MR. DUNNE'S THEORY OF TIME IN "AN EXPERIMENT WITH TIME"

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I WANT to state the theory in *An Experiment with Time* as clearly as I can in my own way; then to consider its application to Precognition; and then to consider whether there are any other grounds for accepting it beside its capacity to account for the possibility of Precognition. Mr. Dunne himself holds that the theory is required quite independently of explaining Precognition. He also holds that the facts which demand a serial theory of Time require that the series shall be infinite. Both these contentions might be mistaken, and yet Mr. Dunne might be right to the extent that it is necessary to assume *a series of at least two terms for the special purpose of explaining Precognition.*

It seems clear from Chapter XIX of *An Experiment with Time* that Mr. Dunne starts from a suggestion made by Hinton in his book *The Fourth Dimension.* It will therefore be well to explain Hinton's suggestion before trying to state Mr. Dunne's theory. But there is one preliminary step which it will be worth while to take before dealing with Hinton's suggestion. We are going to be concerned with the notion of "spaces" or "spatial manifolds" of more than three dimensions; it will therefore be wise to begin by defining certain terms and stating certain elementary facts which are constantly needed in this connection.

MANIFOLDS OF n DIMENSIONS

A spatial manifold is of n dimensions if exactly n independent variables have to be fixed in order to determine a point (i.e. a completely determinate position) in it. Thus, in a spatial manifold of n dimensions, we shall need n independent simultaneous equations to determine a point. And a point is something which, being completely determinate, has "zero *degrees of freedom.*"

Now suppose we were given $n - 1$ independent simultaneous equations. These would leave *one* degree of freedom in a n-fold. They would therefore represent a *line* (straight or tortuous) in that n-fold. We will call a line in a n-fold a "$(1,n)$-fold." Suppose we were given $n - 2$ independent simultaneous equations. These would leave *two* degrees of freedom in a n-fold. They would therefore represent a *surface* (flat or curved) in the n-fold. We will call a surface in a n-fold a "$(2,n)$-fold." In general, m independent simultaneous equations would leave $n - m$ degrees of freedom in a n-fold, and so would determine a set of points in the n-fold which we will call a "$(n - m, n)$-fold." Plainly a $(0,n)$-fold is a *point* in a n-fold; and a (n,n)-fold is identical with the n-fold itself. Conversely a (m,n)-fold is a set of points in a n-fold determined by $n - m$ independent simultaneous equations.

In a three-fold a *point* is a $(0,3)$-fold, and requires *three* independent equations; a *line* is a $(1,3)$-fold, and requires *two* independent equations; a *surface* is a $(2,3)$-fold, and requires *one* equation. The three-fold itself is a $(3,3)$-fold.

In a four-fold a *point* is a $(0,4)$-fold, and requires *four* independent equations; a *line* is a $(1,4)$-fold, and requires *three* independent equations; a *surface* is a $(2,4)$-fold, and requires *two* independent equations. There is also a fourth kind of set of points here, viz. a $(3,4)$-fold, which requires *one* equation. The four-fold itself is a $(4,4)$-fold. And so on for any number of dimensions.

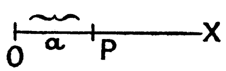
Now it is useful to look at this from another point of view. We can start with a fixed number of independent simultaneous equations, and consider what kind of manifold these equations will determine in manifolds of various dimensions. Thus:

One equation determines a *point* in a *one-fold,* a *line* in a *two-fold,* a *surface* in a *three-fold,* a $(3,4)$-fold in a *four-fold,* and a $(n - 1,n)$-fold in a n-fold.

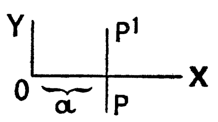
Two independent equations *cannot occur* in connection with a *one-fold*; they determine a *point* in a *two-fold,* a *line* in a *three-fold,* a *surface* in a *four-fold,* a $(3,5)$-*fold* in a *five-fold,* and a $(n - 2,n)$-*fold* in a *n-fold.*

Three independent equations *cannot occur* in connection with either a one-fold or a two-fold; they determine a *point* in a *three-fold,* a *line* in a *four-fold,* a *surface* in a *five-fold,* a $(3,6)$-*fold* in a *six-fold,* and a $(n - 3,n)$-*fold* in a *n-fold.* And so on.

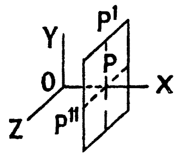
It remains to consider one important consequence of this which we shall need in discussing Mr. Dunne's theory. Take a single equation, involving only one variable, e.g. $x = a$. In a one-fold this represents a *point* at distance a from the origin along the only axis.



In a two-fold it represents a *straight line* at right angles to the X-axis, which cuts the latter at $x = a$.

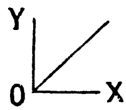


In a three-fold it represents a *plane* at right angles to the X-axis, which cuts the latter at $x = a$.

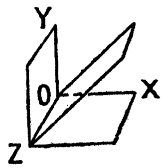


In a four-fold it represents a (3,4)-fold at right angles to the X-axis, cutting the latter at $x = a$. And so on.

