The Wave Mechanics In the Light of the Reciprocal System

Prof. K.V.K. Nehru, Ph. D.

One of the large areas to which the *Reciprocal System* is yet to be applied in detail is spectroscopy. The need is all the more urgent as vast wealth of empirical data is available here in great detail and a general theory must explain all the aspects. To be sure, this was one of the earlier areas which Larson[1] explored. But he soon found out, he writes, that there were complications too many and too involved that he decided to postpone the investigation until more basic ground was developed by studying other areas.

Coupled with this is also the fact that the calculation of the properties of elements like the lanthanides is still beyond the scope of the Reciprocal System as developed to date.[2] The question of the appropriateness of the Periodic Table as given by Larson is still open.[2,3,4,5]

Under these circumstances it is certain that there is lot more to be done toward enlarging the application of the Reciprocal System to the intrinsic structure of the atom. Perhaps it is time to break new ground in the exploration of the mechanics of the *time region*, the region inside unit space. Breaking new ground involves some fresh thinking and leaving no stone unturned. In this context, it may be desirable to examine, once again, such a successful theory as the Wave Mechanics in the light of our existing knowledge of the Reciprocal System.

1 The Fallacies of the Wave Mechanics

The fundamental starting point of the Wave Mechanics is the correlation, which Louis de Broglie advanced originally, of a wave with a moving particle. Like every wave has a corpuscular aspect as shown by Planck's analysis of the blackbody radiation, the photoelectric effect and the Compton effect (the scattering of photons by particles), it is hypothesized that every particle has a wave aspect. Since the characteristics of waves and particles are mutually exclusive in many ways, this concept of associating a wave with a particle had been beset from its inception with a contradiction that had been euphemized by stating that the two are "complementary" aspects. This led to many an epistemological difficulty. The quantum theorists concluded that the phenomena (particles) inside an atom are not localized in physical space, that the electron in the atom does not exist in an objectively real sense, that it is but a mathematical symbol, and that the world is not intrinsically reasonable or understandable in the realm of the very little. One may refer to *The Case against the Nuclear Atom*[6] by Larson for a critical appraisal.

While this is so, it must be noted that the Wave Mechanics was successful in explaining the vast wealth of the spectroscopic data. The several quantum numbers, *n*, *l*, *m*, etc. come out in natural way in the

1 Larson, D.B., *The Structure of the Physical Universe*, North Pacific Pub., Portland, Oregon, USA, 1959, pp. 122-125.
2 Gilroy, D.M., "A Graphical Comparison of the Old and New Periodic Tables," *Reciprocity*, Vol. XIII, No. 3, Winter 1985, pp. 1-27.
3 Sammer, J., "The Old and New Periodic Tables - Again," *Reciprocity*, Vol. XX, No. 4, Winter 1991-92, pp. 7-13.
4 Tucek, R.V., "New Periodic Table," *Reciprocity*, Vol. XXI, No. 1, Spring 1992, p. 20.
5 Kirk, T., "Periodic Table, Revisited," *Reciprocity*, Vol. XXI, No. 2, Autumn 1992, pp. 10-13.
6 Larson, D.B., *The Case Against the Nuclear Atom*, North Pacific Pub., Portland, Oregon, USA, 1963.

theory. Even the "selection rules" that govern the transitions from one energy state to another could be derived. The fine and the hyperfine structures of the spectra, the breadth and intensity of the lines, the effects of electric and magnetic forces on the spectra could all be derived with great accuracy. In addition, it predicts many non-classical phenomena, such as the tunneling through potential barriers or the phenomena connected with the phase, which found experimental verification. Thus we can see that the mathematical success of the Wave Mechanics is accompanied by a gross misunderstanding of the physical concepts involved. It is the latter which Larson points out and condemns in his criticism of the conventional atomic theory.[6]

It might be worthwhile to examine if the Wave Mechanics could be purged of its conceptual errors, drawing from our knowledge of the Reciprocal System, and see if the transformed version could be integrated into the Reciprocal System scheme with advantage. After all we have seen this happen in the case of the Special Theory of Relativity. Some of its mathematical aspects—like Lorentz transformations or the mass-energy equivalence—could be adopted by the Reciprocal System after purging the Theory of the wrong interpretations.

