Theoretical Physics IS:
Sabotaging the next Industrial Revolution

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Superconduction at room temperature will lead to a new world-wide industrial revolution.

Michio Kaku: in his book "Visions"

I. When, where and what!

Superconduction was discovered by Kamerlingh Onnes in 1911 when he found that the voltage across the **current-injection and current-ejection** contacts to a wire of "frozen" mercury dropped to an immeasurably low value below a critical temperature of about 4 K while a constant current keeps on flowing through the mercury. If Ohm's law applies this would mean that the resistance of the mercury dropped to an immeasurably low value.

At present, superconduction is defined as zero electrical-resistance, even though it is impossible that the physics responsible for Ohm's law also applies when superconduction occurs: Ohm's law is **only** valid when the charge-carriers accelerate and scatter at a high rate in order to ensure, in this manner, that there is an average drift speed for the charge-carriers within the material: When they accelerate and scatter like this, the voltage **can never be zero**. In a superconductor the drift speed is also constant, but since there is no acceleration and scattering, this drift speed cannot be caused by the same mechanism which is responsible for Ohm's law. It is an unfortunate accident that the resistance of a superconductor seems to be determined by the mathematical expression of Ohm's law. It is even more unfortunate that physicists who should have known better have been invoking Ohm's law to "explain" superconduction! And it is even more shocking that this has been the case for more than 100 years.

To define superconduction it would have been less confusing if scientists had stuck to THE actual parameter that can be measured directly, namely the voltage. If the voltage is really zero, there cannot be an electric-field accelerating charge-carriers within a superconductor when a current is flowing from the injection-contact to the ejection-contact through such a material. Whether the voltage is really exactly zero across these contacts, while the current is flowing, can **never** be directly determined by any experimental measurement of the voltage, since there does not exist any voltmeter which can measure zero-voltage exactly: Nonetheless, it has been postulated that a current flows through a superconductor while there is not an electric-field present between the injection-contact and the ejection-contact which accelerates the charge-carriers and thus drives the current. To date, this deduction has been found to be self-consistent. But no direct or indirect experimental proof has existed to date that it is really possible to have a zero electric-field between the injection-contact and ejection-contact within a material while it transfers a superconducting current from the one contact to the other contact.

In passing it should be noted that it is possible to prove that a superconducting current can be induced around a ring by means of a time varying magnetic-field, and that this current keeps on flowing around the ring when the resultant induced electric-field becomes zero: But this result does not prove that the electric-field between an injection-contact and its ejection contact is zero when a superconducting current flows from an injection-contact to an ejection-contact through the same superconductor. In the case of the ring there is no injection-contact and ejection-contact, and the induced electric-field **automatically** switches off when the applied magnetic field reaches a constant value. In the case of two contacts, the applied electric-field is supplied by a battery: In this case the battery does not conveniently switch off the applied electric-field when superconduction occurs. If the electric-field does switch off in this case, it must be caused by another mechanism than the one that switches of the induced electric-field around a ring.

It is thus possible that the electric-field between an injection and an ejection contact might not be exactly zero when a superconducting current flows, even though it becomes zero around a ring when a superconducting current flows. Thus, although it has been assumed that the field between an injection and an ejection contact must be zero, there has NEVER been any direct or indirect experimental evidence which compellingly proves that this MUST actually the case (until the year 2000: see below)

After the discovery of superconduction in mercury at temperatures below 4 K, it became the holy grail of physics to find a material that can superconduct at room, and hopefully higher temperatures. Every physicist knows that such a material will initiate a new industrial revolution. Although the critical temperatures have increased over the years and reached about 200 K for some of the ceramic superconductors, room temperature superconduction has not yet been achieved within these materials; even though billions of dollars have been spent since they were discovered in 1986.

In the year 2000, this author serendipitously stumbled across an electron-condensate which superconducts at room temperature, and even up to $\cong$450 °C. It is now 13 years later! So where is the industrial revolution? It is sad to state this, but it is being sabotaged by the theoretical physicists who are not willing to accept that superconduction can occur in another manner than the mechanism based on their theoretical models for which Nobel Prizes have been awarded. We have reached the untenable position in physics where experimental results are rejected, and blocked from being published, when such experimental results contradict the theories of the mainstream theoretical physicists. According to them, experiments are not the arbiters of physics anymore! The theoretical physicists have become the “gods” who ordain what can be possible experimentally.

II. How superconduction at room temperature was discovered in the year 2000

1 The vacuum diode

The basic building block of all electronic devices is the diode, which was first discovered in the 19th century by Thomas Edison when he developed filaments for his electric light bulbs. A vacuum diode is schematically illustrated in Fig. 1.

