UNDERSTANDING SUPERCONDUCTIVITY: A NEW APPROACH

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As we know, in nature, nothing occurs unnecessarily, e.g., our hearts beat persistently without having any source of infinite energy, not unnecessarily; there is an important purpose as to why they beat persistently, and they have special structure, unlike simple balloons of blood, that keeps them beating persistently and provides all the properties our hearts possess. And therefore, as electrons, nucleons etc. all the particles possess persistent spin motion without having any source of infinite energy and several properties; there should positively be some important purpose as to why they possess persistent spin motion, and they should have special structure, unlike simple balloons of charge, that keeps them spinning persistently and provides all the properties they possess. Further, as all the phenomena/activities related with our hearts, e.g., continuous blood circulation etc. taking place in our bodies are the effects of the purpose behind persistent beating of our hearts and their special structure, similarly, all the activities/phenomena related with electrons, nucleons etc. taking place in their systems should be the effects of the purpose behind their persistent spin motion and their special structure. And therefore, presently, that purpose and the special structure of electrons have been determined. Their accounts enable to give very clear and complete explanation as to how resistance-less state, superconductivity, diamagnetism and all the properties exhibited by superconductors are generated, and Meissner effect, levitation of magnet above the superconductor and Josephson's tunnelling take place in specimens at their transition temperature. Finally, it has also been explained as to how currently known some non-superconducting (e.g. ferromagnetic) substances can be made superconducting. In the current theories, no account of the above has been taken. And consequently, the BCS (Bardeen–Cooper–Schrieffer) theory, for which it is claimed that it accounts very well all the properties exhibited by the superconductors, if we examine it, we find numerous logically and practically unbelievable concepts have been taken to arrive at the desired results.

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1. INTRODUCTION

As we know, when a specimen in the form of a close circular loop is cooled down keeping it in an external magnetic field in a plane perpendicular to its direction, as soon as the transition temperature (T_c) of specimen is attained and the resistance-less state is obtained, a persistent current starts flowing through the specimen. Simultaneously, a generation of diamagnetism in the specimen that causes a change in magnetic flux, known as the Meissner effect[1], a reduction in the energy of electrons in comparison to energy of electrons at their normal state (i.e. at temperatures $> T_c$) and a reduction in entropy etc. are also observed.

The above observations lead to conclude:

1. Electrons possess some property (see Sec. 2) that generates linear velocity in them and keeps them always moving with that velocity. Otherwise, they cannot start flowing themselves at T_c, and due to the earth's gravitational force (may be very little but finite) on them, they cannot flow persistently for indefinitely long time.

2. There occurs some means (see Sec. 4) that orients the directions of linear velocity of all the free electrons of the specimen in one direction at temperature T_c. Otherwise, all the free electrons of the specimen cannot start moving in one direction.

3. The electrons possess some special structure (see Sec. 3), unlike simple balloons of charge. And according to their special structure, they possess some magnetism too by the virtue of nature as they possess charge, and in such a manner and form that when the directions of their linear velocity are oriented in one direction, their magnetism and magnetic fields are also oriented simultaneously in such a manner that a resultant magnetism (i.e. diamagnetism) is generated in the specimen, and due to interactions between their magnetic fields, an attractive force is generated between them that reduces their energy in comparison to electrons at their normal state.

4. There occurs some obstacle in the specimen that resists the motion of its free electrons and not lets them to flow persistently without any external aid, e. g. electric field at temperatures $> T_c$, disappears or that's effect is minimized at temperature $\leq T_c$, and a resistance-less state is obtained in the specimen. Otherwise, the resistance-less state cannot be obtained, and the disturbance in the specimen cannot be reduced and the flow of electrons cannot become orderly so that the entropy of the specimen may reduce.

The above conclusions cannot be ruled out because, as we know, electrons, nucleons etc. all the particles possess persistent spin motion without having any source of infinite energy and several properties; there should positively be some important purpose as to why they possess persistent spin motion, and they should have some special structure, unlike simple balloons of charge, that keeps them spinning persistently and provides all the properties they possess. For example, our hearts beat persistently without having any source of infinite energy, there is an important purpose as to why they beat persistently, and they have special structure, unlike simple balloons of blood that keeps them beating persistently and provides all the properties our hearts possess. Further, as all the phenomena/activities related with our hearts, e.g., continuous blood circulation etc. taking place in our bodies are the effects of the purpose behind persistent beating of our hearts and their special structure, similarly, all the phenomena/activities related with electrons, nucleons etc. taking place in their systems, e.g., their beams, deuterons, alpha particles, nuclei and specimens should be the effects of the purpose of persistent spin motion of electrons, nucleons etc. and their special structures.

Presently, that purpose (see Sec. 2) and the special structures of electrons, protons and neutrons (see Sec. 3) have been determined. The determined purpose satisfies the mentioned above first conclusion (see Sec. 2), and the special structure satisfies the third conclusion (see Sec. 3). Regarding the second and the fourth conclusions, the magnetic field, keeping in which the specimen is cooled down to its T_c, satisfies the second conclusion (see Sec. 4). And the photons, which are emitted from the orbiting electrons of specimens, their collisions with the free electrons of the specimen during their stay in the specimen satisfy the fourth conclusion, because their number at T_c is reduced as much that their effect becomes negligible (see Sec. 5).

Their determinations enable to give very clear and complete explanation as to how resistance-less state (see Sec.5), superconductivity (see Sec. 6), diamagnetism and all the properties exhibited by superconductors (see Sec. 7) are generated, and Meissner effect, levitation of magnet above the superconductor and Josephson's tunnelling take place in specimens at their transition temperature (see Sec. 7).

Currently, to explain as to how superconductivity and properties exhibited by superconductors are generated, several theories have so far been proposed. But none has taken account of the mentioned above four conclusions. And consequently, the BCS (Bardeen–Cooper–Schrieffer) theory[2], for which it is claimed that it provides a good quantum explanation of superconductivity and accounts very well for all the properties exhibited by the superconductors, if we examine it and its rigorous mathematical proofs closely and intently, we find that it is based on such concepts which: 1- are practically not possible (see below the bullet i); 2- contradict two well-observed facts (see below the bullet ii); 3- give rise to numerous very serious such questions of which no explanation can be given (see below the bullet iii).

i. The concepts, which are practically not possible

In BCS theory, it is assumed that at T_c of specimen, when an electron approaches a positive ion core, the core suffers attractive Coulomb interaction and that sets the core in motion and consequently the lattice is distorted. But, can it ever be possible that an ion core, which is obtained as the consequence of ejection of electron(s) from a neutral atom and happens to be approximately $1.84A \times 10^3$ (where A is mass number, $1.84 \times 10^3 = m_n / m_e$, and m_n and m_e respectively are the mass of nucleon and electron) times heavier than the electron, is attracted by the electron, and that attraction sets the ion core in motion, and the motion of core distorts the lattice which is a regular periodic array of number of atoms? No, because practically and logically both it cannot be possible. The most surprising things are:

1. According to existing concept, the ion cores and the free electrons are generated as the consequence of ejection of orbiting electrons from the orbits of neutral atoms. And hence, how can an electron, which was earlier a part of such an ion core [before its (electron) ejection from that ion core] at $T >> T_c$, exert such a strong force on that ion core instead of being absorbed back into that ion core! Can it be believed or possible?

