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INSTANTANEOUS RELATIVISTIC ACTION-AT-A-DISTANCE

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Abstract

It is popularly believed that there is some strange disparity between quantum physics and physics generally, that whereas ordinary physical interaction takes time to travel, at speeds up to the finite limit *c*, quantum interaction (action-at-a-distance) is instantaneous, regardless of distance. We shall demonstrate that there is nothing paradoxical about this situation, by proposing a new phenomenalistic approach to relativity in which the 'photon' ceases to be a space-travelling action-capsule and becomes, instead, an irreducible element of those informational time-sequences out of which the phenomena of distance and motion are observationally projected.

Key words:
relativity, quantum, photon, instantaneous action-at-a-distance, information, EPR paradox, Kant, Mach, phenomenalistic.

1. INTRODUCTION

Customarily, we tend to think that there can be only one proper approach to physics. This is the standard ‘empirical’ approach which some see as being simply to discover, by careful observation and instrumental probing, the properties of a preconceived ‘universe’ of space and time, filling in the gaps in our knowledge, wherever necessary, by the exercise of educated scientific imagination. However, all expectations that this would automatically produce a simple, natural and logical understanding of nature have now all but disappeared. For it seems that the ‘Standard Model’ which is the evolutionary end-product of this traditional line of research is now beyond saving by further experiment or theory. For instance, it is increasingly being said by physicists of repute that quantum theory and relativity are ultimately irreconcilable.[REF.1] Many think that this, if true, is a scandal. Our opinion is that no less than a radical revision of our classical conceptions of the ‘universe’ of space and time is the measure of what is needed to avoid that scandal.

What is required, we suggest, is to try out an altogether different philosophical approach to physics. But what other such approach may we contemplate? The answer to that question was provided by Mach, who parted company from standard science to follow the more empirically puristic or ‘phenomenalistic’ route pioneered by Berkeley, Hume and Kant.[REF. 2] Mach’s contribution to physics provided the foundations of the Copenhagen, or “Positivist” approach established by Bohr in the 1920s, which has proved to be extremely influential in some areas of theoretical physics. However, due to certain drawbacks in its original formulation, that philosophy has still not found general acceptance among physicists. Meanwhile, in areas of philosophy there have been significant developments in that method, which show, if our arguments are correct, that phenomenalism has been largely misunderstood and that as an approach to physics it has much more to offer that has hitherto been considered.

2. THE PHILOSOPHICAL RELATIVISM OF MACH

2.1 The observer-centred approach to physics

The ethos of this phenomenalistic tradition is expressed in the words of Kant. "It has always been assumed", he said, "that our knowledge must conform to objects, but the time has come to ask whether better progress may not be made by supposing that objects must conform to our knowledge."[REF. 3]

Mach was the first of the modern physicists to adopt this Kantian, observer-based approach to the discipline. Yet physicists, nowadays, are mostly unaware that this Kantian approach to physical phenomena, which Mach introduced, is the philosophical source of both Relativity and Quantum theory.[EN.1] However, even Einstein and Bohr, who both, in their very different ways, followed Mach in adopting this observationalist approach, did not really grasp its underlying philosophy – which is doubtless why, in their respective approaches to physics, they were so notoriously divided. Why, then, has this Kantian approach been so misunderstood? The reason is that in its formative stages it was judged by practical men of science to be "subjectivistic" or "idealistic" – which, unfortunately, it then was, due to its peculiar formulation, by George Berkeley, in his famous but erroneous dictum *esse is percipi* (to be is to be perceived). This seemed to reduce everything, absurdly, to "ideas in the mind". The general contempt for this early relativism of Berkeley's was expressed by Samuel Johnson, who kicked at a stone, saying "Sir, I refute thee thus!"

This Johnsonian attitude to relativistic philosophy dies hard. Thus, despite improvements in that philosophy since Berkeley's day, by philosophers like Moore, Austin, Ryle and Wittgenstein (see section 2.4), and despite the fact that physics is more and more forced to adopt this relativistic stance, the philosophical "penny" is taking a long time to drop. We might say, then, that the so-called "relativistic revolution" is not so much a revolution occurred as a revolution deferred.

It is proposed, therefore, that we start afresh along the purely observationalistic route provided by Mach in the manner of Kant and see where it takes us along those further, more realistic lines developed by Moore *et al*. Our starting-point, accordingly, would be Mach's observationalistic rejection of Newtonian "realism", that presumptuous "God's-eye-view" of a universally extended and permanent void with geometrical dimensions and other characteristics of its own. For Mach, matter was alright. It was something observable, a thing of sense and instrumental detection. The "void", on the other hand, was for him a thing of nonsense (non-sense). Its only claim to existence was as a measure of separation between one sensed piece of matter and another. To think that if all that matter miraculously vanished, it would leave behind a universe of empty space, "ticking away metaphysically", with nothing going on in it, seemed to Mach the height of absurdity.

This relativism of Mach's, postulating the observer-dependence of the dimensions space and time, was what inspired Einstein in formulating his Special Theory of Relativity. The trouble was that Einstein compromised true relativism by basing it on the classical notion of light travelling invisibly in the sort of space that Mach regarded as nonsense.[REF.2] Nor did it help that as a "relativist", Einstein was able to talk with deistic equanimity about how "God" sees things "behind the scenes".

Doubtless it was for such reasons that Mach, towards the end of his life, rejected Einstein's theory of relativity, declaring that in his view it was "A mere transitory inspiration ion the history of science.[REF. 4] Mach would scarcely have been surprised, then, at the continuing conflict between the followers, respectively, of Einstein and Bohr. The reason could not be plainer: Einstein's Relativity is *continuistic* whereas the quantum theory of

Bohr, *et al.*, is *discontinuistic.* That conflict tells us that as proponents of the same observationalist philosophy, either Bohr or Einstein got it wrong – or that, perhaps, both did.

2.2 The Essential Discreteness of Observational Elements

Bohr, however, was a more consistent relativist, in one sense, than Einstein. The problem with a theory like Einstein's, which assumes a connecting-up of observational events "behind the scenes", by means of any kind of continuum, geometrical or mechanical, call it "field", "ether", "void", "space-time substratum" or whatever, sets that experience "in aspic", so to speak. The classical case of this was the "plenum" of the Eleatic Greek philosophers, who thought that all change and motion are illusory. Everything that *is*, as opposed to what only *seems*, they said, was One, Immutable and Immovable – that is, absolutely continuous, with no gaps or voids. The problem with this, of course, was one of stasis. Existence was "jammed solid".

To solve this problem of immobility, the physicists of the time "loosened things up" by "atomising" the Eleatic Substance and introducing the highly paradoxical notion of "the void" as a real and independently extended *nothing*, in which those "atoms" had room to move about. Splitting substantial reality into matter and void was thus the Atomists' expedient solution to the stasis problem.

This same stasis problem recurs today, with Einstein's geometrising of this Atomistic "void". Relativity is all about observation, which is essentially communication. But communication is impossible where its elements are all determinately connected-up in some geometrodynamical four-dimensional plenum. For communication to be real, information has to be real; and information, as Shannon has demonstrated,[REF. 5] is a measure of improbability. But there can be no improbability in sequences of events that are either mechanically or geometrically determined. Such sequences are therefore devoid of informational content.

A "relativism" like Einstein's, then, which assumes that all observational events-sequences are geometrodynamically connected-up in some continuous "substratum", is philosophically incoherent[REF. 6], which goes a long way towards explaining Mach's rejection of Einstein's Theory of Relativity. Events-sequences have to be "atomised" to allow for communication, in the same way that the "Eleatic One" had to be atomised to allow for motion and change. In true relativism, therefore, all observational events have to be basically dissociate, which means discrete and indeterminate – in a word, *quantised*. Like characters in a printer's font, they cannot convey information without the efforts of a compositor (i.e., an observer). If those characters were all mechanically linked together the compositor's work would be impossible.

2.3 The Holistic and Directive Integrity of Relational Systems (Forms)

Some physicists, whilst accepting this indeterminacy or dissociation of ultimate quantum-events, disallow all such talk of "compositors", or minds, directing such sequences. If mechanical or geometrodynamical determinacy is eliminated, they say, then there is no connection left between the quantum elements of physical processes, which leaves those events entirely random.