Now consider a single equation involving two variables, e.g. $x = y$. In the case of a one-fold this is meaningless. In the case of a two-fold it represents a *straight line* bisecting the angle between the X and the Y axis.



In the case of a three-fold it represents the *plane* which arises from drawing through every point in the previous straight line a straight line parallel to the Z-axis. This plane bisects the angle between the planes ZOX and ZOY and contains the Z-axis.



In the case of a four-fold it represents the (3,4)-*fold* which arises from drawing through every point in the previous plane a straight line parallel to the U-axis. And so on.

Exactly similar remarks apply to curves. Thus the equation $x^2 + y^2 = a^2$ represents a *circle* of radius a with the origin as centre in a two-fold. In a three-fold it represents the *cylindrical surface* obtained by drawing through every point in the circle a straight line parallel to the Z-axis. In a four-fold it represents the (3,4)-fold obtained by drawing through every point in this cylindrical surface a straight line parallel to the U-axis. And so on.

Hinton's Suggestion

Suppose that there were a *material thread* at rest in a *plane*, i.e. a material (1,2)-fold at rest in a two-fold. Suppose that a certain *straight line* moved in this plane with a uniform velocity at right angles to itself. Provided that the thread always makes an angle of less than 90 with the direction in which the moving line travels, the moving line will cut the thread in a *point* at each moment and in a different point at each different moment. Suppose that there were an observer whose field of observation at any moment is confined to the contents of the moving line at that moment. Instead of perceiving a *stationary thread* he would perceive a *moving particle* occupying various positions in the various lines which constitute his successive fields. This will be obvious from Fig. 1.

If there were a number of such linear threads in the plane there would be an equal number of material particles observed in each field. It is evident that the velocities of these particles, as observed by this observer, would be completely determined by (*a*) the velocity of the moving line, which we have assumed to be *uniform*, and (*b*) the purely *geometrical* properties of the threads. Suppose that the equation of a thread is $y = f(x)$. Let the velocity of the moving

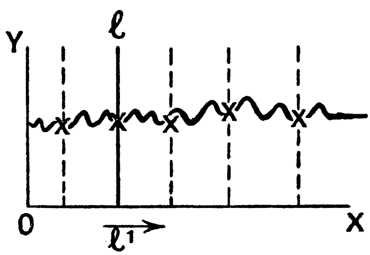


FIG. 1.

line be c along the X-axis. Then the observed velocity of the corresponding particle will be at any moment dy/dt. This $=(dy/dx)(dx/dt)$, i.e. $c(dy/dx)$.

We can now extend this as follows. Suppose that we now have a tortuous thread in a *three-dimensional space*, i.e. a (1,3)-fold at rest in a three-fold. Suppose that a certain *plane* moves at right angles to itself in this three-fold with uniform velocity. At any moment it will cut the thread at a *point*. Suppose that there is an observer whose field of observation at any moment is confined to the contents of this moving plane at that moment. Instead of perceiving the *stationary thread*, as such, he will perceive a *moving particle* occupying various positions in the various planes which constitute his successive fields (see Fig. 2).

If there were a number of such threads in the three-fold, there would be an equal number of material particles observed in each field. The velocities of these particles, as observed by this observer, would be completely determined, both in magnitude and direction in the field, by (*a*) the velocity of the moving plane, which we have assumed to be *uniform*, and (*b*) the purely *geometrical* properties of the threads. Suppose that the equations of a thread are $x = f(z)$ and $y = g(z)$. (It will need two equations because it is now a (1,3)-fold.) And suppose that the moving plane moves along the Z-axis with velocity c. Then the observed velocity of the particle along the X-axis of the observer's field will be dx/dt, which $= (dx/dz)(dz/dt)$, and therefore $= c(dx/dz)$. Its observed velocity along the observer's Y-axis will be dy/dt, which $= c(dy/dz)$.

We have now to extend this one step further. We now imagine a tortuous material thread in a four-fold, i.e. a (1,4)-fold. Suppose that a certain (3,4)-fold moves at right angles to itself with uniform velocity in this four-fold. At any moment it will cut the thread in a *point*. For the (1,4)-fold requires three independent equations, and the (3,4)-fold requires one equation. So their intersection is represented by four simultaneous equations. It therefore is a (0,4)-fold, i.e. a *point* in the four-fold. Suppose that there is an observer whose field of observation at any moment is confined to the contents of this moving (3,4)-fold at that moment. Instead of perceiving the

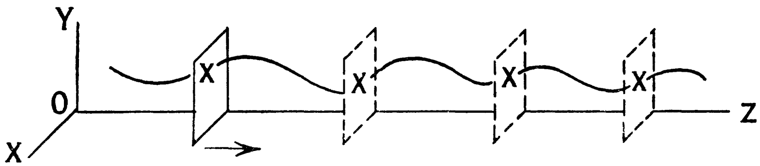


FIG. 2.

stationary thread, as such, he will perceive a *moving particle* occupying various positions in the various (3,4)-folds which constitute his successive fields. If there were a number of such threads in the four-fold, there would be an equal number of such particles observed in each field. The velocities of these particles, as observed by this observer, would be completely determined, both in magnitude and direction, by (*a*) the velocity of the moving (3,4)-fold, which we have assumed to be *uniform*, and (*b*) the purely *geometrical* properties of the threads.