2. The electron, when approaches a positive ion core, attracts the ion core so strongly that the ion core is set in motion and that distorts the lattice, while on the other hand, the same electron, when forms a Cooper pair with another electron as the consequence of electron-lattice-electron interaction, the repulsive Coulomb force between the electrons (of Cooper pair) becomes negligible and the pair persists as long as the persistent current flows. Can it practically ever be possible? Probably, in order to avoid such questions, in BCS theory a postulate has been taken that the Cooper pairs start forming and the superconductivity occurs when the attractive interaction between two electrons by means of a phonon exchange dominates the usual repulsive interaction between electrons. But this postulate does not convince. Secondly, it gives rise to several questions (see below bullet iii) of which no answer can be given.

ii. The concepts, which contradict two well-observed facts

If due to attractive Coulomb interaction between electron and the ion core of specimen, its ion core is set in motion and consequently the lattices is distorted, then the energy and disorderness in the specimen should be increased and consequently the entropy of specimen should be increased, while on the contrary, the entropy of specimen is decreased. Further, due to setting of ion cores into motion etc., the resistance of the specimen should also be increased, while on the contrary it is reduced to zero.

iii. The concepts which give rise to numerous such questions, of which no explanation can be given:

1. At T_c of the specimen, why, how and what situation is suddenly being created in it that its electrons when approach positive ion cores, the cores start suffering attractive Coulomb interaction? Why and how is this situation not being created at $T > T_c$? The postulate, mentioned above, has been taken in order to avoid such questions too, but such questions cannot be avoided because the situation of applicability of the above postulate arises later on when the core is set in motion and that distorts the lattice, not before that. Further, the above postulate too gives rise to several questions, e.g., why, how and what situation is suddenly being created at T_c that the attractive interaction between two electrons by means of a phonon exchange starts dominating the usual repulsive interaction between the electrons? Why and how is that situation not being created at $T > T_c$.

2. Why and how only in few substances (because superconductivity takes place only in few substances, not in all) are their ion cores set in motion due to the suffering of attractive Coulomb force when their electrons approach their ion cores? Why and how does it not take place in all the substances?

Further, since the concepts that when an electron approaches a positive ion core, the ion core is set in motion and the motion of core distorts the lattice etc., cannot be true, there does not arise any question of emission of virtual phonons from the lattices. Therefore, the occurrence of electron-lattice-electron interaction and hence the formation of Cooper pairs cannot be possible. Furthermore, the concept of Cooper pairs gives rise to several very basic and fundamental questions too. For example:

1. According to the existing concept of Cooper pairing, the Cooper pairing starts at T_c and their number goes on increasing till T = 0 K. Therefore, if the persistent current flows due to the flow of Cooper pairs, the strength/intensity of persistent current should go on increasing as the temperature of specimen decreases. Does the strength/intensity of persistent current increase as the temperature of specimen decreases?

2. Applying H_c when the normal state of specimen is restored (i.e. when the persistent current stops flowing), are the Cooper pairs broken and the electrons are separated from their respective pairs? If the Cooper pairs are broken and the electrons are separated from their respective pairs, how does it happen? And if the Cooper pairs are not broken, the question arises, then how does the persistent current stop flowing?

3. At temperatures $\leq T_c$ of specimen, if the persistent current is obtained due to the flow of Cooper pairs, how and from where do the Cooper pairs obtain their initial linear velocity with which they start flowing? And how is that maintained for indefinitely long time against the gravitational force acting on them during their persistent flow?

4. At temperatures $\leq T_c$ of specimen, if the persistent current is obtained due to the flow of Cooper pairs, how are the directions of motion of Cooper pairs are oriented and aligned in one direction, i.e. along the direction of flow of persistent current?

2. DETERMINATION OF THE PURPOSE AS TO WHY ELECTRONS, PROTONS AND NEUTRONS ETC. POSSESS PERSISTENT SPIN MOTION

The spin motion of electrons, nucleons etc. all the spinning particles generate the following two properties in them:

2.1 First property

The spin motion of spinning particle generates the tendency of linear motion in it along the direction of its spin angular momentum L_S (for verification of its truth, see

Sec. I B, Ref. 3). And as electron, nucleon etc. all the particles possess spin motion; a tendency of linear motion is generated in them along the directions of their respective L_S .

If the frequency of spin motion of such a particle is increased by some means, a stage comes when the particle starts moving itself along the direction of its L_S . Then after, as the frequency of spin motion of particle increases, the velocity of particle goes on increasing in accordance to expression[3]

$$\mathrm{v}^2 = h\omega / m \quad \ldots \quad (1)$$

where m, v and ω respectively are the mass, linear velocity and frequency of spin motion of the particle, and h is Planck's constant [for verification of the truth of expression (1), see Sec. I A, Ref. 3].

Electrons, nucleons etc. all the particles probably possess such amount of frequency of spin motion that keeps them always moving with some linear velocity (v). And consequently, they are found always in moving state, not in position of rest, and their motions are always oriented along the directions of their respective L_S . Their linear velocity (v) varies as the frequency of their spin motion (ω) varies, according to expression (1).

2.2 Second property

As a particle, due to its linear motion, obtains kinetic energy (E_K), and due its kinetic energy (E_K), obtains its linear momentum (p_{LIN}), similarly, due to its spin motion, it obtains spin energy ($E_S = h\omega/2$, for detail, see Sec. II, Ref. 3), and due to its spin energy, it obtains spin momentum ($p_S = h\omega/\mathrm{v}$, see Sec. II, Ref. 3). [For verification of the truth that the particle obtains p_S due to its spin motion, see Sec. I C, Ref. 3.]

And therefore, electrons, nucleons etc. all the particles possess motional energy (E_M) $= E_K + E_S$ and motional momentum (p_M) $= p_{LIN} + p_S$. And whenever arises the situation of conservation of energy and momentum etc. of electrons, nucleons etc. during their motion, their E_M , p_M and L_S actually conserve, not their E_K and p_{LIN} . [For verification of the truth of conservation of p_M , see Sec. I D, Ref. 3. And for how E_M , p_M and L_S conserve, see Sec. 3.1.1, Ref. 4.] Due to conservation of E_M , p_M and L_S of electrons, nucleons etc., no violation of the laws of conservation of their energy and momentum etc. happens to be possible, even, e.g.: 1. During motion of electron along its elliptical orbit, where the velocity of electron varies; 2. During motion of electron (accelerated by a large voltage), after attaining relativistic velocity by it, when the rate of increase in its velocity starts decreasing (see Sec. 2.2, Ref. 4).

