TOWARD A PREHENSIVE MODEL OF SPACE

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This unpublished paper presents a glimpse at the early formulation of the subquantum kinetics methodology three years after its inception and 11 years prior to its first journal publication. It presents a philosophical rationale for the theory in the context of process philosopher Alfred North Whitehead's criticisms of contemporary physics. The subquantum kinetics approach, which was developed without knowledge of Whitehead's work, is shown here to provide a viable reformulation of microphysics that is consistent with Whitehead's concept of prehensive space. LaViolette also discusses the ether concept and at this stage in the development of his theory he makes the bolder assertion of referring to his proposed subquantum media as composing ether states in an inherently "alchemic" ether.

In his book *Science and the Modern World*, the American philosopher Alfred North Whitehead criticizes the modern foundations of physics stating:(1)

> "It is the defect of the eighteenth century scientific scheme that it provides none of the elements which psychological experiences of mankind. Nor does it provide any, elementary trace of the organic unity of a whole, from which the organic unities of electrons, protons, molecules, and living bodies can emerge."

Whitehead finds that the trouble lies with the doctrine of materialism which is tacitly assumed. He traces this world view back to the Hellenistic Age:(2)

> "The answer, therefore, which the seventeenth century gave to the ancient question of the Ionian thinkers, 'What is the world made of?' was that the world is a succession of instantaneous configurations of matter - or of material, if you wish to include stuff more subtle than ordinary matter, the ether for example."

He defines matter, or material, as anything which has the property of simple location. This concept of simple location includes certain minor characteristics that space can be divided without dividing time and that time can be divided without dividing space. But, Whitehead's definition of simple location also refers to the popular concept, held to be characteristic of both space and time, that in expressing spatio-temporal relations of a bit of material "it is adequate to state that it is where it is, in a definite region of space, and throughout a definite finite duration of time, apart from any essential reference of the relations of that bit of matter to other regions of space and to other durations of time."(3)

Whitehead notes that this view of concrete reality met with success, in the seventeenth century when scientific interest was mainly concerned with mechanical phenomena. Forces such as gravitation were supposed to be determined by the particular configurations of bodies, such as

their mass:[4]

> "Thus the configurations determined their own changes, so that the circle of scientific thought was completely closed. This is the famous mechanistic theory of nature, which has reigned supreme ever since the seventeenth century. It is the orthodox creed of physical science. Furthermore, the creed justified itself by the pragmatic test. It worked."

This doctrine of simple location which was at the foundation of the seventeenth century scheme of nature also formed that basis for the ether theory accepted up through the 19th century. Space was assumed to be filled with a substance known as the "ether" and objects such as physical bodies were assumed to be simply located in this substance much like stones in a sea of water. Different portions of the ether would not have any affect on these simply located bodies. A body located in this ether, it was supposed, would not be affected by the ether substance itself but would require the impingement of light waves, gravitational waves, etc. transmitted through the ether. Hence, the ether (or space) played the passive role of carrier of matter and energy.

This view has been retained even in modern theories, since modern field theories are essentially remnants of the 19n century ether theories. The field theory developed by Maxwell achieved surprising success by conceptually unifying with a general set of equations, diverse branches of physics such as optics and electromagnetics. However, this theory was originally based on the ether model. Fields were conceived as mathematical representations of real waves in a mechanical ether. However, with the critical experiments of Michaelson and Morely, which demonstrated the speed of light to be constant regardless of the frame of reference, the ether theory was abandoned. Although the notion of the ether as a concrete substance was disclaimed, still its mathematical field representation was retained. Modern physics merely rejected the conceptual model of "ether" while mathematically retaining most of its underlying assumptions.

Hence, the doctrine of simple location, which was tacitly assumed in the ether theory, was carried over to modern field theory. Mathematically, this assumption appears as the assumption of linearity. The fact that an electromagnetic wave is represented mathematically by a linear equation indicates the acceptance of the assumption of simple location. According to such a representation, the field intensities of an electromagnetic wave establish themselves in successive regions of space much in the same way that a moving object would occupy successive spatial locations. This view suggests that space is inherently passive, or inert, fields becoming impressed on space much the same way that magnetic impulses are impressed on the magnetic tape of a recorder. The linear assumption allows two or more wave equations to be superimposed on one another such that their respective values at each spatial coordinate are simply additive. Hence, each equation behaves independently. According to this assumption, if two light waves were to cross paths, i.e., occupy the same region of space during the same period of time, they would not interact with each other, as in the case of two waves crossing paths on the surface of a pool of water. Whether or not this is a legitimate claim cannot be easily ascertained. The mass of a single photon of the kind easily produced in the laboratory is not very great, while its speed of travel is significantly high. By contrast, starlight can be observed to bend when passing near a massive body such as the Sun. But even under such circumstances, the deflection is minor and requires several million miles of travel to be adequately observed.