Since a thread is now a (1,4)-fold it will be represented by three simultaneous equations. Suppose that the equations of a thread are $x = f(u)$, $y = g(u)$, $z = h(u)$. And suppose that the moving (3,4)-fold moves along the U-axis with velocity c. Then the observed velocity of the particle along the observer's X-axis will be $c(dx/du)$; along his Y-axis it will be $c(dy/du)$; and along his Z-axis it will be $c(dz/du)$.

Now a "rigid body" is a set of particles in a three-dimensional space, such that every pair of particles in the set keep at a constant distance apart. It will therefore be the intersection of a *bundle* of (1,4)-fold threads with the moving (3,4)-fold. The condition of rigidity is that for every pair of threads, r and s, in the bundle $(x_r - x_s)^2 + (y_r - y_s)^2 + (z_r - z_s)^2$ shall be independent of u.

This completes my account of Hinton's suggestion. The main interest of it is this. It shows that, if we assume one additional spatial dimension beside the three that we can observe, and if we suppose that our field of observation at any moment is confined to the contents of a (3,4)-fold which moves uniformly at right angles to itself along a straight line in this (3,4)-fold, then there is no need to assume *any other* motion in the universe. This *one uniform rectilinear* motion of *the observer's field of observation*, together with the *purely geometrical properties* of the *stationary* material *threads* in the four-fold, will account for all the *various observed motions* (various both in magnitude and in direction) of the material *particles* which are the appearances of these threads in the successive fields of observation. From this point of view there is no advantage in carrying the suggestion further, viz. into five or more dimensions. There will always have to be a field moving with uniform rectilinear velocity at right angles to itself; so that no further simplification is introduced to balance the added complication of an extra dimension. But, although such an extension of Hinton's suggestion has no advantage from the point of view of simplifying the treatment of the motion of matter, it may be of use for other purposes. It may, e.g., be of use for explaining Precognition. If so, it will be worth trying.

Mr. Dunne's Theory

(1) *Formal Exposition.*—Mr. Dunne's theory, in its purely formal and geometrical aspect, is simply an extension of Hinton's suggestion. The *moving field* of Hinton's observer is now treated in the way in which Hinton treated the *moving particles* of ordinary common sense.

In order to explain this extension we will consider first the artificially simplified case of Hinton's theory, illustrated in Fig. 1, where the threads are confined to a two-fold and the observer's field of view at any moment is confined to the contents of a straight line which moves uniformly at right angles to itself in that two-fold. We will then proceed to the extension of the actual case, where the threads are (1,4)-folds and the observer's field is a moving (3,4)-fold.

Starting with Fig. 1, let us draw an axis OZ at right-angles to the paper, and a plane through OY bisecting the angle between the planes YOX and YOZ. Call this plane YOL. Now imagine a plane moving at right angles to the Z-axis with uniform velocity c. This will cut the plane YOL in a series of straight lines parallel to YO, such as Y'O' (see Fig. 3).

Suppose that there is an observer whose field of observation at any moment is confined to the contents of the moving plane at that moment. Then he will observe in all his successive fields a straight line which keeps parallel to his Y-axis and moves from left to right along his X-axis. The velocity with which it moves along his X-axis will be c. For it will be the rate at which successive lines parallel to Z′O′ in Fig. 3 increase as the moving plane takes up its successive positions along OZ. Now at every moment Z′O′ = OZ′, since the plane YOL makes an angle of 45 with YOX and YOZ.

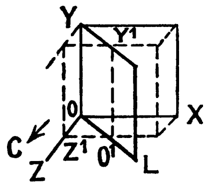


FIG. 3.

And the rate at which OZ′ is increasing is c, for we have assumed that the moving plane travels along OZ with velocity c.

We must now turn our attention to the thread in the plane YOX in Fig. 1. Imagine lines drawn through every point of this thread parallel to the Z-axis. The *thread* is now replaced by a *corrugated sheet* with its corrugations stretching indefinitely parallel to OZ. Our original thread was the section of this sheet by the plane YOX. The moving plane will cut this sheet at every moment in a wavy line exactly similar to the original thread and exactly similarly situated in each successive position of the plane (see Fig. 4).

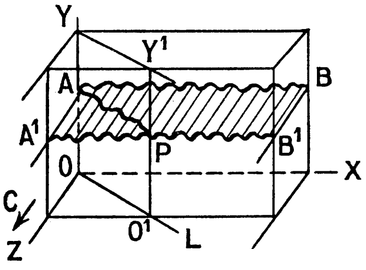


FIG. 4.