A diode is a device which allows an electron-current to flow through it along one direction, but not along the other direction. The original diodes were bulky vacuum-tubes which wasted energy since filaments had to be heated to very high temperatures in order to release electrons so that they are free to be accelerated from the filament electrode (cathode) to a positive electrode (anode).

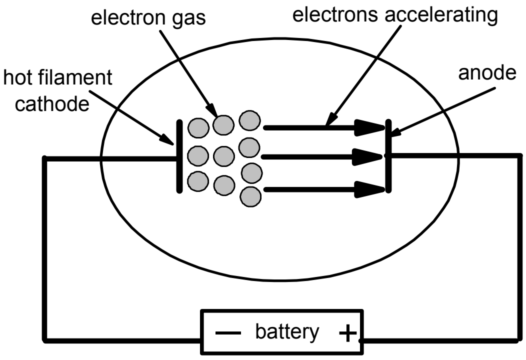

Figure 1: A vacuum diode: Electrons are boiled out of a hot-filament electrode, which is negatively-charged (cathode): These free-electrons are then accelerated into the positively-charged electrode (anode) so that a current flows. When switching the polarity, the previously positively charged electrode becomes negatively charged: The electrons are then pushed back into the hot electrode (which is now positively-charged) so that no current can flow.

When one changes the polarity, the anode becomes negatively charged (it is now the cathode) and the cathode becomes positively charged (it is now the anode) Electrons are then pushed and attracted to re-enter the hot electrode. There are under these conditions no electrons which can be accelerated to transport a current. Thus no electron-current can then flow around the circuit and into the hot-filament.

2 Solid-State diode

In the 1940’s Solid-State diodes were developed which did not require the heating of filaments; and which led to the transistor. In fact, such diode-action has always been present to some extent when sending a current through an interface between two materials which have different chemical potentials: The latter is just a fancy word to state that there is a difference in electric-potential (Volt) across the interface when these materials make contact with one another. An electron will thus have a lower energy within the one material than within the other. When this is the case, there is an electric-field across the junction-interface which will attract electrons (if they are present) from the higher-energy material into the lower-energy material.

When moving across the interface, an electron leaves a positive charge behind which attracts the electron-charges back towards the interface: The outcome is that electron-charges accumulate on one side of the interface while positive charges accumulate on the other side of the interface: A dipole layer forms across the interface which, in turn, causes an electric-field along the opposite direction to the chemical-potential field that attracted the electrons out of the one material into the other material in the first place. This original electric-field is decreased by this polarisation-field.

The residual magnitude of the electric-field within the dipole across the interface is determined by the availability of electrons that can flow through the interface. When two metals make contact there are more than enough electrons to generate a dipole layer which totally cancels the original field. There, thus, remains no net electric-field within the dipole. If at least one of the materials is a semiconductor, one can predetermine the density of electrons which can flow out of a semiconductor, to, in this way, ensure that the original electric-field caused by the chemical potential is not totally cancelled by the opposite electric-field of the dipole-layer.

The availability of electrons within a semiconductor is modified by introducing atoms which release more electrons (donor-atoms) or by introducing atoms which gobbles up electrons (acceptor-atoms: “pac-man” atoms) in order to decrease the availability of electrons. Adding the required atoms is called “doping” of the semiconductor. By means of doping, the dipole-fields across interfaces are carefully engineered to get the different transistors which are at present being used in electronic chips.

The latter engineering of transistors (and chips containing millions of them) has become a highly specialised industry requiring expensive laboratory-factories (called FAB’s): This field is dominated by giant companies like Intel, Samsung, Texas Instruments, etc. In other words it is impossible at present to design and produce electronic devices within one’s garage which can compete with the products of these companies. Any envisaged novel electronic-component requires a FAB just to develop the prototype device.

3 Schottky diode

Let us look at the simplest of all Solid-State devices: The Schottky-diode which is formed between a suitable metal and a semiconductor containing donor atoms. The metal is chosen to have a chemical-potential which will attract donated electrons out of the semiconductor into the metal: A dipole-layer thus forms which consists of accumulated electron-charges within the metal and positive charges within the semiconductor. The latter positive charges are situated on the donor-atoms from which the electrons came; where the latter are situated within a layer within the semiconductor just below the interface to the metal. This layer is called the depletion-layer since it is depleted of electron-charge: Since it has no free charge-carriers, it is an insulating-layer. Such a dipole-layer is schematically illustrated in Fig 2 for the case when no current is flowing through it: i.e. the switch is open.

