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SUPERCONDUCTIVITY: A TIME REGION PHENOMENON

Dr. K.V.K. Nehru

1. INTRODUCTION

The chief characteristic of superconductivity is the complete absence of the electrical resistance. As the temperature is decreased, the change from the normal to the superconducting state takes place abruptly at a critical temperature $T_c$. Though the phenomenon was discovered as far back as 1911, it resisted all theoretical understanding and not until 1957 was the famous BCS theory propounded. According to this theory, superconductivity occurs when the repulsive interaction between two electrons is overcome by an attractive one, resulting from a mechanism which gives rise to electron pairs - since then known to be called the "Cooper Pairs" - that behaved like bosons and moved without resistance.

The tunneling and flux quantization experiments firmly established the presence of electron pairs. However, the phonon mechanism of electron pairing remained experimentally unproven. Subsequent experimental work brought to light many anomalies and unexplained results which demonstrated the inadequacy of the BCS theory. The theoretical trend, in the past decade, has been toward invoking the quantum mechanical concept of "exchange interactions" for the explanation of the formation of the electron pairs.

The explanation of the phenomenon of superconductivity from the point of view of the Reciprocal System, however, has not yet been attempted. Larson himself refers to the phenomenon with nothing more than a passing remark [1]. As the present author sees, progress toward this end would not have been possible in the Reciprocal System, as it needed the discovery of a new development, which emerged only recently. This is the new light thrown by the study of the "photon controversy," leading to the discovery of birotation [2]. It has been shown there that the two equal and opposite rotational components of a birotation manifest as a linear Simple Harmonic Motion (SHM). The knowledge of this now opens the way toward understanding the phenomenon of superconductivity.

2. THE ORIGIN OF THE PHENOMENON

It has been well-recognized that superconductivity, from the abruptness of its occurrence at the temperature $T_c$, is a collective phenomenon - like that of ferromagnetism, for example - involving all particles co-operatively. We have shown that the ferromagnetic ordering is the phenomenon of the time region [3]. We now find that superconductivity is the result of the electron motion entering the time region. In fact, since in solids the atoms are already in the time region, the region inside unit space, it follows that superconductivity, like ferromagnetism, results when the motion concerned crosses another regional boundary, namely, the time region unit of space (which is a compound unit).

2.1 The Perfect Conductor

Larson points out: "... the electron is essentially nothing more than a rotating unit of space." [4] He identifies the movement of the electrons (rotating units of space) through matter (a time structure) as the electric current. We might note that there is no electric charge associated with these electrons. One of the causes, according to Larson, of the resistance to the flow of current is the spatial component of the thermal motion of the atoms. "If the atoms of the matter through which the current passes are effectively at rest..., uniform motion of the electrons (space) through matter has the same general properties as motion of matter through space. It follows Newton's first law of motion, and can continue indefinitely... This situation exists in the phenomenon known as superconductivity."[1]

We would like to point out that the actual situation is somewhat different. Firstly, as we will see later, superconductivity is not solely a phenomenon of zero resistance which we shall call the perfect conduction (that is, infinite conductivity), which is what Larson seems to imply by 'superconductivity' in the para cited above. The second fact is concerning the resistance caused by the impurity atoms due to their space displacement. Since the current moves, according to the Reciprocal System, through all the atoms of the conductor (including the impurity atoms), and not through the interstices between
the atoms, there is a large contribution by the impurity atoms to the resistance.\[5\] Mere reduction of the thermal motion, therefore, cannot serve to eliminate the cause of resistance to the current.

2.2 The Electron Pair as a Birotation

In the "uncharged state the electrons cannot move with reference to extension space, because they are inherently rotating units of space, and the relation of space to space is not motion. ...In the context of the stationary spatial system the uncharged electron, like the photon, is carried outward by the progression of the natural reference system."\[6\] But as the temperature is decreased below the critical value $T_c$, and the electrons in the solid enter the region of the inside of the compound unit of space, the direction of the electron motion changes from outward to inward from the point of view of the stationary reference system. Thus the electrons start moving toward each other, as if mutually attracting.

Remembering that the electron is a unit of rotational space, when two of them with antiparallel rotations approach each other to an effective distance of less than one compound unit of space, the two opposite rotations form into a birotation. As explained in detail elsewhere \[2\] a birotation manifests as an SHM. We might call this process the "pair condensation," following the conventional nomenclature.

The formation into the birotation (that is, SHM) has two distinct effects which need to be noted:

(i) the character of the motion changes from rotational (two-dimensional in extension space) to linear (one-dimensional in extension space);

(ii) the magnitude of the motion changes from steady (constant speed in time) to undulatory (varying speed in time).

Let us call these two effects respectively the "dimension-reduction" and the "activation" for ease of future reference.

2.3 The Zero Electrical Resistivity

The rotational space, that is the electron, may be regarded as a circular disk area. We see that the effect of the dimensional-reduction is to turn the disk area into a straight line element (of zero area). What causes the electrical resistance in normal conduction is the finiteness of the projected area of the electron in the direction of current flow. The vanishing of this projected area on pair formation eliminates the cause for the resistance and turns the material into a perfect conductor (zero resistivity). It should be emphasized that a dimension-reduction from a three-dimensional spatial extension (say, a spherical volume) to a two-dimensional spatial extension (a circular disk) could not have accomplished such an elimination of projected area. This is only possible when the reduction is from a two-dimensional spatial extension to the one-dimension.

