The Alchemic Ether Model: An Organic Conception of Physical Space

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May 1978, Portland State University

The following are excerpts taken from an unpublished paper by the above title written 7 years prior to the first journal publication of subquantum kinetics. Many of the excerpted portions focus on a discussion of how chemical reaction-diffusion systems as well as the alchemic ether approach to physics (subquantum kinetics) fulfill the organic conception of space that Alfred North Whitehead was proposing. This paper is interesting from the standpoint of both the early development of subquantum kinetics and the philosophical context for the theory. In this paper, LaViolette begins to speak of "displaced media concentrations," values taken relative to the ambient steady state concentration. In later editions he identifies these as the counterparts of energy potentials in physics. He also begins to speak of the media being composed of "etheric units". This paper was written about three months prior to a major development in the theory, made in August 1978, when he discovered the importance of the reverse reaction X ← G, which was the final step in the development of Model G.

. . . Comprehension of the alchemic ether model requires a significant reorientation from Cartesian conceptions of space. The organic, processual concept of space expounded by Alfred North Whitehead(7, 18) provides this sought for reorientation and so may usefully serve as a philosophical underpinning to the alchemic ether model. Thus, in the way of an introduction we will begin with a discussion of some of Whitehead's ideas. For example, Whitehead's criticism of the seventeenth century, Cartesian conception of space is reviewed here (a perspective which still hangs on in contemporary "linear" field theory models). To compliment this we will discuss the trimolecular (Brusselator) chemical reaction model as a preparation to the discussion of the alchemic ether model and also as a means of illustrating Whitehead's organic principles. The Whiteheadian conception of space will then be correlated with the concept of physical space presented in the alchemic ether model.*

. . . It is understandable why physical science has retained the linear assumption; linear equations have been successful in representing a substantial range of phenomena, and more importantly, they are relatively easy to solve.** The significance of this last point cannot he overly stressed, for the necessity of achieving mathematical workability and the availability of

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* The alchemic ether model was originally developed without knowledge of Whitehead's works. However, parallels with Whitehead's notions are understandable -- while Whitehead's concepts were inspired from biology, the alchemic ether model was inspired from recent studies of chemical reaction patterning which, of course, are akin to phenomena found in biochemistry.(6, 9)

** On the other hand, nonlinear equations, which may provide a better grounding for field theory have, until recently remained insoluble, and it is not surprising that they are highly uncommon in conventional field theories. However, in the last two decades the availability of high speed computers has made it possible to model certain classes of nonlinear systems. Thus we may be on the brink of a new mathematical revolution.

mathematical tools since the time of Galileo has profoundly influenced the direction which physics has taken, the concepts of reality it has adopted and the kind of experiments it has seen fit to conduct. Modern physics has adopted mathematics as the primary language in which theoretical models are expressed. But, the limitations of these mathematical languages influence the kinds of concepts which may be communicated and experimentally checked. The concepts which achieve workability make up the reality framework in which the physicist operates and determine to a large extent the kinds of experiments he performs. As Ludwig von Bertalanffy has said:(22)

> "Linguistic, and cultural categories in general, will not change the potentialities of sensory experience. They will, however, change apperception, i.e., which features of experienced reality are focused and emphasized, and which are underplayed."

Along similar lines, Joseph Pearce states:(23)

> "Even our most critical, analytical, scientific, or 'detached' looking is a verification search, sifting through possibilities for a synthesis that will strengthen the hypotheses that generate the search... When the scientists look at the forest, they look for additions to their garden, and they look with a gardener's eye."

The linear hypothesis has become deeply ingrained in the present framework of physical field theory, and consequently, physicists have tended to view their forest with "linear eyes". In losing sight of the contingent character of our mental categories, Whitehead would say we are committing the *fallacy of misplaced concreteness*, mistaking the abstract for the concrete.

Since field theory deals with phenomena which are observationally far removed from the human level, we can never hope to directly measure the behavior of fields (like we can chemical compounds) to determine the extent to which the linear assumption is valid. We can only hope to draw inferences from indirect observations and as we have seen, physicists have chosen to draw these inferences in terms of linear models. It must be conceded that linear equations, which have been useful in modeling many mechanical phenomena, have served well as a framework in physics for integrating experimental observation. Yet, physics, especially field theory, seems to be alone among the sciences where use of the linearity assumption (simple location) has been tolerated. Other sciences (i.e., biology, psychology, sociology, etc.) have at some time or other, discovered that the linearity assumption was grossly inadequate, and that instead, phenomena were more appropriately described by nonlinear equations and interactive concepts. That is, it is found that the constituents of natural systems generally do not act independently of one another, but are behaviorally interrelated.