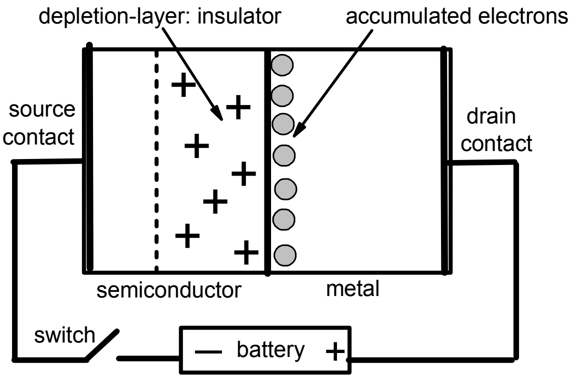

Figure 2: Schottky diode with open switch: The depletion layer has reached its maximum width. When closing the contact, electrons are injected into the semiconductor and moves towards and into the depletion-layer: Some of them cancel positive charges within the depletion layer so that it becomes thinner, thus allowing the rest of the injected electrons to "tunnel" through the junction: A current then flows. When changing the polarity, electrons are scavenged next to the depletion layer: The depletion layer becomes wider thus blocking electrons to flow through it from the metal: No current flows.

Since the depletion layer is an insulator, no electrons should be able to flow through it at all. But electrons are waves which can "tunnel through" a thin insulating layer: Thus, when initially making the contact between the semiconductor and the metal, electrons tunnel through the insulating-layer which is being formed; and in the process leave positive charges behind that increase the width of the depletion-layer until it becomes just too wide to allow further tunnelling. At this critical tunnelling width (CTW) the depletion-layer blocks further electron-flow into the metal.

By increasing the density of the donor atoms, more electrons can flow into the metal before the depletion-layer reaches its CTW. There are then more positive charges within the depletion-layer and also more concomitant electrons at the interface within the metal. The dipole field is now stronger, so that it cancels more of the original electric-field: i.e. the residual electric-field within the dipole layer is much weaker. If one can keep on increasing the density of the donor-atoms, a critical point will be reached at which the polarisation-field totally cancels the original electric-field within the dipole layer when the CTW is reached.

An even further increase in the donor-atom density will totally cancel the original electric-field before the CTW is reached. The formation of an insulating layer that is wide enough to block tunnelling of electrons from the metal into the semiconductor is then impossible. Current can then flow with ease along both directions. The interface, although still a dipole layer, is not a diode anymore but is now an ohmic-contact through which charge-carriers can tunnel along both directions.

When the density of the donor atoms are low enough to prevent the formation of an ohmic contact (the situation shown in Fig. 2) and one closes the switch-contact, electrons are injected through the source-contact into the semiconductor so that they move to the depletion-layer. Some of these electrons cancel positive charges, so that the depletion-layer becomes narrower, thus allowing the other injected electrons to tunnel into the metal, from where they then move further as “normal” charge-carriers towards, and into the drain-contact: An electron-current thus flows from the source-contact into the drain-contact without any problem.

When one changes the polarity of the contacts, electrons adjacent to the depletion-layer are attracted towards the previously source-contact, which now acts as a drain-contact: This increases the width of the depletion-layer even further so that tunnelling of electrons from the metal through the depletion-layer remains blocked: An electron-current can thus not flow along this direction.

4 Cold-cathode diode

Since one can extract electrons from the semiconductor into a metal so that an electron-current can flow through the metal to the drain, it might be possible to extract electrons from a donor-doped semiconductor into the vacuum, so that these electrons can be accelerated through the vacuum into the anode. If this were to be possible, one should be able to generate a vacuum diode, similar to the one shown in Fig. 1, but which has a cathode that does not need to be heated for electrons to be available in the vacuum.

For most semiconductors this has been found to be a very inefficient way to extract electrons into the vacuum. But in the late 1970’s it was found that conducting electrons generated within diamond by photo-excitation (light irradiation), have energies which are higher than the energies they will have in the vacuum; and they should thus be easily extracted by an anode into the vacuum. The possibility arose that by doping diamond with donor-atoms one would be able to easily extract electrons from the diamond by an anode and accelerate these electrons into this anode.

There was only one snag at that time: Donor-doped diamond did not exist in nature, and it proved to be extremely difficult to introduce donor-atoms into a diamond crystal without destroying the diamond. Many years of research went into the development of donor-doped (also called n-type) diamond. Most of this author’s career was spent on this problem. Phosphorous-doped diamond became available during the late 1990’s. It was, however, found that these high-energy electrons could not be accelerated through the vacuum into the anode, as can be done with the hot electrons from a hot-cathode (as shown in Fig. 1).