An observer whose field of observation at any moment is confined to the contents of the *moving plane* at that moment will have the following experiences. He will perceive a *stationary sinuous thread* and he will perceive a *straight line* which keeps parallel to his Y-axis and *moves* from left to right *along his X-axis with uniform velocity c.* The moving straight line cuts the stationary thread at a *different point* at each different moment until the line gets to the right-hand end of the thread. After this the thread will continue indefinitely to be perceived simply as a stationary whole without any line moving along it and cutting it.

Suppose, on the other hand, that the observer's field of observation at every moment were confined to the contents of the *straight line* in which the moving plane intersects the fixed plane YOL at that moment. In that case all that he would perceive would be a *single particle moving up and down* along the X-axis. He would perceive *no* moving straight line and *no* stationary sinuous thread.

It is now quite easy to extend this reasoning to the actual case of a thread in a four-fold. This is a (1,4)-fold, and is therefore represented by three independent simultaneous equations, $x = f(u)$, $y = g(u)$, and $z = h(u)$. Suppose we now assume that our original four-fold is a (4,5)-fold, and that the fifth dimension of the five-fold is the axis W. These three equations will now represent a (2,5)-fold, i.e. a *surface*, in the five-fold. Since the equations do not contain W, this (2,5)-fold will be the surface obtained by drawing through every point in the original thread a straight line of indefinite length parallel to the W-axis. It will, therefore, be a corrugated sheet of the kind already described. The original thread will now be the section of this sheet by the (4,5)-fold $w = 0$. So it is now represented by the *four* equations $x = f(u)$, $y = g(u)$, $z = h(u)$, and $w = 0$.

Let us now suppose that there is in the five-fold a manifold whose equation is $u = w$. This will be a (4,5)-fold. It will intersect the corrugated (2,5)-fold in a *line*. For between them we have the *four* independent equations $x = f(u)$, $y = g(u)$, $z = h(u)$, and $u = w$. These will determine a (1,5)-fold, i.e. a line. It is clear that this line will be symmetrically situated as regards the axes U and W.

Lastly, consider a moving manifold whose equation at any moment t is $w = ct$. This will be a (4,5)-fold moving at right angles to itself along the W-axis with uniform velocity c. As t varies continuously we get a series of such (4,5)-folds further and further along the W-axis. Each of them will intersect the (4,5)-fold $u = w$ in a (3,5)-fold; for between them they give the *two* independent equations $w = ct$ and $u = w$. This (3,5)-fold will intersect the corrugated (2,5)-fold in a *point*. For the intersection is determined by the *five* independent equations $x = f(u)$, $y = g(u)$, $z = h(u)$, $w = ct$, and $u = w$. It is therefore a (0,5)-fold, i.e. a point. Lastly, the (4,5)-fold $w = ct$ will intersect the corrugated (2,5)-fold in a *line*. For the intersection is determined by the *four* independent equations $x = f(u)$, $y = g(u)$, $z = h(u)$, $w = ct$. It is therefore a (1,5)-fold, i.e. a line. It is obviously a line exactly similar to the original thread, whose equations are $x = f(u)$, $y = g(u)$, $z = h(u)$, $w = 0$. The only difference is that it is in the (4,5)-fold $w = ct$ instead of the (4,5)-fold $w = 0$.

Now let us suppose that there is an observer whose field of observation at any moment t is confined to the contents of the (4,5)-fold $w = ct$. At every moment he will perceive the (1,5)-fold which is the intersection at that moment of this moving (4,5)-fold with the corrugated (2,5)-fold. He will therefore perceive a *stationary sinuous thread* in a *four-fold,* and not a stationary corrugated surface in a five-fold. He will perceive the (3,5)-fold, which is the intersection at any moment of the moving (4,5)-fold $w = ct$ with the stationary (4,5)-fold $u = w$, at a different position (viz. further along the U-axis) at each successive moment. He will therefore perceive it as a *three-fold* which keeps at right-angles to the U-axis and *moves steadily along it* with a uniform velocity c. It will be perceived as cutting the stationary sinuous thread at a *different point* at each different moment until it gets to the end of the thread. After this the thread will continue indefinitely to be perceived simply as a stationary whole in a four-fold, without any three-fold moving along it and cutting it at successive points.

Suppose, on the other hand, that the observer's field of observation at every moment were confined to the contents of the (3,5)-fold in which the moving (4,5)-fold $w = ct$ cuts the stationary (4,5)-fold $u = w$ at that moment. In that case he would perceive a *single particle* (viz. the (0,5)-fold represented by the set of equations $u = w,\ w = ct,\ x = f(u),\ y = g(u),\ z = h(u)$) *moving about* in a three-fold. He would perceive *no* moving three-fold and *no* stationary thread. He would, in fact, be in precisely the position of the ordinary man in his normal everyday experiences.

This completes the formal exposition of the second stage of Mr. Dunne's "serial time." The first stage is, of course, simply Hinton's suggestion. Mr. Dunne admits that, for the purpose of explaining Precognition, there is no need to go beyond the stage which we have now reached. On other grounds, which we will not now consider, he thinks that the process must be carried on indefinitely, adding a further spatial dimension at each stage.