This takes us back to another problem which the Greeks encountered: whether what exists in any real sense is the whole of an object or only its parts. To classical physicists it seemed that only the ultimate bits of things were real and that collections of those bits ("forms" or "universals") were unreal in the sense that they could not exist without those component bits (the view known as reductionism). But those ultimate bits ("atoms"), they said, are invisible, so those things we observe, which are not atoms but collections of atoms, are merely figmentary, having no reality in themselves and therefore no powers over their own destinies. And since those invisible atomic bits were regarded as purely mechanical, acting individually in a "space" all of their own, without any cognisance whatever of one another, far less of those wholes of which we say they are the parts, the "universe", inasmuch as it made sense to speak of it, was regarded as a set of ultimate particles, whose movements and contacts were either purely accidental or (as in later theories) mechanically pre-ordained.

With our relativistic (Kantian) reorientation, however, that classical reductionist argument is reversed. Starting with things at the empirical level of reality, that is, with things we actually observe, we say that the ultimate parts, or observational elements, into which those things may be sensibly or instrumentally analysed are simply *events* that have no qualities or characteristics whatsoever other than in the contexts of those observational wholes of which they are the analysed parts.[REF. 7] This removes all justification for assuming that discovering the indeterminacy of sequences of those atomic events is the same as discovering that they are completely random. What indeterminacy does entail is that those sequences may be either completely random (non-informational) or informational (probabilistic).

But if the atomic events that are the ultimate parts of things are mechanically and geometrically unconnected, then what makes those things hang together in the way they do? Our answer is, the *logical character of the whole*. [EN. 2] For example, the reason why the moon circles the earth is not because the "void" between them is in some kind of "gravitational" tension, of a strength which would snap great bunches of steel cables. Nor is it because of any continuous exchange of sub-real "virtual particles" called "gravitons", which "gyre and gymble" in some sub-vacuous "wabe".[REF. 8] It is simply because each body has a holistic relation traditionally called *angular momentum* relatively to the other body and to other bodies in general and because that angular momentum is a paired and overall conserved relation. For the moon to move in some way other than it does relatively to the earth, and vice versa – with the consequence that both bodies would have to change their motions relatively to the aggregate of "fixed stars" – some measure of force i.e., *real* force) has to be applied to one or the other of those bodies. And because that force requires the expenditure of energy, and because energy is also conserved, such losses or gains in energy of the earth or the moon – or any other body, for that matter – have to be accompanied by corresponding gains or losses (respectively) in energy somewhere else; otherwise we have to contemplate some kind of miraculous breach of the law of conservation. The kind of physical connection, if any, by which that transfer of energy takes place is therefore unimportant. The important thing, from our relationist point of view, is to identify the law relating to the whole. Once this holistic law is correctly determined, the motions of the parts are sufficiently explained.

Einsteinian relativity, of course, cannot avail itself of this holistic law-directed way of thinking. This is because such laws demand immediate and mechanically acausal, at-a-distance responses of particles to one another under the law, whereas in Einsteinian Relativity there can be no such immediate and instantaneous responses, due to the limitation placed on physical interactions in the form of the "speed of light *c*"[REF. 9]

2.4 The "Observer" of Post-Machian Relativism

So far as modern relativistic or relationistic philosophy is concerned, the only difference there can be between the classically conceived "world of physical objects" and the "world of subjective appearances" is a difference between one set of *ideas* and another. As Austin would say, [REF. 10] the only difference between a real barn-door and an *idea* (i.e., a concept, subjective impression, illusion, hallucination or whatever) of that barn door is between two different constellations of observational impression. The one involves, say, walking up to that object in broad daylight, knocking on it, picking at it with a penknife, checking that other observers concur with our findings, and so on. The other consists in, say, thinking about that object, having some vague impression of it whilst feeling about in the dark, or whilst under the influence of drink or drugs, seeing it at a distance in a dim light, or in some other similarly disadvantaged way. However, the only possible way of judging whether an impression is of this second, illusory kind is with reference to impressions of the first kind. Since we can never perceive the barn-door as "God" might be presumed to perceive it behind *all* those various impressions, no appeal to any such object as the datum of "reality", can add anything whatever to what we already know about it with the best of our available sense-perceptions, both direct and instrumental.

But, of course, we do not perceive everything there is. There are always those things, parts of things and properties of things that we do not perceive and which may never be perceived by ourselves or anyone else. In what sense can these exist in observationalistic philosophy? It all depends on what we mean by "perceive". The early phenomenalists spoke of "perceiving" as though it meant "directly sensing". Allied with reductionism, this interpretation narrows down even further to the receiving of isolated so-called "sense-data", regarded by positivists as the ultimate "atoms" of sensation. In the extremer forms of this positivistic view, the external sources of those "sense-data" drop out altogether, and all we are left with are those elemental sensations and our own purely subjective ways of interrelating them – the absurd position known as solipsism.

All this, as later philosophers realised, was due to what Wittgenstein identified as "misuse of language" Subsequent phenomenalism, accordingly, makes proper use of the more common sense meaning of "perceiving" according to which what we "perceive" is never "elemental sense-impressions", or "sense-data" – whatever that might mean – but whole *relational systems* of the same. For instance, we perceive that the barn door has shape, size, and solidity, that it has position and distance in relation to other objects. We perceive that it has inertia, mass, momentum and so on, not by some special set of "inertia-impressions", "mass-impressions", "momentum-impressions", etc., but by observing, with all our sensations in concert, what happens when we push it or walk into it or when it slams against the frame. In similar ways, we perceive that it has weight in relation to the Earth, that it has a certain chemical composition, and so on. All these are things that, in the common sense meaning of the term, we *perceive*, and all, without exception, are systems of interrelation which the object has with other objects. An object which has no interrelation whatever with any other object – like the classical atom in the classical void – is impossible not only to perceive but also to imagine, which means that any description of an object as an ultimately real and isolated "thing-in-itself" is no more than a conceptual conundrum.

The old Johnsonian imputation of "subjective idealism", levelled at observational relativism from Berkeley right up to the time of Mach, can therefore no longer be levelled at the later versions developed by Moore and his successors.[REF. 11] This is for two reasons. One is because in systems of relation as wide as we are now considering, when the fullest possible account of those relations and their *relata* [EN. 3] is completed nothing remains, behind and beyond perception, to which the classical term "thing-in-itself" can be meaningfully applied. At that stage, to call all that we know "subjective ideas" is meaningless. This makes the "subjectivity" of our perceptions of things no more than a matter of degree – we can always reduce that level of subjectivity by more and more detailed inspection. The second reason follows from the first, namely, that in such large-scale relational systems there is no uniquely *self*-centred observational frame of reference. The same transformations of one viewpoint, or reference-frame, into another apply, here, as in Einstein's theory. Nor are those other "viewpoints" necessarily those of other *human* observers. They may be the reference-frames of instruments of observation – and any object whatever can be an instrument in this sense and therefore a rudimentary "observer".[EN. 4] In this way, the "self" of early idealistic philosophy – that is, the assumed unique centre-of-reference for physical descriptions –becomes absorbed into the objective relational background. Its appearance and disappearance on the scene (birth and death) and the continuance of the world both before and after those events becomes as much a product of those objective relational systems as does anything else. The fact that this is more or less what commonsense naturally assumes has led to this post-Machian phenomenalism, or relativism, becoming known as normal, or common sense realism. [REF. 12]

2.5 The Quantum Informational *logos* or Language of Nature

Needless to say, in this new, observationalist, approach, the self-sufficient "void" that was invented by the atomists to allow for the motion of matter and which has no relation with anything is now surplus to requirements. So any idea that those relational systems we have been speaking about are immersed in that "eternal vacuum" must be firmly set aside. What we are talking about at this level of analysis is not *physis* but *logos*; that is, not determinate mechanisms of matter in a self-sufficient and continuous space lying "behind the scenes" but indeterminate *systems of information* or *language*. This, of course, is not necessarily *human* language. It is the objective common factor of all communication whatsoever, the universal language of nature, which the Greeks called *logos*. This, we would say, is the ultimate datum of reality that all science seeks.

2.6 The Observer as "Reader" or Information Processor

It is in terms of this quantum informational *logos*, we argue, that objects at various levels of simplicity or complexity, and various levels of automaticity or autonomy, communicate their relative existences and spatial interrelations to one another. At the level of isolated quanta (whatever that might mean) there are no informational sequences, so at that level of analysis there is no "matter" or "space" – or anything else – to speak about.