The reason for this should have been foreseen. The scientists forgot that dipole layers form across interfaces, and could thus also form across an external surface which interfaces with the vacuum. When extracting electrons, the situation which they encountered is schematically illustrated in Fig. 3.

Figure 3 looks very much the same as Fig. 2, except that there is now no metal which, itself, contains charge-carriers: The metal has been replaced by a vacuum that has no charge-carriers of its own. When the electrons are extracted, they leave positive-charges behind which attracts the extracted electrons back to the surface so that they and the positive charges form a dipole-layer that generates an electric-field which opposes the electric-field across the interface that is generated by the positive charge on the anode. These electrons are thus not free to be accelerated through the vacuum into the anode as in the case of a hot-filament diode (see Fig. 1).

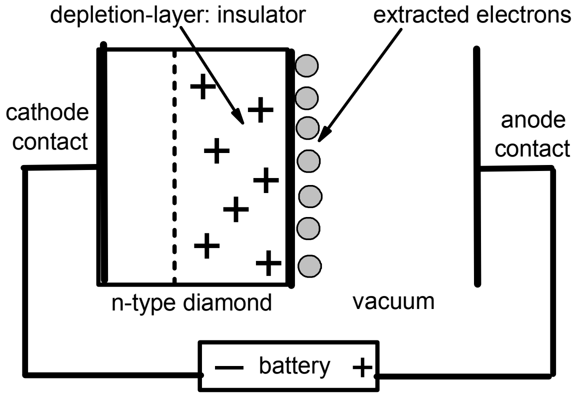

Figure 3: Attempting to extract electrons from an n-type diamond: When placing a positive voltage on the anode, electrons are extracted, but they leave positive charges behind which form a depletion-layer below the surface of the diamond. When this depletion layer reaches the critical width (CTW) above which tunnelling of electrons through it cannot occur, no more electrons can be extracted.

Furthermore, as soon as the depletion–layer reaches the critical width (CTW) at which tunnelling becomes impossible, no more electrons can be extracted when increasing the potential on the anode. Thus, between the extracted electrons (bound at the surface of the diamond) and the anode, there remains a vacuum which is insulating, and which thus does not allow a current to flow from the diamond to the anode as is possible when this vacuum is replaced with a metal. The dream to obtain cold-cathode action from a donor-doped diamond was shattered at the end of the 1990's.

5 Optimising a Cold-cathode

But as already mentioned above, by increasing the donor-density within the diamond, more electrons can be extracted before the depletion layer reaches its critical width (CTW) above which tunnelling becomes impossible. This could not be done with phosphorous-doped diamond owing to a solubility limit when adding the phosphorous atoms to the diamond. The density of donors could not be increased to a high enough level.

Circa 2000 this author found a way around the latter problem by discovering that, when bombarding the diamond surface under suitable conditions with low-energy oxygen-ions extracted from an oxygen-plasma, a much higher density of donors can be generated below the surface of the diamond. The nature of these donors is not yet well understood: But what the heck: The fact is that their density becomes high enough so that copious amounts of electrons can be extracted into the vacuum into the space between the diamond and the anode.

For as long as the depletion-layer does not reach its CTW, more and more electrons can be extracted by increasing the positive voltage on the anode. When at a critical voltage the whole space between the diamond surface and the anode is filled with electrons, an electron-current **must** start to flow from the diamond to the anode. This was experimentally verified during 1999-2000 by extracting electrons from such a diamond surface using a small gold-ball as the anode. This result proved that a cold-cathode device is, after all, possible: Except that it does not quite work in the exact same manner as the hot-cathode device in Fig. 1. In the cold-cathode situation, the extracted electrons cannot be accelerated through the vacuum, but are only accelerated into the anode once the gap between the diamond-cathode and the anode is totally filled with extracted electrons.

6 The electrons in the gap

After the current initiates, light is emitted when the accelerated electrons enter the anode, since when entering the anode they are decelerated: This is the same mechanism which produces X-rays: This mechanism is known as “bremstrahlung”. This experimental observation of bremstrahlung confirms that the charge-carriers are electrons; as they have to be.

But then a strange thing happens! Increasing the anode voltage further, the bremstrahlung stops, and within the electron-gas, between the diamond and the anode, a black rod morphs into existence, which shorts the diamond surface with the anode. One can now send an electron-current from the diamond to the anode, or send it from the anode to the diamond. Diode action has disappeared.