We shall confine our attention to the four-dimensional and the five-dimensional stages, and we shall refer to them respectively as "Stage I" and "Stage II." For many purposes the artificially simplified cases, represented in Figs. 1 and 4, are quite adequate representatives of Stages I and II respectively. They have the advantage that they can be illustrated by diagrams; since the first involves only two, and the second only three, dimensions.

(2) *Application of the Theory to Precognition.*—It is easy to see in outline how the theory just explained bears on the possibility of Precognition. For this purpose we can confine ourselves to the artificially simplified case illustrated in Fig. 4, where only three dimensions in all are introduced and the moving field of observation is supposed to be a plane which keeps at right angles to the Z-axis

and travels along it with uniform velocity *c*. The figure is reproduced below, with the addition of a line Y″P′O″, which will be needed later in the argument.

We have to compare the experiences (*a*) of an observer whose field at any moment is confined to the contents of this *moving plane* at that moment, and (*b*) of an observer whose field at any moment is restricted to the contents at that moment of the *moving straight line* in which the moving plane intersects the stationary plane YOL. Let us call these observers "Observer II" and "Observer I" respectively.

At each moment Observer II perceives the *whole breadth* of the corrugated sheet. It is true that, at each different moment, he observes different linear sections across its length in the Z-direction. He fails to recognize this; for he knows nothing of the Z-dimension and therefore does not know that there is a sheet or that he is travelling along its length in the Z-dimension. But, since all the

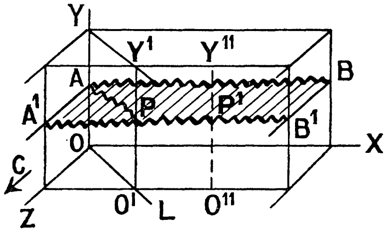


FIG. 5.

sections which he perceives are parallel to each other and exactly similar, the whole spatial form of the sheet in the X and Y-dimensions will be apparent to him at every moment.

At each moment Observer I perceives only *one point* in the corrugated sheet. It will be a different point at each different moment, and it will always lie in the wavy line AP in which the plane YOL cuts the corrugated sheet. This observer knows nothing of the Z-dimension and nothing of the X-dimension. He regards the successive points which he observes as *successive positions of a single particle* which moves up and down the only axis which he recognizes, viz. the Y-axis. Thus Observer II perceives *at every moment* those corrugations which the field of Observer I *has intersected,* but is no longer intersecting, and those corrugations which the field of Observer I *will intersect,* but has not yet intersected. What Observer I perceives *successively* as a *series of events constituting the history of a moving particle* is perceived *continuously* by Observer II as *an unchanging wavy thread.*

Now, if Observer II ever concentrates his attention, so that it is confined to the contents of the moving straight line instead of ranging over the contents of the whole moving plane, he becomes identical with Observer I. Whenever he relaxes his attention again he again becomes Observer II. It will be useful henceforth, instead of talking of "Observer II" and "Observer I," to talk of "the Observer in the expanded state" and "the Observer in the contracted state."

Now, if the observer can, at certain moments, contract his attention to the contents of a single *vertical line* in the moving plane, he may not be obliged to contract it to the contents of *that particular line* Y′O′ in which the moving plane then intersects the stationary plane YOL. He might, instead, concentrate his attention at a certain moment on the contents of another vertical Y″O″ further along the X-axis than Y′O′. If he does this, he will then perceive the point P′, in which the line Y″O″ cuts the corrugated surface, as *an event in the history of a particle* and not as a section of a stationary thread.

Let us now make the following suppositions. (i) That, in normal waking life, the observer's attention is automatically confined at each moment to the contents of the moving line Y′O′ in which the moving plane is then intersecting the stationary plane YOL. (ii) That in sleep and certain other conditions this automatic constraint is removed and he passes into the expanded state. (iii) That, when he is in the expanded state, he may, from time to time, reconcentrate his attention so that it is confined to the contents of some line, such as Y″O″, other than the line Y′O′ in which the moving plane is then intersecting the stationary plane YOL. This line may be either further along the X-axis than Y′O′ or not so far along the X-axis as Y′O′.

Let us suppose that the observer passes into the expanded state a little while before the moment represented in Fig. 5. At the moment represented in Fig. 5, he concentrates his attention on the contents of the line Y″O″, which is further along the X-axis than Y′O′. Later on he wakes up, and henceforth his attention is automatically contracted at each moment to the contents of the line in which the moving plane then intersects the plane YOL. To illustrate the situation we will extract the corrugated sheet from Fig. 5, thus producing Fig. 6 below.

