A Picture of Our Universe

By Charles H. Hinton

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The Kilkenny Cats

IT seems to me that the subject of higher space is becoming felt as serious, and fraught with much that is of the deepest interest, not only as a scientific problem, but in other ways also. It seems also that when we commence to feel the seriousness of any subject we partly lose our faculty of dealing with it. The intellect seems to be overweighted somehow, and clogged. Perhaps the suppositions we make seem to us of too great importance, and we are not willing enough to let them go, fearing to lose the thing itself if we lose our hold of the means by which we have first apprehended it.

But whatever may be the cause, it does seem undoubtedly the fact that the mind works more clearly and more freely on subjects which are of slight importance.

And I propose, that without ignoring the real importance of the subject about which we are treating, we should cast aside any tension from our minds, and look at it in a light and easy manner.

With this object in view let us contemplate a certain story which bears on our problem.

It is said that once in a certain region of Ireland there took place a curious contest. For in Kelkenny there were two cats so alike in size, vigour, determination, and prowess, that, fighting, they so clawed, scratched, bit, and finally devoured each other, that nothing was left of either of them save the tail.

Now, on reflecting on this story, it becomes obvious that it originated when looking-glasses were first imported into Ireland from Italy. For when an Irishman sees for the first time anything new, he always describes it in an unexpected and yet genial and interesting manner. Moreover, we all know what contentious fellows they are, and how all their thoughts run on fighting. And I think if we put this problem to ourselves, how by bringing in fighting to describe a looking-glass, we shall see that the story of the Kilkenny cats is the only possible solution. For consider evidently how it arose. Depositing his favorite shillaly in a corner, the massively built Irishman, to whom the possession was a novelty, saw reflected in his looking-glass the image of his favorite cat. With a scrutinizing eye he compared the two. Point for point they were like. "Begorra if I know which of the two would win!" he ejaculates. The combat becomes real to him, and the story of the Kilkenny cats is made.

Now, to our more sober mind, it is obvious that two cats--two real material things--could not mutually annihilate each other to such an extent. But it is perfectly possible to make a model of the Kilkenny cats--to see them fight, and to mark the issue.

And I propose to symbolize or represent the Kilkenny cat by a twist. Take a pencil, and round it twist a strip of paper--a flat spill will do. Now, having fastened the ends on to the pencil by two pins, so that it will not untwist, hold the paper thus twisted on the pencil at right angles to the surface of a looking-glass. and in the looking-glass you will see its image. In figure 16, M represents the mirror, and on the left hand is shown the twist, on the right hand the image twist.

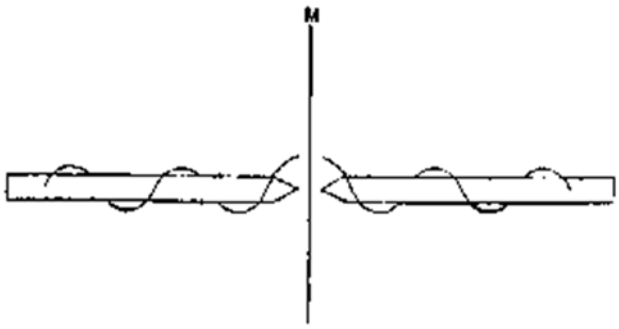


FIGURE 16

Now take another pencil and another piece of paper, and make a model of what you see in the glass. You will be able to twist this second piece of paper in a spiral round this second pencil so that it is an exact copy of what you see in the glass. Now put the two pencils together end to end, as they would be if the first pencil were to approach the glass until it touched it, meeting its image: you have the real copy of the image instead of the image itself. Now pin together the two ends of the pieces of paper, which are near together, and you have your two Kilkenny cats ready for the fray. To make them fight (remember that the twists--not the paper itself, but the paper twisted--represent the cats), hold firmly and pull the other ends (the tail ends, so to speak), so as to let each twist exercise its nature on the other.

You will see that the two twists mutually annihilate each other. Without your unwrapping the paper the twists both go, and nothing is left of them.

Now the image of the twist as a real thing was made by us. It did not exist in nature other than as a mere appearance.

But I want you to imagine this process of producing a real image as somehow existing. I want you to lay aside for the present the question of how it could be done, and to conceive twists and image twists.

This is the mechanical conception I wish you to adopt--there are such things as twists. Suppose by some means to every twist there is produced its image twist. These two, the twist and its image, may exist separately; but suppose that whenever a twist is produced its image twist is also produced, and that these two when put together annihilate each other.

