ENERGY SCIENCE ESSAY NO. 5

'WARM SUPERCONDUCTIVITY'

What follows in this Essay No. 5 is the text of an Essay I wrote in August 1992. I planned at that time to write a book entitled 'Energy Science Essays', but other pressures intervened. Having now launched these Web pages, I have been looking through my papers and have decided to present this 1992 text without amendment. My plan is to comment on later developments elsewhere in these Web pages. However, what I wrote at the time sits well in the overall chronology of what I want to say as I extend the theme to magnetism and other areas, some of which are already of record in these Web pages. In a sense, I wrote this Essay at a time when I was collecting empirical evidence to give support to what I had first introduced in my 1989 paper [1989a] abstracted and referenced in the Bibliographic section of these pages, but also as now presented more fully in the earlier Essay No. 3

INTRODUCTION

We must hope that in the not-too-distant future the phenomenon of superconductivity will become one that we can harness at room temperature. Energy technology could change dramatically if electricity could be transported inexpensively over large distances. Thin superconductive wires carrying high current with no ohmic loss and requiring no special low temperature cooling would, indeed, have a great impact upon the electrical power industry.

In the following discussion, consistent with our treatment of other aspects of the energy science, we shall not recite what is conventional in the theory of superconductivity. Our path will be one of exploration of new ideas in search of clues and the interpretation of any clues that we may discover. As with many problems in science, one cannot just focus on the problem directly in the hope that some flash of inspiration will guide us forward. If that was a likely route to success then others would have reached our destination well before us. The guiding principle we will pursue will be the assumption that it is absurd to imagine that electrons can move through any substance without some loss of energy. They must meet resistance. However, we will make the daring assumption that there is some process at work in a superconductor by which energy is supplied to those electrons, much as occurs when they traverse a thermoelectric junction where they gain energy from an EMF associated with Peltier cooling. Of course, we are not saying here that there is a junction and that Peltier cooling is occurring. The point made is an analogy. Electrons can gain energy from an EMF induced by whatever process causes cooling of the substance through which they travel.

NORMAL SUPERCONDUCTIVITY

Before speculating on hypothetical ideas, let us marshall a few facts to guide us. An obvious consideration is to take note of the known critical temperature properties of normal superconductivity in metals and see if that guides us to our first clue.

For this purpose, the author will use as a reference source tabular data in a 1955 book by Shankland entitled "Atomic and Nuclear Physics". In Table 8 on page 266 of this work, Shankland lists 22 metal elements and gives the date of discovery of their superconductive property (between 1911 and 1951) and the observed transition temperature.

The five metals in this list which had transition temperatures greater than 4.38K were:

TABLE I

Vanadium	$Z = 23$	$T_c = 5.1$ K	$A = 50.94$
Niobium	$Z = 41$	$T_c = 9.22$K	$A = 92.91$
Technetium	$Z = 43$	$T_c = 11.2$ K	$A = 98.9$
Lanthanum	$Z = 57$	$T_c = 5.4$ K	$A = 138.91$
Lead	$Z = 82$	$T_c = 7.26$K	$A = 207.19$

Note that the data for A, the atomic weight of the element, has been added by this author. The reason for adding this data about the atomic weight is that the author suspects that there is something in the vacuum field system acting as a dynamic balance for a rhythmic motion of particles of matter which they have owing to their interaction with something that characterizes the vacuum state.

If an ionized molecule has a motion about a centre of gravity which it shares with something in counterbalance having the same mass, then the impact of an electron upon that molecule as the electron is absorbed will translate as an impact through the centre of gravity plus a turning couple about that centre of gravity. The latter adds angular momentum which can be conserved by this dynamically balanced system until an electron is emitted from the same or another molecule to restore the balance.

Now this would only work well, meaning that little energy is lost, if the 'something' in counterbalance with the molecule has a matching mass. By transferring the linear impact to a point midway between the two masses (at their centre of mass), the energy dissipating vibrations are minimized.

Note that, with superconductivity in mind, one can think in terms of the collision being more likely if the ionized molecule moves in a direction opposite to the electron. In this case the reverse motion of a positive ion and the forward motion of an electron represent current flow in the same direction. Such a current has a self-inductance and the arrest of the electron and the slowing down of the ion capturing the electron implies a sudden change in inductive energy. This means that an EMF is set up which urges restoration of current flow and so the emission of an electron from a nearby molecule which is facilitated if that molecule happens to be moving in a forward direction. This, in its turn, means that, in emitting the electron, the latter molecule is retarded in its motion.

A reader familiar with electrical engineering principles will see from this that the thermal energy of those molecules can be deployed into sustaining the self-inductance of this system and that, to keep the energy balance, the electrons substituted for those absorbed actually gain energy in the process. What this means is that a current might possibly be sustained thermodynamically provided the dynamic balance is such that the impact of the electron absorption and of the reaction impulse of electron emission is carried through the centre of gravity of a balanced system. It is this possibility that causes the author to seek evidence of the mass quanta best suited to provide this dynamic balance. Hence the interest in the molecular weight of the substances which have good superconductive properties. This introduces the theme which we now address in detail in our enquiry into the phenomenon of superconductivity.