From information communicated in this way the human observer projects his dimensions of distance and time in the manner described by Ayer (see Sec. 3.1). That is to say, each observer becomes a "reader" of that natural informational script compiled by other observers both complex and rudimentary, and the *world* is the story they tell one another in all this prolific correspondence. All this is consistent with the stance of phenomenalism insofar as it eschews all discussion of any supposed "reality" lying behind and beyond *observation* in the ordinary, catholic sense of "observation" we have defined.

2.7 Redundancy of the "Velocity" Interpretation of *c* in Relativity

It scarcely needs saying that these ultimate quanta of the informational script out of which we project physical space, time and motion, cannot travel in that same physical space and time. There is thus a clear distinction between our alternative, Kantian-inverted, contextualist approach to relativistic physics and the approach of the "standard model". The one is the conceptual "inside-out" of the other. That is to say, the light-in-space of the standard model becomes the space-in-light of the contextualist alternative. In other words, "light" ceases to be a quasimechanical, space-travelling interconnection between otherwise unconnected things-in-themselves and becomes part and parcel of the observer-integrated relational system. So, instead of travelling in space, photons become discrete and irreducible microphenomenal bits (quanta), appearing in observation like the sequences of magnetic "blips" on a video-tape out of which the viewer projects the programme scenario.

It is thus the processions of photonic events, in direct and communicated observation which are propagated in terms of distance, time, speed, energy, entropy, and so on, not isolated photons in some underlying and continuous "vacuum". Sequential improbabilities of such processions are, as we say, the information out of which phenomena and their distributions in space and time are constructed. So instead of thinking of *c* as a "speed *in vacuo* we may think of it simply as a constant for converting observationally projected distances-in-metres into observational times-in-seconds.

3 MACHIAN ACTION-AT-A-DISTANCE

3.I The Pythagorean Time-Cone

The effect of this Kantian-inverted interpretation of *c* is profound. For instance, the orthodox Minkowskian derivation of Pythagorean time-dilation from Einsteinian premises about "light-velocity" is made redundant by deriving time-dilation from Pythagoras directly. [REF.13]

Let our basic reference-frame, therefore, be that described by Ayer.[REF. 14] As he describes it, "Places are places in a visual field and times those that furnish the temporal order of experiences." We shall assume, however, in keeping with our relationist standpoint, that the information which is structured in this way is purely and primarily observer-sequential.[REF. 1] That is to say, all events occurring in the framework Ayer describes, whether they are the sort we customarily call spatial or temporal, occur to us ultimately in the way our birthdays do: that is, without involving any question of a mediating agency. They occur to us simply "in the fullness of time".

But this time is no longer a one-dimensional abstract continuum, as classically conceived. It is the observationally given four-dimensional observer-extrapolated system, whose dimensions are:

(1) Observational distance-time or range (axis *S*) measured in seconds (or in units of 3×10^8 m/*c*). This is projected from information (see Section 3.4) manifest in the size and brightness-comparisons, parallax, perspective and so on, of visual objects [EN. 5] – or, of course, in terms of Bondi's radar distances. [REF. 15]

(2) Elevation, or the vertical angle of the range direction, measured conventionally in radians.

(3) Azimuth, or horizontal angle of the range direction, also in radians.

(4) Duration, or clock-measure (in seconds) at the observer-origin, *O*, of this three-dimensional system, conventionally plotted at right-angles to the radial axis *S*.

Some of the objects distributed in this way in *O*s spherically extrapolated system are, of course, other observers. By standard transformations, any of these observers may be made centres of reference in the same way as *O*. This gives us the kind of objectivity described by Ayer, in which "We can identify a sense-field not only by reference to its own character but also to that of its neighbours, and if necessary to their neighbours, and so on." [REF. 14]

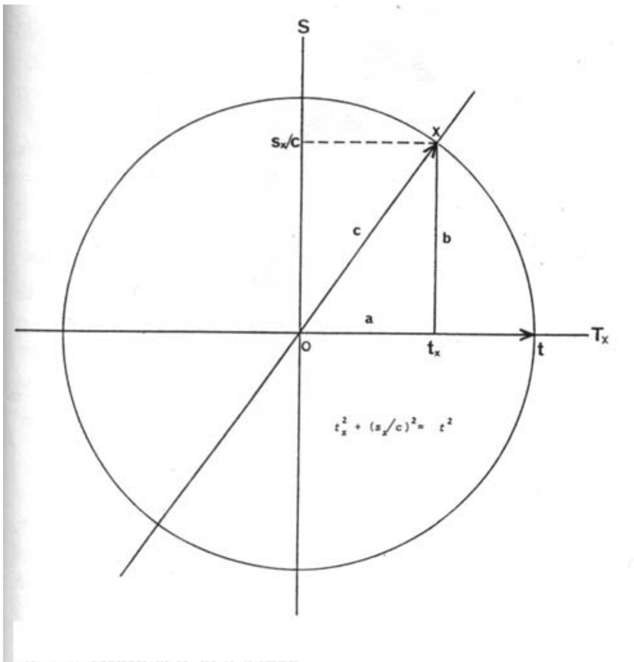

Figure 1. Motion of X by X's clock

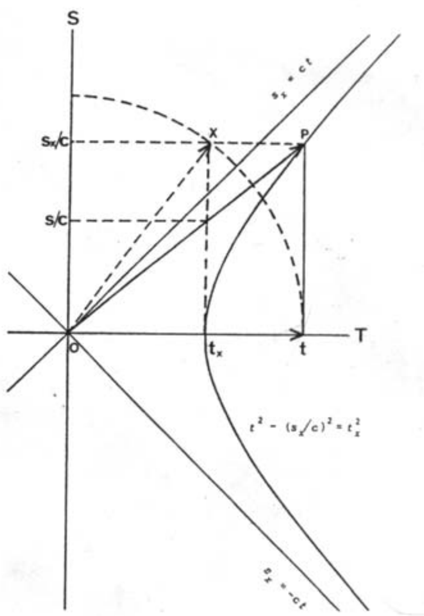

Figure 2. Motion of X by O's clock

Thus the basic observational information matrix has the dimensions of an objective intercommunicational space quantified in terms of the usual Cartesian coordinates into which our spherical coordinates are transformable by standard mathematical procedures. The essential difference, however, between this objectively extrapolated *bloc-space* and classical space, is that it is entirely observational – which is not to say subjective (see section 2.4) – and that it is composed entirely of discrete informational elements.

There is no absolute "universal time" nor "universal simultaneity" of this *bloc*-space as such. Nevertheless, a common time-datum, or "GMT" may be allocated on condition that there is *no motion* of any content relative to the system so designated. On this condition, all clocks at all the various centres can be synchronised by the usual method of subtracting, from the moment of receiving a central time-signal t the observational distance s in metres, of the signal-source divided by the constant c. In this way may be extrapolated, throughout the observer-community, a common time-zero, or "instant", $t - (s/c) = 0$. Thenceforward, all clocks of the system, if properly synchronised and regulated, will "simultaneously" record the time-readings t of the central clock and therefore of the system as a whole.

Nevertheless, from the standpoint of observer, O, although events at different distances from him may be judged "simultaneous" in this way, he can never actually *observe* them simultaneously, so the idea that they are "simultaneous" is no more than a convention. From any point in *bloc*-space, all dimensions of separation extrapolated in this way are *time* dimensions, all measured in equivalent units. While there are four of these time dimensions so far identified, the intervals measured from any point O in the system fall into two main categories. In the one are measures of pure time, or duration, as, for example, between Os birthdays, which, when they occur, exhibit none of those characteristics we customarily associate with distance and which are traditionally measured in units and multiples of seconds. In the other category are those measures of what we customarily describe as "distance" and which we now express (in contrast to custom) either in seconds or equivalent units of 3×10^8 m/c.

The effects of *motion* in this observational *bloc*-space may now be considered. Let O and X be observers equipped with identical clocks. Let X travel at a constant speed relative to O and pass O at the start of their respective time-readings. Suppose that X then travels, at that same speed, a distance s_X/c relative to O and that X's clock, as observed by O, registers a time t_X at that point. Let t be the corresponding duration as recorded in the *bloc*-space time, i.e., in the time of O's observation of the event minus the travelled distance-time s_X/c. This is indicated in Fig. 1. (The angular dimensions have been suppressed for simplicity without loss of generality.) Segment OX is a segment of the path of X relative to O. The S-axis in this diagram represents observational *distance-time* relative to O and the T_X-axis represents X's duration as registered by clock X.