In the conventional parlance we might say that while the single-electron (rotational) is a fermion, the electron pair (linear SHM) behaves as a boson. In the analogous case of a photon, we see that the photon is a linear SHM and is a boson. One can, therefore, conjecture that the circularly polarized photon \[2\] ought to behave like a fermion. I suppose that an experimental verification of this prediction could easily be borne out.

3. THE MEISSNER EFFECT

This an interaction between superconductivity and magnetic field and serves to distinguish a superconductor from the so-called "perfect conductor." If we could place a perfect conductor in an external magnetic field, no lines of magnetic flux would penetrate the sample since the induced surface currents would counteract the effect of the external field. Now imagine a normal conductor placed in the magnetic field and the temperature lowered, such that at $T_c$ it turns into a perfect conductor while in that field (see top row Fig.1, which is adopted from Ref.\[7\]). The field that was coursing through it would be continuing to do so (top center, Fig.1). If now the external field is removed (top right) the change in this field would induce electrical currents in it which would be persisting (as there is no resistance), and these currents produce the internal flux that gets locked in as shown.

But the situation is quite different in the case of the superconductor. As can be seen from the bottom row of Fig.1, a metal placed in an external magnetic field and cooled through the superconducting transition temperature $T_c$ expels all flux lines from the interior (providing, of course, the field is less than a critical value, $H_c$) (see bottom center). This is called the Meissner Effect. In fact, the external field threading the superconductor generates persistent surface currents, and these currents generate an internal field that exactly counterbalances the external field resulting in the flux expulsion phenomenon. Termination of the
external field induces an opposing surface current which cancels the previous one and leaves the superconductor both field-free and current-free.

Now the crucial point that should be noted is that a constant magnetic flux threading a conductor that is stationary relative to it does not induce an electric current. What induces a current is a change in the magnetic field. In the case of a perfect conductor we considered above, the field is steady (that is, constant with time) and no induced currents appear (top center, Fig.1). But in the case of the superconductor, the steady field does induce an electric current. This has been a recalcitrant fact that defied explanation in the conventional theory and forced the theorists to hazard weird conceptual contrivances like the exchange interactions. The development of the Reciprocal System has clearly demonstrated that in all such cases there is no need to devise extreme departures from the otherwise understandable straightforward explanations. For instance, we have shown in the explanation of ferromagnetism there is no need to invoke the aid an "exchange interaction" at all [3]. It was shown that understanding of the origin and characteristics of that phenomenon follows from the recognition that it has crossed a regional boundary and entered the time region.

Exactly for identical reasons, we find that in the present too, there is no need to resort to the purely hypothetical exchange interaction explanation. The reason why a steady magnetic field threading the superconductor induces a current in it follows from the activation aspect of the electron pairing. That is, while in the case of the normal electron the rotational space is constant with time, in the case of the electron pair the space is sinusoidally varying with time. In normal conduction, electric current is induced if the magnetic flux threading the space of the electrons changes with time. In superconductivity, the electrical current is induced since the space of the electrons threading the magnetic flux varies with time. We may call this "superinduction," and the relevant current "activation current."

4. THE NON-LOCALITY OF THE PAIRING

As a matter of fact, one of the great difficulties of understanding this phenomenon originally was that that is not the way things are. The electrons which form the pair are really spread over a considerable distance; and the mean distance between pairs is relatively smaller than the size of a single pair. Several pairs are occupying the same space at the same time."[9] By any standard of conventional thinking this is rather a strange state of affairs.

From the point of view of the Reciprocal System, however, we see that the two electrons that form the pair are adjacent in time, and not in space, since the electron motion is in the time region as has already been noted. As the location of the particles in space is in no way correlated to their location in time, adjacency in time does not necessarily entail propinquity in space. Therefore, the components of a pair could be spatially separated while contiguous in time. Their maximum separation could be the natural unit of space multiplied by the interregional ratio (nearly $7 \times 10^{-4}$ cm).

5. SUPERCONDUCTIVITY AND MAGNETIC ORDERING

As both magnetic ordering and superconductivity are the result of the respective motions entering the time region, it would be of interest to examine whether and how they affect each other. In the ferromagnetic arrangement of the directions of all the atomic dipoles are mutually parallel. Such a state of ordering precludes the electron pair formation required in superconductivity since the spins of the electrons are disposed to orient parallel to each other. As such, we can predict that superconductivity and ferromagnetism cannot coexist.

On the other hand, in the antiferromagnetic ordering, adjacent magnetic dipoles are oriented antiparallel to each other. Since the rotational space that is the electron will have greater chance of assuming the directions of these dipoles, adjacent electrons with opposite spin directions would be readily available for pairing. Consequently, we can conclude that the antiferromagnetic ordering can co-exist with or even promote the electron pairing that underlies superconductivity. If this is so, it might lead to the development of high $T_c$ superconducting materials by exploiting the potential of the antiferromagnetic type of structures.
6. THERMODYNAMICAL ASPECTS

The observable relationships among the superconducting and the normal states follow directly from the quadratic nature of the relationship between the corresponding quantities of the time region and the outside region [10].