Note that we have here introduced mechanical principles into our argument, presuming that, if the collision energy can be deployed into angular momentum as opposed to linear vibrations, then there will be less heat dissipated and the conductivity property must therefore be enhanced. This argument should apply equally to a situation where molecules collide without there being any free electron motion. In other words, it could have bearing upon thermal conductivity as well. We will not, however, seek to bring such thermal conduction properties in this empirical investigation, being well aware that generally the two are closely related so far as normal conductivity in metals is concerned.

EMPIRICAL DATA

There is something having a mass quantum value that is deemed to provide the dynamic balance of the field medium. That is our assumption as we move forward in our investigation. However, with hindsight and the benefit of several years of research, the author has discovered that there are two such quanta, one being substantially heavier than the other, and so we will advance with that thought in mind.

Now, for reasons discussed elsewhere [1989a], it is appropriate to refer to these balancing quanta as 'gravitons' and so our investigation will aim to establish the respective mass quanta of two types of graviton, which will be termed the 'graviton' and the 'supergraviton'. The latter have the larger mass. The 'graviton' is a term used conventionally in physics to refer to something of a virtual nature that mediates in the gravitational interaction.

Looking at the five values of A listed above it is not reasonable to expect to see a link with two distinct mass quanta. We need more data before our analysis can begin. To find such data it is appropriate to extend the idea of our scheme in the following way. If the process contemplated can account for why normally conductive metals become super-conductive, may it not also explain why substances which one thinks of as semi-conductors really exhibit the normal conductivity we associate with metals? With this in mind one can survey various available data sources, but one which came to this author's attention will suffice for the immediate purpose. It was published in 1984 and is a commercial summary of certain substances classified as *'Electrocatalysts and Solid State Ionic Conductors'* (issued by Basic Volume Limited of 12/13A Cotswold Street, London, England).

The referenced text devoted 39 pages, each to describing the properties of a different electrocatalyst, and included a statement concerning conductivity type as well as the molecular mass data applicable to the chemical composition. Of the 39 examples listed, some were specifically identified as having metallic conductivity (denoted MC) or a transition from semiconductor to metallic conductivity (denoted SC/MC) and in the latter category some were to have such a transition near to room temperature (denoted SC/MC/RT). Those that were so identified are listed below:

TABLE II

$La_{0.5}Sr_{0.5}MnO_3$	MC
$LaCoO_3$	SC/MC
$La_{0.5}Sr_{0.5}CoO_3$	MC

La_2NiO_4	SC/MC
$La_3Ni_2O_7$	SC/MC/RT
$La_4Ni_3O_{10}$	SC/MC/RT
$SrLaNiO_4$	MC
$LaNiO_3$	MC
La_2CuO_4	MC
$LaCuO_3$	MC
$SrMoO_3$	MC

Now, before examining the data concerning molecular weight, the reader is asked to consider the following statistical proposition. Suppose that, having regard to the progression in atomic weights of the elements of the periodic table and the myriad of molecular compositions that are possible, including small molecular clusters of several similar molecules, we consider a range of numbers chosen at random from, say, 200 to 1000. Now, we ask: "Given an optimum numerical value, say 100, what is the chance that a number chosen at random will have a value within 2% of a multiple of the prescribed optimum number 100?"

To make the problem just a little easier, let us extend the range of numbers to be from 197 to 1019, which brings those within 2% of the 200 and 1000 norms fully into the range. There are then 8 numbers centred on 200 and 40 numbers centred on 1000 that will be counted, along with 12+16+20+24+28+32+36 intervening numbers, altogether making a total of 216 out of 823. Roughly, there is a 1 in 4 chance of a molecular unit chosen at random satisfying the criterion presented in this arbitrary way. If the range were extended by three steps to be from 197 to 1325 then the range extension by 316 would add 144 chances, a less than 1 in 2 chance of the criterion being satisfied at random in this extended range.

With this as background, it is noted that the 39 substances chosen for presentation in the commercial handbook mentioned above were not chosen at random. They were selected because they were electrocatalysts. There was something special about their physical properties. Furthermore, the 11 substances listed above were chosen from those 39 because the handbook declared that there was something special about their electrical conductivity property. This is of interest to this survey because a substance which might reasonably be deemed to be a poor conductor has, for some mysterious reason, acquired metallic conduction properties. We are, of course, directing our attention to that theme introduced above by which some kind of mass coupling can affect the process of energy exchange involving conduction electrons.

The 39 substances listed in the reference data book included a specification of their molecular weights. Thus, for example, $LaNiO_3$ has a molecular weight of 245.618. If we consider this as forming in collective groupings of 4 such molecules the group would have a mass number of 982.472. This is within 2% of 10 times the arbitrary unit of 100 taken as the test criterion in the above statistical example. On that test this particular substance meets the required conditions.

Logically, the reader will see that, if we track through all 39 substances in this way, we should expect no more than a one in four match if the range extends to a mass number of 1019 and no more than a one in two match if the mass number falls in the range 1020 to 1325.

However, this is not what we find. On the contrary, without exception so far as the 11 above-listed substances are concerned, all meet the test condition 100%. Indeed, 8 of the 11 meet the condition in the 197 to 1019 range and, so far as the other 3 are concerned, these meet the condition in the 1020 to 1325 range <u>but the latter fall well within 1% of the 100 norm.</u> Note that the second-listed substance '2 Lantanum Strontium - (1,1,6)' has a mass number of 220.194 and a cluster of 5 such molecules has a combined mass of 1100.97. Based on 11 units of 100, this is within 0.09% of the set norm.