When one now switches off the battery, this rod remains intact. Is it contamination? Many subsequent experiments have proved conclusively that it is not and cannot be contamination. In fact, contamination is highly unlikely since the vacuum systems used were scrupulously clean and the vacuum was very high so that it could not cause plasma to form: Furthermore, the voltage at which the rod forms is totally reproducible and increases with distance between the diamond and the anode, as it must in the case of electrons. In addition, according to the observed bremstrahlung, there are **only** electrons between the diamond and the anode just before the rod morphs into existence.

Many experiments have subsequently proved that this rod cannot have formed from anything else but the electrons in the gap: For example, when the maximum width of the depletion-layer (CTW), above which tunnelling is not possible, is exceeded, the rod cannot exist. One can first form the rod, and then slowly increase the space between the diamond and the anode: In order for the rod to maintain contact with both the diamond and the anode, more electrons must flow from the diamond into the rod. This increases the depletion-layer until it reaches its critical width (CTW) above which tunnelling through it is not possible anymore. The rod then breaks up and it is slowly sucked back into the diamond and the anode until there is no trace of it anymore.

The evidence is compelling that this rod forms from the electrons and nothing else but the electrons. But once formed, it is so stable that it does not explode away from itself when switching off the battery. Can it then exist of electrons? Should separate electrons not repel one another? Correct, separate electrons should **and will** do so. So this rod, although it has formed from separate electrons, cannot consist of separate electrons after it has formed. That electrons can interact in this manner should have been anticipated, since electrons do it on a daily basis when they form chemical bonds.

It is well-established physics and chemistry that a hydrogen molecule consists of two protons held together by a covalent bond which has formed from two separate electrons. Such a molecule is schematically illustrated in Fig. 4a. In this case there are two electrons sitting on top of one another without repelling one another: They bond so well that they form the strongest chemical bond that is known to date. Thus, obviously, they cannot be two separate electrons after they have formed the bond.

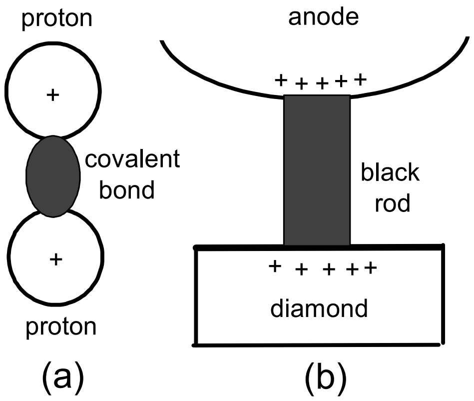

Figure 4: Fusion of electrons to form a single holistic wave: (a) Two electrons fuse into a covalent bond between two protons in order to form a hydrogen molecule; (b) Many electrons fuse to form a single macro-wave between a diamond substrate and an anode. Except for the number of electrons involved, the two processes are the same.

Theoretical chemists model this bond, and similar bonds on a daily basis by assuming that each electron is a wave having a distributed charge within it; and that the bond is formed when the two electron-waves overlap by so much that their separate distributed charges fuse to form a single distributed-charge with a single centre of charge. Clearly after this has happened, the original two electrons cannot exist as separate entities with their own centres of charge anymore; and therefore they cannot repel one another anymore.

Similar chemical bonds can form from more than two electrons. In organic chemistry it is known that four-electrons can form a double bond and six electrons can form a triple bond. So why should it not be possible for more electrons, even millions of them, to fuse and form a new holistic wave which does not consist of separate electrons after it has formed? It is compelling to conclude that the black rod, which forms between the gold-ball (acting as the anode) and the diamond (acting as the cathode), consists of many fused electrons: The electrons have formed a single, holistic condensate. The resultant rod-condensate is schematically illustrated in Fig. 4b.

The similarity with the hydrogen molecule should be noted. There are positive charges under the diamond surface (the depletion-layer) and positive charges on the anode, between which the fused electron-wave forms. The difference is that in the case of the hydrogen-molecule there is only one positive charge on each proton, while in the case of the diamond and anode there are many more charges, which thus allow many more electrons to fuse into forming a single-wave.

7 The electric-field in the gap

When the black rod forms, bremstrahlung stops: This indicates that electrons are not accelerated into the anode anymore. In turn, this indicates that the same current, which now flows, might not be caused by acceleration of charge-carriers at all. In fact, there cannot be acceleration since it is impossible that there can be an electric-field within the gap that would accelerate them.