6.1 Specific Heat Relations

Quoting Larson: "... the relation between temperature and energy depends on the characteristics of the transmission process. Radiation originates three-dimensionally in the time region, and makes contact one-dimensionally in the outside region. It is thus four-dimensional, while temperature is only one-dimensional. We thus find that the energy of radiation is proportional to the fourth power of the temperature.

\[ E_{\text{rad}} = K_s T^4 \] \hspace{1cm} (11)

We have seen earlier that the phenomenon of biroton of the electron pair is identical to that of the birotation of photons (except for the absence of the rotational base in the latter). Consequently, the time region energy associated with the electron pairs is proportional to the fourth power of the temperature. Therefore, considering unit volume of the material, the expression for the thermal energy in the superconducting state can be written as

\[ E_s = K_s T^4 \] \hspace{1cm} (1)

where \( K_s \) is a constant and suffix s denotes the superconducting state.

Differentiating this equation one gets the expression for the specific heat in the superconducting state,

\[ C_s = 4K_s T^3 \] \hspace{1cm} (2)

This cubic relationship is confirmed experimentally.

Continuing the quotation from Larson: "The thermal motion originating inside unit distance is likewise four-dimensional in the energy transmission process. However, this motion is not transmitted directly through the thermal oscillation is identical with the oscillation of the photon, it differs in that its direction is collinear with the progression of the natural reference system rather than perpendicular to it. The transmission is a contact process ... subject to the general inter-regional relation previously explained. Instead of \( E = KT^4 \), as in radiation, the thermal motion is \( E^2 = KT^4 \)," [12] that is, \( E_n = K_n T \) \hspace{1cm} (3)

where \( K_n \) is a constant and suffix n denotes the normal state. This, of course, gives the linear relationship between the normal specific heat \( C_n \), and temperature that Larson uses in his calculations.\[ 12 \]

\[ C_n = 2K_n T \] \hspace{1cm} (4)

We know that the entropy of both the states, \( S_n \) and \( S_s \), must be equal both at \( T_c \) and at 0 kelvin (by the third law of thermodynamics). Using \( dS = dE/T \), we have from Eqs. (1) and (3),

\[ S_s(T) = \int_0^T 4K_s T^2 dT = \left( \frac{4}{3} \right) K_s T^3 \] \hspace{1cm} (5)

\[ S_n = \int_0^T 2K_n dt = 2K_n T \] \hspace{1cm} (6)

At \( T = T_c \) we have \( S_s(T_c) = S_n(T_c) \) which gives

\[ K_s = \frac{3K_n}{2T_c^2} \] \hspace{1cm} (7)

Using Eqs. (2), (4) and (7), we can now find that at the transition the excess specific heat is given by

\[ C_s - C_n = 6K_n T_c - 2K_n T_c = 4K_n T_c = 2C_n \] \hspace{1cm} (8)

The above result is experimentally corroborated.

6.2 External Magnetic Field

Below the critical temperature \( T_c \) superconductivity is quenched by applying an external magnetic field of intensity greater than the critical value \( H_c \). The fourth power and the second power relations, Eqs. (1) and (3) respectively, pertaining to the two regions across the boundary lead us to the result (see Appendix)
\[
\frac{H_c(T)}{H_c(0)} = 1 - \left(\frac{T}{T_c}\right)^2
\]

where \(H_c(T)\) is the critical magnetic field that quenches the superconductivity at the temperature \(T\) (less than \(T_c\)).

This is the well-known parabolic relation that is especially found to hold good in the case of all the soft (Type 1) superconducting materials. A more rigorous treatment should, of course, take into consideration the probability of existence of some unpaired electrons at temperatures greater than 0 kelvin. The Type II superconducting materials have a mixed state which we cannot consider in a preliminary study such as the present one.

7. CONCLUSION

The foregoing explanation of superconductivity adds one more item that demonstrates the coherence and generality of the Reciprocal System of theory. It has been shown that the apparent reversal of direction, from the point of view of the stationary threedimensional spatial reference system, that takes place when the scalar motion constituting a phenomenon crosses a unit boundary of some sort underlies the explanation of such diverse phenomena as the white dwarfs, quasars, cohesion in solids, sunspots and ferromagnetism. In this present article we extend this explanation to the phenomenon of superconductivity as well. Superconductivity is the result of the electron motion (rotational space) entering the time region and turning into a birotation.

* The formation of electron pairs,
* the non-locality of the pairing,
* the zero electrical resistance,
* the expulsion of magnetic field,
* the abrupt change in the specific heat at the transition,
* the manner of variation of the critical field with temperature,

all of these are shown to follow logically from the theory.