Observer O's time measure t now lies between the following two extremes: (1) a measure of *pure time*, that is $t = t_X$ with the space-time s_X/c at zero; or (2) a measure of pure space-time s_X/c with t_X at zero.[REF. 16] This is encapsulated in the following two axioms:

A.l $t \equiv t_X$ if and only if $s_X/c \equiv 0$.

A.2 $t \equiv s_X/c$ if and only if $t_X \equiv 0$.

Since both axes in Fig. 1 are now measures of time, any measure of time is the magnitude of a vector in this two-dimensional system. Any such vector is generated by the vectors **a** and **b**, shown in the figure. Thus, as observed by O (or any other *bloc*-space observer) the passage of time t for X to travel the distance s_X/c and register the time t_X at that point is the magnitude of the vector $\alpha a + \beta b$ for some constants α and β (since the motion of X is uniform). If X always coincides with O then their clocks will record the same time, so that $\alpha = 1$, from Axiom 1. From Axiom 2 it follows that $\beta = 1$ also. Thus t is the magnitude of the vector **c** in the diagram and is given by

$$t^2 = (s_X/c)^2 + t_X^2. \qquad (1)$$

The speed of X relative to O (that is, the usual relative speed v as defined in special relativity) is given by $v = s_X/t$. Substituting this into Eq. (1) gives

$$t_X = [1 - (v^2/c^2)]^{½}\, t, \qquad (2)$$

which is the standard time dilation formula.

The idea of using a right-angled triangle to deduce the time-dilation effect has been used elsewhere.[REF. 17] However, our approach is fundamentally different. Not only is it simpler but it is also philosophically connected and coherent and provides a hands-on type of model for understanding not only relativistic time dilation and length contraction but also the Machian, so-called, "action-at-a-distance". This model is as follows.

For constant t, Eq. (1) is the equation of a circle, with centre O and radius t, as indicated in Fig. 1. In this case, the greater the value of s_X/c the smaller the value of t_X, that is, $t_X \leq t$ with equality if and only if $s_X/c = 0$.

For constant t_X Eq. (1) is the equation of a rectangular hyperbola with asymptotes having equations $s_X = \pm ct$. This is indicated in Fig. 2. In this diagram the T-axis represents X's duration as registered by O's clock (i.e., the standard synchronised time of *bloc*-space). The hyperbola is drawn for positive t only. For fixed t_X, the greater the value of s_X/c, the greater the value of t. In this diagram, we see not only the relativistic protraction in the duration of X relative to O and to *bloc*-space generally, as the gradient of OP tends to the limit of unity, but also the (conventional) shortening of the distance in the *bloc*-space S-dimension from s_X to s:

$$(s/c)/t_X = (s_X/c)/t$$
$$\cdots s = (t_X/t)s_X = [1 - (v^2/c^2)]^{½}s_X$$

by Eq. (2).

When Eq. 1) is treated as an equation in all three variables it becomes the equation of a three-dimensional circular time cone relative to the mutually orthogonal T_X- S- and T-axes (see Plate 1). This cone describes the intimate relationship between these three time-measures in a simple and graphical way. The axis of such a cone is the T-axis and its apex is situated at O. The cone is given for non-negative values of t only. Any point P on the surface of the cone has coordinates (t_X, s_X/c, t) relative to these axes. The plate shows one rectangular hyperbola, plotted on the cone for constant t_X, and its asymptotes $s_X = \pm ct$. Note that by Eq. (1) $t_X = 0$ along these asymptotes. The changing position of the point P along this hyperbola for constant t_X is illustrated.

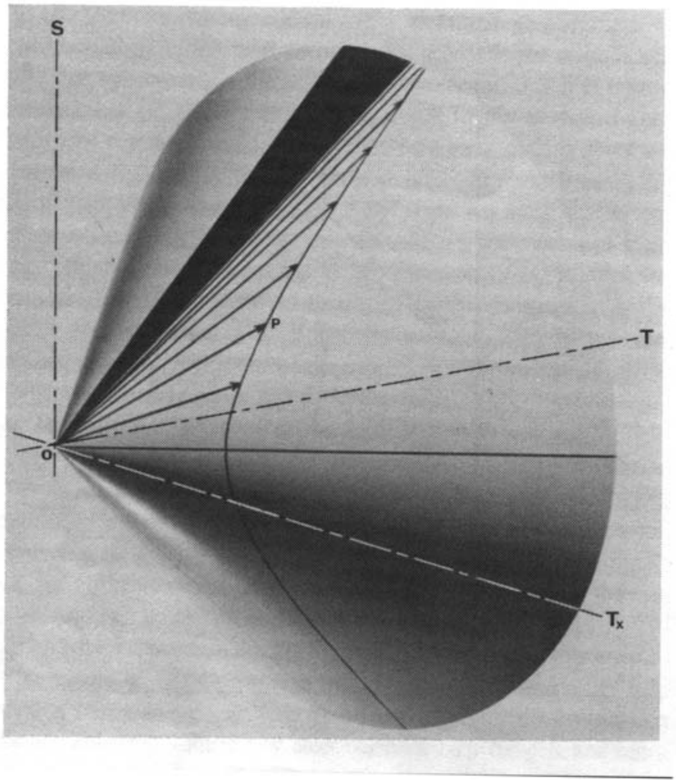

Plate 1. The Pythagorean space-time cone [graph of $t^2 = (s/c)^2 + t_X^2$].

Plate 2 shows the cone and this hyperbola as viewed (b) from the side [from a plane parallel to the (S, T) plane as in Fig. 2 and (a) from the apex looking down [from a plane parallel to the (S, T_X) plane, as in Fig. 1]. The hyperbola in (b) appears in (a) as a straight line parallel to the S-axis, the asymptotes $s_X = \pm ct$, which in (b) represent the finite speed c in the classical sense, having now become the S-axis, representing an infinite speed. In both (a) and (b) the changing position of the point P, for constant t_X, is shown with the corresponding values of t (see, also, Figs. 1 and 2). In the limit as t ƛ ∞, OP lies on one of the asymptotes of the hyperbola and represents the path of a "photon", along which $s_X = \pm ct$.

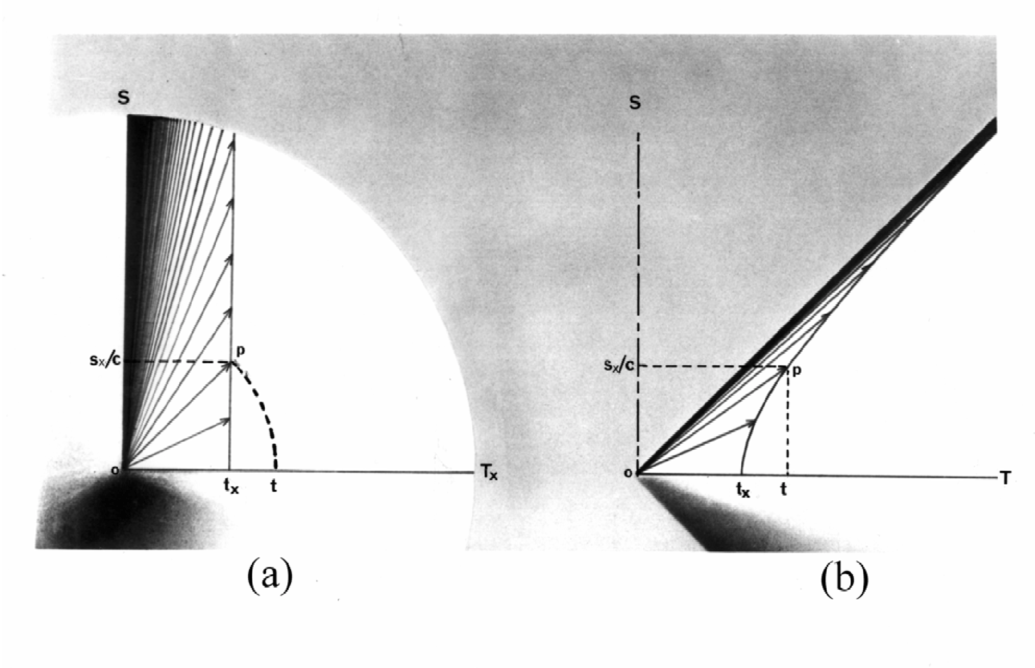

Plate 2. The double aspect of motion. (a) End view of cone ("Newtonian" view of motion). (b) Side view of cone ("Einsteinian" view of motion).

