Universal mechanism of high temperature superconductivity and other phenomena of superconductivity

Zygmunt Morawski

ABSTRACT:

The universal mechanism of high temperature superconduction (UMHTS) [1] was used to explanation of others phenomena connected with superconduction.

And so using this mechanism, an effect of periodic changes of conduction (resistance) of high temperature superconductor (HTS) as a function of induction of magnetic field has been explained.

The influence of Josephosn's effect on creation of Cooper's pair in HTS has been discussed. It has been shown that the influence of this effect is implicated in the natural way by the suggested mechanism of superconduction.

The amplifying influence (on HTS) of Andreev's effect has been analysed. It has been shown in this work, that Andreev's effect is an interesting but with small quantitative meaning phenomenon.

The Quantum Hall effect has been discussed as an analogous effect to HTS. It has been established that so called fictitious magnetic field in quantum Hall effect is a real field, whose origination can be explained using the similar effect of creation of Cooper's pair in HTS.

Chapter I. Introduction

Model BCS explaining the superconduction wasn't dangered till the moment of discovery of HTS. Then the problem has appeared, if BCS explains this superconducting effect too . P.W.Anderson is of the opinion that it explains, but only certain corrections are demanded [1,2]. J.Schrieffer is of the opposite opinion and states [3,4] that the different conception is necessary and cites the by him created conception of spin sack.

HTS was tried to be explained using excitons [5].

All these seemingly contradictory conceptions have been supported on the ground of UMHTS created by the author [6], where each of these conceptions is a limit case. These conceptions proved to be not only undiscrepant, but complementary too.

In this work the UMHTS has been developed.

First of all the periodic dependence of conduction (resistance) on induction of magnetic field [7] should be solved.

This problem was a fundamental test for the new model.

It has been solved in the classical approximation in very easy way. It has been noticed, that the periodicity of the dependence $\varrho(B)$ is connected with periodicity of Cu-O layer which is accompanied by the radius of orbit of electron. UMHTS has a semiclassical character, so classical approximation corresponds with it.

Then it has been stated that Josephson's effect is not discrepant with UMHTS (chapter III).

In the attitude of author, the Andreev's effect is only an interesting theoretical effect with small quantitative meaning, contrary to [7]. This attitude has been based (chapter IV).

Then the quantum Hall effect was analysed, in which two parallel layers occure, between which electrons exist. The composed bosons have been identified with spin sacks and fictitious magnetic field has been treated like real field originating from the hole component of exciton (chapter V).

The phenomenon of superfluidity has been analysed, especially in context of superfluidity of unidentical particles (chapter VI).

The literature facts confirming UMHTS model have been presented in part VII.

Chapter II. The dependence of resistance on induction of magnetic field.

For explanation of this dependence, UMHTS and classical approximation are enough.

We assume, that for effect of resistance the interaction of electron with magnetic field is responsible during the tunneling of electron through the plate Cu-O, which is responsible for creation of Cooper's pairs [6]. We analyse the component of magnetic induction vector perpendicular to the surface of the layer.

An interaction of electron with magnetic field induces the circle motion of electron.

An electron lies in the plain inside the layer and parallel to limit surface of the layer.

The radius of this circle is obtained traditionally from the condition of the identity of magnetic force and centripetal force.

$$\frac{m\,v^2}{R} = B\,q\,v \qquad \text{and} \qquad R = \frac{m\,v}{B\,q} \qquad (1)$$

