INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & MANAGEMENT

RELATION BETWEEN CRITICAL TEMPERATURE AND SUPERCONDUCTIVITY ZERORESISTANCE ACCORDING TO QUANTUM LAWS

Mubarak Dirar Abdallah[*1], Einas Mohammed Ahmed Widaa[2]
& Sawsan Ahmed Elhouri Ahmed[3]
[*1]International University of Africa- College of Science-Department of Physics& Sudan University of Science & Technology-College of Science-Department of Physics-Khartoum-Sudan
[2]Sudan University of Science & Technology-College of Science-Department of Physics-Khartoum-Sudan
[3]Univesity of Bahri-College of Applied & Industrial Sciences-Department of Physics-Khartoum - Sudan

ABSTRACT

Plasma equation is used to find new Schrodinger temperature dependent equation. The solution of these equations are based on free particle solution beside quantum expression for resistance. This expression splits into real and imaginary or positive and negative one. The real positive superconductivity resistance vanishes beyond a certain critical temperature, which requires large binding energy and hopping mechanism.

Keywords- *critical temperature superconductivity, zero resistance, plasma Equation..*

I. INTRODUCTION

Plasma equations describe ionized fluids subjected to electric and magnetic potentials for particles having thermal energy[1]. These equations are more generalized than Newton's equations for single particle[2]. Because it accounts for particles having thermal energy and moving in bulk matter[3].

Thus plasma equation is suitable for describing behavior of bulk matter
[4]. Thus it can be used to develop quantum equation for particles moving inside a certain medium[5].Such equation can reduce quantum equation from large degrees of free dimension to 3dimensionson space only. Such equation was first developed by M.Dirar and Rasha.A[6].This equation is used to explain some Schordinger behavior, unfortunately this approach is complex mathematically.Thus there is a need for a simple model that can explain some Schordingerphenomena. Section(2) is devoted for quantum equation derived from energy equation found from plasma equation. The solution and equation expression for resistance is exhibited in section(3). Section (4) is concerned with finding critical temperature. Discussion and conclusion are in section (5) and(6) respectively

.

II. COMPLEX QUANTUM RESISTANCE MODEL

Plasma equation describes ionized particles in a gaseous or liquid form. This equation can thus describes the electron motion easily. This is since the electrons be behaves as ionized particles in side matter. For pressure exerted by the gas plasma equation becomes:

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

But for pressure exerted by the medium on the electron gas, the equation become:

$$mn\frac{dv}{dt} = \nabla P + F = \nabla P - \nabla V \qquad (2)$$

In one dimensions, the equation becomes:

$$mn\frac{\mathrm{dv}}{\mathrm{dx}}\frac{\mathrm{dx}}{\mathrm{dt}} = \frac{d(\mathrm{nkT})}{\mathrm{dx}} - \frac{\mathrm{dnv}}{\mathrm{dx}}$$

$$mn\frac{vdv}{dx} = \frac{d}{dx}[\mathrm{nkT} - \mathrm{nv}]$$

where V is the potential for one particle

$$mn\frac{d1/2\,v^2}{dx} = \frac{d}{dx}[\mathrm{nkT} - \mathrm{nV}]$$

Thus in integrating bothsides by assuming n to be constant, or in- dependent of K, yields:

$$\frac{n}{2}mv^2 = nkT - nv + c$$

$$\frac{1}{2}mv^2 + v - K\,T = \frac{c}{n} = constant = E$$

This constant of motion stands for energy, thus:

$$E = \frac{P^2}{2m} + v - kT \qquad (3)$$

Multiplying by ψ, yields:

$$E\psi = \frac{P^2}{2m}\psi + v\psi - kT\psi \qquad (4)$$

According to the wave nature of particles:

$$\psi = \mathrm{A}e^{\frac{i}{\hbar}(px-Et)}$$

$$i\hbar\frac{\partial\psi}{\partial t} = E\psi$$

$$-\hbar^2\nabla^2\psi = P^2\psi \qquad (5)$$

$$i\hbar\frac{\partial\psi}{\partial t} = \frac{-\hbar^2}{2m}\nabla^2\psi + v\psi - kT\psi \qquad (6)$$

The time in dependent equation becomes:

$$\frac{-\hbar^2}{2m}\nabla^2\psi + v\psi - kT\psi = E\psi \qquad (7)$$

Consider the case when these electrons wave subjected to constant crystal field.This assumption is quite natural as far as particles are distributedhomogenously. Thus, equation (7) becomes:

$$\frac{-\hbar^2}{2m}\nabla^2\psi + v_o\psi - kT\psi = E\psi \qquad (8)$$

One can suggest the solution to be:

$$\psi = Ae^{ikx} \qquad (9)$$

A direct substitution yields:

$$(\frac{\hbar^2}{2m}k^2 + v_o - kT)\psi = E\psi$$

Therefore:

ISSN 2277 – 5528
Impact Factor- 3.145

$$K= \frac{\sqrt{2m(E+kT-V_o}}{\hbar} \quad (10)$$

This wave number K is related to the momentum according to the relation :

$$P = mv = \hbar\, k = \sqrt{2m(E+kT-V_o)} \quad (11)$$

This relation can be used to find the quantum resistance R of a certain material . According to classical laws :

$$R = \frac{V}{I} \, (12)$$

For electrons accelerated by the potential . the wavedone is related to the potential V and kinetic energy K according to the relation :

$$W = V = 1/2\, mv^2 (13)$$

But since the current I is gives by .

$$I = nev\, A \qquad (14)$$

$$R = \frac{mv^2}{2\, nev\, A} = \frac{mv}{2\ ne\ A} = \frac{P}{2\, ne\, A} \quad (15)$$

From (12) and (13) :

$$R= \frac{\sqrt{2m(E+kT-V_o}}{2nev} \quad (16)$$

Splitting R to real partR_s and imaginary part R_i :

$$R = R_s + R_i \quad (17)$$

According to equation (16) R becomes pure imaginary , when :

$$E + kT - V_o < 0$$
$$kT < V_o - E$$
$$T < (V_o - E)/K \quad (18)$$

Thus the critical temperature is given by :

$$T_c = \frac{V_o - E}{K}$$

Which requires:

$$v_0 > E \qquad (19)$$

In this case (see equation (17)):

$$R = jR_i$$

$$R_s = 0 \quad (20)$$

 ISSN 2277 – 5528
Impact Factor- 3.145

Thus the superconductivity résistance R_s Becomes zero beyond a certain critical temperature given by equation (17).Which requires binding energy to dominate.

Another direct approach can also be found by considering the pressure exerted by the electrons . In this case [6] the Hamiltonian becomes :

$$\hat{H} = \frac{\hat{p}^2}{2m} + kT + V \quad (21)$$

For spin repulsive force :

$$V = - V_o$$

Thus :

$$\hat{H} = \frac{\hat{p}^2}{2m} + kT - V_o \quad (22)$$

Thus the average energy which is equal to the classical energy is given by:

$$< \hat{H} >= <\hat{P}^2 / 2m >+ kT - V_o = E_o + kT - V_o \quad (23)$$

Using the quantum definition of K [6] :

$$R = \frac{<\hat{H}>}{I} = \frac{E_0 + KT - V_0}{I}$$

$$R = R_+ + R_- \quad (24)$$

Where one splits R to positive and negative one.

When :

$$E_o + kT - V_o < 0 \quad (25)$$

$$R_- = \frac{E_0 + KT - V_0}{I}, \ R_+ = 0 \quad (26)$$

From equations (25) and (26) the super conductivity resistance R_S Vanishes i .e :

$$R_+ = R_s = o$$

When :

$$kT < V_o - E_o$$

$$T < \frac{V_o - E_o}{K} \quad (27)$$

Thus the critical temperature is given by :

$$T_C = \frac{V_o - E_o}{K} \quad (28)$$

Again for T_c to be positive $V_0 > E_0$

Thus for:

$$T<T_c$$

$$R_{sc} = R_+ = 0$$

III. DISCUSSION

Using plasma equation(1) a useful energy expression containing thermal energy is found in equation(3).Assuming electrons are free. Free wave solution is given by equation (9).This gives quantum momentum relation in equation(11).This relation is used in quantum resistances R. Expression(15) which splits R to real and imaginary part. Thus one gets condition for zero resistance in equations(18)and(19).This happens beyond a critical temperature given by equation(19).This critical temperature T_c requires binding energy domination, which means that condition takes place by hopping.

Another quantum resistance expression, which splits R to positive and negative terms is also proposed in equation(24).The superconductivity positive resistance vanishes beyond critical temperature given by equation(27).Again this T_c requires bindingenergy domination and hopping mechanism.

IV. CONCLUSIONS

Plasma equation is used to find temperature dependent energy and temperature dependent schordiger equation. By suggesting quantum expression for resistance superconductivity state takes place when electrons hope.

REFERENCES

1. *J.A. Bitten Court, Fandamental of Plasma Physics, Springer Sciensce& Business Media, New York, 3rd Edition, 2004.*
2. *Francis F. Chen, PlasnaPhsysics, Springer science and Business Media, LLC., 2nd Edition, 2013.*
3. *T. J. M. Boyd , J.J. Sonderson, The Physics of Plasma, Cambridge University Press, 2003.*
4. *Richard Fitz Patrick, Plasma Physics: An Introduction, Tayloraud Francis Group, LLC. 2015.*
5. *James E. Drummond, Plasma Physics, Dover Publications, Inc., Mineola. New York, 2013.*
6. *R.AbdElhaietal,, Using the tight binding approximation in deriving the quantum critical temperature superconductivity equation, Natural Science,v.5,N.8,941-946(2013).*