3. DETERMINATION OF SPECIAL STRUCTURE OF ELECTRONS, PROTONS AND NEUTRONS THAT KEEPS THEM SPINNING PERSISTENTLY AND PROVIDES ALL THE PROPERTIES THEY POSSESS

3.1 Determination of the special structure of electrons

The current concept about the structure of electron that it is like a ball of charge (-e), and the magnetic field, spin magnetic moment (μ_S) etc. properties it possesses are obtained due to spin motion of its ball of charge is not true (see Sec. 1, Ref. 5).

The electron has special structure, unlike simple ball of charge (-e). It possesses a bundle of magnetism too by the virtue of nature as it possesses a bundle of charge ($-e$) by the virtue of nature. And the magnetic field the electron possesses occurs due to this magnetism. The magnetism the electron possesses occurs in the form of a circular ring, shown by a dark solid line circle around the charge of electron, Fig. 1(a), where charge has been shown by a spherical ball, as for example, around the planet Saturn, there occurs a ring. Around the ball of charge of electron, there occurs its electric field (which has not been shown in figure), and around the ring of magnetism of electron, there occurs its magnetic field shown by broken line circles, Fig. 1(a). The ring of magnetism and the ball of charge of electron both spin with frequencies ω_{EM} and ω_{EC} respectively, but in directions opposite to each other, shown by arrows in opposite directions, Fig. 1(b), where the ball of charge has been shown by quite a thick dark line circle and the ring of magnetism by comparatively a thinner dark line circle.

The spin motion of the ring of magnetism and the ball of charge of electron in directions opposite to each other is the special characteristic of the special structure of electron, because when they spin in directions opposite to each other, there is created such situation (see Sec. 3.2, Ref. 4) and their fields interact (electromagnetic interaction) with each other such that their spin motion persists.

When the ring of magnetism and the ball of charge of electron spin with frequencies ω_{EM} and ω_{EC} respectively, due to their spin motion, the linear velocities v_{EM} and v_{ES} respectively are generated in them according to expression (1) along the directions of their respective spin angular momentum L_{SM} and L_{SC}. And consequently, electron obtains linear velocity $\mathrm{v}_{\mathrm{E}}\,(= \mathrm{v}_{\mathrm{ES}} - \mathrm{v}_{\mathrm{EM}}$ or $= \mathrm{v}_{\mathrm{EM}} - \mathrm{v}_{\mathrm{ES}})$ along the direction of its spin angular momentum L_S which (L_S) is generated in electron due to the frequency of its spin motion ω_E, where ω_E is corresponding to v_{E} of the electron obtained according to expression (1). During motion of electron along its elliptical orbits or after attaining relativistic velocity by it, the frequency of spin motion ω_E of the electron corresponding to its linear velocity $\mathrm{v}_{\mathrm{E}}\,(= \mathrm{v}_{\mathrm{ES}} - \mathrm{v}_{\mathrm{EM}})$ is obtained according to expression[4] (2).

The μ_S the electron possesses, is generated due to the spin motion of its ring of magnetism and occurs along the direction of L_{SM}. As normally $\mathrm{v_E}$ occurs along the direction of L_{SC} (for detail, see Sec. 3.1.1, Ref. 4), and L_{SC} occurs in direction opposite to the direction of L_{SM}, $\mathrm{v_E}$ occurs in direction opposite to the direction of μ_S.

3.2 Determination of the special structure of protons and neutrons

For the special structure of protons, see Sec. 3.1.2, Ref. 4, and for neutrons, see Sec. 2, Ref. 6.

4. DETERMINATION OF THE MEANS THAT ORIENTS THE DIRECTIONS OF LINEAR VELOCITY OF THE FREE ELECTRONS OF THE SPECIMEN IN ONE DIRECTION AT ITS TEMPERATURE $\leq T_c$

The external magnetic field, placing in which the specimen is cooled down to $\leq T_c$, orients the directions of linear velocity v (or can say of L_s) of the free electrons of the specimen in one direction, according to Lorentz force (for proof of its truth, see Sec. 4.1). The directions of linear velocity of the free electrons were earlier, i.e. at temperatures $> T_c$, oriented in different directions of the specimen due to their frequent collisions with photons present in the specimen (see Sec. 5).

4.1 Proof of that, at superconducting state of the specimen, the directions of velocity of electrons of the specimen are oriented and aligned

If we take an iron bar and place it in the magnetic meridian (or in any position) of the earth's magnetic field, the lines of force of the earth's magnetic field pass through the body of the iron bar and we find no change in the lines of force of the earth's magnetic field near the iron bar. Whereas if, after magnetizing the iron bar, we place it in the same position of the earth's magnetic field, we find that the magnetic lines of force of the earth's magnetic field are now expelled out from the body of the bar, i.e. a change in flux is observed. The expulsion of the lines of force of the earth's magnetic field from the body of bar takes place because when the bar is magnetized, its lines of force are generated, and according to property of magnetic lines of force, since the lines of force neither intersect themselves nor other lines of force, the lines of force of the earth's magnetic field are expelled out from the bar.

Similarly, when the lines of force of the external magnetic field, which were earlier passing through the body of the specimen when the persistent current had not started flowing through it, Fig. 5(a), are expelled out from the body of the specimen, i.e. a change in flux is observed when the persistent current starts flowing through it, Fig. 5(b), it means, there is generated some magnetic field, the lines of force of which are oriented and aligned with respect to the direction of lines of force of the external magnetic field such that they stop the lines of force of the external magnetic field to pass through the body of specimen. Consequently, the lines of force of the external magnetic are expelled out from the body of specimen, as shown in Figs. 5(b). The lines of force, which stop the lines of force of the external magnetic field to pass through the body of specimen, since do not come from outside but are generated within the specimen when the persistent current starts flowing through it, it means, then the magnetic fields of electrons of the specimen are oriented and aligned such that the lines of force of the external magnetic field are stopped. Because, other than this, there is no means by which the generation of magnetic field within the specimen can be possible.

The orientation of magnetic field of electrons means the orientation of velocity (v) of electrons, otherwise, their fields cannot be oriented.

5. DETERMINATION OF THE OBSTACLE THAT RESISTS THE MOTION OF FREE ELECTRONS OF THE SPECIMEN AT IT TEMPERATURES $>T_c$ AND DISAPPEARS AT ITS TEMPERATURE $\leq T_c$

As we know, photons are emitted from the orbiting of the substances and their emission goes on continuously, some photons remain always in the specimens despite their absorption again in the specimens and emission out from the surfaces of the specimens. They, during their stay/existence in the specimens, go on travelling here and there inside the specimens and collide with the free electrons of the specimens found in their way and resist the free electrons to move persistently along the directions of their velocity v.