The reason for the latter absence of an electric-field is as follows: The black rod is still negatively-charged and still forms the negative part of a dipole-layer across the interface of the diamond. On the other side below the diamond surface is the positively-charged depletion-layer; which has not yet reached its CTW. Thus, if there is a net electric-field within this dipole, the width of the depletion layer will adjust to cancel this field completely. Therefore, when increasing the current by increasing the applied voltage to the anode, the concomitant electric-field between the diamond and the anode, will, and must be cancelled, for as long as the width of the depletion layer is below its CWT.

This means that when a constant current flows through the depletion-layer and black rod, it must do so without an electric-field being present to accelerate the charge-carriers through these regions. And since it is experimentally found that a current does keep on flowing, one is compelled to conclude that, according to the impeccable well-known properties of dipole layers, it is physically, **totally impossible** that there can be an electric-field driving this current through the depletion-layer and the black rod: This black rod **MUST** thus be, according to the definition of superconduction, a superconducting phase.

In fact, it is the first time since superconduction had been discovered in low-temperature mercury (in 1911) that there is a clear-cut proof that a current can actually flow from an injection-contact (interface of diamond to the depletion-layer) to an ejection-contact (interface of gap-electrons to the anode) through a material, while it is impossible that there can be electric-field present. This has never been proved for any of the other superconducting phases that had been discovered since 1911. Although it was postulated that there cannot be an electric-field present between the injection-contact and the injection contact when a current flows through a superconductor, the possibility always existed that there might be an electric-field. In the case of the black rod, it is physically impossible that there can be such an electric-field for as long as the depletion-layer has a width below its CTW.

In addition, the latter superconducting behaviour is not just present at room temperature but also up to temperatures at which the donor-centres within the diamond become destroyed. The latter temperatures are even above 400 ^{o}C.

It is now thirteen years ago that this superconducting phase was discovered: The proof that there cannot be an electric-field that drives the current from the injection-contact to the ejection-contact is better than for any other previous material for which superconduction had been claimed. In fact, it is the **FIRST** proof ever that this can actually be so! This means that if superconduction does actually require the absence of an electric-field, this “black-rod” phase is the **best proof EVER** that superconduction is possible; and that it actually also occurs at room and much higher temperatures.

8 A single mechanism for superconduction?

It is at present believed that superconduction can only occur after the conduction-electrons (within a material) form charge-carriers where each charge carrier consists of two electrons which are “glued” together. Since the spins of such a pair of electrons cancel, each pair becomes a “boson-particle” where these “particles” are supposedly able to form a Bose-Einstein Condensate. It is then claimed that it is the quantum-mechanical properties of this condensate which allow superconduction to occur by means of phase-coherence.

It is also believed that in the low temperature metals these pairs are formed by a quantum-field mechanism, first proposed by Cooper, which involves the exchange of virtual phonons between the electrons. Bardeen, Cooper and Schrieffer, developed this concept further, and came up with, what is at present known as, the BCS-model for superconduction. The Nobel Prize was awarded to Bardeen, Cooper and Schrieffer in 1972 for this model.

After the discovery of the ceramic superconductors it was found that the BCS model cannot explain these higher temperature materials. The most logical question which should have been asked at that point is the following: “*Is this not evidence that the BCS-model has all along been wrong, or at best only partially correct?*” The latter possibility was, and still is just too horrible for the theoretical physicists to contemplate! What about all the thousands of publications based on this model? What about all the funding applications based on this model. What about the Nobel Prize that has been awarded for this model? The model **must** be protected at all cost to remain sacrosanct!

In order to avoid even considering the possibility that the BCS-model does not really explain superconduction, it has been proposed by Brian Pippard that, although BCS does not explain the high temperature ceramic-superconductors, it fits the low-temperature metals so well that we must accept that there are “conventional superconductors” which are modelled by BCS, and “unconventional superconductors” which we do not yet understand. Although this situation might be possible, the latter argument just does not ring right. Superconduction is such extraordinary behaviour that it is difficult to believe that there can be more than one fundamental mechanism responsible for it within different materials. And, in fact, subsequent data was measured on lead (which is a “conventional” superconductor) that cannot be explained by BCS at all. But if one points this out, it is argued by an “expert” like Doug Scalapino (who was responsible for pointing out that this behaviour of lead cannot be explained by the “conventional” models), that he is sure it will one day be explained in terms of BCS. BCS is thus “holy scripture” that should not be questioned under any circumstances: If you do so you must be a crackpot!