2 Reinterpretation of the Physical Concepts of the Wave Mechanics

Let us take a look at the original points linking the concepts of the wave with that of the moving particle. The frequency ν and the wavelength λ of the wave are respectively given by

$$\nu = \frac{E}{h} = \frac{M\,c^2}{h} \tag{1}$$

$$\lambda = \frac{h}{\rho} = \frac{h}{(M\,v)} \tag{2}$$

where E is the energy, ρ the particle momentum, M the mass, v the particle speed, c the speed of light and h Planck's constant. Now the product of ν and λ gives the wave velocity

$$u = \nu \cdot \lambda = \frac{c^2}{v} \tag{3}$$

That is, measured in the natural units, the propagation speed of the wave associated with the particle is the inverse of the particle speed:

$$u_{nat} = \frac{u}{c} = \frac{1}{\left(\frac{v}{c}\right)} = \frac{1}{v_{nat}} \tag{4}$$

As the speed of the particle increases from zero upwards, the corresponding speed of the associated wave decreases from infinity downwards.

It is at this juncture that our knowledge of the Reciprocal System helps clarify the physical situation. In particular, we recall that while speed is reckoned from the standpoint of a three-dimensional spatial reference system, inverse speed is reckoned from the standpoint of a three-dimensional temporal reference system. While the speed of the origin of the three-dimensional spatial reference system is zero in that system, the inverse speed of the origin of the three-dimensional temporal reference system is zero in the latter system. Or what comes to the same thing, the speed of the temporal zero would be infinite in the spatial reference system. It can easily be seen that a particular speed v_{nat} reckoned from the spatial reference system is identical to the inverse speed $1/v_{nat}$ reckoned from the temporal reference system. Therefore it follows that the switching from the particle speed v_{nat} to the associated wave speed $u_{nat} = 1/v_{nat}$ is tantamount to the shifting of the reckoning from the three-dimensional spatial reference system to the three-dimensional temporal reference system.

This is exactly what needs to be done at the juncture where the phenomena (motion) under consideration enter the time region (see Appendix I). In the time region there could be only motion in time, and the relevant reference frame to represent the motion would have to be the three-dimensional temporal reference frame. Since changing from the corpuscular view to the wave view has the significance of shifting from the three-dimensional spatial reference frame to the three-dimensional temporal reference frame, the theorists have been unknowingly adopting the right procedure in connection with the calculations relevant to atomic dimensions. But it is no longer necessary to maintain, as the theorists do, that an entity is a particle as well as a wave at the same time, since these two views are irreconcilable. The truth is that the particle viewed from the three-dimensional spatial reference frame is the wave viewed from the three-dimensional temporal reference frame. While the particle has a definite location in the former reference frame, the associated wave, being monochromatic, has infinite extent. In the temporal reference frame it appears as infinite repetition.

We often come across situations where a change of the coordinate frame, say, from the rectangular to the polar, facilitates the mathematical treatment. In such cases, the same geometrical form—or more generally, the space-time configuration, namely, motion—takes on different mathematical forms in the different coordinate frames. In the present context we have the converse situation, wherein different coordinate frames engender different space-time configurations from the same underlying reality (see Appendix II). In other words, a change of coordinate frames transforms one physical object (space-time configuration) into an apparently different physical object.

Time and again we find the theorists being compelled to resort to similar transformations (without, of course, the benefit of the insight given by the Reciprocal System). Consider, for example, the phenomenon of diffraction of particles/waves by crystal lattices. Here they customarily work out the interaction in terms of the wave vector k and the *reciprocal lattice*, instead of the wavelength λ and the direct lattice respectively.

The quantity $k = 2\pi / \lambda$ is called the wave number. The vector with modulus k and an imputed direction is the wave vector k. From Equation (2) it can be seen that the wave vector represents momentum. If a_1, a_2 and a_3 are the sides of the unit cell of a crystal lattice, then the array of points drawn with unit cell sides $b_1 = 2\pi / a_1$, $b_2 = 2\pi / a_2$ and $b_3 = 2\pi / a_3$ is called the reciprocal lattice. Without genuine insight, it is regarded as the invariant geometrical object whose properties are fundamental in the theory of solids. However, from the Reciprocal System we know that in solids the motion equilibrium is in the time region, where space is replaced by equivalent space (reciprocal space). Therefore we can readily see the rationale in adopting the wave vector (reciprocal length) and the reciprocal lattice in place of the wavelength and the direct lattice respectively.