When we come to assess the whole 39 substances recommended for their electrocatalytic properties, the test criterion is satisfied within the 1325 range by all but 4. Statistically, this is astounding unless (a) there is a definite physical connection between the mass quantity and the physical property selected and (b) the 100 arbitrary norm selected for discussion happens, fortuitously, to be extremely close to the mass unit of the dynamically reacting quantum that we are seeking.

Of the 39 substances, the test is satisfied within the 197 to 1019 range by 28 and within the 1020 to 1325 range by 7. Note that 28 in 39 compares with the statistically probable ratio of 216 in 823 and 35 in 39 compares with the statistically probable ratio of 350 in 1139.

So that you may check what I say here, I list in TABLE III all 39 of the compositions alongside their molecular weights.

TABLE III

$NiAl_2O_4$	176.670	
$CoAl_2O_4$	176.893	
$CUAL_2O_4$	181.500	
$MnTiO_3$		160.838
$CrVO_4$	166.938	
$Cu_3V_2O_8$	420.503	
$NaCrO_2$	106.984	
$CuCr_2O_4$	231.529	
$ZnCrFeO_4$	237.210	
$CoMn_2O_4$	232.806	
$CuMn_2O_4$	237.405	
$LaMnO_3$	241.846	
$La_{0.5}Sr_{0.5}MnO_3$	216.204	
$CoFe_2O_4$	234.624	
$ZnFe_2O_4$	241.061	
$NiCr_2O_4$	226.699	
$LaFeO_3$	242.750	
La_2CoO_4	400.741	
$La_4Co_3O_{10}$	892.433	
$LiCoO_2$	97.873	
$NaCoO_2$	113.921	
$MnCo_2O_4$	236.802	
$NiCo_2O_4$	240.574	
$LaCoO_3$	245.840	
$La_{0.5}Sr_{0.5}CoO_3$	220.194	
La_2NiO_4	400.52	
$La_3Ni_2O_7$	646.132	
$La_4Ni_3O_{10}$	891.764	
$LiNiO_2$	113.649	
$NaNiO_2$	113.698	
$La_2Li_{0.5}Ni_{0.5}O_4$	374.6365	
$SrLaNiO_4$	349.237	
$LaNiO_3$	245.618	
La_2CuO_4	405.350	
Eu_2CuO_4	431.462	

$LaCuO_3$	250.42
$CoMoO_4$	218.870
$CuMoO_4$	223.483
$SrMoO_3$	231.56

THE GRAVITON MASS

We still do not have enough data to determine the mass of the dynamically reacting mass quantum of the vacuum field background. Certainly there is a suggestion that a mass of about 100 atomic units is indicated, but this is too high to be realistically associated with the dynamic balance needed by much lighter atoms.

Looking at the data already listed for the five superconductors, there appears to be an atomic cluster connection possibility if the dynamically balancing reaction unit were to interact with a pair of Vanadium atoms, or three Lanthanum atoms or one single Lead atom. A mass value of 102 lies within 2% of the 100 norm selected empirically above and is also within 2% of the value needed to match the Lead atomic clusters. A 2.09% discrepancy applies for the Lanthanum atomic cluster.

Therefore, one wonders if the 102 mass might be more representative of the supergraviton dynamically reacting property. It is appropriate also to note that atomic elements present their individual masses by their isotopic form. Take Uranium as a familiar example. U^{235} becomes superconductive below 2.1K, whereas U^{238} becomes superconductive at the higher temperature of 2.2K. This was reported in 1967 (R. D. Fowler et al, Physical Review Letters, 19, 892 [1967]) and this was significant because this finding was contrary to what was expected from conventional theories of superconductivity. Something was overriding the normal action. There is something special concerning U^{238} in relation to U^{235} as far as superconductivity is concerned. Let us make a check using the atom cluster argument in relation to the dynamic mass balance. 3 U^{238} atoms adds to a mass of 3x238 or 714 units, which is exactly 7 times 102. 3 U^{235} units adds to 3x235 or 705 units, which is 7 times 100.7. Here, then is a hint that the 102 supergraviton mass value may be more likely than our arbitrary choice of 100. Looking now at the niobium and technetium superconductors, using their actual mass numbers of 92.91 and 98.9, respectively, our problem here is that of finding a graviton link. Both are less than 102 and it would take rather many atoms in a cluster to justify the dynamic balance being shared by nearly as many supergraviton units. Accordingly, bearing in mind that these two metals are exceptional in their superconductive properties, the logical hope is that both are very close to being integer multiples of the normal graviton mass.

Now, one has to be careful in expecting Nature to conform with mathematical logic. Physical processes that depend upon the evolutionary effects and mutual interactions between numerous physical forms tend to be governed by energy adjusting to its optimum state and also by electric particles engaging in a contest for survival. The ruling action is one of 'survival of the fittest' as particles of the same family interact to give support by enhancing their mutual equilibrium. The root of this is their ability to exchange energy at a rate of exchange related to their own family characteristics as implicit in their mass property.

When we consider the graviton and the supergraviton we are considering two separate families of virtual particles. These virtual particles can be present in empty space or in dense matter, dense meaning in relation to substance which is composed of heavy atoms. These have atomic nuclei which have dynamically-centred concentrations of mass measured in tens or hundreds of atomic mass units. In the empty space medium, which is the seat of action of the virtual energy world of the sub-quantum vacuum, and in air and water, for example, the prevalent mediator in the gravitational action will be the basic graviton form.