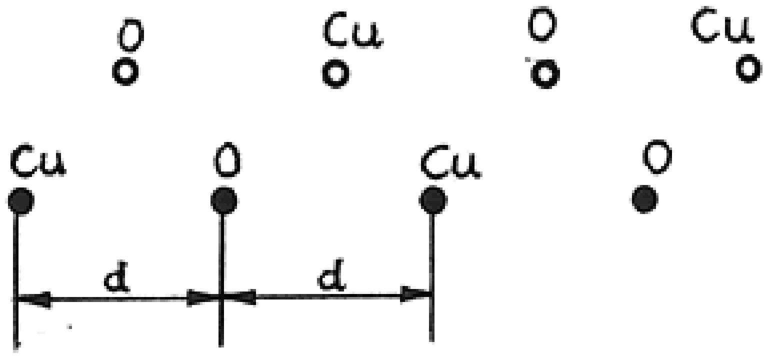

Fig.1

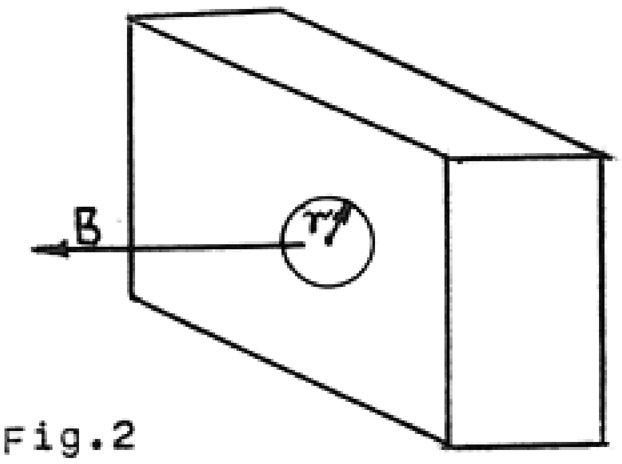

Fig.2

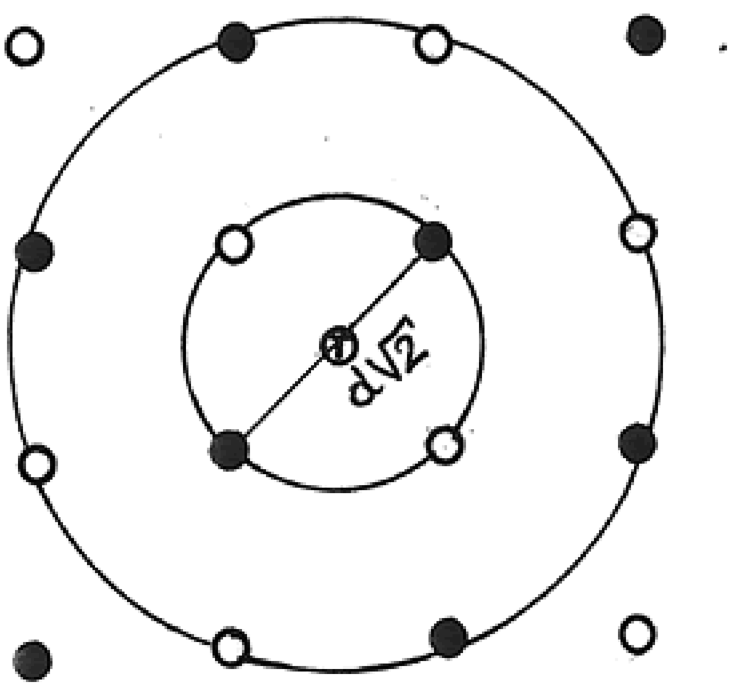

Fig.3

We assume further that the lenght of interval binding atoms Cu and O is equal to the lenght of interval binding atoms O and Cu (see fig.1).
This distance is equal d.

If during the motion of electron through Cu-O layer a collision with atom Cu or O occurs, it leads to dispersion of electron and by this fact to increasing of resistance.

Such interaction occurs if the diameter of circle of motion of electron is equal the constant lattice of its uneven multiple multiplied with $\sqrt{2}$ (see fig.3).

The assumptions that the tunneling occurs in the halfdistance between the nearest atoms multiplied with $\sqrt{2}$ is result of the work [1].

So we have:

$$2R = (2k + 1)\, d\sqrt{2} \qquad k = 0, 1, 2 \ldots \qquad (2)$$

It is the condition of decreasing of conductivity (encreasing of resistance).

The periodicity of oscillations of the dependence $\rho(B)$ is connected with periodicity of crystal lattice (of Cu-O layer) which is spied by the radius of motion of electron.