3.2 The Double Aspect of *c*

The cone-model therefore provides a pictorial representation of the well-known *double aspect* of light-velocity, in the sense that $v = c$ in Eq. (2) gives $t_X \equiv 0$, so that the speed of a photon relative to *O* is finite [Plate 2(b)], whereas relative to itself its speed is infinite [Plate 2(a)]. We say the "well-known" double aspect of *c* because it is well known that the proper time of a photon moving at "speed *c*" is identically zero, so that its proper speed [$v_X = s_X/t_X$ in Plate 2(a)] is infinite. Also well-known is the fact that at speed *c* the distance s_X relative to the photon contracts to zero. So there is no intrinsic time and no intrinsic distance – hence nothing we may sensibly call "velocity" – in a photonic interaction.

But although this intrinsic instantaneity and immediacy of the photon is "well known", it does not fit into the Einsteinian picture of *in vacuo* light separation. This bids us think of the beginning and end of a photon-jump as *two events* separated by the same kind of space and time as separates people, planets, stars and so on, which is the cause of much theoretical confusion. The conceptual "flip over" which the contextualist approach to relativity requires is to see the photon as *a single irreducible quantum event common to both object and observer*.[EN. 6] At the level of individual photons, space, the dimension of distinction and separation between objects simply does not exist. It is only in observational *sequences* of large numbers of these events that we may have the *information* from which space, with all that goes on in it, is projected. At that informational level the language we use to describe nature makes sense, but used to speculate about the mechanics or the geometry of quantum interstices, it makes nonsense.

3.3 **The "Universe" Problem**

The essential assumption underlying most physical theories is that of a *universe* of absolutely simultaneous overall coexistence. This includes Einstein's relativity since even he assumed the existence of a deity with ubiquitous oversight of all that goes on. But that presents a paradox, since in Einstein's relativism it is axiomatic that there is no such state as that of absolute simultaneity.

However, without being able to define some all-embracing reference-system in which things interrelate with one another simultaneously. That is, *instantaneously*, in that absolute way, how can all this talk of such a "universe" makes sense? And unless we know what is meant by "universe" we have to regard the motions of all the different physical objects as independent of one another, as in the situation described by Bell's "inequality condition". No "universal law" of energy, angular momentum, entropy or whatever, could ever apply to such isolated objects and events.

Proponents of the standard 'realistic' model of physics, however, tend to eschew all philosophical discussion on this issue, preferring, like Einstein, to rest in the age-old, unstated assumption of a ubiquitous "God's-eye-view" reference-frame residing, vaguely, somewhere behind the scenes. However, since such a God's-eye-view reference-frame is forever inaccessible to us, the empirical cash-value of that assumption is nil and all talk of "the universe", based upon it, becomes just noise – as, consequently, does all talk of how physical laws may apply "universally".

The root of this confusion is Einstein's interpretation of relativity according to which no causal influence between bodies can travel faster than the "finite speed of light, *c*". This isolates objects from one another, inexorably, making a complete mystery of how it is that distant bodies can be "relative" to (i.e., *interrelate* with) one another and with the observer when they are separated by perhaps millions of light-years. In such cases, the time needed for the "relation" to be established may far exceed the lifetimes of the *relata*.[REF. 18]

In fact, however, as is now well documented, [REF. 19] experiments in quantum physics have shown that the overall balance of quantities like angular momentum, in systems of particles extending over very large distances, are conserved in a way they could not possibly be if that assumption of the causal limitation of *c* were true. That is, Bell's inequality condition is proved to be violated.[REF. 20] All that this evidence achieves, however, in the context of the standard model is to create more paradoxes. [REF. 21]

Instead of seeing these paradoxes as the natural *reductio ad absurdum* of the "finite speed" interpretation of *c*, some theories [REF.22] have taken this experimental evidence of instantaneous action-at-a-distance as having established the existence of some mysterious, acausal, "telepathic" influence passing between particles in advance of the "speed of light". The fact that these theories do not define the sort of "instantaneity" they ascribe to these actions-at-a-distance serves only to compound the problem. But there simply is no need to interpret the constant *c* in that way. There are no mysterious "actions-at-a-distance" which act instantaneously, ahead of "the speed of light", because there is no "speed of light" to act "ahead of". As Plate 2 shows, *c* is no more than a dimensional aspect of zero-proper-time interaction. To contemplate acting ahead of that would be absurd.

3.4 **Immediate and Reciprocal Distance-Extrapolated Interaction**

In which way, then, do physical objects coexist to form a conserved and balanced "universe"? The answer our theory gives is, in those discrete proper-time-instantaneous interconnections we have described, which are drawn parallel to the *S*-axis in Plate 2(a). Nor does that interaction have to be a light interaction. Any such interaction a body *A* may have with any other body *B*, along that axis is immediate and reciprocal. Due to the logical character of the whole (see Sect. 2.3), if *A* jumps, the effect we call "gravitational" on *B*, and *B*'s inhibiting effect on *A*'s action, which we call "inertial",[REF. 23] are instantly balanced in such a way that the overall energy, angular momentum, etc., along that instantaneous axis are conserved, regardless of distance. On the other hand, where *s* is the observational distance of *B* from *A*, *A* will not record the effect of his jump on *B* (i.e., in the *bloc*-space time-dimension *T*) in any time less than 2*s/c* shown in Fig. 3.

In other words, when *A* jumps, or sends a light signal to *B*, *B* reacts absolutely instantly (along the proper time instant defined by the vertical axis *S* in Plate 2(a), whose conic side-elevational, or *bloc*-space, aspect is the line with unit positive gradient in Fig. 3). This transaction consists of a loss of some energy by *A* and a corresponding gain in energy by *B*, which is felt by both parties simultaneously. For *A* to *observe* that reaction, *B* must now *lose* some energy, which distinguishes, however minutely at *B*, *another* instant. The situation in this next instant is now exactly reversed, with *B*'s "jump" and *A*'s resistance to it being instantaneous along the reversed axis -*S*, whose *bloc*-space aspect is the line with unit negative gradient in the figure (the negative asymptote of another cone with its apex at *B*). The cone-model makes it clear, then, that no matter how small may be the proper time difference between these two instants at the point of reaction *B*, in terms of *bloc*-space time *T*, it becomes larger and larger in direct proportion to the distance [EN. 7], *s*, of that reaction from the point of observation *A*.

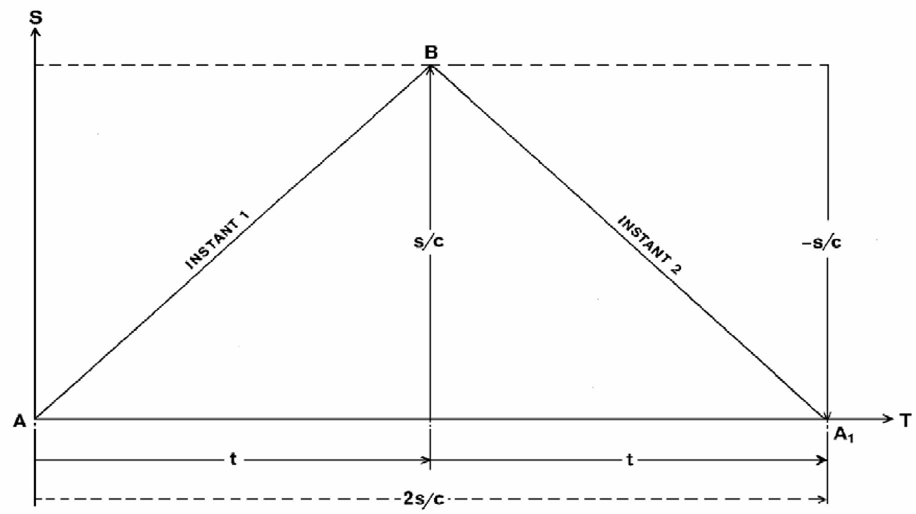

Figure 3. Two-way proper-time-instantaneous quantum interaction between *A* and *B*

If *A* acts on *B* at the same time as *B* acts on *A*, then there can be no *sequence* in such an interaction and therefore no informational content (see Sec. 2.6). The only simultaneity that is compatible, therefore, with any informational account is that of discrete interaction events in which either *A* acts directly on *B* or *B* acts directly on *A*. Any other kind of two-way, or *indirect*, interaction, as we see from the figure, is time-retarded. Each of these discrete events, in itself, is *unilaterally* reciprocal, in the sense that the effect of the photon being received by the one party to the transaction is the reciprocal of its being contributed by the other. [EN. 8] That is, in such an interaction, the two are virtually "touching"[REF. 24] at that quantum level. That there is no possibility, then, of *multilaterally* reciprocal simultaneity is fortunate for any information-based theory.