There is evidence connected with the theoretical derivation of G, the constant of gravitation, in terms of the usual charge and mass properties of electrons or protons, which tells us that the graviton has a virtual mass-energy of a few GeV. Indeed, it has a composition involving the tau lepton. However, in dense matter and particularly in metals composed of atoms high in the periodic table, it would take too many such gravitons to focus their dynamic balance on each atomic nucleus. It then becomes energetically desirable for a supergraviton state to consolidate the gravitons into a supergraviton form. The theory associated with this phenomenon has revealed [1989a] that the criteria for this transmutation of form between the graviton and supergraviton family involves 31 graviton systems deploying their energy to create 2 supergravitons.

From the viewpoint of this discourse on superconductivity, the question at issue is that of determining whether the supergraviton exists side-by-side with gravitons in a particular substance. For example, if a dense metal contains inclusions formed by holes or atoms of low mass, will there be gravitons in the virtual energy world associated with those inclusions and exclusively supergravitons in the virtual energy associated with the crystals constituting the metal proper?

The answer to such a question depends upon the evidence of the mass resonance found in superconductive properties. Given technetium and niobium, which both involve heavy atomic nuclei having values marginally related to the mass already assigned to the supergraviton, can we exclude what could appear as a normal graviton component?

It is to be noted that a cluster of 11 niobium atoms of 92.91 atomic weight has a composite mass of 1022, which is very close to 10 units of 102.

The random chance of taking a number of the order of 100 in magnitude and finding an integer multiple of it to be within 0.2% of an integer multiple of particular value, which we assume is 102, is about 1 in 5 if the integer multiple is as much as 10. If the match is to be within 0.05% the chance is 1 in 5 when the integer multiple is 20 or 1 in 2 when the integer multiple is a little over 30.

The relevant formula for estimating this is:

$$p = kN'N$$

where p is the probability factor governing the chance of a resonance, involving a group of N particles of atomic mass A, being within a factor k of an integer multiple N' of supergravitons of atomic mass G'. Note that the factor k represents the degree of approximation to the equality of N'G' and NA.

The derivation scans an arbitrary mass range from 0 to N'G' and assigns 2kG'x units to segments of this range with x incrementing from 1 to N'. Upon summation the result obtained is $kG'(N')^2$ and there are N times that many chances in N'G' of the match condition indicating supergraviton resonance. The probability factor p is therefore kN'N.

We will now examine the five metal superconductor highlighted in TABLE I above as having higher than normal T_c values. We explore the proximity of a match in an integer relationship referenced on the G'=102 mass value. Thus niobium needs 11 atoms (N) to form a cluster balanced by 10 supergravitons (N') and the match holds true to within k=0.2%=1/500. This appears to present the 4.5 to one chance that defies the odds, because p should be 0.220 whereas at match (meaning p=1) was found with the designated k value. Such a discrepancy if repeated with other substances has to mean that there is an underlying physical phenomenon at work that has guided us to that choice of niobium, by virtue of its superconductive property.

TABLE IV

Vanadium	T_c=5.10K	A= 50.94	N=2	N'= 1	k=0.12%
Niobium	T_c=9.22K	A= 92.91	N=11	N'=10	k=0.20%
Technetium	T_c=11.2K	A= 98.90	N=33	N'=32	k=0.01%
Lanthanum	T_c=5.40K	A=138.91	N=11	N'=15	k=0.13%
Lead	T_c=7.26K	A=207.19	N=32	N'=65	k=0.001%

Note that all five of these metals would appear to defy the statistics of a random process. The expected random value of p, based on the rounded value of k in the table, is 0.0024, 0.220, 0.106, 0.214 and 0.021, respectively for these metals, yet their k values give unity probability. The metals have not been chosen because they gave the best fit, but because they were the highest T_c values of record at the time the list was compiled by Professor Shankland. There is really no chance that this 102 matching can be fortuitous. There has to be physical significance in this finding!

THE PEROVSKITE COMPOSITION

It is noted that some of the substances listed in TABLE II are of perovskite composition and that it is of record in the science literature (Jonker and Van Staten, *Physica*, v. 16, pp. 337 and 599, 1950) that compounds of the form $(La_{1-x}A_x)MnO_3$ have a perovskite composition centred around the lanthanum atom or its substitute denoted by the symbol A, which here represents calcium, strontium or barium. It was reported that this substance had good electrical conductivity for values of x between 0.2 and 0.4 and that in this range the substances were also ferromagnetic.

Note that the manganese atoms form a simple cubic structure and that Mn stands next to Fe, Ni and Co in the periodic table of elements. The latter are ferromagnetic.

What is of interest here is that this particular substance comes close in composition to the first amongst the list of 11 in TABLE II above. Important also is the fact that manganese has a 100% abundant isotopic form of atomic mass number 55.

The compounds covered by this generic formula can be made up in what, hopefully, might be very close to a homogeneous mass-distributed system. This is provided calcium is selected as the substitute variable. Calcium 40 is a 97% dominant isotopic form, which means that a fairly definite mass value applies whether the particular atom has the calcium or lanthanum composition. For the lanthanum-centred structure the unit mass number is 242 and for calcium-centred structure it is 143. Assuming that the aim is to have a molecular grouping which is a multiple of 102, one needs to imagine the molecules responding in clusters of 5.