When the moving plane has got to a certain position, A‴B‴, in Fig. 6, its intersection with the fixed plane YOL intersects the corrugated sheet in a point R. R lies on the same corrugation as P′, the point on which the observer concentrated his attention when he was asleep and the moving plane had got only to A′B′. Since the observer is now awake, his attention is now automatically confined to the contents of the intersection between the moving plane and the fixed plane YOL. He therefore perceives the point R as the *present position of a moving particle.* Since R lies on the same corrugation as P′, and the sheet is assumed to stretch uniformly in the Z-direction, the geometrical properties of the sheet round about R will be an exact reproduction of the geometrical properties of the sheet round about P′. Now, when successive intersections of the moving field with the corrugated sheet are perceived as successive events in the history of a particle, the position and motion which this particle will be perceived as having at any moment depend entirely on the geometrical properties of the corrugated sheet at the point then intersected and on the velocity of the moving field. Therefore the position and motion which the observer *perceives* the particle to have when his moving field gets to A‴B‴ are exactly like the position and motion which he *dreamed* the particle to have when his moving field had only reached A′B′. If he recorded his dream when he woke up, i.e. when his moving field had reached the intermediate position A″B″, he would certainly be inclined to say, when

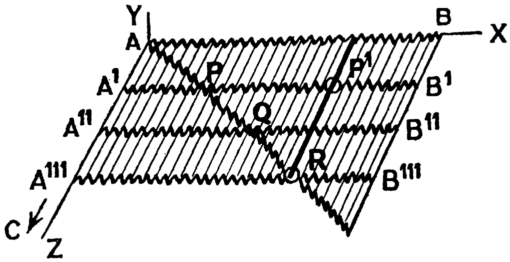


FIG. 6.

his field reached the position A‴B‴, that he was now perceiving an event of which he had already dreamed.

It is evidently quite easy to extend this reasoning from the artificially simplified case of three dimensions to the real case of five dimensions. We have simply to make the following substitutions. (i) For the sheet, corrugated in the X and Y-dimensions and uniform in the Z-dimension, we substitute a (2,5)-fold, corrugated in the X, Y, Z, and U-dimensions and uniform in the W-dimension. The old sheet was of finite breadth in the X-dimension and of indefinite extent in the Z-dimension. The substituted (2,5)-fold is of finite breadth in the U-dimension and of indefinite extent in the W-dimension. The corrugations of the old sheet were of small extent in the Y-dimension as compared with the breadth of the sheet in the X-dimension. The corrugations of the substituted (2,5)-fold are of small extent in the X, Y, and Z-dimensions, as compared with its extent in the U-dimension. (ii) For the plane $z = ct$, moving with uniform velocity c along the Z-axis and keeping always at right angles to the latter, we substitute the moving (4,5)-fold whose equation at any moment t is $w = ct$. This moves along the W-axis with uniform velocity c, keeping always at right angles to the latter. For the stationary plane YOL, whose equation is $x = z$, we substitute the stationary (4,5)-fold whose equation is $u = w$. The argument then proceeds, *mutatis mutandis*, exactly in the same way as the argument in the artificially simplified three-dimensional case.

It is extremely important to notice that, on this theory of "Precognition," no event ever is "precognized" in the strict and literal sense. The dreamer who has a veridical precognitive dream *is not* acquainted in his dream with *that very same event* which later on will happen and fulfil his dream. In the dream he was acquainted with a certain point in the corrugated surface *as it then was*, viz. the then state of the point P′. When the dream is fulfilled he is acquainted with a *different* point in the corrugated surface *as it now is*, viz. the now state of the point R. The latter event is *identified* with the former because the two are precisely alike. And the two are precisely alike because the perceived points occupy corresponding positions on a sheet which is assumed to have remained rigid during the interval between the two experiences, and because this sheet is assumed to be uniform in the dimension along which the moving field is travelling. It is just because Mr. Dunne's theory of "Precognition" excludes precognition, in the strict and literal sense, that it can deal with the paradox that a "precognition" may cause the person who has it to take measures which will prevent the "precognized event" from happening. We must now turn to this aspect of the theory.

(3) *Action to Avoid the Fulfilment of a "Precognition."*—Here, again, it is easy to see in outline how the theory must be applied. We must modify the assumption that the corrugated sheet is absolutely rigid and absolutely uniform in the dimension along which the field of observation is moving. We must suppose that the observer can act on the sheet at the place in it which his moving field now occupies, and can thus modify its structure in parts further ahead which the moving field has not yet reached. In order to explain this we will return to the artificially simplified three-dimensional case, illustrated in Figs. 5 and 6.