It is the same if *A*'s signal is received at a number of different places. For instance, let a light signal from a source *A* be received on a screen, via a pair of slits, as in the well-known Thomas Young double-slit experiment. Irrespective of whether the phase conditions are right for the receipt of the photons at screen points *B*, *C*, *D*, ... etc., the overall energy of those photons across the screen is conserved, so that each photon responds instantly to the others (i.e., unilaterally), no matter how far apart they are on the screen or how far from the slits – all of which is, of course, confirmed by experiment. [REF. 25] The effect is "superluminal" in the sense that no signal from any of these points, say *B*, announcing that the photon has "arrived", may be received at any other point, *C*, *D*, or whatever, in a time less than the distance between them divided by *c*. However, this presents no paradox because in signalling to one another their receipt of the photons, *B*, *C*, etc., are *mediating* the interaction; and as Fig. 3 shows, all such *indirect* interaction is time-retarded.

The case is similar where these photons are replaced by other particles travelling at speeds *v*, as in Plate 2(b). In this case, we may imagine that those fanned-out velocities shown in the figure are the speeds of particles which are the products of some scattering event ("particle collision") at point *O*. The vertical at t_X in Plate 2(a) [seen as a hyperbola in Plate 2(b)] then represents the three-dimensional instant defined by the simultaneously registered proper-times of any number of those particles – what Phipps calls a proper-time "clock-gas".[REF. 26] Since the horizontal (T_X) also records proper time, which is invariantly defined, Plate 2(a) presents a dimensional configuration similar to that of pre-relativistic (i.e., Newtonian) absolute space and time.

And, as in classical physics, the total energy, spin, strangeness or whatever, of all those particles are conserved in accordance with the laws of conservation for those measures. For example, if one of the scatter-products, *P*, of an originally spinless contact (spin = 0) at *O*, manifests, at some detector, a spin +½, then the spins of the remaining products must add up to –½, no matter where they appear. As described by Home, [REF. 27] experiments with "correlated neutral kaons ... originating from the decay of a spin-1 ϕ (1020) resonance",

> Time-evolution of the non-separable form of the two-particle wave-function $|\Psi_o\rangle$ correlates the oscillations between $|K^o\rangle$ and $|\bar{K}^o\rangle$ states such that it carries the essence of the EPR-type non-local connection. If the left [right] kaon is observed to be a K^o (strangeness $S = +1$) at a particular instant then the right [left] kaon can be predicted with certainty to be observed as a $\bar{K}^o$ ($S = -1$) at that same instant.

From the Standard Model point of view, of course, this so-called "nonseparability" of particle states presents a chronic conceptual problem. As Home observes (Ref. 27, p.49) the "spookiness" of such effects lies not only in their "superluminal" (instantaneous) character but also in the fact that these "spatially separated and non interacting members of the EPR pair can affect one another without exchanging any physical signal."

However, as in the case of photons, this overall conserved "superluminal" effect may take place without creating any paradox whatsoever and without having to assume that any "spooky" influence travels "faster than *c*" The only reason we see these effects as "spooky" is that we make it so by fiat, that is, by our conventions of assigning simultaneity on the basis of two-way and therefore retarded light interaction. By this convention, if, when we see some event on the Sun, we insist that it occurred eight minutes ago (the time we judge the light to have taken in "travelling" the distance), then the time at the sun, "right now", when we see that event, is put at eight minutes later than when it occurred. Any holistic (i.e., immediate and reciprocal, or Machian) interconnection between one's seeing that event and its occurrence at source is thus arbitrarily placed "in the future" of the source-event and is therefore "clairvoyant" so far as the source is concerned. On the other hand, if the time we allocate to that solar event is the time at which we actually see it, then there is no question of "spookiness" in balanced interaction. The only sacrifice we have to make, in order to accept that complete answer to the "EPR problem" is the presumed "God's-eye-view simultaneity" of classical "realism", which supposes that somehow, everything, everywhere, coexists absolutely and continuously in parallel. So far as we are concerned, the search for that multilateral kind of simultaneity is as vain and unempirical as the quest for "perpetual motion" or the "philosopher's stone". Otherwise, there is no reason why we should not settle quite happily for the truly realistic, *relativised* and *discretised* version of space and time represented by the cone model.

3.5 The "Cinematographic" Character of Observational Space-Time

The only "universe", then, in which things can be meaningfully said to coexist, or simultaneously and reciprocally interrelate is in those unilateral, asymmetrical instants depicted in Fig. 3. Unlike the Newtonian "universe", in which the seeing of "simultaneous" events is delayed by the "finite speed of light", this post-Newtonian universe consists of everything that is directly seen or otherwise responded to at an instant, that is, simultaneously, either by an observer such as B (along the positive gradient in Fig. 3) or such as A (along the negative gradient), but never by both together in any "God's-eye-view" kind of way. The proper *time* universe is therefore empirical in the phenomenalist sense, because it is *directly perceived* rather than metaphysically conjectured.

In abandoning, then, the quest for absolutely symmetrical, universal simultaneity, we do not merge space and time in the way Einstein and Minkowski did, into a single geometrodynamical "space-time continuum". Our space-time, at the microphenomenal level, is an overall conserved *discontinuum* consisting of interweavings of discrete four-dimensional "world lines" of all sorts of limited lengths t in Eq. (1).

Now the main limitation of Kantian and Machian phenomenalism – what physicists customarily refer to as "positivism" – was, as we have seen, its unjustified and antirealist assumption that things unseen cannot configure in any phenomenalistic account of physics. However, our demonstration, in Sec. 2.4, of the fallacy underlying that subjective assumption gives us a licence, in the context of the newer phenomenalism, to refer to and theorise about things that neither we personally, nor perhaps any other human being, may ever directly observe. The following speculative ontology is therefore perfectly in keeping with our neophenomenalist stance and is to be distinguished from the usual "hidden variables" ontology which opposes itself to "positivism" in the false dichotomy between "realism" and phenomenalism. EN. 9

The vertical axis, S , in Plate 2(a), as we have seen, is the dimension of either positive or negative, unilateral, proper time instantaneity in which, at any discrete instant, everything is holistically and absolutely simultaneously related to everything else. However, what we actually *observe* along that three-dimensional axis is never those instantaneous sets of spatial interrelations, as such, because in those instants themselves there is, by definition, no *sequence* and therefore no *information* of the sort on which observation depends. So we never observe those instants as they are "in themselves". All we observe are the *changes* in, or *sequences* of, those instantaneous sets of relations, in quantum jumps of the sort which appear in observation as "photons", "gravitons", or whatever. Nevertheless, we now have a phenomenalist licence to speculate theoretically on what the standing relations behind those changes might be.

Now there are all sorts of standing relations we might consider, such as the traditional field forces of gravity, electricity, magnetism, and so on. However, for those reasons explained in Se. 2.2., all such *in vacuo* "field force" conceptions must be eliminated from our theory. What remains is *angular momentum*, which is, by definition, a *paired*, *orbital* and holistically *conserved* relation between mass particles. The basic type of standing relation then, we may suppose, is that of various forms of angular momentum. In ultimately analysed, *cyclic* units $\hbar$ ($h/2\pi$). Our ultimate rudimentary observer, or observational communicant, is thus some elementary particle pair in a locked-in and indivisible, orbital angular momentum relation $n\hbar$. Those “particles” are our ultimate *relata* [EN. 3], $\hbar$ is the ultimate *relation*, and the combination of the two is our ultimate observer-communicator –the most rudimentary “whole” in the holistic hierarchy.

The universe thus envisaged at any proper time instant, has absolute distance-dimensions defined by the combined lengths of quantum angular momentum cycles and radii. So space, whose observational dimensions are defined in the previous section, is no mere subjective projection of human intuition, as its basis in observation might suggest. It consists of the combined lengths and circumferences of the moment-arms of all the various angular momentum relations between all the various particulars at that proper time instant. Its *voids* are thus no more nor less than the empty lengths between the angular momentum countermasses and have no existence (*pace* Mach) other than as parameters of those angular momentum relations.