Thus 5 calcium centred molecules has a total mass of 715 units which is 7 times 102.14. In fact, since the calcium and the manganese isotopes have actual masses slightly below the integer values, the combination of 5 such molecules gives a result even closer to the 102 norm.

The latter condition takes the substance outside the bounds of the 40% A-component of the generic formula specified by Jonker and Van Staten and one is therefore left to wonder whether the simple calcium trioxymanganate would be a conductor. Since the 0% A-component version lanthanum trioxymanganate is included in the above reference list of 39 but is stated only to be a semiconductor, one must, however, assume that the 20% to 40% range specified is a constraining condition.

It is possibly of significance that a cluster of 5 molecules is needed to establish the dynamic matching under discussion. Given such a cluster one can see how one or two molecules in the 5 can have the calcium-centred form. The different cluster versions have, respectively, masses that are 11 units of 101 and 10 units of 101.2. This might suggest that, in spreading its action over several molecules, the supergraviton has an effective mass value that is closer to 101 atomic units than to 102 such units.

WARM SUPERCONDUCTIVITY

In proceeding from this point, the reader should take note of the fact that the evidence discussed above all dates from data of record before 1984, which is before the Nobel prizewinning breakthrough on 'warm superconductivity' was reported. This is a reference to the discovery of perovskite properties of superconductivity at temperatures exceeding that of liquid nitrogen.

There were several compositions that then became the centre of interest, one of which is amongst the above list of 11. This is La_2CuO_4 which has a molecular weight of 405.35 units on the C-12 scale. Note that this is very nearly 4 times 101. Another high T_c superconductor reported was Sr_2CuO_4 which has a molecular weight of 302.78 which is very nearly 3 times 101. Note that one gives a value marginally above 101 and the other a value marginally below 101 and that the discrepancy is a very small fraction of one per cent in each case.

This again urges one to the conclusion that there is something special about the quantum of 101 mass units and that, for these molecular clusters involving many atoms, we mean 101 and not 100 or 102.

As an aside here, however, one must conjure a picture of a group of atoms forming molecules which, in turn, form groups or clusters which tend to have their own dedicated supergraviton system, with the supergraviton form jumping around to spread its favours amongst all the group components in acting as a dynamic balancing agent. Perhaps, if the supergravitons have only to range over a few atoms in a metal crystal (as for the U^{238} situation), their effective mass is higher at the 102 value. If they have to share their effects in ranging over 7 atoms, as in the two superconductor substances just mentioned, or 25 atoms, as in the manganese perovskite, then some of their reacting capacity is wasted in a component of disordered motion in migrating over the necessary range. They would then lose some effectiveness and this could be why the 101 value comes into evidence in these substances.

EVEN MORE EMPIRICAL DATA

The reader may think that the emphasis being placed on the optimum mass number of 102 is just a 'play on numbers' that has no physical meaning. It is tempting to suggest that if what I am saying is true one should be able to contrive the artificial creation of molecules from isotopes which fit the mass match condition and thereby produce new superconductors. Hopefully this could take us into the realm of the warm superconductor at ambient temperatures.

Well, the author here admits that the idea did present itself so strongly that patent protection was sought for this very proposition, though the U.S. Patent Examiner was not amenable to the granting of a patent in the absence of a proven and demonstrable showing of the working invention. The U.K. Patent Office was more obliging and GB Patent No. 2,210,870 dating from an application filed on October 12, 1987 was duly granted on this subject.

In the event, however, the author later came to realize that the workers in this new and specialist field tend to be intent on developing their own ideas. They do not listen to theories offered by intruders. In the absence of demonstrable proof of a working invention, the commercial value of the patent, which was a mere speculative venture, is therefore minimal. Also, it was only after that patent was granted, that the research by Jonker and Van Santen at the Philips Eindhoven-Netherlands Laboratories reported above and dating from as long ago as 1950 came to the author's attention. As explained above, it concerns perovskites having compositions which could be deemed relevant to the territory covered by the author's patent. On the other hand, that 1950 research presumably did not probe the high conductivity phenomenon discovery with superconductivity and the magical 102 atomic mass number in mind. An extension of that research on manganese compounds could well be warranted.

To add just a little to show that we are not here talking about mere numbers, but rather something physical, it is interesting to consider how the properties of a superconductor can be affected by very slight adjustment of the molecular mass. The way this can be done experimentally is to consider metals which form hydrides by absorbing hydrogen or deuterium.

An extensive review of research on this very subject appeared in 1978 in a report by Stritzker and Wuhl [*Sadly, in the lapse of time, some five years, between writing this text in a draft form and preparing it for these Web pages, I have lost the specific reference data.*]. On page 246 et seq of the referenced text they explain how for some substances the addition of H or D causes the critical superconductor temperature to increase whereas for other substances the addition causes a critical temperature decrease.

The standard argument adopted to explain these effects is that impurities can influence superconductivity, but that really is a vague design criterion if one seeks to fabricate the perfect superconductor.

The data discussed includes mention of the effect of adding H to niobium alloys. These were chosen because Nb was the superconducting element with the highest T_c value of 9.2 K. The alloys investigated were Nb-Pd, Nb-Pd-Mo, Nb-Pd-W and Nb-Ru.

Now, before we consider the findings, note the atomic weights involved. These are Nb=92.91, Pd=106.4, Mo=95.94, W=183.85 and Ru=101.07.

