material becomes a superconductor when

Tc>T, T<Tc (15)

Thus, the velocity becomes

$$v = i\sqrt{\frac{2}{m}}\sqrt{\mathrm{c_0}} \quad (16)$$

The resistance is:

$$R = \frac{mv}{2e^2nA} = i\frac{\sqrt{2mc_0}}{2e^2nA} \quad (17)$$

$$R = R_r + R_i \qquad R_r = 0 \qquad \neq \quad (18)$$

Super conducting conditions Using Schrödinger equation
The energy equation is:

$$E = \frac{1}{2}mv^2 + V + P \quad (19)$$

In terms of the wave function:

$$E\Psi = \frac{P^2}{2m}\Psi + V\Psi + P\Psi \qquad (20)$$

The wave function is:

$$\Psi = Ae^{\frac{i}{\hbar}(Px-Et)} , \ \frac{\partial\Psi}{\partial t} = -\frac{i}{\hbar}E\Psi , \ E = i\hbar\frac{\partial\Psi}{\partial t} \qquad (21)$$

The Schrödinger equation becomes:

$$\frac{\partial^2\Psi}{\partial x^2} = -\frac{P^2}{\hbar^2}\Psi , \ P^2\Psi = -\hbar^2\frac{\partial^2\Psi}{\partial x^2} = -\hbar^2\nabla^2\Psi \qquad (22)$$

$$i\hbar\frac{\partial\Psi}{\partial t} = -\frac{\hbar^2\nabla^2}{2m}\Psi + V\Psi + P\Psi \qquad (23)$$

$$\Psi = Ae^{i(kx)} , \ \nabla\Psi = \frac{\partial\Psi}{\partial x} = ik\Psi , \ \nabla^2 = -k^2\Psi \qquad (24)$$

$$\frac{\hbar^2 k^2}{2m}\Psi + V\Psi + P\Psi = E\Psi \qquad (25)$$

Substituting for the wave vector K:

$$k^2 = \frac{2m}{\hbar^2}[E - V - P] , \quad k = \frac{1}{\hbar}\sqrt{2m(E - V - P)} \qquad (26)$$

$$R = \frac{mv}{2e^2nA} = \frac{\hbar k}{2e^2nA} = \frac{\sqrt{2m(E-V-P)}}{2e^2nA} \qquad (27)$$

$$k^2 = \frac{2m}{\hbar^2}[E - V - P] , \ k = \frac{1}{\hbar}\sqrt{2m(E - V - P)} \qquad (28)$$

The resistance becomes:

$$R = i\frac{\sqrt{2mc_0}}{2e^2nA} \qquad (29)$$

$$R = R_r + R_i \qquad R_r = 0 \qquad \neq \qquad (30)$$

The critical temperature conditions are found similar to that from equation (11-16).

Discussion

The fluid equation (1) was used to derive energy expression in equation 5 that consists beside kinetic and potential energies a term standing for the pressure. Using the relation between the electric potential and the electron speed in equation 7 a useful expression for velocity dependent resistance was found in equation 8. With the aid of equation 5 the condition of the imaginary resistance was obtained in equation 11 relating the potential and the pressure. Using equation 12 for thermal pressure and finding the potential Vo at which the thermal pressure equals the kinetic energy the conditions for zero resistance when the resistance is a pure imaginary quantity was found in equation (13). The critical temperature is dependent on the potential including internal and external potential. According to these relations the material becomes super conducting for all temperatures less than the critical temperature.

The same energy equation was utilized to derive a modified Schrödinger equation which is pressure dependent as shown in equation 23. Suggesting travelling wave solution in 24, a useful expression for the wave number dependent on the potential and the pressure was obtained in equation 26. A direct insertion of 26 in the wave number dependent resistance in equation 27 gives again a similar conditions for superconducting state as for the fluid approach, where the resistance vanishes according to equation 30.

It is very clear that the critical temperature is strongly dependent on the internal and external fields including electric and magnetic fields.

Conclusion

The laws of fluid mechanics was used to find a new energy expression including the pressure which is related to the thermal energy. This expression was used to find the resistance. The resistance vanishes and the material becomes a super conductor when the temperature is less than a certain critical value. The critical temperature was found to be dependent on the internal and external fields.

Using Schrödinger equation a useful expression for the resistance dependent on the wave number was obtained. The conditions for super conducting conditions indicated that the material becomes a superconductor when the temperature is less than a certain critical temperature which is dependent on the internal and external fields. Using quantum laws indicated that such conditions can explain the behavior of nano materials.

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