Combining (1) and (2) we obtain, that for

$$B = \frac{\sqrt{2}\, m\, v}{(2k+1)\, d\, q} \qquad k = 0,1,2\ldots \qquad (3)$$

the maxima of resistance (minima of conductivity) occur. We assume that the value of velocity of electron is constant for the definite (each) state of interactions, it means, in each concrete surrounding of Cu-O layer.

m is the effective mass of electron which is the result of interactions of electrons with other electron, lattice, magnetic field and others electromagnetic fields of the system.

An effective mass may be functions of many physical quantities, especially of magnetic fields, and it determines the intensity of maxima in the dependence $\varrho(B)$.

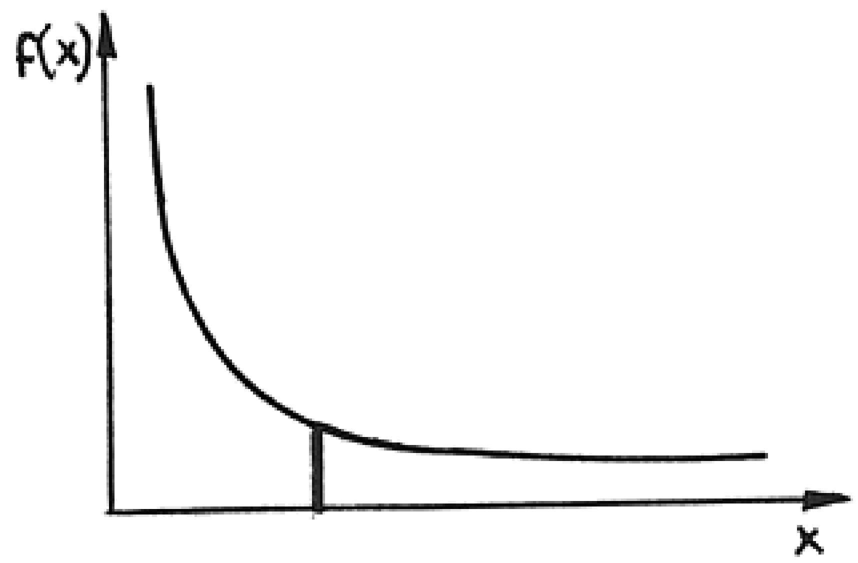

Fig.4

This fact is the next one supporting great meaning of effective mass (compare [8,9]).

If the factor $\frac{\sqrt{2}\, m\, v}{d\, q}$ is small, then the oscillations may occur in the identic distances of B, so functions B(k) in the domain of natural numbers is nearly linear. (The hyperbolic branch may be, in this region, approximated by the line.)

Chapter III. Josephson's effect and UMHTS.

In the high temperature superconductors Josephson's effect may occur [5] which increases the superconductions as an indirect effect in the process of tunneling through Cu-O layers. (In the traditional image of Josephson's effect these layers would play the role of "semiconductors".)

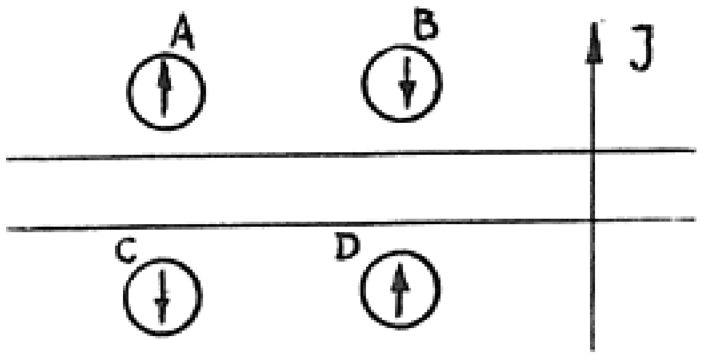

Fig.5

The Cooper's pairs are created from electrons A,B and C,D. It is known too, that A is attracting C, and B is attracting D.