Nor are those systems of angular momentum to be conceived, in the manner of the God's-eye-view “realists,” as hidden mechanisms, ticking away behind and beyond observation. They are uniformly observational in the sense described in Sec. 2.4. That is to say, when the particles involved in those angular momentum relations are optically dormant, that is, not actually participating in photonic interactions with the observer – their presence is nevertheless “felt” in the way they affect the positions and movements of our bodies in relation to other bodies under the law of conservation of angular momentum (those Machian effects we customarily call “inertial” and “gravitational,” see Sec. 2.3). An illustration of this is the way the planet Neptune was discovered, not optically, but by its effect on the motions of the visible planets. Like photonic interaction, those so-called “gravitational” and/or “inertial” interactions are also quantized in ultimate action units h.

The observational succession of those holistic instants defined by the verticals in Plate 2(a) may therefore be likened to a cinematographic sequence of quantum “stills” in a strip of film stretching in the T_X direction. However, we must remember that unlike the frames of a cinematographic film strip, those quantum “stills” have no determinate, one-dimensional time succession. As an illustration of how the succession occurs, take our previously considered rudimentary observers A and B (Sec. 3.4). Observer A consists of an angular momentum $n_1\hbar$, let us say, and B an angular momentum $n_2\hbar$. When A “sees” or otherwise interacts with B , they both immediately experience a quantum jolt, which is the elementary equivalent of “sending a signal.” In that jolt, consisting of a loss by B of some portion of those n_2 quanta, and a gain by A (and/or other parties, C, D, E, . . ., etc.) of those same quanta, in ultimate units of action $e/\nu = h$, [REF. 28] lies the *change* to the next instant of *time* which is unilaterally simultaneous at those places. However, the elementary particles forming those quantum relations relate in that way not only with each other, but also, in the same instant (under the laws of overall conservation), with all other particles in that angular momentum “universe.” So, even though there is no determinate mechanical or geometrical connection between one such action jump and any other (see Sec. 2.2), no quantum jump ever occurs in isolation. The universe, at any (standing) proper time instant, is a whole relational network of quantum “resonances” – a vast and intricate “chord,” so to speak, whose individual “notes” are the discrete and irreducible “frequencies” of the fundamental particles and their angular momentum relations. No quantum transaction of the sort we have described can occur, therefore, without its being “in tune” with the relational system as a whole. These systematically integrated or “tuned” quantum jumps can be thought of as changes in the “chord” – the movement of the music, to continue the analogy – which are introduced by various instruments in the orchestra. Some of these play crotchets whilst others play quavers and so on, whilst others again "sit it out," awaiting their cue. This "music" (or *logos*, see Sec. 2.5) is the information from which the observer extrapolates, in those dimensions depicted by the cone model, what is going on and where.

No change from one instantaneous state to another can therefore take place unless the circumstances overall are propitious. This answers to what is called *quantum potential* and is consistent with the Kantian inversion, described in Sec. 2.3, in which it is the relational whole, by the laws of conservation, which (instantly) decides the arrangements of the parts rather than vice versa.

The radical distinction, then, between the system depicted in Plate 2(a) and the system of Galileo and Newton which it so much resembles, is that in our neo-Newtonian universe, causality, in the sense of overall balance or action-at-a-distance on the quantum level, goes from whole to part rather than from part to whole. However, to make a philosophical point, this does not mean that the only *parts* are entirely elementary ones. There may be parts of this universe that are wholes in their own right, in a hierarchical series of wholes-within-wholes. Some of these may have sufficient autonomy (e.g., of the sort we humans have) to exert "causal" influences in something like the classical mechanistic way – as, for instance, when we push a billiard cue or conduct an experiment. There is thus no absolutely deterministic "Whole" any more than there are absolutely deterministic parts. "Fatalism" is avoided on both counts, and so is any prospect of dualism or metaphysical ' detachment. So, as higher-order observers with powers of determination that are self-evident, we interfere with the system every moment of our lives, sometimes involuntarily and sometimes at will. Every observation we make gives the system a jolt, and every jolt the system receives sets up a new arrangement of fortuities for further action and observation. However, we are never entirely self-determined, for no action we may contemplate can ever defeat the overall balance of nature – what the Greeks called "cosmic justice".

3.6 The Wavelike Propagation, *c*, of Instantaneous Action

The development in time of one holistic proper time instant to another, between the verticals in Plate 2(a), takes the form of our expanding time cone, whose developing transverse cross section at any instant is a *spherical* distance-time expansion at the rate *c*. In other words, whilst all quantum transitions (jumps) are instantaneous, measured in proper time [Plate 2(a)], ' the further away they are (as Fig. 3 shows), the later their effect will be registered in *bloc*-space "GMT" [Plate 2(b)], the ratio of distance to time-lapse in that temporal advance being, of course, *c*.

As *bloc*-space time advances, those conic surfaces (positive and negative, as in Fig. 3) are crisscrossing one another, expanding at some places and contracting at others, all at the uniform and invariant rate *c*. There is thus a clear similarity between our cone model account of temporal development and "quantum wave mechanics," for the expanding spherical cross section of the time cone implies a typically wavelike attenuation in a signal as the amplitude of that signal energy diminishes in relation to the developing spherical interface. Also, since there is no determinate connection between point instants on successive wave fronts, we should expect the propagation, from instant to instant, to appear "probabilistic" as in standard model quantum wave mechanics.

This, however, is where all comparison with "quantum wave mechanics" ends, because the latter is problematical in a way the cone model is not. For instance, as Lockwood [REF. 29] says:

> A classic point of reference, in quantum mechanics is the celebrated "two-slit" experiment in which electrons can be made to create interference-fringes, similar to those that Young

> demonstrated in the case of light. So long as both slits are open, and there is no device to register which slit an electron goes through, one gets an interference pattern of alternating zones of impact and non-impact, *even if the electrons are passed through one at a time, at arbitrarily large intervals*. (The corresponding phenomenon in regard to light was, in effect, experimentally demonstrated by Taylor as long ago as 1909.) So it isn't the electrons themselves that are interfering with each other. How could it be, if they are passed through, say, one every quarter of an hour (or come to that, one every twenty-five years)? Rather, the interference pattern reflects interference between the alterative trajectories of each individual electron. In other words, the path of each electron must be conceived as a superposition of the paths corresponding to passage through the different slits.

Lockwood, like Home (*q.v.*) presents this situation, typically, as a mystery which it is, of course, according to standard “wave-particle” theory. Anything so remote from our understanding as “particles” that dissolve into “waves” that are propagated in nothing and consist of nothing but “probability” is bound to create mystery

The fact that this wave-particle concept is a mystery has had to be put “on ice” by physicists for whom the evidence seems clear that particles such as electrons do exhibit *both* those contradictory properties. This explanation, put forward as a plain statement of the evidence, is beyond criticism. However, no one in his senses would hold to that conception when some less contradictory one becomes available. Perhaps the following non-standard account will prevent that contradictory “wave-particle” conception from seeming like a “Hobson's choice.”

What makes this behaviour of fundamental particles seem mysterious is, of course, the classical way of thinking of matter as existing and enduring in a single time dimension in which everything coexists continuously and (multilaterally) simultaneously with everything else. In contrast, any theory that makes time *discontinuous* makes existence and duration discontinuous also. So when we find ourselves mystified as to where the particle is between leaving the source and reaching the detector, our mystification is due to our habit of thinking in that former, classical way. Otherwise, we may simply settle for the fact to which those experiments cited by Home *et al*. attest, that in observer space the durations of fundamental particles are “staggered'; that is to say, some particles cease to endure while others are enduring like those instruments in an orchestra that are silent while others are being played.

According to our cone model, then, a particle, in the sort of experiment Lockwood describes, may quite logically disappear at the source and reappear at the screen, after some *bloc*-space interval $t = s/v$, without having a continuous particulate existence throughout, by simply going out of existence in the meantime. The only way for this to happen without breaking the law of conservation is for that loss of momentum, which is the particle's disappearance from the source, to be gained, in that meantime, by something else. And that *something* else that the cone model provides is the overall system of absolutely simultaneous angular momentum relations described in the previous section.

So, after its emission from the source, the particle's momentum at that point is no longer sustained in any determinate, particulate form, but remains, throughout succeeding instants (in *bloc*-space, that is) as a bare potentiality – an energetic tension or overall increase in the angular momentum system, awaiting resolution into a particle once again as soon the circumstances are propitious (compare “the collapse of wave function” in quantum mechanics).