Still though, the assumption of linearity does not hold a monopoly in the physical sciences. There are several physical phenomena which have been more appropriately described by nonlinear mathematics. Most of these deal with nonequilibrium systems and involve either flow processes (physical translocation) coupled with dissipative processes, or, on the other hand, purely dissipative processes. The former includes thermal convection, tornadoes, and weather patterns, while the latter includes transmutational phenomena such as chemical or nuclear reactions and ecological predation interactions. Moreover, certain nonequilibrium chemical reaction systems exhibit some interesting properties which may provide useful insights for understanding microphysical phenomena. One such system, which has received extensive mathematical treatment is known as the trimolecular model (or the Brusselator).

The Trimolecular Model

The trimolecular model is a chemical reaction scheme developed by the Brussels group;(4, 24, 25) see below:

$$\begin{array}{rcll} A & \xrightarrow{k_1} & X & \text{(i)} \\ 2X + Y & \xrightarrow{k_2} & 3X & \text{(ii)} \\ B + X & \xrightarrow{k_3} & Y + D & \text{(iii)} \\ X & \xrightarrow{k_4} & E & \text{(iv)} \end{array} \qquad (1)$$

Then the paper discusses the Brusselator reaction-diffusion system. This is followed by a section (given below) which discusses attempts that had been made to model the chemical reaction-diffusion wave phenomenon with linear wave equations and the implications of microphysics. proposing that our linear equations in physics may be approximations describing nonlinear processes taking place in a subquantum ether.

A General Representation of Reaction-Diffusion Phenomena

Much work has been done recently in attempting to derive general mathematical representations for reaction systems such as the trimolecular model and others.(28 - 30) These approaches study various mathematical solutions of a generalized reaction system having i species. Each species is considered to have a concentration c_i, a net rate of chemical production $R_i = R_i (c_1, c_2 \ldots c_n)$, and a net diffusive flux J_i. Wave solutions have been worked out for 1 and 2 dimensional geometries.

The point of departure for studying such wave phenomena has been to describe the character of the underlying reaction medium. Generally, one begins by writing the following conservation equation which must hold for all chemical species in all regions of the medium:

$$\partial c_i/\partial t = R_i + J_i \qquad (5)$$

This basically states that the rate of increase in the concentration of a species i in a localized region of space (say dV) is due to the net rate of production of specie i in dV by chemical reactions plus the net rate of diffusion of specie i into dV from other regions of the medium.

If we assume that diffusion in the system can be described by a version of Fick's law that accounts for coupled diffusion, and by making certain approximations we can express the net diffusive flux in the system as:(28)

$$J_i = \sum_{j=1}^{n} D_{ij} \nabla^2 c_j \qquad (6)$$

The D_{ij} are diffusion coefficients giving the magnitude of the flux of the i^{th} component caused by a gradient in the concentration of the j^{th} component and the Laplacian operator here measures the departure of the concentration profile from linearity, or the "bumpiness" of the concentration field.(28)

At steady state S the concentrations of the species remain constant in time, hence, $\partial c_i^s/\partial t = 0$. If in addition this state i is uniform, there will be no gradients so $J_i = 0$ and therefore substitution in equation (5) yields $R_i^s = 0$. We may represent excursions ψ_i from the steady state in terms of chemical concentrations as ψ_i, $= c_i - c_i^s$. We will refer to ψ_i as the *displaced concentration*. For small amplitude excursions from the steady state, we may approximate equation (5) by a linear version:

$$\frac{\partial \psi_i}{\partial t} = \sum_{j=1}^{n} K_{ij}^{s} \psi_j + \sum_{j=1}^{n} D_{ij}^{s} \nabla^2 \psi_j \qquad (7)$$

where K_{ij}^s stands for the chemical reaction rate constants of processes that follow first-order kinetics in the concentration perturbations.(28) In matrix notation this may be represented as a standard linear partial differential matrix equation:

$$\frac{\partial [\psi]}{\partial t} = [K][\psi] + [D]\nabla^2[\psi] \qquad (8)$$