3 The Uncertainty Principle

The quantum theorists, being uninformed about the existence of the time region, naturally thought that these waves, associated with the particles, exist in the space of the conventional reference system, while the truth is that they exist in the *equivalent space* of the time region. Now a particle is localized whereas its associated wave is spread out infinitely. Since the theorists have been mistaking that both the particle and the associated wave exist in the space of the conventional reference frame, they thought if Δx is the region in which the particle is located then it is reasonable for the wave too to be limited to the same extent Δx. So they took recourse to the concept of wave packet. The latter is a superposition of plane waves, with their wave numbers in the range Δk centered around the de Broglie wave number k (= $2\pi/\lambda$) and producing a resultant wave whose amplitude is non-zero only for a space of Δx, equal to the "size" of the particle. They then identify the wave packet, rather than the original monochromatic wave, with the particle. The so-called uncertainty principle stems from this procedure, because the range of size Δx, and the range of wave number Δk, of the waves composing the wave packet, are inversely related as could be seen from Fourier analysis.

$$\Delta x \simeq \frac{1}{\Delta k} \tag{5}$$

Using Equation (2) we have

$$\Delta x \cdot \Delta \rho \simeq \frac{h}{2\pi} \tag{6}$$

which is the conventional statement of the uncertainty principle.

But now, one realizes that while the particle is localized in space, it does not entail that the associated wave is also to be somehow localized in space, since the latter is to be reckoned from the point of view of the three-dimensional temporal reference frame and not the spatial reference frame.

It may be a practical difficulty to measure both the location and the momentum of a system of atomic dimensions with unlimited accuracy simultaneously. But the conclusion drawn by the theorists from the uncertainty principle that a system of atomic dimensions *does not possess* these properties of precise location and precise momentum simultaneously can be seen to be invalid. As Larson rightly points out, conclusions such as these are applicable only to the theorists' model, not to the actual system. The uncertainty principle is merely the statement of the fact that the characteristic length belonging to space, namely Δx cm, and the characteristic length belonging to equivalent space, namely Δk cm^{-1}, are reciprocally related (Equation (5)).

4 The Probability Interpretation

The next thing to be recognized is that the wave information is not to be visualized as mapped out in the space of the conventional spatial reference system. The reference frame for the wave is a temporal manifold. As creatures of the material sector we have no direct access to the three-dimensional temporal reference frame: rather we are anchored to the three-dimensional spatial reference frame. But fortunately, we can accomplish the equivalent of the transformation from the spatial to the temporal frame by the contrivance of adopting the wave picture in place of that of the particle. It must continually be borne in mind that the three-dimensional spatial manifold being used in this context is so used as a *temporal analogue*. This is why the wave function (specifically, the square of the amplitude) takes on the probability interpretation. The action itself is unambiguous and precise, but since it takes place in the temporal reference frame, the outcome in the three-dimensional spatial reference frame is governed by chance and therefore statistical.

The randomness of the radioactive disintegration is another example to the point. When the total mass (rotational + vibrational) of the atom builds up to the upper zero point for rotation, the time-zero as we might call, the (excess) motion reverts to the linear status and is jettisoned as radiation or other particles. Since it is the result of reaching the time-zero point the action is in time instead of space. The radioactive disintegration proceeds continuously and contiguously in three-dimensional time. But since locations in the three-dimensional temporal frame are only randomly connected to the locations in the three-dimensional spatial frame, the apparent disintegration of the atoms (as observed from the conventional spatial standpoint) seems utterly random.

Again the interference of light is another example. The crests and troughs of the resultant wave in the two-slit experiment coincide respectively with the regions where the maximum and the minimum number of photons reach. But if the beam intensity is very low, say only a few photons are passing the slits, then all that we can say is that a photon has a greater likelihood of arriving at the location indicated by the wave crest rather than at any other place. In other words, the wave (square of the amplitude) takes on a probability interpretation.