It is understandable why physical science has retained this assumption; linear equations have been successful in representing a substantial range of phenomena, and more importantly, they are relatively easy to solve mathematically. The significance of this last point cannot be overly

stressed. Mathematical physics has unconsciously oriented its concepts of reality and its choice of areas for investigation to conform with its ability to achieve mathematical workability. Moreover, 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. We can only hope to draw inferences from indirect observations.

The physical sciences (especially field theory) seem to be alone among the sciences where use of the linearity assumption (simple location) leads to acceptable approximations of the observed phenomena, where the use of a mechanistic model appears to be a somewhat successful choice. In all other sciences (i.e. biology, psychology, sociology, etc.) it was discovered quite readily that the linearity assumption was inadequate. In the field of economics, this is only now being recognized. In all these fields of study, the mechanistic model failed and was replaced by the concept of organism. Most phenomena in these natural sciences are more appropriately described by *nonlinear* equations. The elements of natural systems are generally not independent in their behavior, but interactive.

There are, however, several physical phenomena which are more appropriately described by nonlinear mathematics. Most of these phenomena deal with nonequilibrium systems, i.e. flow phenomena (physical translocation) such as convection, tornadoes, weather patterns, or transmutational phenomena (physical transformation) such as biochemical or nuclear reactions. One example in the field of chemistry is the Belousov-Zhabotinskii reaction system, which may be classified as essentially a transmutational phenomenon.

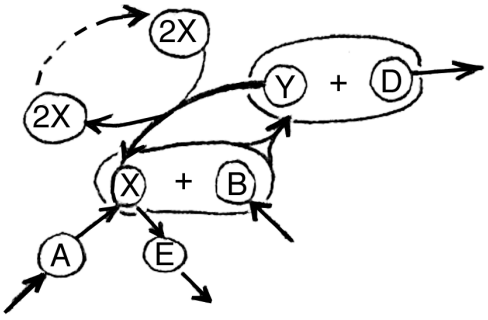
For brevity this model will not be discussed here due to its complex nature. Instead a simpler reaction scheme will be substituted, one known as the Tri-molecular model, or Brusselator; see below.

$$A \rightarrow X \qquad \text{(a)}$$

$$2X + Y \rightarrow 3X \qquad \text{(b)}$$

$$B + X \rightarrow Y + D \qquad \text{(c)}$$

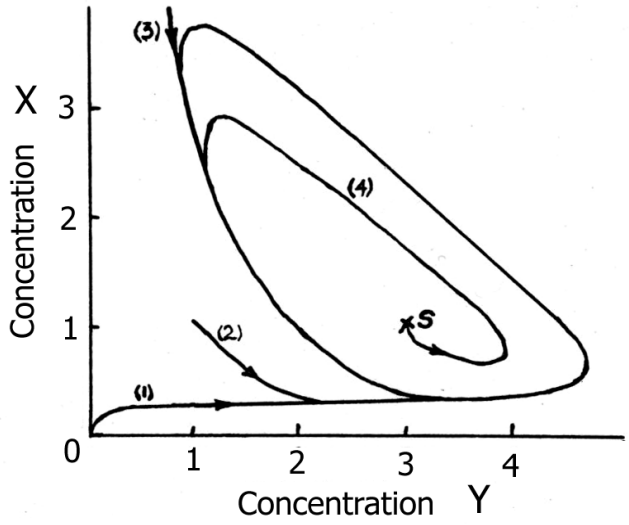
$$X \rightarrow E \qquad \text{(d)}$$



This chemical reaction model, which was first introduced by R. Lefever and further studied by P. Glansdorff and I. Prigogine,[5] is not observed to occur in nature, however it serves to illustrate some important aspects of nonlinear systems. Kinetic equations (a) - (d) depict a series of chemical transformations which proceed irreversibly in the direction indicated by the arrows. As long as input chemicals A and B are supplied, the system will remain in a nonequilibrium condition with the overall reactions proceeding as A X E and B D. Chemicals D and E are

constantly being removed from the system (i.e. their concentrations arc maintained vanishingly small). Therefore, if chemicals A and B were no longer supplied to the system, eventually all the chemicals of the system would become transformed and nothing would remain. Such a system, an "open system" is inherently dynamic, its existence being dependent upon the maintenance of the dynamic state.