Solutions to this equation may take the form of either stationary or propagating waves. If we consider a one dimensional reaction system, one solution to equation (8) is the function representing simple harmonic waves propagating in the r-direction:

$$[\psi] = [a]\, e^{i(k_R r - \omega t)}\, e^{-k_i r} \qquad (9)$$

This equation is restricted by the condition that the wave-number k and the frequency factor ω both must satisfy the determinantal equation:

$$\det([K] - k^2 [D] + i\omega[I]) = 0 \qquad (10)$$

where [I] is the identity matrix, $k = 1/\lambda = k_R + k_i$ and $\omega = 2\pi f$.(28) In the special case of marginal stability, we have $k = k_R$ such that equation (9) dictates undamped oscillations of constant amplitude:*

$$[\psi] = [a]\, e^{i(kr - \omega t)} \qquad (11)$$

We may consider the amplitude of the wave to be a function of the wave vector k, $A = A(k^2)$ and the frequency to also depend on the wave vector in a dispersion relation $\omega = \omega(k^2)$.(30) The wave velocity given by $v = \omega/k$ is therefore a function of k, $v = \omega(k^2)/k$.

Ortoleva and Ross(30) take an approach similar to that of Gmitro and Scriven(28) and derive for small amplitude perturbations in a two dimensional system solutions representing circular standing waves and rotating waves; see Figure 9. The solid lines n Figure 9 indicate nodal curves of constant concentration while the (±) symbols indicate deviations above and below the mean nodal value. In the case of a rotating wave, nodal axis AB would rotate in the plane of the paper.

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* On the other hand, a region of stability will dictate damped oscillations while a region of instability predicts exponentially growing oscillations possibly leading to a stable limit cycle.

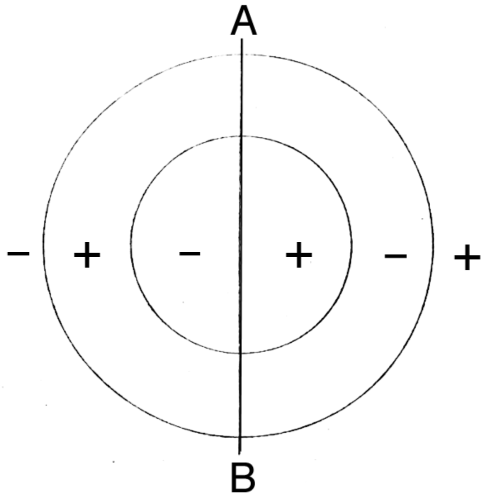

Figure 9. Concentration pattern in a generalized two dimensional reaction-diffusion system representing standing or rotating waves.

It should be noted that representations of small amplitude waves such as equation (11) provide no direct information about the reaction diffusion processes taking place "under the surface". They simply model how the value of Y, changes above and below the zero point as a function of distance and time. Such equations are linear approximations of deviations from a steady state c_i^s. The reaction processes maintaining this steady state, however, are nonlinear. We may put this in perspective by plotting both ψ and c for a particular species i at a particular location r_0 as a time; see Figure 10. Whereas the behavior of ψ_i (t) is given by a linear equation of the form of equation (11) (where $r = r_0$), the behavior of $c_i(t)$ is given by a nonlinear equation of a form similar to equation (5).

Now imagine for the moment that we are observing small amplitude traveling waves of the sort shown in Figure 4 (see next page) and that these are produced in a chemical reaction of the