Taking a pairing of an atom of Nb and Pd the combined mass number is 199.31, very slightly below twice the value we said was optimum. Therefore, if we add one or two atoms of H or D we should bring the relevant mass quantity closer to the optimum dynamic condition and should increase T_c.

Taking Nb-Pd-Mo we can see also that the Pd and Mo atoms might pair together to give a mass number of 202.34. Simply add two H or one D atom to this pair to form what is effectively a hydride molecule and the optimum match at twice 102 is expected for these components of the alloy. T_c should be increased for this alloy when absorbing hydrogen.

Taking Nb-Pd-W much depends upon the amount of Pd in the alloy but if W were to combine with two Pd atoms to give a combined mass number of 396.65 we would again need to add just a few hydrogen atoms to bring this closer to being a multiple of the 101 or 102 quantity which our analysis says should increase T_c.

Finally, Nb-Ru is interesting because we know that Nb as a non-alloyed element has the T_c value of 9.2 K. If we add one atom of Ru of mass number 101.07 plus one hydrogen atom as well, we are adding the optimum 102 mass value. The value of T_c must therefore increase.

For these reasons, all four alloys should show improved superconductor performance when hydrogen is added. In the event, quoting the source text:

> Nb based alloys were chosen because Nb is the superconductive element with the highest T_c (9.2 K) and dissolves large amounts of H. The transition temperatures of the alloys investigated varied between 0.4 and 3 K. A remarkable T_c increase of about 2 to 4 K is observed in these alloys after addition of H.

If the reader thinks that this comes about merely from the addition of hydrogen and has nothing to do with the 102 mass resonance, then let the following further evidence from the Stritzker and Wuhl review come under consideration.

They refer to the alloy HfV_2 which has a T_c value of 9.7 K and point out that when the composition became HfV_2H the value of T_c dropped to 4.9 K, but further, when deuterium was added instead of hydrogen to bring the composition to HfV_2D the value of T_c became 2.8 K.

Now, looking solely at the pair formed by the two vanadium atoms, which incidentally has a 99.76% isotope of mass number 51, these have a combined mass number of 102, which is the value we are prescribing for near resonance and good superconductivity. If we now add a single H atom, the mass value moves away from optimum and so T_c should decrease. If, instead, we add a single D atom, then T_c should decrease even further. This is exactly what is reported.

Quite clearly, we are not dealing here with something that is merely fortuitous 'number play'.

To confirm what is said even further, consider the simple metal elements vanadium, niobium and tantalum and add hydrogen. The reported review notes that vanadium has a T_c value of 5.3 K. As just observed above we recognize that two V atoms have a combined mass number 102. Similarly Nb has a T_c value of 9.2 K and 11 Nb atoms have a combined mass number of

10x(102.20). Tantalum has a 99.99% isotopic form of mass number 181 and 5 Ta atoms therefore have a combined mass number of 9x(100.56). Its T_c value is rather lower at 4.4 K.

Now read further from the quoted review article:

> Satterwaite and Peterson searched in vain for superconductivity above 1.2 K in the compounds VH_2, NbH_2 and TaH.

Evidently the added hydrogen took the first two metal hydrides off their resonant mass values, but in the case of tantalum, here, admittedly, we do see a departure from the theme we are advancing. Is it speculation, however, to wonder whether the dynamic resonance adapts to a larger cluster of atoms if there is a closer fit to the 102 condition for a somewhat larger grouping? Thus, for tantalum, it is noted that the 181 mass number really corresponds to 180.948 atomic mass units and 13 such units combine as a mass of 23x(102.27). In this circumstance it becomes understandable why the addition of hydrogen does reduce the T_c value of TaH so markedly.

Following this theme one can now examine the corresponding effect of varying the composition of a warm superconductor perovskite by addition of oxygen.

F. Devaux, A. Manthiram and J. B. Goodenough (*Physical Review* B, 41, 8723-8732 [1990] have presented data showing the progressive increase of T_c from zero to near 100K as x changes from 0.4 to 1.0 in $YBa_2Cu_3O_{6+x}$ and the progressive decrease of T_c from near 100K to zero as y changes from 0.1 to 0.4 in $Nd_{1+y}Ba_{2-y}Cu_3O_{6+x}$, where x=0.94+0.5y.

These two results provide a way of testing the '102-theory' and determining its the optimum resonance mass and the width of the resonance.

For the Y-based composition we find that with Y=88.90, Ba=137.34, Cu=63.54 and O=16.00, the molecular unit has a mass number 650.2+16x. Therefore we expect two such molecules to define a resonant group, making the mass 1300.4+32x units dynamically reacting with 13 supergravitons.

The authors state that the value of T_c is at a plateau maximum when x is between 0.90 and 0.98, which implies a supergraviton mass having a value between 102.246 and 102.443. When x is 0.4 T_c is zero so a lower limit on the graviton mass is 101.015, which is a little just over 1% below the resonant condition.

For the Nd-based composition, we see that Nd=144.24 replaces Y=88.9, meaning that, when y=0, which is when x=0.94, we have an extra mass quantity of 55.34 to add to the 650.2+16x value above. In this case the result of 720.58 represents a molecule which stands alone as a resonant unit interacting with 7 supergravitons. With y=0 to y=0.1, the value of T_c is at its plateau and this corresponds to a superconductivity induced by partial resonance at a supergraviton value between 102.94 and 102.89, which seems high from our foregoing analysis. However, as y in increases to 0.4, taking x up to 0.96, this adds 0.32 in oxygen mass and 2.76 in Nd-Ba mass to the y = 0 value, making the loss of superconductivity occur for a system of mass 7(103.38), which is 723.66. The mass quantity of 103.38 fixes an upper limit on the bounds of the supergraviton resonance.

