

Super Conduction Hopping Process on the Basic of Generalized Statistical Physic

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Abstract

The Hubbard model suggested hopping conduction mechanism by using complex quantum model. This work utilizes the generalized statistical model that shows that hopping can take place if the kinetic energy exceeds the potential energy and when the temperature is less than the critical value this model shows also that when the temperature exceeds it critical value no hopping take place. It shows also that superconductivity is destroyed when the magnetic field is large

Key words: Super conductivity, Coulomb repulsion, Critical Temperature, Generalized Statistical laws.

1. Introduction

Superconductor (SC) is one of the most important phenomena in modern physic it is based on Barden, cooper and Schrieffer theory (BCS). But at high temperature above 135.this theory suffers it cannot explain how the resistivity abruptly drops to zero below critical temperature T_C Beside the explanation of the so called pseudo gap, and isotope and pressure effects. In addition to the phase transition from insulating to super conductivity state [1, 2].The models proposed to cure these draw backs are mainly based on quantum mechanics beside generalized special relativity and plasma physics [3, 4].This new model can explain why the resistance drops to zero below T_C abruptly, beside the expression for isotope and pressure effect. it also gives an expression which is mathematically simple and is in conformity with experimental result is such as the phase change from insulator to superconductor the from work of this model[5].In this work the new generalized statistical physic model is used to describe different condition leading to hopping in SC below T_C . This is done in section (2).section (3) and (4) are devoted for discussion and conclusion.

2. Generalized statistical laws for super conductor

The generalized statistical model was proposed by some authors to solve so of the length standing problems in material science [5]. According to this version the number of particles having local energy E and moving in a medium having average energy \bar{E} is given by.

$$n = n_0 e^{\frac{-E}{\bar{E}}} \quad (1)$$

This expression can be used to try to describe the hopping mechanism [6]. To do this considers electrons hopping in superconductor having uniform coulomb attractive field. In this attractive the potential is negative. Thus the energy is given by.

$$\bar{E} = -V_c \quad (2)$$

Assume now the local energy is equal to kinetic energy T beside potential energy which result again from attractive Coulomb force. Therefore.

$$E = T + V = T - V_c \quad (3)$$

Inserting equation (2) in equation (1) yields.

$$n = n_0 e^{\frac{E}{V_c}} \quad (4)$$

It is well known that hopping process. takes place when the kinetic energy exceeds coulombm1.e.

$$T \gg V_c \quad (5)$$

Thus according to equation (3) and (4)

$$E \gg 0 \quad (6)$$

$$n = n_0 e^{\frac{E}{V_c}} \rightarrow \text{large} \quad (7)$$

This means that hopping take place as far as n which reflects hopping probability is large. In superconductivity, when coulomb attraction dominate, it follows that [See equation (3)]

$$V_c \gg T \quad (8)$$

Hence

$$E = T - V_c = -|E|$$

$$|E| \rightarrow \infty \quad (9)$$

A direct substitution of (9) in (4) yields

$$n = n_0 e^{-\frac{|E|}{V_c}} = n_0 e^{-\infty} = 0 \quad (10)$$

This means that when coulomb attraction dominates no hopping takes place, when the coulomb potential dominates. This conforms to what is written in the literature [7, 8]. The sc hopping mechanism can also be studied by considering a large coulomb repulsive potential resulting from the repulsion between the electron which needs to hop and the electron which exists in the atom to which the electron needs to hop, In this case the local repulsive energy becomes

$$E = V \quad (11)$$

The average uniform energy can be assumed to result from thermal energy and average attractive positive ionic field. In this case the average energy become

$$\bar{E} = KT - V_0 \quad (12)$$

Substituting (11) and (12) in equation (1) yields

$$n = n_0 e^{\frac{V}{V_0 - KT}} \quad (13)$$

Hopping takes place when the probability is large. This requires

$$V_0 > KT$$

$$KT < V_0 \quad (14)$$

Thus the critical temperature T_c is given by

$$V_0 = KT_c \quad (15)$$

Thus is large when

$$T < T_c \quad (16)$$

Which is ordinary sc condition since coulomb repulsion V is large.

Thus

$$\frac{V}{e^{K(T_c - T)}} \rightarrow \infty \quad (17)$$

Hence according to equation (13)

$$n_0 \rightarrow 0 \quad (18)$$

To make n finite
but when

$$T > T_c \quad (19)$$

$$\begin{aligned} KT &> KT_c \\ KT &> V_0 \end{aligned} \quad (20)$$

Thus from (13)

$$\begin{aligned} C &= V_0 - KT < 0 \\ C &= -|C| \end{aligned} \quad (21)$$

Thus equation (13) reads

$$n = n_0 e^{\frac{-V}{|C|}} \quad (22)$$

For very large repulsive force

$$\begin{aligned} V &\rightarrow \infty \\ e^{\frac{-V}{|C|}} &\rightarrow 0 \end{aligned}$$

Thus from (18) and (22) equation (13) gives

$$n \rightarrow 0 \quad (23)$$

Thus no hopping takes place when

$$T > T_c \quad (24)$$

Thus SC is destroyed

Another attractive approach can be suggested by assuming the electron moving in uniform repulsive electron field, and subjected to coulomb repulsive potential. In the case

$$E = V \quad \bar{E} = V_0 \quad (25)$$

$$n = n_0 e^{-\frac{V}{V_0}} \quad (26)$$

In this case hopping can take place when no local field exist or when it is very small. In this case

$$V = 0 \quad (27)$$

This can forms with the fact that the electronic local field vanishes inside sc

$$n = n_0 e^{-0} = n_0 \quad (28)$$

The electrons are driven here by the uniform field.

But when very large external magnetic field is applied, such that the local field becomes extremely large, i.e

$$V = V_m \rightarrow \infty \quad (29)$$

In this case equation (22) gives

$$n = n_0 e^{-\infty} \rightarrow 0 \quad (30)$$

Thus no hopping takes place and the conductivity is destroyed due to the existence of external magnetic field.

3. Discussion

The GSM can explain the SC mechanism by hopping process. In the first approach the verge uniform energy can be assumed to be an attractive coulomb potential [see equation (2)], while the local field energy, as proposed by Hubbard model is the kinetic and potential energy. Probability n is large, and hopping takes place as show by equations (3-7) These agree with that proposed by Hubbard model. But when the kinetic energy is less than the potential no hopping take place, since the probability vanishes [as equation (8-10)]. When thermal energy is considered as contributing to the uniform energy [see equation (12)]. For repulsive Coulomb force shown by relation (11) Hopping is possible if T exceeds a critical value T_c shown by equation (15). This strikingly agrees with observation. It is also very interesting to note that when T is greater than T_c , the probability n vanishes [see equation (23)] and no hopping take place. Hopping can also exist when no local field exist as shown by equation (28) which conforms with the fact the inside SC The electric field vanishes. When very strong magnetic field is applied SC is destroyed as shown by equation (29) and (30). This agree with the fact that very strong external magnetic field should of course exceeds critical values above which sc is destroyed.

4. Conclusion

The generalized statistical physical model can successfully describe sc. Hopping conduction mechanism proposed by Hubbard.

5. References

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