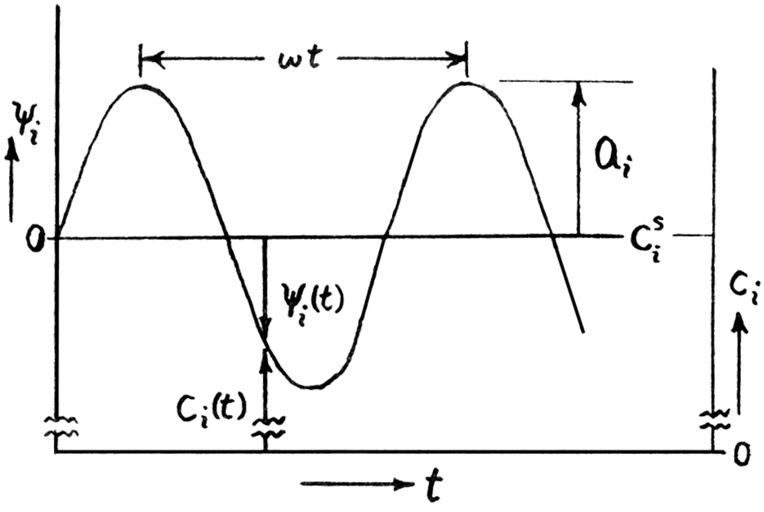

Figure 10. A temporal plot of a chemical wave comparing absolute concentration c_i to displaced concentration ψ_i.

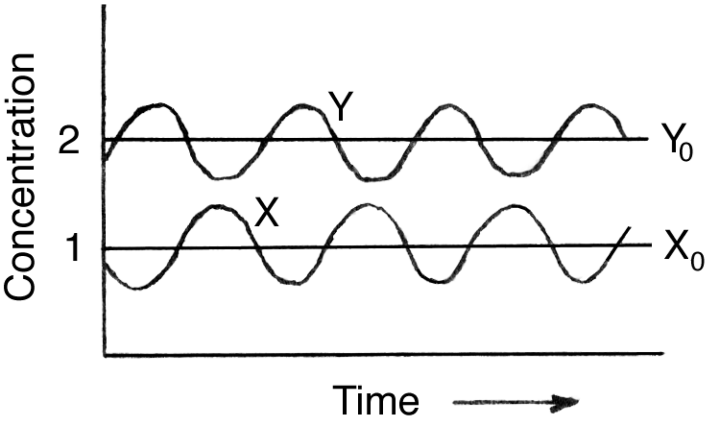

Figure 4. Concentrations of X and Y vs. time for a small amplitude deviation from the steady state in the Trimolecular model (Brusselator) with A = 1 and B = 2).

type shown in scheme (1) operating at a point of marginal stability P. Also, imagine that we are observationally myopic, that all we are capable of detecting is the superficial character of this chemical wave, i.e., its space-time dependent concentration intensities. We would then be in a situation which approximates the predicament of the physicist who with his sensitive instruments is capable only of measuring electric and magnetic field intensities of an electromagnetic wave above and below the zero norm. Under these conditions it is quite likely that we would model the observed chemical wave with a linear equation like equation (11) and possibly even make the mistake of assuming that the existence of the wave was not dependent on the action of any underlying continuum. Since the spatial medium through which the chemical wave was traveling would remain invisible to our detection, we might go so far as to suppose it to be inert, simply a mechanical carrier or a volume called "space" possessing certain mathematical properties.

However, the truth is that we <u>are</u> able to perceive the nature of this underlying substance and know it to be reacting according to scheme (1). Also, we know that the proposed linear wave equation is only a small amplitude approximation, a modeling of an epiphenomenon. A more accurate representation of the wave, would be given by equations (4), but of course, such a representation is mathematically more cumbersome.

The linear wave assumption, arrived at by modeling our myopic perception of the chemical wave, carries with it the tacit assumption that different spatial regions of the "carrier medium" bear only positional relationship to one another, and apart from that they exist independent of one another. However, given that we can perceive the reaction intricacies of the chemical medium, we find this view to be naive; regions separated in space are not isolated from one another, but are interwoven into an organic whole. That is, the chemical concentrations observed within a given volume of medium, dV, will depend both on the production within that volume due to internal reactions , and on the net transport of chemical molecules to or from that volume due to diffusion, see equation (5). These two factors constitute, so to speak, intrinsic and extrinsic processes with respect to dV. Since any change in concentration (say in X or Y) communicated to dV from its environment via diffusion will interact nonlinearly with the chemical medium in dV and affect the level of chemical concentrations in dV, adjacent volumes of medium must be considered, not as being independent of one another, but as being an inseparable whole. Since what is true of volume dV is true of all volumes of the medium, we may say that the entire volume must be treated in organic unity.

This is essentially what Whitehead had in mind when he spoke of "prehensive unification" of things being "together in space, and together in time even if they be not contemporaneous". The diffusion of chemicals from one region of space to another and their interaction with chemicals present in that region would constitute what Whitehead called a *prehensive event*.