When the temperature of specimen decreases, thermal energy of that's atoms and hence of that's orbiting electrons goes on decreasing. In this process of decreasing the temperature of specimen, a temperature should be obtained when the thermal energy of the orbiting electrons of the specimen shall be reduced as much that some of them shall become unable to excite to any allowed higher energy state. Then, these orbiting electrons shall stop emitting photons. If the reduction in temperature of the specimen is continued, a temperature, say T', should be obtained when all the orbiting electrons shall become unable to excite and emit photons. Then (i.e. at temperature T') the photons present inside the specimen shall start disappearing from the specimen. All the photons shall not disappear from the specimen immediately because practically it is not possible. In the beginning, the speed of disappearing shall be very fast, but shortly, say at temperature T_c and afterwards, the speed shall be reduced very much. Then the number of photons remaining in the specimen is reduced as much that they become unable to resist the flow of the free electrons of the specimen due to their collisions with the free electrons.

So, at temperature T_c, the specimen can be said to be at resistance-less state, and the temperature T_c can be said to be the transition temperature of the specimen. (For verification of the truth that at T_c, due to the disappearance of photons from the specimen, the resistance of specimen is reduced to zero, see Sec. 5.1**)**

5.1 Evidence to confirm that at temperature $\leq T_c$ of specimen, due to disappearance of photons from it, its resistance is reduced to zero.

Currently it is believed that at T_c of superconducting substance, its resistance is suddenly reduced to zero. But it is not true. Before arriving at T_c, every superconducting substance arrives at temperature, say T'_c, from where the resistance of the substance suddenly starts decreasing very fast, and at T_c, that reduces to zero, as shown in Fig.1(a). Consequently, the straight line joining points A (at T'_c) and B (at T_c), which shows the rate of fall of resistivity of the substance during decrease in its temperature from T'_c to T_c, Fig. 1(a), is not found to be exactly vertical but it is very little inclined. For example, in the case of mercury, Fig. 1(b)[7], where T'_c is nearly 4.25° K (Kelvin) and T_c is 4.2° K, and line AB is not vertical but very little inclined. The inclination of straight line AB varies from substance to substance. (Why and how the inclination of straight line AB varies from substance to substance, see Sec. 7.2.)

The above complete phenomenon occurs due to the reason that T'_c happens to be actually T', at which (i.e. T') all the orbiting electrons of the substance stop exciting and emitting photons (see Sec. 5), and the photons present inside the substance start disappearing from the substance. In the beginning, the disappearance of photons happens to be very fast, and very shortly a temperature T_c is obtained when their number is reduced as much that they become unable to disturb the flow of free electrons of the substance.

Beyond T_c, as the temperature of substance decreases, the disappearance of photons goes on continuously but the rate of disappearance becomes very-very slow.

So, near T'_c, resistance of the substance starts reducing very fast and very shortly at T_c, that is reduced to zero and the resistance-less state is obtained.

6. EXPLANATION OF HOW SUPERCONDUCTIVITY IS GENERATED IN SPECIMENS AT TEMPERATURE T_c

At temperature T_c of the specimen, when the number of photons inside the specimen is reduced as much that they become unable to resist the flow of free electrons of the specimen, the directions of the linear velocity (v) of electrons [generated in them due to their persistent spin motion (see Sec. 2.1)] are found randomly oriented in all the different directions of the specimen because of their frequent collisions with the photons earlier, i.e. at temperatures $> T_c$, present in the specimen. The external magnetic field, placing in which the specimen is cooled down to $\leq T_c$, orients and aligns the randomly oriented directions of v of the free electrons of the specimen in direction perpendicular to its direction according to Lorentz force (for confirmation of its truth, see Sec. 7.4.1). And as soon as the directions of v of the free electrons are oriented and aligned, the electrons start flowing in that direction, i.e. the persistent current starts flowing through the specimen in that direction. This state of specimen is its superconducting state.

Once the directions of linear velocity of electrons are oriented and aligned and they start flowing in that direction, their motion persists and is not being disturbed even after removing the external magnetic field. That can be disturbed only by some external means, e.g., by generating photons again in the specimen applying a magnetic field of strength H_c (see Sec. 7.7.1).

7. EXPLANATION OF PROPERTIES AND EFFECTS EXHIBITED BY SUPERCONDUCTORS

7.1 Explanation of why and how the entropy at superconducting state of the substance decreases

The decrease in entropy at superconducting state of the specimen means, the system becomes more orderly, in other words, the disturbance in the specimen is reduced. At temperature T_c, since all the orbiting electrons of the specimen stop exciting and emitting photons, and the number of photons present inside the specimen is reduced as much that they (photons) become unable to disturb the alignment of free electrons of the specimen due to their collisions with the electrons, the alignment of electrons persists, i.e. the system becomes orderly. And hence the entropy of the substance is reduced.

7.2 Explanation of variation of T_c from substance to substance

As we know, thermal conductivity varies from substance to substance. Suppose, thermal conductivity of substance $S_1 >$ thermal conductivity of substance S_2, i.e. in substance S_1, the thermal energy can be conducted more easily and effectively as compared to that in substance S_2.

The conduction of thermal energy in substances is done by transportation, and that is done by thermal energy carriers, i.e. photons, because photons are the radiation energy carriers, where the radiation energy produces the heat and the light effects (see Sec. 3, Ref. 8). The photons, after their emission from the orbiting electrons of the hot portion of the substances, during their travel in the substances, they transport the thermal energy from the hot portion of the substances towards their cooler portions, and when the photons are emitted out from the surfaces of substances into the atmosphere existing around the substances, there too they do the same thing.

In substance S_1, the thermal energy can be conducted more easily and effectively as compared to that in substance S_2, if in substance S_1, more number of orbiting electrons are excited and they emit more number of photons as compared to that in substance S_2. And more number of photons can be emitted in substance S_1, if the orbiting electrons in substance S_1 are loosely bound with their respective atoms in comparison to binding of orbiting electrons with their respective atoms in substance S_2.

Now, if the temperature of different substances, e.g. S_1, S_2, S_3, of which the binding energy (by which their orbiting electrons are bound with their respective atoms) increases as we go from substance S_1 to S_3, reduces, the temperature T', at which all the orbiting electrons of the substance become unable to excite and emit photons shall be obtained earliest in substance S_3, and in substance S_1 shall be obtained in the last, i.e., T' for substance S_3 shall be $> T'$ for substance S_2, and T' for substance S_2 shall be $> T'$ for substance S_1. Thus the temperature T' varies from substance to substance. Further, since the temperature T' happens to be T'_c (see Sec. 5.1), T'_c too varies from substance to substance. During the fall of temperature of the substance from temperature T'_c to T_c (see Sec. 5.1), the rate of disappearance of photons from the substance too varies from substance to substance. Consequently, the slope of straight line AB [see Fig. 2(a)] and T_c vary from substance to substance (see Sec. 5.1).