From this one can see that the evidence points to a resonant effect centred on a supergraviton state having 102.3 atomic mass units, with 1% either way, for the small molecular cluster being enough to destroy resonance and so the superconductive state.

Note that it was suggested earlier that if many individual atomic structures were sharing in the group reaction, the effective mass value could be effectively reduced to 101. However, where one or two molecules constitute a dynamically reacting group, the supergraviton value of about 102 is governing. Where three individual atoms, as with U^{238}, form a group, the 102 value holds.

It is submitted that very strong evidence has been presented to show that something special affecting superconductivity centres on a mass quantum of 102 atomic mass units.

A full explanation of how this can be justified in terms of physical theory is, as already mentioned, of reference elsewhere [1989a].

However, to end this empirical account of the 102 phenomenon, let us just bring the endeavour up to date by noting that the author is writing this text in July 1992 and referring to the review given in the July 1992 issue of Physics World. On page 37 under the title *'Superconductors'* Ken-Ichi Sato describes a substance identified as 2223-BSCCO which has a Tc value of 110 K and a composition $(Bi,Pb)_2Sr_2Ca_2Cu_3O_{10}$.

Inevitably, the author applies the '102 test' to find the following:-

Pb:207.19	2xPb:414.38	
Bi:208.98		2xBi:417.96
Sr: 87.62	2xSr:175.24	2xSr:175.24
Ca: 40.08	2xCa: 80.16	2xCa: 80.16
Cu: 63.54	3xCu:190.62	3xCu:190.62
O: 16.00	10xO:160.00	10xO:160.00
(SUM):	1020.40	1023.98

Quite clearly, there are 10 dynamic reacting supergraviton mass quanta involved but a single molecular compsition, and, depending upon the relative composition content of lead and bismuth the mass quantum indicated ranges from 102.04 atomic mass units to 102.39 atomic mass units.

Compare this with the findings deduced above from the 1978 review of superconductive hydride compositions.

CONCLUSIONS

What has been attempted in this Essay is an explanation of the phenomenon of superconductivity in a way which leads us to a reacting mass quantum in the vacuum field. It would be foolish to ignore the very strong evidence which the above empirical argument provides. There is a strong case for suspecting that the supergraviton, which is the name we assign to the reacting mass quantum, has a mass value of the order of 102 atomic mass units, which might in some cases reduce to 101 units in certain large molecular systems.

More important, from an energy science viewpoint, is the guidance which the above research should offer in helping researchers to find superconductive substances which have even higher critical temperatures. Such research should focus on the need for that homogeneity of mass distribution which can interact efficiently with that supergraviton mass quantum.

The chemistry of warm superconductivity can, it seems, help to tell us something about the reaction properties of the vacuum field, which is the primary topic of the author's work.

Nothing has been said about the BCS theory of superconductivity but that is understandable, having regard to the fact that the author's theoretical objective has been to connect this remarkable phenomenon with the quantum features of gravitation. It is the author's thesis that the ability of electricity to flow as current, meaning transported electrical charge, by travelling through material substances without apparently encountering resistance depends simply upon a dynamic balance and reaction processes inherent to the vacuum field. This is the realm which governs not only the action of gravitation (hence our choice of the name 'graviton' above) but the quantum of action we know as Planck's constant, which is a universal regulator sourced in the vacuum field.

From an energy science point of view the graviton is a catalyst which assists in the thermodynamic actions between a flow of electrons and the quasi-rigid crystalline structure, not only of matter but also that of the aether. Superconductivity is a clear manifestation of the ability of the vacuum medium to assert action which causes a reversal of the degenerative process we associate with the second law of thermodynamics.

FOOTNOTE

Warm superconductivity was a topic that hit the media headlines in 1987. At that time superconductivity was, so far as this author was concerned, a low temperature phenomenon with little future except as applied to the magnetizing coils of powerful electromagnets. One application which had, however, been a subject of some personal attention was the possibility of building superconductive field windings into the alternators used in association with turbine prime movers to generate electrical power. To operate such machines with their innermost core system cooled to liquid helium or liquid hydrogen temperatures has its problems.

The author had, by association with co-inventor Frank Mumford of Southampton University in England, before he joined GEC's Engineering Research Centre at Stafford, contributed to the idea of a new form of electrical generator which has its main field windings on the stator structure. This became the subject of granted U.K. Patent No. 2,183,102. The need to convey current across brushgear and sliprings to feed a powerful magnetic field set up by a superconductive circuit was thereby avoided. The patent application was filed before the news of the breakthrough discovery of perovskites which are superconductive at liquid nitrogen temperature 77K. This was seen as a step which could benefit the 'Inside-out' design of the machine we had patented. It had special promise, because whereas the new superconductors were of a brittle composition in comparison with metals and alloys, this weakness as a design property is less important for applications in a stator structure compared with use in a high speed rotor.

A curious circumstance was drawn to the author's attention at the time 'warm superconductivity' was 'hot news'. This was in respect of a substance that was said to be superconductive at room temperature and had led to the grant of a U.S. Patent. (*Again, sadly, the author has misplaced the reference data and so cannot quote it in these Web pages.*) This described the invention as comprising a series of very thin bismuth filaments embedded in a matrix composition.