Even in the case of the ceramics the “holy principle” remains that the charge-carriers **must** be paired-electrons (or paired holes). The present stance is that only a total heretic, who should be burned at the stake, will ask whether pair-formation is really required for superconduction to occur. Such a person **must** be silenced with all the might possible within the physics community! His/her viewpoints must not be heard or published in “any journal” since these viewpoints must be seditious!

Nonetheless, although the BCS model is suspect, it does contain elements of truth. For example, the black rod extracted from diamond (see Fig. 4b) is a condensate of electrons, and by analogy to the covalent bond (Fig. 4b), and the double- and triple-bonds found in organic chemistry, the electrons must form pairs in order to form this condensate. But the difference is that these pairs are not separate entities after the condensate have formed: All the electrons, whether paired or not, have fused to form a single holistic matter-wave. There is no wave-particle duality within this condensate!

According to the BCS-model, it is claimed that the Cooper pairs still act as separate charge-carriers after the condensate has formed. In contrast, the black-rod condensate does not consist of separate electrons, or separate electron-pairs: This means that it does not have any charge-carriers which can transfer a current from the injection to the ejection contact. It has to do this in terms of phase-coherence (as is correctly assumed in BCS that such a condensate must do), but this coherence cannot generate a current carried by separate charge-carriers (as is incorrectly assumed in BCS). The transfer through this phase has to be non-local: By means of teleportation.

But in addition, there is another component when this black-rod superconduction occurs: This is the presence of tunnelling, which in this case occurs through the depletion layer for as long as its width is below its CTW. In other words, the depletion-layer is in its own right a superconductor; and the charge-carriers moving through it are singly-charged electrons. Paired-electrons are not required at all in this case! Thus, the dipole superconducting phase formed by extracted electrons, from diamond, occurs by: (i) Phase-coherent teleportation through the black rod which does not involve wave-particle duality; and (ii) tunnelling by singly-charged charge-carriers through the depletion layer.

The black rod in Fig. 4b is probably the very first superconducting phase ever found since 1911 that is really a true Bose-Condensate. If this is correct, it means that there are not separate "boson-particles" within any Bose-Condensate and thus also not within a Bose-Einstein Condensate; if the latter is at all possible. Furthermore, such a condensate does not require phonon-exchange between electron pairs to form. In the case of the black-rod it forms within the vacuum within which there is no atoms that can generate phonons.

The tunnelling through the depletion-layer is convincing proof that superconduction need not require electron-pairs to form within a material. It is thus possible that in all the other superconductors discovered to date, superconduction occurs by tunnelling of charge-carriers through insulating regions between the charge-carriers, and not by the phase-coherent transport that occurs through the black rod which forms outside a material. Assuming the latter to be the case, all these materials, from the low-temperature metals, the ceramics and the superconducting semiconductors have been modelled by this author in terms of a single mechanism (namely tunnelling); and it is found that all the experimental data on superconduction, including those aspects that the BCS approach cannot explain within lead and the ceramics, are explained by this model.

This model predicts that it is highly unlikely that the ceramics will ever superconduct at room and higher temperatures. For this to happen, one requires materials with higher densities of atoms than the known materials contain; or else localised, valence-electron states with properties which have not yet been discovered or generated.

This author has tried to publish this model for the past 8 years without any success. The editors and referees reject it out of hand without giving any reasons based on physics, or by just stating that it cannot be correct since it contradicts what the world already knows about the mechanism responsible for superconduction.

A typical response is the following from Brian Josephson: "*The conclusion is that zero resistance is now well understood and there is no reason to look for alternative theories, as indeed seems to be needed for high Tc. But in the case of ordinary superconductors the BCS theory fits the facts so well that there is really no cause to look elsewhere for an explanation.*" This is after he refused to read this author's manuscript. His argument is that even though BCS cannot explain the ceramics, it is such "holy scripture" that if one comes up with a single model that explains both the "ordinary superconductors" and the ceramics, this model must be wrong. Wow! In other words, the "correct" model for the ceramics **must not** also explain the low-temperature metals!

I was forced to write a book called "The Physics Delusion", and my model based on tunnelling of otherwise stationary charge-carriers, is summarized in chapter 23 (see http://www.cathodixx.com/pdfs/SingleMechanism.pdf) and the correct derivation of Josephson-tunnelling is summarized in chapter 28 (see http://www.cathodixx.com/pdfs/SuperTunnelling.pdf). Although Josephson's prediction that tunnelling can occur is correct, his motivation in terms of Cooper pairs, and his mechanism in terms of phase-slip, are physically and mathematically completely wrong. He received the Nobel Prize in 1973 for a wrong model. Superconducting-tunnelling does not occur in the manner that Josephson modelled it to occur.