7.3 Explanation of why and how the substances like Cu and Au etc. do not superconduct even down to very low temperatures

Some substances, e.g. Cu, Au etc., which are very good conductors of current, do not superconduct even at temperatures down to 0.05 K. If we investigate, we find that these substances are very good conductors of heat too, that means, these are very susceptible to temperature and even a very little change of temperature in them is conducted in their full system (i.e. body).

In conductors, the thermal energy is conducted by transportation which is done by photons (see Sec. 7.2), and in substances-Cu, Au etc., since even a very little change of temperature in them is conducted to the full system even a very little change in temperature is conducted in their full system, the excitation of orbiting electrons of these substances and hence emission of photons from them continues even down to very low temperatures. And consequently, these substances do not become able to get free from photons and hence do not become able to superconduct even down to so low temperatures.

7.4 Explanation of how Meissner effect takes place and how a magnet is levitated above the surface of a superconductor

7.4.1 How Meissner effect takes place

At superconducting state, when the directions of linear velocity v (or can say of L_s) of the free electrons of the specimen are oriented and aligned and the persistent current starts flowing (see Sec. 6), according to their special structure the directions of their μ_s are also oriented and aligned but in direction opposite to the direction of orientation and alignment of L_s of electrons. And the planes of magnetism and magnetic fields of electrons are oriented and aligned in a plane perpendicular to the direction of their persistent flow.

But, through the specimen when the persistent current, i.e. the free electrons of the specimen start flowing, they flow through every inter-lattice passage of the specimen in the form of number of queues. Their flow in such a manner can be assumed as, through every inter-lattice passage, the electrons are moving in the form of a beam, as shown in Fig. 3. Since the directions of L_s, μ_s and the planes of magnetism and magnetic field of electrons are oriented and aligned, the so called beams obtain all the properties, i.e.

electromagnetism, μ_s, magnetic field etc. which the electron beams possess (see Sec. 4.1, Ref. 5). The magnetic fields generated around the so called beams passing through inter-lattice passages, say 1, 2, 3, 4,……. interact as shown in Fig. 3, similarly as magnetic fields around electrons interact, as shown in Fig.[5]2 and explained in Sec. 4.1, Ref. 5. Consequently, a force of attraction is generated between all the so called beams and they are bound together, electromagnetism is generated in the specimen and magnetic field is generated around and along length of the specimen in a plane perpendicular to the direction of motion of electrons in the specimen, Fig. 4, similarly as a force of attraction is generated between all the electrons of an electron beam and the electrons are bound together in their beams, electromagnetism is generated in the beam and a magnetic field is generated around and along the length of the beam in a plane perpendicular to the direction of motion of electrons in the beam (see Sec. 4.1, Ref. 5). Further, since the magnetic field of all the electrons and beams possess spin motion in anticlockwise direction (if the electrons are moving towards the face of the clock), the generated magnetic field around and along the length (perimeter) of the specimen too possesses anticlockwise direction. [Or clockwise, if we consider the direction of magnetic field with respect to the direction flow of persistent current i, Fig. 4, because electrons flow in direction opposite to the direction of flow of i.]

Thus, the specimen starts behaving like a magnetic dipole similarly as an electric current carrying close loop behaves as a magnetic dipole (see Sec. 6.2, Ref. 5). And consequently, the magnetic lines of force of the external magnetic field, which were earlier passing through the body of specimen, Fig. 5(a), when no persistent current had started flowing through the specimen and the specimen had not acquired the superconducting state, are now expelled out from the body of the specimen, Fig. 5(b), and a change in flux, i.e. the Meissner effect[9] is observed. The change in flux is observed similarly as, if an iron bar is placed in the magnetic meridian of the earth magnetic field, the lines of force of the earth magnetic field pass through the body of the iron bar, whereas if the iron bar is replaced by an exactly similar bar magnet (i.e. a magnetic dipole), the lines of force of the earth magnetic field are now expelled out from the body of the bar magnet, i.e. a change in flux is observed.

7.4.2 How a magnet is levitated above the surface of a superconductor

If above the upper surface of this magnetic dipole, a magnet is laid down, the magnet shall experience a force of repulsion, if their similar poles lie facing to each other, and the magnet shall be levitated above the surface of the dipole provided the mass of magnet is such that the repulsive force on it may levitate it. The magnet shall experience a force of attraction, if their opposite poles lie facing to each other.

Currently, it is claimed that the levitation of magnet takes place if the superconductor is a high temperature superconductor. The reason behind it may be that, in high temperature superconductors, due to their high temperature, their free electrons possess more energy and hence more velocity that causes increase in the persistent current flowing through them, and the increase in persistent current increases the strength of the magnetic field generated in them. The increase in the strength of magnetic field increases the force of repulsion on the magnet and the magnet is levitated.

7.5 Explanation of why and how diamagnetism generated in substances at their superconducting state persists, while generated at normal state does not persist

In substances at their superconducting state, since the number of photons is reduced as much that the alignment of the directions of the planes of magnetism and magnetic fields of the free electrons of the substance caused due to the external magnetic field, the magnetism (diamagnetism) generated in the substances persists. Whereas in substances at their normal state (i.e. at temperatures $> T_c$), since the number of photons existing in them happens to quite large, due to the frequent collisions of photons with the electrons of the substances, the alignment of the planes of magnetism and magnetic fields of their electrons caused due to the external magnetic field applied to magnetize the substances (or due to the allowance of electric current to flow through the substances, because it too causes the generation of diamagnetism in the substances, see Sec. 4, Ref. 5) happens to be weak. And hence, in them the alignment does not persist and very shortly it is being destroyed after the removal of the external magnetic field (or after disallowing the electric current to pass through the substance). Therefore, the diamagnetic property in substances at their normal state does not persist and very shortly it disappears.

7.6 Explanation of no occurrence of superconducting state in ferromagnetic substances

We observe that when a current carrying close loop or a coil is suspended freely between two magnetic poles of an external magnetic field, the loop/coil is rotated such that its south and north poles may lie towards the north and south poles respectively of the external magnetic field. The angle of rotation of loop/coil depends upon the strength of current flowing through the loop/coil, strength of external magnetic field and also upon how much loop/coil is free to rotate.

Since the electronic orbits of substances also behave like magnetic dipoles, if a specimen is placed in an external magnetic field, its orbits are also rotated and their rotations depend upon how much the orbits are free to rotate and the strength of the external magnetic field. In accordance as the orbits of the specimen are rotated, the specimen acquires magnetism.

In ferromagnetic substances, the electronic orbits are probably so configured in different planes and with different magnitudes of binding in their respective atoms such that when ferromagnetic substances are placed in external magnetic fields, their orbits are rotated/oriented as much and in such a way that the resultant magnetism generated in them due to their orbital rotations are obtained to be quite strong.