Bismuth has an atomic mass number of 209 and so it is not a good candidate for the multiple-of-102 classification explored above. One may, however, wonder whether something akin to the molecular mass number effect in the perovskites could develop by surface oxidation along these bismuth filaments. For example, bismuth oxide Bi_2O_3 has an molecular atomic mass number of 466 and two such molecules form a group that is slightly greater than 9 times 102. The difference is too great to meet the criteria suggested above, but maybe the constraints enforced by the filamentary path feature can relax the criteria just a little. Also, one should keep in mind that what a physicist regards as 'superconductive' need not necessarily be essential in fabricating some types of electrical power equipment. If loss is the primary criterion, the a superconductor having sporadic but short-lived interludes of normal conductivity can still have scope for commercial application.

When one considers electrical conductivity in very thin films or wires, where the thickness is less than the mean free path of the charge carriers, it could well be that a very substantial enhancement occurs over the bulk conductivity. Perhaps the constraint of guiding the electron motion to be in-line with the flow path so far as possible, with less chance of random divergence by collision, can regiment the energy exchanges so that ohmic losses actually fall below the cooling effect resulting from collisions which cause the slowing down of the counter moving opposite-polarity ionic lattice structure.

If the claim to have achieved room temperature superconductivity in bismuth filaments is unwarranted, then our speculation here on that topic serves little purpose. However, as already stated, one needs to be cautious about what is meant by 'superconductivity'. It has come to mean zero resistivity, but from a technological viewpoint a very substantial reduction of resistivity well below that of a normal metal for the same temperature may well suffice as a 'superconductive' condition.

According to *'Superconductor Week'* Vol. 6, No. 26 for August 24, 1992, there is now a school of thought which argues that there are 'radical differences' when comparing certain characteristics of high T_c and low T_c compounds. The alternative argument is that both are similar and that the phenomena are explicable in terms of conventional BCS pairing via electron-phonon interaction and a special Fermi surface feature called the "van Hove singularity (vHs)". However, the developing opinion is that one needs to pay attention to the fact that a magnetic field applied to a high T_c superconductor develops a gradual electron-pairing because of the strong thermal fluctuations. For a low T_c superconductor excess magnetic field leads to an abrupt step function in the resistivity transition.

This suggests that there is still much to learn about the effects of a magnetic field upon electrical current flow through conductors and the thermodynamic interactions associated with those effects, particularly in thin films and filaments. Hopefully, the vast amount of effort going into research on superconductivity research will bring its reward, but a different aspect of electrical conductivity began to capture this author's attention early in 1988.

The author's research had been attentive to experimental anomalies in electrodynamics and the underlying theory where current is carried not just by electrons, but also by heavy ions, as in plasma discharges using cold cathodes. The current breaks up into filaments when such discharges reach certain critical levels of current. The author had long thought that here was a process where the discharge involved avalanche process of an in-line organized filamentary flow of charge carriers, one behind the other, in short transitory bursts. Transiently, this means that current flows without collision and so without loss, for those momentary periods before the filament collapses and a new one is regenerated to sustain the discharge.

The latter was deemed by this author to occur also in bulk metal, and the only pointers, it seemed, to such a phenomenon were the implications to be drawn from certain electrodynamic force anomalies in the cold cathode arc discharges, a phenomenon which had ceased to command interest in mainstream physics.

This situation, so far as this author was concerned, changed in a dramatic way in 1988, when it came to attention that something unusual could happen to the thermoelectric EMF generated by the Seebeck Effect in a thermocouple subjected to a magnetic field. Tests to verify this were performed by John Scott Strachan, a research scientist in Edinburgh, Scotland and it was realized that this could imply that oscillations were occurring in the current flow across the bimetallic junctions. Here was a clue to that suspected filamentary surge process in current conduction through metals.

The consequence of this was a first meeting between the author and Strachan on the occasion of a conference held in Canada in July 1988. Peripheral to that event, and before leaving Canada to return home, a plan for building a test device for converting heat into energy, incorporating a magnetic and thermoelectric structure, was agreed.

This venture promises the means for the conversion of heat to electrical energy and vice versa at a level of efficiency which surpasses prior art techniques by an enormous margin of performance.

That project can be linked in a way with the subject of this Essay by reference to the filamentary flow of electrons through 'superconductive' channels. One has only to consider a concentrated flow of filamentary current across a Peltier cooled junction interface between two metals. It is then realized that cooling at a spot in the junction interface will enhance the conductivity and possibly cause the regenerated current filaments to take the path of least resistance, always through that same spot. The result is that the conventional thermocouple chokes itself by reducing the effective temperature at the Peltier cooled interface to a value far below that of the external heat input. The spot temperature falls and could go down to the superconductity threshold T_c, were it not for the fact that the Peltier current flow would cease if the temperature fell to that of the Peltier heated junction interface. This action devastates the efficiency of the conventional bimetallic thermocouple.

*****

Since the above Essay was written, in 1992, that thermoelectric project ran into problems, owing to what this author now regards as a progressive magnetic saturation of the device in a curious manner connected with the start-up and switch-off heat cycle arising from repeated demonstrations. In 1997 the topic became the subject of Energy Science Report No. 3 of record in these Web pages.