III. Superconduction at room temperature: The future

1 Lateral superconduction

Thus, superconduction at room temperature and higher temperatures has been discovered by this author already 13 years ago. But this phase was obtained by extracting electrons from a highly-doped donor-doped semiconductor. Furthermore, superconduction only occurs perpendicularly to the substrate's surface passing through the depletion layer and the external Bose-Einstein Condensate of electrons. It is not immediately obvious how such a superconducting phase can be used in practice, but this author is sure that it will find an application in future.

It would have been better if one could have had a superconducting layer parallel to the substrate's surface: i.e. a layer which is already present without having to extract the electrons by means of an anode. Whereas the oxygen-doped surface supplies electrons when they are extracted by an anode, it is well known in the literature on diamond physics, that when treating a diamond surface with an oxygen-plasma, electrical conduction parallel to the surface is usually quenched. Thus, it is not obvious that a similar treatment, to the one that allowed the black rod to form, will cause lateral superconduction.

Nonetheless, to make a long story short, after many attempts novel conditions were found that, in contrast to what was expected, caused external electrons to be present which could pass a current laterally along the surface. It was also found that when measuring the resistance for different lengths of the substrate so that one could subtract the contact resistances by extrapolation, the resistance consistently extrapolated to zero. This non-obvious phase has been patented.

Since the electrons are external, it is difficult to make low resistance contacts to these low resistance layers. The higher the work-function of the contact material, the higher the resistance of the contacts: By using different materials, the contact resistances have been substantially reduced from the initial resistances when gold was used. If the author had a well-equipped materials science laboratory it should be possible to reduce the contact resistances even further. The author is at present searching for such facilities.

2 Applications

These layers, which conduct parallel and external to the surface, open up possibilities for electronic applications. Two have so far been identified:

(i) A fast-switching transistor which does not generate heat within its gate region is shown schematically in Fig. 5. It should be clear that a processor chip consisting of such transistors would be able to generate so little heat, that fans will not be required to cool computers. This in turn, will mean that less electrical energy is wasted. With the ubiquity of computers in our modern age, this might even allow us to close down power stations.

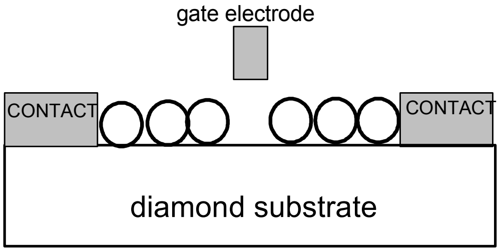

Figure 5: A heat-free field-effect transistor: The circles represent the lateral superconducting phase. Although the source and drain contacts still have resistances, the gate region under the gate electrode has no resistance.

(ii) A superconducting magnetic-energy storage ring is shown schematically in Fig. 6. A diamond substrate was machined to form a ring with a slot cut from the hole in the ring to the outside. The ring was then treated to become superconducting so that a current could be send around the hole between two contacts on opposite sides of the slot.

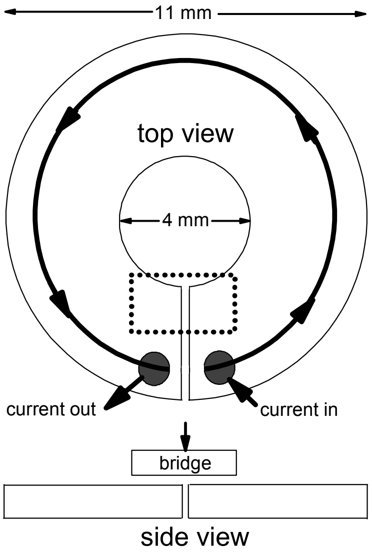

Figure 6: A magnetic-energy storage ring that operates at room and higher temperatures. Combining such rings very robust rechargeable batteries might be possible.

The dashed square shown in the top view is a separate diamond block which has also been made superconducting. It can be used to bridge the slot between the two contacts when lowered onto the diamond ring.

When sending a DC-current around the ring from one contact to the other, a magnetic flux is generated through the hole. When now lowering the bridge, a short is established across the contacts. When switching off the power supply the magnetic-flux stays trapped through the hole of the ring. This magnetic energy can then, when required, be extracted as electrical energy.

Experiments have proved that the devices in Fig. 5 and Fig. 6 are feasible: However, further development is required to eventually manufacture cold processor-chips and super-conducting magnetic storage (SMES) batteries. This author requires the collaboration of an electronics company which has a FAB or more than one FAB to achieve this.