(For example A creates the lack of electrons in the plate which acts as the effective positive charge attracting electron C.)

If both these processes occur in the same time, then Josephson's effect occurs.

The tunneling of whole clusters of n Cooper's pair is possible.

Chapter IV. Andreev's effect and UMHTS.

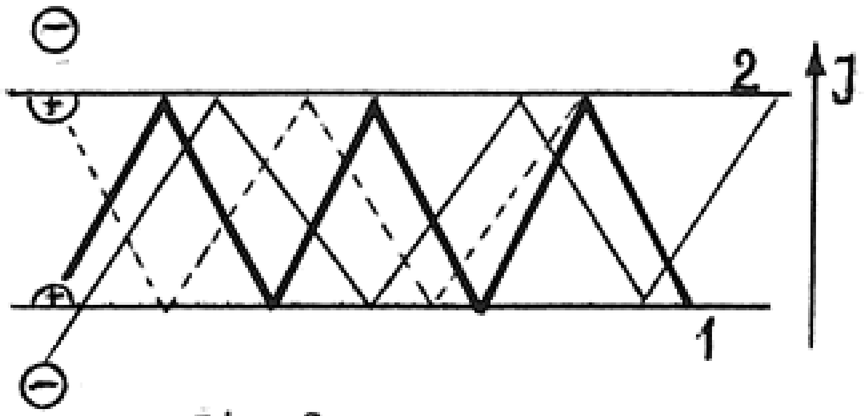

Fig.6

Andreev's effect consists in this, that the electrons and holes are tunneling through the Cu O shell and are reflecting by turns from the first and second limit surface [7] .

In so way the electrons and holes associated at both sides of layer retain.

We will prove that Andreev's effect is an accompanying effect only.

When the current in superconductor (for example from surface 1 to 2) is stable , then the greater tendency to tunneling is presented by the electrons and holes associated at the surface 1 than at the surface 2, and these carriers associated at the surface 2 may be neglected.

Thus because of association of carriers at both surfaces the elimination of influence of Andreev's effect does not occur.

Let's analyse the surface 1 more absorbing the associated carriers.

We have:

$$\vec{j} = e\, n\, \vec{v}$$

The concentrations of electrons and of holes are identical, the charges have different signs and velocities have the same senses. So the components to conduction originating from electrons and holes have different signs but don't countermand, because of different signs of value of velocity of types of carriers.

So,

$$j = e\,n\left(v_e - v_n\right) \neq 0 \quad \text{generally.}$$

So Anreev's effect (AE) can't be neglected because of different signs of value of velocity of electrons and holes.
The effects countermanding the influence of AE occur because of the motions of carriers with the same sign beginning the motioj from the same surface , and elimination of influence of AE occurs for both surfaces and both signs of carriers separately.

The carriers are reflected many times by turns from the surfaces A and B (see fig.7).

This motion is not synchronized, because the synchronization is not possible, because always next carriers begin to penetrate the Cu-O layer, because they are always adsorbed at the sur face and absorbed by it.

Let'a analyse it more precisely. Let's charge 1 be at surface A and move to surface B, and charge 2 moves from surface B to surface A. Because of many reflections and lack of synchronization, part of carriers moves in certain direction and another part in opposite direction, so their component to conduction is countermanded.

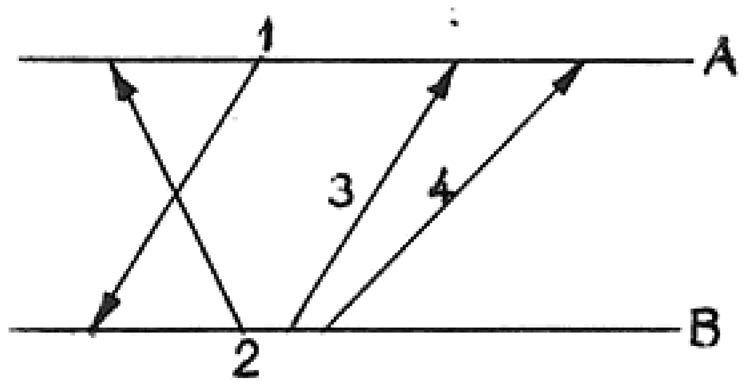

Fig.7

(The same situation occurs in the case of motion of charges 1 and 2 in one direction, and charges 3 and 4 in opposite direction.)