I would suggest that the term "empathy" might also be suitable since this word carries the meaning of both spatial communication and affection. Thus, if the reactions at a point in space A are affected by the reactions at a distant point B, point A can be said to be empathizing with point B. If the empathy is mutual, we can say that points A and B are sympathizing with one another.

Prehension, or "empathy," is seen to be the basis for the propagation of chemical waves through the reaction volume. To get a rough idea of how such wave propagation arises, consider the trimolecular model operating at a critical point P and consider two adjacent volumes dV_1 and dV_2 in a linear reaction vessel. Also, suppose that initially the concentrations of X and Y are uniformly distributed at their steady state values. If now in region dV_1 the concentration of X increases and Y decreases in a departure from the steady state, this deviation will be communicated to region dV_2 through diffusion. That is, component X will diffuse into dV_2 and component Y will diffuse out of dV_2. Now since the reaction system is operating at point P, $D_y > D_x$. So, the concentration of Y in dV_2 will be the first to change. Its concentration in dV_2 will fall causing the concentration of X to fall exponentially via reaction step ii (see scheme 1). This fall in X will reduce the rate at which Y is consumed in dV_2 via reaction (ii) allowing Y to build up in concentration via step (iii). This increase in Y will now increase X exponentially and consequently decrease Y. This increase in X will be compounded by the contribution of X diffusing from dV_1 (delayed until now). Thus we find that the conditions of high X and low Y previously present in dV_1 have now been transmitted to region dV_2 via reaction and diffusion processes. This analysis may be extended by considering successively other volumes along the reaction vessel. We would find that the disturbance initiated in dV_1 would be transmitted along the vessel as a wave having a particular velocity and wavelength. The concentration oscillation in each volume would be synchronized but slightly out of phase with the oscillation in an adjacent volume. Thus, the wave emerges as a macrolevel inhomogeneity which is propagated as a result of microlevel molecular reaction and diffusion processes taking place throughout the medium.

The remainder of this paper will explore a new conception of space based on a nonlinear *ether* reaction scheme that is similar in many respects to the trimolecular model (Brusselator). Such a model of space embodies the essential features which Whitehead has stressed in his organic theory of nature and offers a basis for understanding the emergence of inhomogeneities such as photons and material particles.

The paper then goes on to describe a Brusselator-like reaction-diffusion ether scheme that hypothesized in the subquantum kinetics approach. This approach was at this early stage of development referred to as the alchemic ether model.

The alchemic model allows a new conception of space. The notion of simple location is abandoned; space is now viewed as being active and organic, composed of media which are engaged in a process of mutual transformation.* Consequently, a medium inhomogeneity communicated from point A to point B by diffusion will affect the nature of the media transmutations taking place at point B. With this in mind, the notion of spatial volume must be recast from a Whiteheadian perspective:(17)

> ". . . the prehensive unity of the volume is not the unity of a mere logical aggregate of parts. The parts form an ordered aggregate, in the sense that each part is something from the standpoint of every other part, and also from the same standpoint every other part is something in relation to it. Thus if A and B and C are volumes of space, B has an aspect from the standpoint of A, and so has C, and so has the relationship of B and C. This aspect of B from A is of the essence of A. The volumes of space have no independent existence. They are only entities as within the totality; you cannot extract them from their environment without destruction of their very essence."

Whitehead defines the "mode in which B enters into composition of A" as "the aspect of B from A." Accordingly, the *modal character of space* of which he speaks is expressed by his statement that "the prehensive unity of A is the prehension into unity of the aspects of all other volumes from the standpoint of A," or that "every volume mirrors in itself every other volume in space". In a certain sense he says, then, "everything is everywhere at all times. For every location involves an aspect of itself in every other location."

The paper then goes on to describe the alchemic ether model's application to the formation of photons and particles. Eventually this leads into a continued discussion of Whitehead's ideas.