This is also precisely the reason why the theorists find some of these forces to be *non-local* in nature—a totally non-classical phenomenon—namely, that they originate in the time region and the connection between the locations in three-dimensional time and the locations in three-dimensional space is random. We have discussed this point in connection with the phenomena of ferromagnetism[7] and superconductivity.[8]

5 Wave Mechanics without the Nucleus

In *The Case Against the Nuclear Atom*[6] Larson advances arguments to establish that the concept of the nucleus of the atom is untenable. He points out that, in fact, the "size" of the nucleus obtained by the scattering experiments is rather the size of the atom itself. Our calculations in the next section corroborate this. While Larson's confutation of the nuclear concept proceeds from his original arguments, his criticism of the Quantum Theory, given in the same work, was based entirely on citations from other experts in the field, including those of the pioneers of the Theory. Larson himself does not directly analyze or comment upon any part of the Quantum Theory or the Wave Mechanics. And all those criticisms he quotes deal with the epistemological difficulties only—such as the "lack of rationality," etc. which we mentioned at the outset—none deal with the mathematical aspects.

Now since we realize that the entire confusion in the area arises from the fact that the theorists do not distinguish between the space of the conventional reference system and the equivalent space of the time region (of which they do not know), if we set this right by explicitly recognizing that the associated wave is reckoned from the three-dimensional temporal reference frame, we would have achieved much progress.

Since according to the Reciprocal System there is no nucleus, we need to give new interpretation to the energy term occurring in the Schrödinger equation for the wave. It cannot be regarded as the energy level of an orbiting electron. But as we shall see below, this can be treated as the energy level of the atom itself.

6 The Size of the Atom

Larson[6] has pointed out that as the three-dimensional motion that constitutes the atom extends in the time region, its measured size in the time-space region (namely, the conventional three-dimensional

7 Nehru, K.V.K., "Is Ferromagnetism a Co-magnetic Phenomenon?" *Reciprocity*, Vol. XIX, No. 1, Spring 1990, pp. 6-8.
8 Nehru, K.V.K., "Superconductivity: A Time Region Phenomenon," *Reciprocity*, Vol. XIX, No. 3, Autumn 1990, pp. 1-6.

spatial frame) would be much smaller than one natural unit of space, s_{nat}. It is reduced by the inter-regional ratio, 156.444, which was calculated earlier[9] as the number of degrees of freedom in the time region, and 8, which is the number of degrees of freedom in the time-space region. Since the atomic rotation is three-dimensional, the cube of 156.444 is the applicable value. So the measured atomic radius would be the following

$$\frac{s_{nat}}{8\times156.44^3}=1.4883\times10^{-13}\ \ cm$$

(adopting s_{nat} = 4.558816×10^{-6} cm from Larson[10]). Since actually it is the volume with which the equation is concerned, rather than the length (radius), there is an additional geometrical factor, f, relating the volume of a cube (of side $f\times x$) with that of a sphere (of diameter x) given by

$$(f\ x)^3=\frac{\pi x^3}{6}$$

which gives f = 0.806. Adopting this, the measured radius, based on the natural unit of volume concerned, would be

$$f\cdot1.4883\times10^{-13}\,cm=1.1995\times10^{-13}\ \ cm$$

But this is specifically the measured radius of an atom of unit atomic weight. If the atomic weight of the atom is A units, then the measured radius of the atom turns out to be

$$r_A=1.2\cdot A^{1/3}\ \ fm \qquad (7)$$

As can be seen, this agrees well with the results obtained from the scattering experiments for the so-called nuclear radius. This therefore confirms Larson's view that the experimenters are confusing the atom with the nucleus.

7 The Region of One-dimensional Motion

We recall that the atom is constituted of three rotations a-b-c. "a" and "b" are two-dimensional rotations (three-dimensional motion) in two of the scalar dimensions, and "c" is the one-dimensional reverse rotation in the third scalar dimension. Since this one-dimensional rotation is not the basic rotation of the atom, the inter-regional ratio applicable to this is the purely rotational factor 128. As the degrees of freedom in the time-space region is 8 as already pointed out, the range of sizes associated with the one-dimensional rotation in the time region is

$$\frac{s_{nat}}{8\cdot128}=4.45\times10^{-9}\ \ cm \qquad (8)$$

Hence we can expect the discrete speeds which exist within this spatial range, as far as the one-dimensional type of rotation is concerned, to be part of the atomic structure and the origin of the energy levels that explain the line spectra. Our preliminary study suggests that further prospects for the understanding of the spectroscopic data lie in this zone of one-dimensional rotation of the time region.