REFERENCES


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**FIG. 1** THE MEISSNER EFFECT

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<th>Condition</th>
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<td>(T &gt; T_c)</td>
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<td>(H &gt; 0)</td>
<td>(0 &lt; H &lt; H_c)</td>
<td>(H = 0)</td>
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C 19.3-5
5. Ibid., p.114
6. Ibid., p.113
12. Ibid., p.58

APPENDIX : Temperature Dependence of the Critical Field

At the transition temperature \( T_c \), under an external magnetic field \( H_c \), the condition of equilibrium is the equality of the free energies \( F_n \) and \( F_s \) of the normal and the superconducting states respectively [13]. Considering the variation of the free energies with temperature we can write

\[
dF_n = dF_s \tag{i}
\]

Since by definition

\[
dF = -SdT - B dH \tag{ii}
\]

with \( S \) as entropy and \( B \) the magnetic induction, we have

\[
-S_n dT - B_n dH = -S_s dT - B_s dH
\]

or

\[
(B_s - B_n)dH = (S_n - S_s)dT \tag{iii}
\]

We can take that the material is only weakly magnetic in the normal state and so omit the term \( B_n \). Since in the superconducting state the material acts as a perfect diamagnetic, we can take

\[
B_s = -\mu_0 H \tag{iv}
\]

where \( \mu_0 \) is the permeability. Using Eqs. (iv),(v),(vi), and (vii), we obtain from Eq.(iii)

\[
-\int_{H_c(T)}^{0} dHdH = \int_{T_c}^{T} \left( 2K_s T - \frac{2K_s T^3}{T_c^2} \right) dt
\]

since at the limit \( T = T_c, H_c = 0 \). Carrying out the integration and simplifying,

\[
\mu_0 H_c^2(T) = K_s T_c^2 \left[ 1 - \left( \frac{T}{T_c} \right)^2 \right] \tag{v}
\]

For \( T = 0 \) K this gives

\[
\mu_0 H_c^2(0) = K_s T_c^2 \tag{vi}
\]

Substituting from Eq. (vi) in Eq. (v) and taking the squareroot, we finally get

\[
\frac{H_c(T)}{H_c(0)} = 1 - \left( \frac{T}{T_c} \right)^2 \tag{vii}
\]

* * * *

Corrigendum to “The Law of Conservation of Direction”

Reciprocity, XVIII (3), p.6

The following paragraph was missing entirely. It should be added immediately after the Table I in page 6, first column:

It may be seen that in the case of the translational situation the vectorial direction reverses in unison with the scalar direction. But in the case of the vectorial directions it is not so: it is perplexing why the scalar and vector directions do not maintain a constant relationship in the case of the vibrational motion (cp., for example, the third and the fourth units in the tabulation).
DISCUSSION ON KIRK'S EXPLANATION OF PHOTON

(Reciprocity, XIX (1), Spring 1990, pp. 3-5)

Dr. K.V.K. Nehru

This is a very interesting article by Thomas Kirk. He evinces good understanding of the nature of scalar motion. The article would have been excellent but for a few points needing clarification. Presuming that the article had been reviewed, one feels that the reviewer ought to have raised these points.

(Denoting page number by “p”, left and right columns by “lc” and “rc”, paragraph numbers by “pr”, and line numbers by “l”)

1) p 3, lc, pr 1,2 : Kirk talks of the displacement giving rise to the speed 1/2 as space displacement, while in fact it should be referred to as time displacement.

2) p 3, lc, pr 2 : "The inward unit motion which is the photon cannot continue over a second unit of time, because that would require an additional unit of energy."

But there is no bar for the motion to continue over another unit of time, so long as the speed is the same (1/2 = 2/4 = 3/6 etc.). Additional unit(s) of energy are required only if the speed extends to another speed unit.

3) p 3, lc, pr 2 bottom & pr 3 : "... the inward motion inevitably lapses and is replaced by the natural progression for one unit of time at the end of which it can assume its form of a unit displacement again ... due to its energy conservation."

Since energy is the derivative of speed, and during the one unit of time in which the inward motion is replaced by natural progression, how (or where) is the energy conserved? Conservation means that this unit of inward speed exists in some other (or potential) form during this time unit of natural progression. But no such alternative is apparent from Kirk's explanation. In fact, the mechanism suggested by Kirk actually breaks the law of conservation of energy on the level of individual time units.

4) p 3, rc, pr 1 : Kirk refers to the explanation in p. 209 of The Universe of Motion. At this juncture it must be borne in mind, that while Larson was speaking of speeds in the reference cited, Kirk is dealing with speed displacements (see p 3, lc, pr 1&2), and since these two are very different ways of talking about the speed magnitudes, comparison would be misleading.

5) p 3, rc, pr 1 bottom : "... when the two motions are added vectorially."

But these two motions he talks of are scalar motions (see the cited paragraph). Adding two scalar motions vectorially is self-contradictory. Here "vectorially" must be replaced by "algebraically."

6) p 3, rc, pr 4 : "This creates a packet of zero motion of unit size..."

What does the author mean here by zero motion? Is it zero speed? And since the author has been talking in terms of speed displacements, one would ask what displacement will produce zero speed or zero motion. His implication that unit displacement produces this (p 3, rc, pr 4, 1 3-7) is patently wrong: it produces a speed of 1/2 or 2. But the inconsistency is the zero motion being unit size. The motion size could be either zero or unit.

7) p 3, rc, pr 4, bottom : "... this packet of... motion... acts similarly to a pulse..."

Pulse of what?

8) p 3, rc, pr 5 : He represents "...wavelengths by the expression n+1, where n is the pulse duration, or unit of energy...The frequency is of course forward unit speed divided by the wavelength...This frequency is therefore 1/(n+1)."