One important feature of this reaction scheme is that it has a nonlinear reaction, equation (b). This equation is nonlinear because its product X has the tendency to grow in abundance exponentially with time. This happens because equation (b) is self-catalyzing with respect to X, that is, as more X is produced as a product (right side) more X becomes available as a reactant (left side) to convert Y to X. However, the quantity of X is not able to grow indefinitely. It is kept in balance by equation (c) which converts X back into Y. These two equations taken together constitute a self-closing reaction loop. That is, they are coupled by elements X and Y which are common to both equations. Coupling marks a second important feature of our reaction scheme because, in general, nonlinear coupled reactions have the ability to oscillate. That is, the rate of production of the respective species X and Y may not be constant, but may vary with time such that first X grows in predominance at the expense of Y followed by a period when Y grows at the expense of X. The nature of this exchange between X and Y is illustrated clearly by the principle of *yin* and *yang*, wherein the total amount of activity remains constant while alternating between two poles. In scientific terminology this is known as a "limit cycle"; see the diagram below.(6)



Thus, the phenomenon of periodicity, Whitehead's principle of reiteration or endurance, arises naturally in dynamic systems (such as chemical reaction systems) provided that such systems have processes that are coupled (i.e. that take account of one another, in Bacon's terminology) and provided that at least one of these processes is nonlinear, has growth characteristics.

Having briefly reviewed some of the dynamic characteristics of the Trimolecular model, let us now study its behavior distributed in space: Imagine a volume filled with a reacting medium of this sort. The concentrations of chemicals A, B, D, and E would be expected to be homogeneously distributed in space and constant over time since the reaction kinetics dictate time invariance for these quantities. However, with respect to variables X and Y, three

conditions may prevail:

1) the concentrations of X and Y may remain uniform throughout the volume, unchanging with time (i.e., remain in a steady state condition). Such behavior usually occurs when the rate of transmutation is relatively low (near equilibrium);
2) the concentrations of X and Y may become inhomogeneously distributed in space while remaining invariant with respect to time; or
3) the concentrations of X and Y may vary both spatially and temporally, hence this behavior would give the appearance of propagating waves, with X and Y mutually oscillating with respect to one another.

These last two possible modes of behavior of dynamic systems, known respectively as space ordering and space-time ordering, usually occur when the rate of transmutation in the system exceeds a certain critical threshold (i.e. when the reaction system is operating far from equilibrium).

It is interesting to note that the periodic wave of condition (3) may be modeled by the same type of linear wave equation used to describe the propagation of an electromagnetic wave, for the special case in which the chemical wave travels in a one-dimensional medium such as along the length of a capillary tube. Such an equation might successfully model the overall sinusoidal character of the X, Y concentrations as they appear at successive positions in the tube, however, they tell nothing about the underlying dynamic processes which, in the space-time ordered state, produce the observed traveling wave pattern. Thus, the linear wave equation provides only a superficial description of the chemical wave phenomenon.

As in the case of observing electromagnetic wave phenomena, imagine that all we are capable of detecting is the superficial character of the chemical wave itself. Under these conditions, it is quite likely that we would model it with a linear equation, and possibly even make the mistake of assuming that its existence was independent of any underlying continuum. Since the substance through which the chemical wave was traveling would remain invisible to detection, we might go so far as to suppose it inert, simply a mechanical carrier or a volume possessing certain mathematical properties. However, the truth is that we do know the nature of this underlying substance (as postulated in the original definition of our model) and we know that the proposed linear wave equation would only be an approximation. A more accurate representation would depict a series of reaction equations, one of which would be nonlinear.

In studying the relationship between different regions of the proposed reaction volume, it would be discovered that 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. Since any change in concentration (say in X or Y) communicated to dV from its environment will interact nonlinearly with the chemical medium within dV and since the resulting concentration will no longer be simply the sum of the impinging external contributions, adjacent volumes of medium must be considered as 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 has in mind when he speaks 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 region of space and their interaction with chemicals present in that region would constitute a prehensive event.

This prehension is seen to be the basis for the propagation chemical waves through the

reaction medium. For example, consider a region dV whose concentrations of X and Y are in mutual oscillation over time at a fixed frequency, see limit cycle diagram. Due to the mutual interconnection between this region and surrounding regions, as a result of diffusion, the X,Y oscillation in adjacent regions will be synchronized but slightly out of phase with the oscillation in region dV.