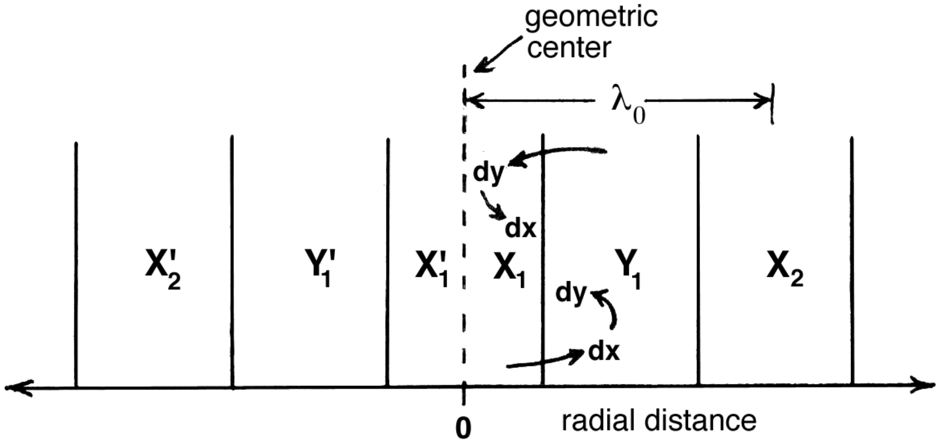

Figure 15. One-dimensional cross sectional view of a 3-dimensional dissipative space structure (material particle) showing how spatial inhomogeneity is maintained through a balance between reaction and diffusion.

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* (from p. 7) The view that the underlying character of the universe is one of activity and change is rooted in eastern religion and also corresponds to Shelley's portrayal of nature. According to Whitehead: "Shelly thinks of nature as changing, dissolving, transforming as it were at a fairy's touch. The leaves fly before the West Wind 'like ghosts from an enchanter fleeing.' In his poem *The Cloud*, it is the transformations of water which excite his imagination. The subject of the poem is the endless, eternal, elusive change of things: 'I change but I cannot die."

. . . Consider Figure 15 which shows a one-dimensional profile of this spherical propagation [steady state dissipative space structure produced by the alchemic ether model]. It is seen that any diffusion of medium X from region X_1 into its complimentary region X_1' is compensated by an equal diffusion from X_1' into X_1. Consequently, the diffusive loss of medium X can only take place in directions away from center point 0; i.e., from X_1 into Y_1 or from X_1' into Y_1'. Consider for the moment just regions X_1 and Y_1. Suppose a quantity dx of medium X diffuses from region X_1 into region Y_1 and an equal quantity dy of medium Y diffuses from region Y_1 into X_1. As was discussed earlier with respect to the tri-molecular model (Brusselator), in regions of high Y concentration there is an affinity for X to be preferentially converted to Y and in regions of high X concentration an affinity for Y to be preferentially converted to X. Consequently in region Y_1, dx will be transmuted into an equivalent amount dy as symbolized by the process dx → dy. This transmutational input of dy into region Y_1 will exactly compensate for the diffusive loss of dy from this region provided that the rate of transmutation keeps pace with the rate of diffusion, as will be the case when the pattern has fully developed and maintains a steady state. Consequently, the concentration of Y in region Y_1 will be preserved unchanged in the face of diffusion. Likewise, the concentration of X in region X_1 will also remain invariant, and similarly for other regions to the left and right of point 0.

We may regard a material particle as being composed of a distribution of etheric units spatially ordered according to whether they are type X or Y. From a thermodynamic perspective this constitutes a state of negentropy. The fact that etheric units diffuse from regions of higher concentration to regions of lower concentration indicates that the Second Law of Thermodynamics is in operation. However, certain open reaction systems, such as the one proposed here, have the ability to oppose the increase of entropy through the action of their processually ordered transmutational (dissipative) processes. Thus, if we visualize the regions of high X and high Y in Figure 15 as alternating regions of red and blue beads engaged in random motion, we would observe, in conformance with the Second Law, that red beads tended on the whole to diffuse into blue regions and blue beads into red regions. However, the original segregated order would remain preserved, for just as fast as the red beads enter into blue regions, they are converted into blue beads, and vice versa.

Thus, a material particle, viewed as a dissipative space structure, has the unique property that, by virtue of its geometry and autocatalytic character, it is able to preserve itself as a stable pattern. Consequently, as the initial quantum X, Y disturbance travels outward radially its "past" becomes frozen; inner lying regions formerly excited into their inhomogeneous state remain so as an enduring structure is formed. A particle is essentially the historical travel itinerary of its parent nucleating fluctuation. Linearly propagating quanta, on the other hand, are more "now oriented." They leave no trace behind as they travel.