If n is the number of units of energy and 1/(n+1) is the frequency of the photon they are inversely related. Then how is it reconciled with the fact that photon energy is h (Planck's constant) times the frequency?

There is another important point that must be realized. Kirk's treatment (see p 3, lc, pr 1&2) envisages that a frequency with zero displacement from the natural progression, that is unit speed, is tantamount to zero energy. But the fact is that photons of all frequencies other than zero (that is, the LF or low frequency type
or 1/n, the HF type on n/1, and also the unit frequency or 1/1) do possess non-zero energies. In other words, the zero point for photon speeds (frequencies) is not unity as Kirk assumes, but the mathematical zero. Larson himself is clear about this and identifies the unit frequency as being in the infrared range (ref. *The Universe of Motion*, p. 202 and 246).

9) p 4, lc, pr 2: "... the photon motion is distributed and centered on the line of travel about one wavelength in total width. This is opposed to conventional theory which puts the wavelength along the line of travel ..."

Firstly, if the wavelength is not posited to be along the line of travel then how does the author take the frequency as "forward unit speed divided by the wavelength" (p 3, rc, pr 5, l 11-12)?

Secondly, how does he take that the motion is distributed about one wavelength in total width? Why can't it be the integral multiple of it?

10) p 5, rc, pr 2: "This one unit speed displacement occupies one unit of space. It is essentially a disk of distributed scalar motion in the three-dimensional reference system."

Compare this with: "The motion 1/n which is the photon itself could not be represented in extension space..." (p 3, rc, pr 1, l 2-4). Once we recognize that the three-dimensional reference system is the same thing as the extension space, these two statements can be seen to be mutually contradictory.

Kirk asserts that the photon motion is linear translation in a second scalar dimension (p 4, lc, pr 1, l 2-5). So far it is correct. But his conjecture that it is rotationally distributed -- a "disk" he says -- in the three-dimensional reference system is not correct. The translatory motion in the second scalar dimension takes on a constant direction, in the geometric representation, for one unit of time. This direction may change to a new direction, and only this is relevant in any interaction of the photon with matter. If the representation is to be a disk, the motion has to be rotational, not translatory.

In this context, it is important to distinguish between rotational motion and rotationally distributed translational motion. The inward translational effect of gravitation, for example, is a rotationally distributed motion. In the three-dimensional reference system, it has a fixed direction for one natural unit of time. As it enters a new time unit the vectorial direction is redetermined by the chance process (see *Nothing but Motion*, p 58, pr 3).

11) Further, Kirk's account, like Larson's, does not explain polarization and related phenomena.

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The editors of *Reciprocity* welcome papers, especially from new contributors. The requirements that a contributed paper must meet in order to qualify for publication are clarified below. Editorial assistance is available in those cases where a limited amount of revision will enable a paper to meet the requirements.

As stated in the by-laws of the International Society of Unified Science, the objective of the Society is the advancement of the Reciprocal System of physical science. This theory, as it is defined, consists of two fundamental postulates, together with everything that can be derived from those postulates by logical and mathematical processes, without introduction from any other source.

The unitary character of the theory, resulting from the derivation of all its conclusions from the same set of premises, is its most essential feature. It is this status of this theory as a general physical theory - the only thing of its kind - that enables extension of the theory into areas inaccessible to observation.

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2. Original technical articles must deal with the Reciprocal system of theory, as defined above, or aspects thereof; that is, the propositions supported must purport to be derived from the postulates of the Reciprocal System, or from previously published work based on that basis, without introducing further assumptions.
3. Arguments advanced against previously published material must be similarly based.

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Alternatively, you may now, if you wish, submit your papers on 3.5 inch disks for the Macintosh computer, in Word 4.0 or MacWrite (version 2, 4.5, and 5.0) formats. This helps to eliminate the errors that may occur in transcription and reduces the amount of time to take us to put the journal together.
Comments on Halprin’s Article on United States, etc.
(RECIPROCITY, XIX (1), Spring, 1990, pp. 9-13)

by K. V. K. Nehru

(Denoting page no. by ‘p’, left or right column by ‘lc’ or ‘rc’, para no. by ‘pr’ and line no. by ‘l’)

1) To start with, one wonders at the appropriateness of the title “The Constitution of the... etc...” since it does not apply to the main bulk of the article. I feel that the style of the article is not in line with what a scientific reader expects to find in a strictly technical journal. We must remember that since the arena of the physical theory is replete with a multitude of short-lived ‘unified theories’ such a reader is apt to be wary about possible quacks. The comparison with the constitution of the U.S.A. may make him misjudge the seriousness of the article, especially since he does not see how the (dis)similarities between the two ‘constitutions’ are relevant to the issue or why the ‘legal loop-holes’ are compared with ‘logical loop-holes.’ There is not much harm if such a reader limits his misjudgement only to that particular article he reads. The real danger is that he begins to look askance at the RS theory itself or the bonafides of its originator.

Also see: “...let us investigate any opening (loop-hole) for possible variations.” (p. 10, lc, pr 4). One wonders how a logical opening can be regarded as a loop-hole! A loop-hole is a means of evading a rule without infringing it. It evades existing applications of a law whereas an opening looks for new/more applications.