The same situation is both in the case of electrons and of holes. It must be so because of desynchronization of motion caused by different interactions with environment, because of its unhomogeneity.

The motions of carriers in opposite directions practically countermand AE.

The next effect decreasing the conduction is annihilation of electrons and holes.

However the effect of plate creating both Cooper's pairs and excitons explains the whole mechanism of HTS. Such layer creating Cooper's pairs exists in the systems semiconductor--superconductor-semiconductor, too.

The countermanding may not be complete, but an effective influence of AE on conduction is very small. (x)

Certain electron passes to the opposite side of Cu-O layer after few reflections and binds with the partner at the opposite side, creating with it the Cooper's pair. (xx)

So in this case the multiple reflections don't disturb the general mechanism of HTS.

The excitons are created like in the case of UMHTS too, where their origination is immanently connected with creation of Cooper's pairs.

AE is now an accompanying effect too - many times reflaction of electrons and holes would induce deexcitation.

It is obvious that even in eventual systems with pure (it means; the only) AE, the part of electrons deserts the plate and with this plate the electrons are associated, and the electrons with opposite spins may create the Cooper's pair with new coming electron.

Even the pure (hypothetical) AE gives the component to conduction with UMHTS mechanism in the system with Cu-O layers.

Generally both in case (x) and (xx) AE is only an accompanying effect but very interesting. However its meaning for conduction may be big only in the extreme situation.

All conceptions have been confirmed, which have postulated great influence of electric interaction in the mechanism of HTS .

Chapter V. Quantum Hall Effect.

The quantum well made of thin conducting material between two superconducting materials contains electron charges with great concentration [10] between two plates organizing the motion of carriers.

The construction of such system presents the physical and structural similarity to high temperature superconductor with Cu-O layers.

In quantum Hall Effect (QHE) there is the reduction of motion to the plane only. There is not the repulsion of magnetic field.

The wave functions describing QHE may be treated as the wave functions of superconducting state created by particles called composed bosons [10].

The composed bosons are interpreted by author as Cooper's pairs and the condensats of Cooper's pairs, which are an analog of spin sacks [11].

In QHE the induced charge, what means the effecive charge exists , which is an analog of effective mass [9] .

The fraction charge in QHE and in the case of quarks, supports the idea of superconducting character of confinement of quarks [12].

In the cases of QHE and HTS there is identical mechanism of creation of Cooper's pairs because of two limiting motion parallel plates. In such situation mirror effect, effect of spin sacks and exciton effect arise. (see fig.8)

The composed boson is electron component of exciton, which is composed of electron and positive holes (in plates) accompanying electrons.

These holes are moving with electrons, and they both are put in motion by an outside magnetic field and create so called the fictitious magnetic field with the sense opposite to the sense of outside field, according to Lenz' Law.

The exciton effect accompanying the spin sacks explains the mechanism of origination of this inside magnetic field. So this fictitious magnetic field has real character.