The direction of magnetic moment of magnetism generated in ferromagnetic substance due to orientation of its electronic orbital dipoles lies along the direction of external magnetic, whereas the direction of magnetic moment generated in it due to orientation of planes of magnetism of its free electrons lies in direction perpendicular to the direction of external magnetic field, the magnetism generated in ferromagnetic substance due to the former reason opposes the orientation and alignment of the planes of magnetism of the free electrons of the specimen and does not let the planes of magnetism of the free electrons to get oriented and aligned. Then v of electrons too are not oriented and aligned and consequently electrons fail to flow persistently through the specimen. And hence, in ferromagnetic substances, superconducting state does not occur.

In non-ferromagnetic substances, which superconduct, too, their electronic orbital dipoles are rotated as the consequence of application of the external magnetic fields across them, but the resultant magnetisms generated in them are probably happened to be insignificant in magnitude or in producing the effective obstruction in the orientation of the planes of magnetism of their free electrons.

7.6.1 An important conclusion

The currently known some non-superconducting substances, e.g. ferromagnetic substances (where due to generation of magnetism in the substances because of orientation of their electronic orbits, superconducting state fails to occur) can be made superconducting as follows:

By some means, other than the application of external magnetic field, if it is tried to orient and align the directions of v of their electrons, magnetism shall not be generated in them due to orientation of their electronic orbits. Then the directions of v of their electrons can be oriented and aligned and they can be made superconducting. That means can be the application of appropriate electric voltage across the substance (because the electric voltage also orients the directions of v of the free electrons of the substances, see Sec. 4.5, Ref. 5). For example: we take a close (circular) loop of the substance and couple its two ends by a weak link which can consist of a thin insulating barrier. The thin insulating barrier should be such that, when at normal state the loop is connected in a electric circuit, the thin insulating barrier produces resistance, and when the loop is brought down to its superconducting state and its resistance becomes zero, the E_M and p_M of its free electrons may enable them to transmit through the thin insulating barrier (as happens in the case of Josephson's Tunneling, see Sec. 7.10). We connect this loop in an electric circuit containing a battery, ammeter and a load, i.e. a voltage is applied across the weak link. If this loop is cooled down, as soon as T_c of the loop is obtained, the resistance of loop shall become zero. Then the directions of v of the free electrons of the loop shall be aligned, and due to having E_M and p_M, the free electrons shall pass through the insulating barrier. And consequently a sudden increase in current through the circuit shall be observed. Now if the circuit is broken, the flow of persistent current shall not be affected and it shall go on flowing persistently.

7.7 Explanation of how normal state of specimen is restored applying a critical value of external magnetic field H_c across it at its superconducting state, why H_c increases as temperature of specimen decreases beyond its T_c, and why H_c varies from substance to substance.

7.7.1 How normal state of specimen is restored applying an external magnetic field H_c across it at its superconducting state.

The normal state of specimen is restored applying an external magnetic field H_c across it at its superconducting state means, due to the application of field H_c, the generation of photons in the specimen is restarted. The Zeeman effec[10] confirms the generation of photons as the consequence of application of external magnetic field.

In Zeeman Effect, it is observed that when a strong magnetic field is applied across a source of light, the single spectral line is split into three lines (i.e. normal Zeeman Effect) which mean, as the consequence of application of a strong magnetic field, there now start emitting two more photons, total three photons of three different frequencies instead of emission of one photon of a single frequency. The emission of two additional photons as the consequence of application of a strong magnetic field confirm that due to the application of field H_c, the generation of photons in the specimen is restarted.

The discontinuously increase in thermal conductivity of specimen, when its superconducting state is destroyed by the application of external magnetic field H_c, also confirms the truth of generation of photons as the consequence of application of external magnetic field H_c (see Sec. 7.8).

7.7.2 How H_c increases as temperature of specimen decreases beyond its T_c

As the temperature of specimen decreases beyond its T_c, since: 1. The very slow emission of photons from the specimen goes on, the number of photons remaining in the specimen goes on decreasing continuously; 2. The binding force between electrons generated due to interaction between their magnetic fields (see Sec. 7.4.1) goes on increasing (because, as temperature of specimen decreases, thermal energy and hence thermal agitation of its free electrons goes on decreasing that causes increase in binding force between the electrons); the need of number of photons to destroy the alignment of free electrons of the specimen, goes on increasing. So, to fulfill this need, H_c of increasing magnitude is needed. Hence the magnitude of H_c goes on increasing as the temperature of specimen decreases.

7.7.3 How H_c varies from substance to substance.

We know that at same temperature, thermal conductivity varies from substance to substance. It happens so because at the same temperature, the number of photons emitted from the orbiting electrons, which conduct the heat, varies from substance to substance. Therefore, if at some temperature, say $T'(<T_c)$, H_c is applied to different substances to restore their normal states; the magnitude of H_c varies from substance to substance.

7.8 Explanation of why and how the thermal conductivity of specimen changes continuously between its two phases and it is discontinuously increased when superconducting state of the specimen is destroyed by the application of an external magnetic field H_c

7.8.1 Why and how the thermal conductivity of specimen is discontinuously increased when superconducting state of the specimen is destroyed by the application of an external magnetic field H_c

Thermal conductivity of superconductors undergoes a continuous change between their two phases and is usually lower in the superconducting phase. For example, at 2° K, thermal conductivity of Tin (for which $T_c = 3.73\,K$) has value $34\,W\,cm^{-1}\,K^{-1}$ for the normal phase and $16\,W\,cm^{-1}\,K^{-1}$ for the superconducting phase (see Ref. 11). But it changes discontinuously when superconducting state of specimen is destroyed by the application of external magnetic field H_c.

To destroy the superconducting state of specimen when H_c is applied across the specimen, large number of orbiting electrons of the specimen are excited (depending on the magnitude of H_c) resulting into sudden emission of large number of photons. That causes discontinuous increase in the thermal conductivity of the specimen because the photons are the radiation energy carrier[8] and the heat energy is conducted through transportation by the photons. Consequently the thermal conductivity of specimen under goes a discontinuous change between its two phases.

7.8.2 Why and how thermal conductivity of specimen changes continuously between its two phases, and how at superconducting phase, it is found to be lower

When superconducting state of specimen is obtained by bringing down its temperature to its T_c, since the photons are not disappeared from the specimen suddenly in bulk but disappear continuously, quite fast in the beginning and very shortly becomes very slow (see Sec. 5), thermal conductivity of specimen does not undergo a discontinuous change but undergoes a continuous change between its (specimen) two phases.

Further at T_c, i.e. at superconducting phase, since the number of photons is reduced very much, thermal conductivity becomes lower.