While presently it is extraordinarily difficult to hasten the acceptance of the RS, in view of the atmosphere of suspicion and unwillingness on the part of the Establishment, it is fatally easy to delay it. One’s intentions may be good but the results might prove disastrous if words and phrases are not chosen very carefully and discreetly. The reviewers of the articles must constantly be on the lookout for possible semantic side-effects and advise the authors lest in our enthusiasm to further the cause we jeopardize it. We have already the Boston university experience to bear witness.

2) p 10, lc, pr 3 & 7: Halprin keeps on regarding the physical universe as six-dimensional (presumably because he adds up the 3 dimensions of space and the 3 dimensions of time). Larson repeatedly points out that the universe is three-dimensional since we are talking of the dimensions of motion (see Basic Properties of Matter, pp. 142-3). Extending Halprin’s logic of the six dimensions (3 of space + 3 of time) why can’t one conclude that the universe is nine-dimensional (3 of space + 3 of time + 3 of motion? I am confident that whatever argument the author might be able to devise against this conclusion can be turned against his six-dimensional conclusion as well.

3) p 10, lc, pr 5 bottom: “The Primal Universe is indeterminate, and Heisenberg’s description may well obtain.”

This is an unwarranted conclusion. It cannot be deduced from the premises of the Theory.

4) p 10, rc, pr 2: “I shall now quote Larson ...”

But he fails to give the reference!

5) p 10, rc, pr 3: “The material sector can be regarded as a three-dimensional frame of reference moving ‘linearly’ through a three-dimensional temporal frame of reference.”

Firstly, the material sector is not just a frame of reference. It may be regarded from such a frame of reference.

Secondly, the conclusion that this reference frame is moving ‘linearly’ through a three-dimensional temporal reference frame is unwarranted. All that could be said is that it is moving ‘one-dimensionally’ through a three-dimensional temporal reference frame.

6) p 11, lc, pr 5 “...the smallest part of this line is the unit of space. Within this unit there cannot be space, or we would be contradicting a basic premise...”

This is a fatal mistake. There is space within this unit simply because it is a unit of space! Discreteness of space only means that the smallest space that can participate in physical action is this natural unit of space. From this one cannot conclude that within unit space there cannot be space. Please see Nothing But Motion, p 47 bottom para.

We see that Halprin has here difficulty with the understanding of the ‘time region.’ In the texts it is mentioned as the region inside unit space. This is true as far as physical action at
distances less than unit space is concerned. It is, thus, a region of physical action. (Region here denoted a particular class of motion). But unfortunately, the word 'region' (or any cognate word chosen as its alternative) immediately evokes in our mind the response of 'spatialization' which is a creature of the old paradigm of the 'setting' concept of space. The result is that the mind regards the time region as "time...effectively manifesting itself as space..." etc. (p 11, lc, pr 5). This, of course, is not the truth. The inside of one natural unit of space is space only and it is fallacious to localize the time region in any way in the space unit.

Also this misunderstanding of the nature of space unit leads him to conclude (wrongly) that the photon vibration ought to be more than one unit wide for it to be observable at all (see p 11, lc, pr 1 & 2). I recommend reading of Larson's explanation in The Neglected Facts of Science, pp. 62-3.

7) p 11, rc, pr 4: "Material matter...

A rather ungainly expression, seeing that 'material' is the adjectival form of 'matter'!

8) p 11, rc, pr 4: "...material rotational base...has a vibratory unit, whose speed of vibration, is that fraction of unit speed, denoted by 1/2π..."

This is wrong. The speed of this vibration is not a fraction but a multiple of unit speed, say n, where n = 2, 3, etc. The vibratory unit with less than unit speed constitutes the cosmic rotational base.

9) p 12, rc, pr 1: Regarding the observability of photons, it should be realized that both LF (low frequency, or less than unit frequency) and the HF photons are observable from either the material or the cosmic sector.

10) p 12, rc, pr 3, 4: "...in a serious attempt to develop all the consequences of the basic premises, some items should be summarily dismissed.

"... theosophy, zen, mysticism, supernatural, and such concepts as 'beyond space and time'..." etc.

I wonder whether such a conclusion as this can be deduced from the postulates of the RS! In our eagerness to reject all that is wrong in the old, let us not commit the mistake of reject-

ing all that is old. The above quoted statements make one think that the author has not only not understood what theosophy and zen imply, but also misunderstood the implications of the RS itself. I do not pretend that my understanding of these is superior. But I can point out that there is nothing in the RS which establishes that the physical universe is all that is there, or could be there. In fact, the emancipation from the previous paradigm, namely, the 'setting' concept of the universe of matter, clears all the scientific objections against existences other than space-time-like. I refer one to the last chapter, 'Implications,' of The Universe of Motion and Larson's forthcoming book Beyond Space and Time.

Even in the case of those concepts of the conventional physical theory that the RS shows to be definitely wrong, rash pronouncements like "blackholes should be forthwith dismissed," do not accomplish anything except provoking hostility, when not accompanied by logical explanations as to why it is so.

11) p 13, lc, pr 1: "It is impossible to have a vibrational frequency that is exactly unit speed, (as perceived in our four-dimensional sector)."