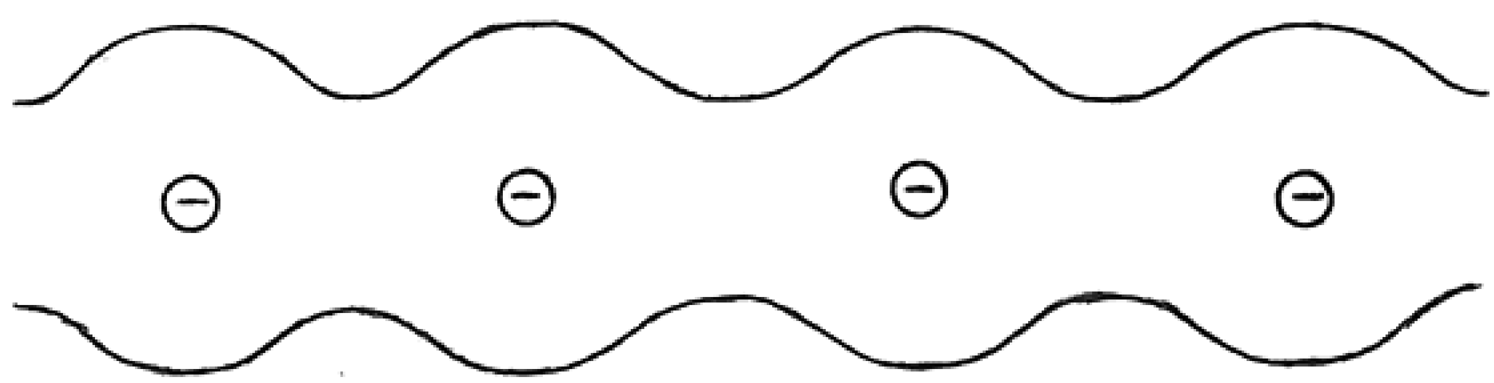

Fig.8

Chapter VI. The superfluidity of identical and unidentical particles.

The excitations in liquid helium for the second minimum of the dependence $\mathcal{E}(p)$ are called rotons. They correspond with rotational motion of atoms of helium [13].

With the flow of superfluidity currant the superfluidity field characterized by circle lines is connected. The quanta of this superfluidity fields are called rotons.

The rotational motion is connected with superfluidity field and rotons.

The interactions between nucleon and meson scalar field are connected with the process, in which the mesons of wave p are created and annihilated by the conjuction with the spin of nucleon s .

Such conjuctions create the deformation in the conjucted spaces of nucleon and mesons.

The analogous deformation exists in the description of superfluidity caused by the correlation of pairs [14].

It means that the phenomenon similar to the superfluidity may characterize the unidentical particles.

Chapter VII. The literature facts confirming the correctness of UMHTS.

In the layer systems of semiconductors the excitons arise like in the high temperature superconductors with Cu-O layers [15]

The time of life of excitons encreases with decreasing of thickness of the wall which is identical with UMHTS: the thinner the potential barrier is, the easier an electron tunnels and dissociates from the hole encreasing the stability of exciton.

So we have the dependence layer-exciton. This dependence is general and exciton is one element of mechanism in the system presenting HTS.

The delocalisation of excitons corresponds with the tunneling of electron through the layer.

In QHE [15] for two-dimensional gas (limited by the plates) the pairs of quantum Hall liquid states exist , which are analog of superconduction.

This fact attests the affinity between QHE and superconduction, especially with HTS with plate character; and attests the correctness of model of QHE in which electrons create the Cooper's pairs.

The magneto-roton excitations in QHE [11] reflect the character of spin sacks and of excitons, which corresponds with HTS with plate limit.

The existence of rotons attests the affinity with superfluidity.

The integral

$$\oint \vec{a}\,\vec{dl} = (2k + 1)\,\phi_0$$

corresponds with existence of loops of rotons.

The next integral corresponds with roton loop :

$$Q = \frac{e\nu}{\phi_0} \oint \delta\vec{a}\,\vec{dl} = \pm\frac{e}{2n+1}$$

Q, charge connected with roton loop, exists as charge and anticharge, according to two signs in the equation.

The increase of conduction (in the case of thin, superconducting layer between two semiconductors) [7] reflects the fact that the plate may mediate in the creation of Cooper's pairs.

This dependence on the thickness reflects the fact, that not only Andreev's effect exists although the excitons arise and migrate along the layer.

Only the refluction connected with migration along the plate is not enough, because the recombination exists, and this what passes through the plate contributes to the conduction . Such process occurs with certain probability.

There is the general dependence: plate - superconduction. So the plate generates the superconduction and connected with with it in HTS mechanism exciton effect.

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