The overall effect will be to give the appearance of a wave being propagated through the medium at a fixed velocity, its propagation velocity and wavelength being related to this diffusion dependent phase difference and to the oscillation frequency. Thus, a wave is, in effect, a phase pattern fleeting through a medium of underlying dynamic activity. At any given instant this pattern will incorporate an internal reality and an external reality. Such a model seems to fit the description of Whitehead:(7)

> "Accordingly, a non-materialistic philosophy of nature will identify a primary organism as being the emergence of some particular pattern as grasped in other events, whereby those other events receive a modification, or partial determination. There is thus an intrinsic and an extrinsic reality of an event, namely, the event as in its own prehension, and the event as in the prehension of other events. The concept of an organism includes, therefore, the concept of the interaction of organisms."

In the remainder of this paper I would like, to propose the idea that the above nonlinear reaction model, or something similar to it, be proposed as a new concept of space. Such a model would embody the essential features that Whitehead stressed. One might envision the following reaction scheme, where A, B, G, X, Y, D, and Ω represent different media filling space:

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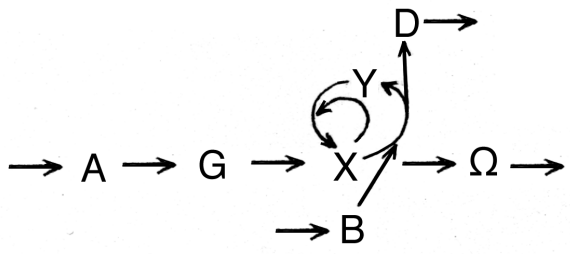
$$A \rightarrow G \qquad (a)$$
$$G \rightarrow X \qquad (b)$$
$$2X + Y \rightarrow 3X \qquad (c)$$
$$B + X \rightarrow Y + D \qquad (d)$$
$$X \rightarrow \Omega\ . \qquad (e)$$



Media A, B, D, and Ω would remain homogeneously distributed in space and in time, hence they would be physically undetectable, while media G, X, and Y would be free to acquire space-time dependence. A gradient in the G medium would indicate a gravitational field while a gradient in the X and Y media would indicate the presence of an electrostatic field (magnetic field affects arise from the X,Y media gradients when observed from a different frame of reference). These various media might be thought of as different states of an all embracing ether whose inherent nature is not passive, but dynamically active, being in a continual state of transformation. The physical universe would be a manifestation of oscillations in the X, Y, and G variables while the global reactions $A \rightarrow G \rightarrow X \rightarrow \Omega$ and $B \rightarrow D$ could be conceived as being a portion of a hyper-

dimensional "primal flow" or *prana*. Time becomes viewed now as this 4th spatial dimension of the ether which is inherently dynamic. Our perception of time, or of change, arises because our physical universe has evolved from a stationary point in this primal flow (the X, Y cycle).

This view of the underlying character of the universe would conform with Shelly's conception of nature. According to Whitehead:(8)

> "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.'"

Whitehead also emphasizes the importance of endurance and eternality:(9)

> "Every scheme for the analysis of nature has to face these two facts, *change* and *endurance*. There is yet a third fact to be placed by it, *eternality*, I will call it. The mountain endures. But when after ages it has become worn away, it has gone. If a replica arises, it is yet a new mountain. A color is eternal. It haunts time like a spirit."

One might say that the respective ether states, or media, are eternal in their nature, that in the presence of this ethereal transformation, these unique states persist. Also, the pathways of transmutation and the self-closing X,Y cycle could be said to be eternal.

What was described earlier with regards to the Trimolecular model could be applied to this spatial ether, which may be referred to as the alchemic ether to distinguish it from the conventional materialistic concepts of ether prevalent in the 18th and 19th centuries. Light waves according to this theory would not be impressed upon space like waves on the surface of water, but would emerge in space as temporal modulations, or limit cycles in the ever present transmutation (i.e., $X \rightarrow Y$, $Y \rightarrow X$) going on in all regions of space.

We arrive, therefore, at a new concept of space, of space being active and organic. This view abandons the traditional notion of simple location, for as Whitehead says:(10)

> "In a certain sense, everything is everywhere at all times. For every location involves an aspect of itself in every other location. Thus every spatio-temporal standpoint mirrors the world."

In summary, we see that the reaction-diffusion ether concept proposed here offers a viable model for realizing Whitehead's prehensive, organic view of space.

References

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4) Ibid., p. 50.
5) Glansdorff, P., and Prigogine, I. *Thermodynamic Theory of Structure, Stability, and Fluctuations*, New York: Wiley, 1971.
6) Ibid., p. 241.
7) Whitehead., p. 103.
8) Ibid., p. 86.
9) Ibid., pp. 86-87.
10) Ibid., p. 91.