This is wrong. Photons of unit speed frequency can exist are observable (see my comment No. 9 above). Unfortunately it is misunderstood here that unit speed is the natural zero for the photon frequency. However, the zero point for frequency is the mathematical zero. Another wide-spread mistake that the students of the RS seem to commit is the lack of recognition that the unit speed is the natural zero only for the speed measured in terms of displacements. They misapply the displacement reckoning to the photon case and consequently land in all sorts of troubles.

12) p 13, lc, pr 2: "... could some elements have more than one representation, depending on the frequency of the rotational base..."

Larson, in fact, considers the possibility of different vibrational frequencies for the rotational bases: he talks of vibration two. (Basic Properties of Matter, chapter 1). Also Ronald Satz considers this in some detail: ("Further Mathematics of the Reciprocal System," Reciprocity, X (3), Autumn, 1980, p 12)
Correcting Discrete Time/Space Measurement Procedures

by Frank H. Meyer

In Reciprocity, Vol. XIX, No. 1, Spring, 1990, when discussing the absolute magnitudes of unit speed (the speed of light), I incorrectly asserted on page 17 that the smallest length of space is "measurable by the reciprocal of the Rydberg wave number constant". In truth more is involved.

Since 1986 physicists have agreed to take the measured value of the Rydberg wave number constant to be $1.09737 \times 10^6$ cm$^{-1}$. It is easy to compute the reciprocal of this number, which amounts to $9.11 \times 10^{-6}$ cm. However, $9.11 \times 10^{-6}$ cm is not the smallest space length. It is twice the length of the absolute discrete space unit, which is a component of absolute unit speed. In other words, the finitely divisible natural unit of space equals $4.56 \times 10^{-6}$ cm.

How the Rydberg wave number and fundamental frequency constants relate to the existence of quantized space, quantized time, quantized motion and quantized speed can not be understood in terms of the traditional space-time continuum postulate of modern physics. Nor can the known existing quantization of energy, electricity, magnetism, matter, etc., be understood in terms of the continuum postulate, as Einstein(1) in his later years acknowledged. The existence of motion in quantized forms can be understood in terms of the postulate of the Reciprocal System of physical science that the universe is composed entirely of one component, motion, existing in three dimensions and in discrete units. We define motion as the relation between two uniformly progressing reciprocal quantities, space and time. By reason of this postulate and this definition each individual unit of motion is a relation of one unit of space and one unit of time, motion at unit speed.

Let $R = 109737$ cm$^{-1}$ denote the Rydberg wave number constant for infinite mass.

Let $\lambda$ denote the wave length of unit frequency, measured in cgs units of cycles per second and on the assumption that frequency is a function of time only.

Then $\lambda = 1/R = 9.11 \times 10^{-6}$ cm.

Let $v$ denote unit frequency, the inverse of period, denoted by $T$.

$v \lambda = c = $ unit speed or $\lambda/T = $ unit speed.

Absolute unit speed, $c$, has been measured very accurately as the speed of light in vacuo. $c = 2.9979 \times 10^{10}$ cm/sec.

Unit frequency also has been well-established, as measured and determined from an empirical study of the characteristics of radiation. It is known as the Rydberg fundamental frequency, $v$.

$$v = c/\lambda = 2.9979 \times 10^{10} \text{ cm/sec} / 9.11 \times 10^{-6} \text{ cm} = 3.29 \times 10^{15} \text{ cycles/sec}$$

Actually frequency is a velocity, a ratio of space to time, according to the Reciprocal System. Motion, as defined, is measured in terms of speed, the scalar magnitude of the relation between space and time. The term 'frequency' has been introduced into physics to allude to the truth that a photon has not one speed but two speeds, as it is a compound of two motions. What is called 'the speed of light' is actually the speed it shares in common with all other photons, that is, the speed of its physical location in which it happens to originate and remains so long as it continues to exist. This is its uniform translatory and extrinsic speed. Its other speed is its intrinsic oscillatory speed or velocity by which it distinguishes itself from and relates itself to other photons of different or the same kind. To distinguish the photon's former speed from its latter, it is referred to as its 'frequency'. A special frequency is 'unit frequency', $v$.

Unit frequency, $v$, is the ratio of unit space to unit time.

Unit frequency is the equivalent of one-half cycle per unit of time rather than one full cycle, as a full cycle involves one unit of motion, in each direction. For the purpose of measuring the absolute magnitudes of absolute unit speed, therefore, the measured value of the Rydberg frequency constant, $v$, must be expressed as $6.58 \times 10^{15}$ half cycles/second.

The prevalent view that frequency is a function of time only is not quite true. Since frequency is actually a velocity, it involves space as well as time. The conventional view of frequency only in terms of reciprocal time (or
cycles per second) is equivalent to using unit space in conjunction with the cgs unit of frequency. That is, ignoring the space term when selecting the method of measuring unit frequency has the same outcome as assigning space a unit value.

Consequently, the natural unit of time in cgs terms and units, that is, the smallest duration of time, is the reciprocal of the Rydberg fundamental frequency constant.

\[ t = \frac{1}{6.58 \times 10^{15}} \text{ half cycles per sec.} = 1.52 \times 10^{-16} \text{ sec.} \]

Now by multiplying the natural unit of time by unit speed, the existing natural unit of space, s, is measured:

\[ ct = s = 2.9979 \times 10^{10} \text{ cm/sec} \times 1.52 \times 10^{-16} \text{ second} = 4.55 \times 10^{-6} \text{ cm}. \]

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**A Note on Scalar Motion**

by Ronald W. Satz

Beginning students of the Reciprocal System often have difficulty understanding scalar motion, confusing it with vectorial motion. I will attempt here to clarify matters.