Let us suppose that the observer, who concentrated his attention on P′ in Fig. 6 when his field had reached A′B′ and he was still asleep, wakes up when his field gets to A″B″. Let us suppose that he then remembers his dream and takes it to be a precognition of a certain future position and motion of a particle. Suppose that, for some reason, he desires that the particle shall not have this position and motion in future. Now that he is awake his field is automatically contracted to the intersection of the moving plane with the stationary plane YOL in Fig. 5. Its content is therefore confined to the point Q of the corrugated sheet in Fig. 6. Suppose that he can act on the corrugated sheet at Q in such a way as to modify its geometrical structure instantaneously at every point whose Z-co-ordinate is greater than that of Q and whose X-co-ordinate is also greater than that of Q. Two consequences will follow. (*a*) The geometrical properties of the sheet at R will no longer be exactly like the geometrical properties of the sheet at P′, as they would have been if he had not interfered with the sheet at Q. Therefore the position and motion which the observer perceives the particle to have when his moving field gets to A‴B‴ *are not* (as they would have been if he had not interfered in consequence of his dream) exactly like those which he dreamed the particle to have when his field had only reached A′B′. As a consequence of his "precognitive dream" he has taken action which has prevented the "precognition" from being fulfilled. (*b*) As the interference with the sheet at Q has affected *all* points in the sheet whose Z and X-co-ordinates are greater respectively than the Z and X-co-ordinates of Q, it will have affected all the points in the line QR. Therefore the modification of R will not be perceived as a sudden isolated miracle when the moving field reaches R. It will be perceived as the consequence of a change which was deliberately initiated when the field had reached Q and which modifies all the subsequent events in the history of the particle.

As before, there is no difficulty in extending this reasoning from the artificially simplified three-dimensional case to the real case of five dimensions. The necessary substitutions have already been stated.

(4) *Concrete Interpretation of the Theory.*—I have now completed the purely formal exposition of the theory and its application to Precognition. The question remains whether it is a mere ingenious formal curiosity. Can we identify the corrugated (2,5)-fold, the stationary (4,5)-fold $u = w$, and the moving (4,5)-fold $w = ct$, respectively, with any three entities of which we have empirical knowledge? I do not find Mr. Dunne's answer to this question at all clear. He seems to connect the corrugated (2,5)-fold, which he calls the "Substratum," with the observer's brain. He calls the stationary (4,5)-fold $u = w$ the "Reagent"; but I have failed to discover or to understand what empirical object he proposes to identify with it. I am afraid that I can throw very little light on these vitally important questions, but there are certain things which seem worth saying.

(i) A brain is a very complex material system which, from the ordinary three-dimensional point of view, consists of an enormous number of material particles moving about in various ways and influencing each other's motions by occasional impact or continual action at a distance. From the five-dimensional point of view ***each*** particle is correlated with the whole of *one* of our corrugated (2,5)-

folds, and each *different* particle is correlated with a *different* (2,5)-fold. Therefore a complete brain must be correlated with a whole *stack*, containing an enormous number of these (2,5)-folds touching each other at certain points (corresponding to impacts of the brain-particles) and separated at other points. Such a stack will be of no great thickness in the X, Y, and Z-dimensions; for when a brain is regarded as a persistent three-dimensional object, it is a comparatively small thing. The width of the stack in the U-dimension may be considerable, since it is proportional to the time for which the brain would be said to last by an observer who regarded it as a three-dimensional object with a variable history. The extension of the stack in the W-dimension would, for all we know, be indefinitely great. If we are to correlate Mr. Dunne's "Substratum" with the observer's brain, we must identify the Substratum with such a stack of (2,5)-folds, taken as a whole, and not with any one (2,5)-fold.

(ii) Even the suggestion of a stack of (2,5)-folds, such as we have just described, is an over-simplification of the actual facts about the brain. It would be adequate if a brain, from the three-dimensional point of view, were a system which consisted of the same particles throughout its whole history. But this is certainly not true. The brain is constantly, if slowly, breaking down into waste products which are ultimately excreted; and it is constantly, if slowly, being rebuilt from materials which were ultimately ingested in the form of food, water, and air. The sheet corresponding to each ultimate particle of the brain would, so far as we know, be extended indefinitely in the U-dimension as well as in the W-dimension. For when atoms are regarded as particles which persist and move about in a three-dimensional space, we know of no limit to the length of their history. We shall have to think of each stack by analogy to a finite length of cable made of numerous wires twisted together in the following way. Each individual wire is much longer than the cable. Each wire enters the cable at a certain point, becomes part of the cable for a certain segment of its length, and leaves the cable again at a certain other point. The segment of any individual wire which forms part of the cable is considerably shorter than the cable itself, though each individual wire as a whole is indefinitely longer than the cable itself. If we are to correlate Mr. Dunne's "Substratum" with the observer's brain, we must identify the Substratum with a stack of (2,5)-folds conceived by analogy with such a cable as has just been described.

(iii) An observer, whether he is in the waking or the sleeping state, is acquainted with sensa, images, and bodily feelings. He is not, *prima facie*, acquainted with the moving particles of his own brain. I think it is clear at the outset that Mr. Dunne takes the contents of the observer's field at any moment to be "presentations" (i.e. sensa, images, bodily feelings, etc.), and *not* to be that part of the Substratum which the field intersects at that moment. He assumes that there is a one-to-one correlation between the sensible, positional, and other qualities of the presentations in the observer's field at any moment, on the one hand, and the geometrical characteristics of that part of the Substratum which the field is then intersecting, on the other. But, although this distinction between the contents of the field at any moment and the part of the Substratum which the field intersects at that moment is definitely drawn at the beginning of the discussion, it seems to drop out of sight in the formal exposition of the theory. In Mr. Dunne's formal exposition, as in my modified reproduction of it, everything proceeds as if what the observer is acquainted with were *the Substratum itself.* Everything proceeds as if the observer, when in the expanded state, perceives sections of the Substratum itself as a set of stationary sinuous lines; and as if, when he is in the contracted state, he perceives certain points of the Substratum itself as a set of moving interacting particles. When we remember that this supposition is admittedly false, we begin to wonder whether the consequences developed from it in the formal exposition can be carried over to the presentations of our actual waking and sleeping experience.