7.9 Explanation of: (i) energy gap between electrons at normal state and electrons at superconducting state of the specimen; (ii) why energy of electrons goes on decreasing as temperature of specimen decreases below T_c

7.9.1 Energy gap between electrons at normal state and electrons at superconducting state of the specimen

At superconducting state of specimen, when the planes of magnetic fields of its free electrons are oriented and aligned in a plane perpendicular to the direction of flow of persistent current, due to interaction between magnetic fields of electrons there is generated a force of attraction between electrons (see Sec. 7.4). This force of attraction keeps the electrons bound together, and due to this binding, the energy of free electrons of the specimen at its superconducting state is being reduced, which causes an energy gap between electrons of specimen at its superconducting state and electrons at its normal state.

7.9.2 Why energy of electrons goes on decreasing as temperature of the specimen decreases below T_c

As temperature of specimen decreases below its T_c: 1- due to decrease in thermal energy of its free electrons, thermal agitation of electrons against the binding force generated among them due to interaction between their magnetic fields goes on decreasing; and 2- the number of photons, left in the specimen, too goes on decreasing [see Sec. 2.1.1(a)]. Therefore, the binding force among electrons goes on increasing continuously and consequently energy of electrons goes on decreasing as temperature of specimen decreases below its T_c.

7.10 Explanation of Josephson's tunnelling

The Josephson's tunneling is the phenomenon of supercurrent across two superconductors coupled by a weak link. The weak link can consist of a thin insulating barrier known as S-I-S (superconductor-insulator-superconductor), or S-N-S (a short section of no-superconducting metal), or S-s-S (a physical construction that weakens the superconductivity at the point of contact).

Why and how the phenomenon of supercurrent across the weak link takes place, is as follows:

When a voltage is applied across the weak link, the directions of L_s, i.e. the directions of linear velocity of free electrons of both the superconductors of the weak link are oriented and aligned parallel but opposite to the direction of the applied voltage. Now, if the applied voltage is removed, the orientation and alignment of linear velocity of free electrons of both the superconductors of the weak link remain oriented and aligned as such because in both the superconductors, the number of photons are reduced very much and hence they fail to disturb the orientation and alignment of the directions of linear velocity of the free electrons..

Now, since the electrons possess spin motion too along with their linear motion, they possess E_M and p_M (see Sec. 2.2) and hence possess more penetrating power in comparison to particles possessing only linear motion. Secondly, when the directions of linear velocity of electrons are oriented and aligned, they incident almost normally at the surface of the weak link, the power of penetration of electrons through the weak link is increased more. Therefore, when the applied voltage is removed, the flow of electrons remains continued, i.e. the phenomenon of supercurrent across the weak link is obtained.

7.10.1 A short discussion

The prediction of a mathematical relationship for current and voltage across the weak link by Josephson[12] is based on quantum mechanical treatment of the phenomenon, transmittance T = finite for particle having energy $E < V_0$ (where V_0 is the potential energy of the barrier). But the above treatment is not true, because it is based on the concept of wave nature of particle while the concept of wave nature of particles is not true (for its confirmation, see Sec. 1, Ref. 8). Secondly, it has several very fundamental faults (see Sec. 5.3.2, Ref. 8). How this phenomenon actually takes place, see Sec. 5.3.1, Ref. 8.)

7.11 Explanation of latent heat of transition

When superconductivity of a specimen is destroyed isothermally (i.e. at constant temperature) by a magnetic field, the specimen absorbs heat and that happens to be the latent heat. For the adiabatic case (constant heat), the specimen's temperature becomes lower. In the isothermal case, when the field is reduced and the specimen restores its superconducting state, the superconductor gives up that latent heat of transition.

7.11.1 Why and how the specimen absorbs heat when superconductivity of the specimen is destroyed isothermally by a magnetic field

When the magnetic field is applied to destroy the superconducting state of the specimen, as the electronic orbits behave like magnetic dipoles, the planes of electronic orbits are rotated such that their electrons may excite and emit photons. Then those electrons need some energy for their excitation which is obviously drawn from the heat energy of the specimen. Consequently, the heat energy of specimen is being reduced. If the temperature of specimen is maintained constant, the heat energy, drawn by the orbiting electrons from the specimen, is absorbed by the specimen from the atmosphere in the form of latent heat. If the field is reduced isothermally and the specimen restores its superconducting state, the heat energy, absorbed earlier by the specimen from the atmosphere in the form of latent heat, is now given up by the specimen.

7.11.2 Why and how the specimen's temperature becomes lower for the adiabatic case

If the temperature of specimen is not maintained constant, i.e. adiabatic case, then due to absorption of heat energy by the orbiting electrons for their excitation from the heat energy of the specimen, the temperature of the specimen is lowered down.

7.12 Explanation of why and how the specific heat of specimen is discontinuously increased when temperature of specimen is brought down to its T_c

The orbiting electrons of the specimen derive some part of heat energy for their excitation from the heat energy subjected to increase the internal thermal energy of the specimen (for its confirmation, see Ref. 13), and hence the heat energy left in the specimen, say dE_{int}, in order to increase its internal thermal energy is being reduced. Consequently specific heat $C_v = dE_{\text{int}} / dT$ of specimen is found to be reduced (for detail, see Ref. 13).

As temperature of specimen decreases to arrive at its T_c, since the heat energy of specimen goes on decreasing (but probably not so fast as temperature of specimen decreases), more and more orbiting electrons go on becoming unable to excite and emit photons because of non availability of sufficient amount of energy for their excitation. And thus at temperature T'_c (or T', see Sec. 5.1), all the orbiting electrons become unable to excite and emit photons. So at temperature T'_c, lot of internal thermal energy, which would have earlier been absorbed by the orbiting electrons for their excitation if they had found it to be sufficient for their excitation, is left stored in the specimen. If at this stage, the specific heat of specimen is measured, an abrupt increase in it shall be found. Consequently, the specific heat of specimen is discontinuously increased when temperature of specimen is brought down to its T_c.

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FIGURE CAPTIONS

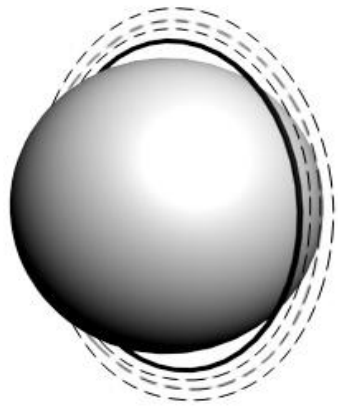
Fig.1: (a) Spherical ball, dark solid line circle and concentric broken line circles respectively represent the charge, magnetism and magnetic field of electron. (b) Transverse cross sectional view of electron, where, in order to introduce arrow marks with the ball of charge to show the direction of its spin motion, the ball of charge has been shown by a dark thick solid line circle in place of a dark disc.

Fig. 2: Variation of resistance with temperature near the transition temperature.