Assume as a thought experiment, a spherical light source in gravitational equilibrium with us, the observers. In our ordinary 3-D spatial reference system, the source is stationary, and photons are streaming away from it at the speed of light in all directions. Without the knowledge of the Reciprocal System, you might conclude that the photons have independent motion and are moving vectorially through coordinate space away from the source. However, the theory says that this is not the case from the standpoint of the true, natural reference system. The photons actually have no independent motion and thus are stuck in the same space-time units in which they originate. It is the atoms of the source that have independent motion and are moving against the space-time progression. This resulting motion is termed gravitation and is always inward. Most importantly, this motion is scalar: it is inward in all directions, with no one direction favored. It is because the source is moving inward in all directions that makes it appear that the photons are moving outward in all directions. Since the inward gravitational motion is taking place in space, the motion imputed to the photons is outward in space.

Likewise for the cosmic sector: the cosmic atoms are moving inward in time, and so cosmic observers would conclude that the photons from their light are moving outward in coordinate time. In actuality, of course, the photons remain in the same absolute space-time locations and are not moving either in coordinate space or coordinate time!

Now suppose, as in the Einstein-Podolsky-Rosen experiment, that two photons originate at the same event and move in opposite directions. In the material sector, the motion appears to be outward in space; in the cosmic sector, the motion appears to be outward in time. In actuality, we are moving inward in space away from the photons, and cosmic observers are moving inward in time away from photons. We have no independent motion in coordinate time (at low vectorial speeds), and since the photons do not either, we are able to effect a change in both photons by means of a change in one of them. Likewise, the cosmic observers have no independent motion in coordinate space (at low vectorial inverse speeds), and since the photons do not either, the cosmic observers are able to effect a change in both photons by means of a change in one of them. (Existents which are contiguous in either space or time may both be affected by application of a suitable single force).

Because photons are stationary in the natural reference system, they are not "lost" from either sector and are not "disappearing over the time or space horizon"; the universe is not "running down" toward a slow "heat death".
Rebuttal to Comments of Nehru on “A New Derivation of Planck’s Constant”

by Ronald W. Satz

While I am pleased that K.V.K. Nehru agrees with the numerical result in my paper [Ref. 1], I am displeased that he is unable to follow the derivation [his comments in Ref. 2]. I will make one more attempt here to explain it.

1. Observers in our sector (the material or time-space sector) measure photon frequency in cycles per time unit, such as cycles/sec. In this sector, time appears to be one dimensional and progressing.

2. Observers corresponding to us in the cosmic, or space-time, sector measure photon frequency in cycles per space unit, such as cycles/cm. In this inverse sector, space appears to be one dimensional and progressing.

3. From statements 1 and 2, it follows that to have a definition covering both sectors, we must combine the two equations and measure photon frequency in cycles per space-time unit, such as cycles/cm-sec. In application to the time-space sector, the numerical value of the space factor in the general equation is set to unity; in application to the space-time sector, the numerical value of the time factor in the general equation is set to unity. But it is important to realize that the dimensions of these factors are still present.

4. In our sector, with energy in ergs, the dimensions of the energy equation are

\[ \text{erg} = \frac{\text{sec}^2(\text{sec/cm})/\text{erg})}{1/(\text{cm*sec})} \]

In the inverse sector, with energy in gres (inverse ergs), the dimensions of the energy equation are

\[ \text{gre} = \frac{\text{cm}^2(\text{cm/sec})/\text{gre})}{1/(\text{cm*sec})} \]

From these two expressions, it follows that Planck’s constant in the inverse sector has the dimensions gre-cm-sec. With the space factor unity in our sector, and treating the frequency here as cycles/sec, the dimensions on Planck’s constant become erg-sec. With the time factor unity in the inverse sector, and treating the frequency there as cycles/cm, the dimensions of Planck’s constant become gre-cm.

5. The ratios (sec/cm)/erg and (cm/sec)/gre in the equations above are simply conversion factors from the natural system to the cgs system and gsc system (the equivalent of the cgs system in the inverse sector).

6. The factor for sec^2 in the expression for the inverse sector comes from the natural unit of time (expressed in seconds) squared.

Similarly, the factor for cm^2 in the expression for the inverse sector comes from the natural unit of space (expressed in centimeters) squared. These terms are the keys to transforming the frequency to energy and must be included!

7. Finally, the interregional ratio must be included because the oscillation of the photon takes place within a unit of space-time. The result is equation 4 of my paper [Ref. 1].

8. The calculated numerical value of Planck’s constant in our sector can be stated as 6.61026552 x 10-27 erg-cm-sec, with frequency given as cycles/cm-sec. The resulting quantity of energy in ergs is identical in both cases! In scientific and engineering equations we may group terms in whatever way we find most convenient for solving the problem at hand, provided we observe dimensional consistency. I have taken great pains to ensure that this has been the case in my papers.

I conclude, most emphatically, that Nehru’s objections are totally devoid of merit.

References