The situation so far, but for the “wave” terminology, is precisely in accordance with de Broglie's hypothesis that whenever there are particles of momentum p , their motion is associated with a wave of wavelength, $\lambda = h/p$ (where p is the particle's momentum mv, and λ is the wavelength in meters). The particle might therefore be expected to appear (resolve itself) at the screen after a time $t = s/v$, as in standard wave mechanics [EN.10] We may even assume, after de Broglie, that "the square of the amplitude of the `wave' (at that point) is proportional to the probability of its appearing."[REF. 30]

However, the perplexing question of "which of the two slits" the electron passed through on its way to the screen no longer applies. The electron *en route* is now nowhere in particular, neither as a "wave" nor as a "particle." Its momentum is "spread" throughout the whole world network of angular momentum relations as a bare potentiality (potential energy), awaiting some opportunity to appear – an accident, as one might say, "waiting to happen."

And when these accidents do happen, it is not surprising that they avoid some parts of the screen and pile up in others. This is because the slits so restrict the avenues of interaction that when both are open, certain points on the screen have distances vt from the source which differ by some odd number of half-lengths, $\lambda/2$. In that case the probability of an interaction at that point via the one slit is cancelled by an equal and opposite probability via the other slit; hence the probability of a resolution at that point approaches zero. By the same token, the probability of resolution is greatest where the distances through the slits are either the same or where they differ by some even number of half-lengths, so the overall energy is conserved. Insofar as the situation from instant to instant does not change, it does not matter whether the particles come all in a bunch or one at a time – even if they occur, as Lockwood says, "one every quarter of an hour or one every twenty-five years."

3.7 Conclusion

The picture of space, time, and simultaneity we have now described is one that, basically, common sense has always intuited; namely, that at any instant it is a universe of directly sensed, holistically balanced and simultaneously coexisting objects. Each historical attempt to codify this commonsense intuition, however, has introduced its own brand of confusion. Philosophers, for instance, have artificially divided that universe into "mental" and "material," making a mystery of how "mind" can arise out of matter and how that "mind" can know of the existence of matter, anyway.

Meanwhile, physicists, due to that "mentalistic" stigma attaching to philosophy, have tended to avoid all taint of it in pursuit of their subject, assuming that some sort of "realism" is served by simply presenting "the experimental facts" in a "plain common sense" way. Nothing, however, has confounded common sense more than the plethora of purely specialized theories this method has created, which remind us more and more of the elegant but uncomprehended mathematical precision of the Ptolemaic account of the solar system.

The era that has seen the proliferation of so much disparate philosophy and science is therefore one in which commonsense, the very cement of any democratic civilization, has been all but eaten away by the corrosive mixture of those antagonistic intellectualisms. If our analysis is correct, then much of this confusion is unnecessary. It is high time, we suggest, that the long outdated "logical positivism" and its reactionary elements were eliminated and physics given an infusion of more up-to-date observational philosophy We may then, perhaps, contemplate the prospect of a new, truly realistic and *holistic* approach to understanding, with our physics and philosophy flourishing together under the democratic governance of an enlightened and more self-assertive commonsense.

Acknowledgment

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Endnotes (In the text denoted by [**EN …]**)

1. This observationalistic approach was very much a feature of physics in the 1930s and 1940s, due to the respective influences of Einstein and Bohr. It takes its departure, however, from the "logical positivism," so-called, of the Vienna Circle philosopher-scientists, of the 1920s, who were much influenced by Mach. Meanwhile, in philosophy, that same "positivism" was rejected by Wittgenstein, whose *Tractatus Logico Philosophicus* had been a source book of the movement. Since then, "relativism" has split, going one way in modern physics, via Einstein and Bohr, and another via Wittgenstein, Austin, Ryle, *et al*., whose work is largely unknown outside those academic philosophical circles. To demonstrate that the work of the philosophers did not end with "logical positivism" and that the relevance to physics of the newer philosophical approach is greater than the former may be said to define the general purpose of this present paper.
2. The question of what constitutes the "whole" (wholes within wholes) is dealt with in Sec. 3.5.
3. For there to be relations there have to be *relata*. To think of a "phenomenalism" that deals with systems of perceptual relations without perceptual *relata* is therefore as absurd as a "realism" whose ultimate *relata* are things beyond perception and between which there is no relation. The customary distinction, in physicists' current thinking, between "realism" and "phenomenalism" is therefore a "red herring." A truly *realistic* approach to physics is an empiricism that is not truncated in either of these ways.
4. This has reminded commentators more of Leibniz than of Kant and Mach. This is understandable insofar as Kant and Mach were primarily concerned to argue about what we know from the point of view of an individual subject, whereas Leibniz constructs an ontology that explains the relationships among many such subjects. Also reminiscent of Leibniz is that for him, space and time are relative and there is no self-sufficient vacuum. However, that is where all similarity ends. Leibniz's rudimentary observers (his so-called "monads") were spiritual beings, whereas ours are material (see Sec. 3.5). Moreover, Leibniz's "monads" do not physically interact. Their actions are entirely self-determined and the coherence or harmony between them that forms the world is entirely pre-established and automatic. By contrast, our observational elements are physically interlinked and temporally *discrete*, so that their contacts are statistically improbable in a way that makes informational *communication* a reality (see Sec. 2.3).
5. There are no special difficulties in measuring distances this way. It is essentially the method astronomers use to measure distance-time (e.g., in light-years). Ordinary methods, using tapes, measuring rods, milometers, etc., although not regarded as primary, are nevertheless still available wherever relevant.
6. The Wheeler-Feynman action-at-a-distance theory [J.A. Wheeler and R.P. Feynman, Rev. Mod. Phys. 21, 425 (1949)] discusses direct particle interaction, but there is still an *a priori* space-time substructure assumed. We suggest that there is no such a priori substructure and that therefore the principles of "advanced" Newtonian and "retarded" light propagational spatiotemporal interaction are not competing principles as these writers assume.
7. Not one of the quantum elements of the phenomenon of distance, taken on its own, gives any clue as to that dimension. Obviously, then, the phenomenon of distance

must be a function of informational distributions of these quantum components, not any property of those components themselves. It is, we would say, the sorts of instructions our intuitions receive from those distributions of elements that enable us to do that kind of distance extrapolation. Since Fig. 3 is essentially four-dimensional, each instant AB and BA_1 is the radius of a sphere with centre of B or A_1 , respectively. Typically of spherical polar countings, units counted along the spherical "shells" of largest radii are the most numerous. In the *Gestalt* consisting of these various simultaneous quantum occurrences, it is those distributions of numbers, according to that typical spherical relation, that signal to our intuitions the phenomenon of distance. Our way of defining optical distance, then, is that it is proportional to the reciprocal square root of the *intensity* of simultaneously observed events in a *Gestalt* such as AB or BA_1 in the figure.

8. In this case the preparedness of *B* to receive the photon is as much a "cause" of the interaction as is *A*'s capacity to subscribe it. Thus we should expect the receiver to have an at-a-distance, repressive, or conducive effect on the source. This, of course, stands in complete contrast to the expectations of causal theories, such as standard electrodynamics and Ritz's ballistic theory of the photon [A. 0'Rahilly, *Electromagnetic Theory* (Dover, 1965).

9. This false opposition between "realism" and "phenomenalism" is typified by Blackmore, who writes,(2)

   > If measuring instruments exist and can measure physical behaviour *even when no-one is observing or conscious of the instruments*, then there is objective evidence, even if people may be required to read the instruments, and even if one somewhat misleadingly continues to call such an approach "phenomenological." We can also use automatic cameras to photograph both the instruments and their readings. Neither people nor consciousness have to be present.

   In assuming that "phenomenalists" have no proper access to these "instruments" and the "objective evidence" they provide – that for phenomenalists, observers are necessarily "people," "conscious," and "present" – Blackmore, like many physicists and physics commentators, betrays that he is unaware of those *realistic* developments in phenomenalism since the era of Mach and his contemporaries, which are described in Sec. 2.4. As Blackmore admits, his own "standard distinctions between realism and nonrealism ... go back to the eighteenth-century debate over Berkeley's identification of the physical world with what he called "ideas."

10 In the case of a potentiality involving more than one particle, that potentiality might, perhaps, only partly resolve itself. For instance, where one of a pair of particles may be detected with a spin ½, although it might be some time before the other particle is detected, when it does it will be found to have a spin -½. This is confirmed by Home.(27)

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