9 Nehru, K.V.K., "The Inter-regional Ratio," *Reciprocity*, Vol. XIV, No. 2-3, Winter 1985-86, pp. 5-9.
10 Larson, D.B., *Nothing But Motion*, North Pacific Pub., Portland, Oregon, USA, 1979, p. 160.

8 Conclusion

It is shown that while the Wave Mechanics has been very successful and accurate mathematically, it is fraught with some fundamental errors. A review of the latter in the light of the Reciprocal System of theory shows that the principal stumbling block was the ignorance of the existence of the time region and its peculiar characteristics.

Knowledge of the Reciprocal System enables us to recognize two crucial points: (i) that the wave associated with a moving particle, in systems of atomic dimensions, exists in the equivalent space of the time region; and (ii) that the switching from the particle view to the wave view is equal in significance to shifting from the standpoint of the three-dimensional spatial reference frame to that of the three-dimensional temporal reference frame. This recognition not only throws new light on the intriguing wave-particle duality, but also corrects the conceptual error that eventually led the theorists to the wrong conclusion that the world of the very small does not conform to the rational laws that are applicable to the macroscopic world.

It is shown that the uncertainty principle does not stem from the intrinsic nature of the atomic phenomena, as the theorists would have us believe, but is rather the result of gratuitously assuming that the wave associated with a moving particle is spatially co-extensive with the particle.

The probability connotation of the wave function is shown to arise from the two facts that the wave is existent in the three-dimensional temporal manifold, and that locations in the three-dimensional temporal manifold and the three-dimensional spatial manifold respectively are randomly connected. The non-local nature of the forces in the time region also follows from this.

Calculations based on the inter-regional ratios applicable confirm Larson's assertion that the measured size of the atom is in the femtometer range and hence the actual atom is being confused with the non-existent nucleus.

It is suggested that the investigation of the one-dimensional motion zone of the time region, in conjunction with the adoption of the Wave Mechanics corrected of its conceptual errors, will lead to greater understanding of the atomic structure and thereby pave the way for the complete explanation by the Reciprocal System, of the spectroscopic data, as well as the other recalcitrant problems connected with the properties of rare-earths etc.

9 Appendix I

According to the Reciprocal System space and time occur in discrete units only. If two atoms approach each other in space, they cannot come any nearer than one natural unit of space, s_{nat}. Within one natural unit of space no decrease in space is possible since one natural unit is the minimum that can exist. However, since the basic constituents of the physical universe are units of motion, or speed, in which space and time are reciprocally related, an increase in time (t) with space constant is equivalent to a decrease of space (1/t). This is referred to as the equivalent space in the Reciprocal System. Therefore, though the atoms cannot approach each other nearer than one natural unit of space, they can do so in the equivalent space by moving outward in time. As all changes in this region inside unit space are in time only, it is referred to as the time region.

10 Appendix II

Consider, for instance, a wave motion in the three-dimensional temporal reference frame, of amplitude given by

$$\sigma = A + B \cdot \cos(\theta) \quad (9)$$

with A and B constants, and θ the time coordinate. In order to return to the spatial reference frame, we (i) transform the time coordinate θ into φ , a rotational space coordinate—rotational because all our time measurements are based on cyclical processes; and (ii) transform σ into $1/r$, since equivalent space and actual space are reciprocally related. We then find that the above equation (of the wave configuration) becomes the equation of an ellipse (or hyperbola) that represents the locus of a planetary mass point revolving around a central force

$$\frac{1}{r} = A + B \cdot \cos(\phi) \quad (10)$$

where $A / (A^2 - B^2)$ is the semi-major axis and B/A the eccentricity. (It must be cautioned that though the above example illustrates the point in question, it is not a complete analogy.)