(iv) I cannot think of any concrete interpretation which can plausibly be put on the "Reagent," i.e. the stationary (4,5)-fold $u = w$ which intersects the moving (4,5)-fold $w = ct$ in a moving (3,5)-fold to which the observer's field is automatically confined whenever he is in the contracted state. Mr. Dunne talks of it as "coming *between*" (his italics) "observer 2 and the substratum section . . . which is, somehow, affecting that observer 2." It looks as if he pictured the Substratum as the floor of a long, narrow room, and the Reagent as a long, thin strip of carpet stretched from one corner to the diagonally opposite corner of the room, leaving most of the floor bare. The field of the observer in the expanded state seems to be pictured as stretching right across the breadth of the room and moving down the length of it. So at every stage in the motion of the field the carpet comes between the field and one part of the floor, but the field is in direct contact with the floor where it extends beyond the edges of the strip of carpet on both sides of the latter. This, however, is mere mythology.

Perhaps it would be enough to make the following assumptions. (*a*) That those points of the Substratum which satisfy the equation $u = w$ have a peculiar property which does not belong to any other points of the Substratum. (*b*) That the various presentations which occupy the moving field at any moment are determined jointly by the velocity of the field along the W-axis and the properties of the points at which the field then intersects the Substratum. (*c*) That the peculiar property of those points of the Substratum which satisfy the equation $u = w$ imparts a peculiar quality to the presentations which are due to *them*, and thus makes these presentations stand out in any field from the rest of the presentations in that field. And (*d*) that the "contracted state" of the Observer just consists in his inability to turn his attention away from the presentations which are marked out by this peculiar quality and to attend to the contents of his field as a whole.

(5) *The Alleged Infinite Series.*—Mr. Dunne's doctrine on this point seems to be fairly summarized in the following four propositions. (i) Even if there had been no evidence for Precognition, the admitted facts about time make it necessary to start on the series whose first two stages we have described. (ii) It is then found, as an interesting and important collateral consequence, that at Stage II an explanation of Precognition emerges. (iii) If it is necessary to start on the series, it is impossible to stop anywhere in it. At each stage there is precisely the same need to introduce a further spatial dimension as there was at the stage before. (iv) This regress, though infinite, is harmless. Mr. Dunne never doubts the reality of time and change, and he talks cheerfully of "the Observer at infinity."

I can state quite briefly my own opinion about these four propositions. (i) I accept the third proposition. At the first stage motion of particles along the X, Y, and Z-axes is replaced by motion of the field of observation along a fourth spatial axis, U, at right angles to these three. At the second stage this motion along the U-axis is replaced by motion along a fifth spatial axis, W, at right angles to the previous four. Plainly, if it is *necessary* to start this process, there is no stage at which it is not equally necessary to continue it. (ii) I reject the fourth proposition. If this regress is involved in the notion of time, it is vicious, and the notion of time must be rejected as delusive. The "Observer at infinity" would be the *last* term of a series which, by hypothesis, *cannot have* a last term. Therefore the notion of "the Observer at infinity" is a self-contradictory notion and there can be no such observer. Yet, on Mr. Dunne's theory, unless there were such an observer, there would be no observer at all. (iii) I cannot find in *An Experiment with Time* any conclusive reason for Mr. Dunne's first proposition. The process starts, as we have seen, with Hinton's suggestion of replacing moving particles by stationary sinuous (1,4)-folds and a (3,4)-fold field of observation moving uniformly along a fourth spatial axis. This is an interesting and ingenious suggestion, and it has the positive merit of introducing a unity and simplicity into the phenomena of motion which is otherwise lacking. But I can see no trace of logical necessity about it. And, if there is no logical necessity to take the first step, there can be no logical necessity to take the second or any subsequent step in the series. The second step does not even have the merit of introducing additional unity and simplicity. If it is justifiable at all, it is justifiable *only* on the empirical ground that there are cases of Precognition and that they can be explained by taking the second step and not otherwise. So far as I know, there are no empirical grounds for taking a third step. In his later book, *The Serial Universe,* Mr. Dunne infers the necessity of an endless regress from the movement of "presentness" along the series of events in time. The regress to which this seems to lead is used by McTaggart as the basis of his argument against the reality of time; and, if it does lead to this regress, McTaggart's conclusion is the right one. (iv) I agree with Mr. Dunne's second proposition. At Stage II we do get the formal outline of a possible explanation of Precognition, though, as I have tried to show, it is not very easy to put a concrete interpretation on the various elements in the formal theory.