Earlier (cf. p. 6) we noted that the prehensive character of the trimolecular (Brusselator) reaction medium is the basis by which chemical reaction waves are propagated. The prehensive character of space as depicted in the alchemic ether model, similarly may be regarded as the basis for the spatial propagation of quanta (both linearly and radially) and for the maintenance of the inhomogeneous steady state known as matter. As an illustration of this latter case, we may note, by reference to Figure 15, that when a quantity dx diffuses from region X_1 into Y_1, region Y_1 "takes account" of this environmental communication by incorporating it into its local reaction kinetics, i.e., through the transformation dx → dy. Consequently, the structure of a particle of matter can be said to maintain its ordered state by virtue of spatial empathy, or what may be otherwise called nonlinear interaction.

It is interesting to note that Whitehead's organic conception of material particles in many respects resembles the dissipative space structure view proposed here.* Whitehead visualizes a subatomic particle, what he calls a "primate", as being associated with a pattern of electromagnetic waves, or what he terms "vibratory organic deformations," which are radially disposed in a stationary manner:(17)

> "A primate must be associated with a definite frequency of vibratory organic deformation so that when it goes to pieces it dissolves into light waves of the same frequency, which then carry off all its average energy. It is quite easy (as a particular hypothesis) to imagine stationary vibrations of the electromagnetic field of definite frequency, and directed radially to and from a centre, which, in accordance with the accepted electromagnetic laws, would consist of a vibratory spherical nucleus satisfying one set of conditions and a vibratory external field satisfying another set of conditions. ...The total energy, according to one of these ways, should satisfy the quantum condition; so that it consists of an integral number of units or cents, which are such that the cent of energy of any primate is proportional a to its frequency.
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> . . . In this particular hypothesis of vibratory primates, the Maxwellian equations are supposed to hold throughout all space, including the interior of a proton. They express the laws governing the vibratory production and absorption of energy. The whole process for each primate issues in a certain average energy characteristic of the primate, and proportional to its mass. In fact the energy is mass. There are vibratory radial streams of energy, both without and within a primate. Within the primate, there are vibratory distributions of electric density. On the materialistic theory such density marks the presence of material: on the organic theory of vibration, it marks the vibratory production of energy. Such production is restricted to the interior of the primate."

His "vibratory radial streams of energy" might be likened in the alchemic ether model to the electric field propagating outward at the boundary of the space structure. However, these stationary vibrations would not be "in accordance with the accepted electromagnetic laws," as he states, since the laws of electromagnetics accepted by contemporary physics do not presuppose that such waves are sustained by underlying nonlinear interactions.

One major discrepancy between Whitehead's view of particles and that proposed in the alchemic ether model is that Whitehead accepts the field-source dualism. He distinguishes between the interior and exterior of a particle, which he says each satisfy a different set of conditions. The alchemic ether model, on the other hand, makes no distinction between inside and outside. A particle has only an "inside" in the conventional sense, no "outside." The extent of this inside region is determined by the particle's event horizon, i.e., the radially propagating electromagnetic field boundary induced by the photon that created it (i.e., in the case of pair production). Thus, the particle's radius is time dependent, expanding at the rate of 186,000 miles per second, where $r = ct$.

What is usually thought of as the "inside*' of a particle, i.e., the nucleus (which is on the order of 10^{-13} cm in the case of a proton) is not distinguishable in the alchemic ether model, save for the central concentration inhomogeneity. But, this core inhomogeneity contains no units of charge or mass. As a will be discussed in a subsequent paper, the seat of a particle's electrostatic potential resides throughout its space structure. The attractive or repulsive action of a particle's "electrostatic field" may be traced to the geometry of the particle and whether an elevated concentration of X or Y resides at its center. Thus "charge" becomes viewed as a property characteristic of the entire volume of a particle. Likewise, "mass" is also viewed as a property of the entire particle space structure, being related to the peak intensity of the displaced medium concentration in the particle's standing wave pattern.

> The paper then goes on to discuss de Broglie's wave theory of matter and how the dissipative structure particle predicted by the alchemic ether model (i.e., subquantum kinetics) satisfies quantitative experimental observations of particle diffraction and correctly predicts the radii of the Bohr orbits in the hydrogen atom. All this is essentially as is described in the published version of subquantum kinetics.

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