Fig. 3: Transverse cross-sectional view of interaction between the magnetic fields generated around the electron beams passing through the different inter-lattice passages of the specimen, where the lattices have been shown by small solid dark discs.

Fig. 4: Longitudinal view of the magnetic field generated around and along the length (perimeter) of specimen taken in the form of a close loop carrying persistent current i

Fig. 5: Magnetic lines of force of the external magnetic field passing through the body of specimen when no current is flowing through it. (b) Ejection of the magnetic lines of force from the body of specimen when the persistent current i starts flowing through it.



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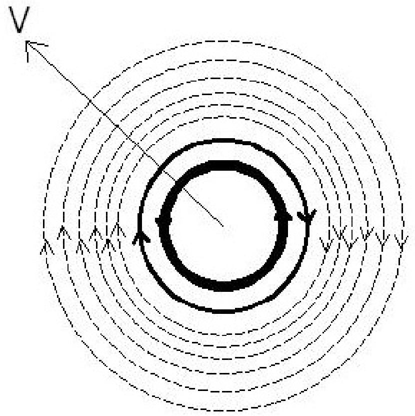
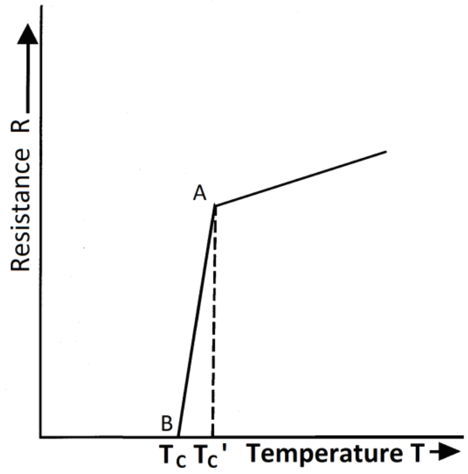
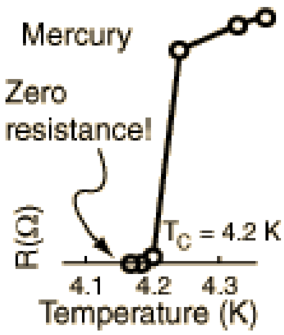


(b)

Fig. 1


Resistance R
A
B
T_C T_C'
Temperature T

(a)


Mercury
Zero resistance!
R(Ω)
T_C = 4.2 K
4.1
4.2
4.3
Temperature (K)

(b)

Fig. 2

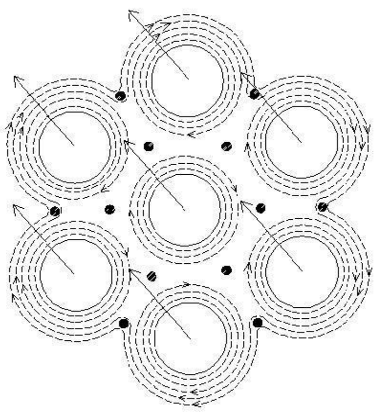


Fig. 3

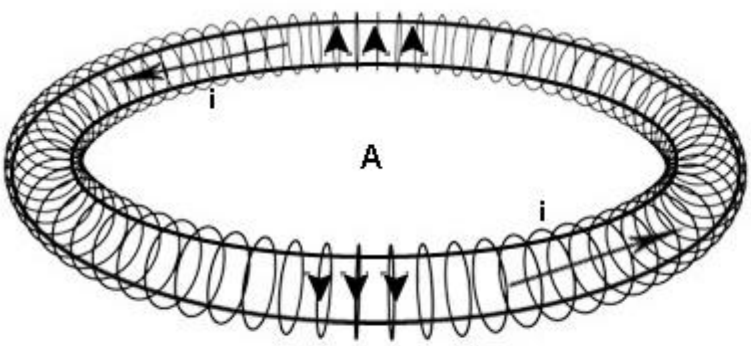
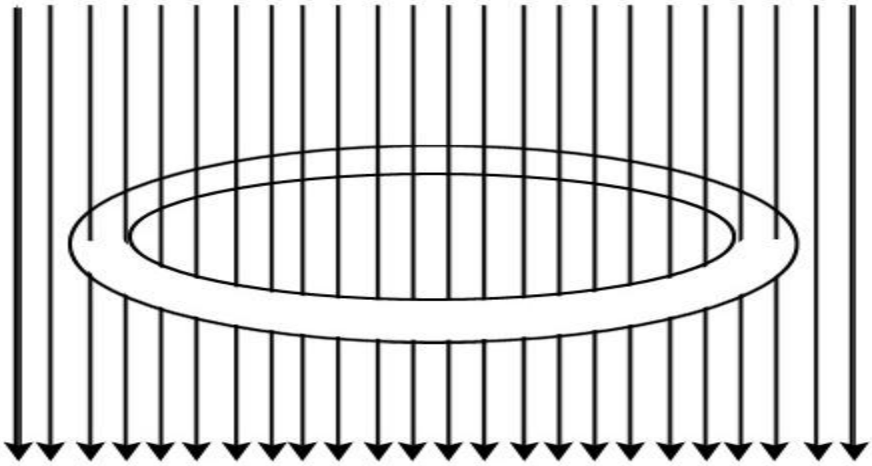
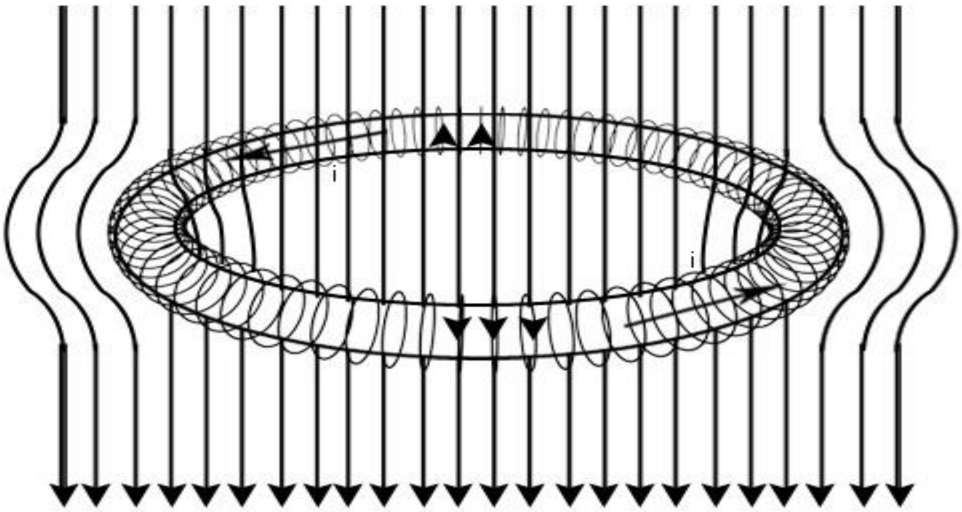


Fig. 4



(a)



(b)

Fig. 5