With this conception let us explore the domain of those actions which are called electrical.

We will suppose that a metallic body consists of particles so arranged together that it easily acts as a set of minute threads or chains of particles which will twist, each thread or chain twisting

as a whole. Thus the conception which should be formed of a metallic body conducting electricity along it is this: Conceive a bundle of very fine but very rigid wires, each wire twisting separately but with the same kind of twist as all the others, and each, as it twists, rotating amongst its fellow threads. If we have a metal rod we can twist it between the finger and thumb. This is not the kind of twist we suppose, but that each separate string of particles is thus twisted, so that each set twisting remains in the same part of the metal rod--but is turning round in its fixed position. This is a body conveying an electric current. If the current will not pass, the set of minute wires must be conceived as held at the far end, and given a twist, starting from the point where the electricity is communicated. Now if a conductor is thus charged and left, it is found that it retains its ('barge; to be discharged it must be touched with another conductor. Hence this twist of minute threads differs from a twist of a wire in that the threads cannot untwist of themselves unless other threads come into contact with them to which they can impart the twist. That this should be the case may depend on the fact that the twisting strings are strings of molecules, and the ends of them would thus be connected with other molecules with something of the same tenacity as that with which the strings themselves cohere together, and are unable to unlock themselves from these insulating or untwisting molecules.

We have seen that if we make a certain supposition as to the calling up of an image twist by a twist of molecular matter, then the main facts of electricity are capable of an explanation, which, involving merely the motion of ordinary matter, is far preferable to the idea of there being a mysterious fluid, and more in harmony with our present ideas of electricity.

And yet it is impossible to retain this supposition unless a clear mechanical explanation can be given of how a real image of itself can be called up by the twist which we suppose electricity to be.

We can by intelligent agency produce a twist which is the real image of a given twist. But it would be absurd to suppose amongst the molecules an agency which, acting with prescribed aim, gave in that domain those real simulacra, those evident images, those phantoms with which we in our larger world of masses are for ever mocked.

And yet it would be curious if such an hypothesis were to claim a recognized position in our mental apparatus with which we think about nature.

For in that molecular world, if we imagine it to ourselves, there would be a curious state.

If we consider a twist and its image, they are but the simplest and most rudimentary type of an organism. What holds good (if a twist and its image twist would hold good of a more complicated arrangement also. If a bit of structure apparently very unlike a twist, and with manifold parts and differences in it--if such a structure were to meet its image structure, each of them would instantly unwind the other, and what was before a complex and compound whole, opposite to an image of itself, would at once be resolved into a string of formless particles. A flash, a blaze, and all would be over.

To realize what this would mean we must conceive that in our world there were to be for each man somewhere a counter-man, a presentment of himself, a real counterfeit, outwardly fashioned like himself, but with his right hand opposite his original's right hand. Exactly like the image of the man in a mirror. And then when the man and his counterfeit met, a sudden whirl, a blaze, a little steam, and the two human beings, having mutually unwound each other, leave nothing but a residuum of formless particles.

The Aether

There are some expressions which, being somewhat vaguely used, are apt to cause confusion in the mind of those who read or hear about higher space.

And perhaps the most mischievous is the expression, a curvature of space. Now of space as it is generally used, in its accepted significance, there can be no curvature. For space means a system of positions extending uniformly in the number of dimensions we choose to fix upon.

If we take the straight line as our space, we may call it I space; then the set of positions follow one on after the other without bending. If the line is bent it becomes a *line*, not a straight line. It should not be called 1 space, but a thing in 2 space. That is, it is a bent line in a plane.

A being who was on the line might not perceive the fact of this bending, and it might not affect the measurements he made. But if the line ran into itself again, and he found that he was moving on what we should call a circle, this would in no way affect his idea of space. He would recognize that what he called space, namely, his line, was not space, but a curved thing in 2 space.

Similarly, taking a plane--this is by definition not curved in any way, known or unknown, and it can only be conceived to be bent by ampler space being conceived, and its being imagined as having force applied to it so as to become a bent thing in this ampler space. In this case the term "plane" is not the correct name.

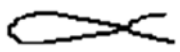
And so about our three-dimensional space; we cannot be robbed of that idea, although it might conceivably be proved that our earth and our whole universe were on a curved thing in 4 space.

We will then keep the term "space" for the ordinary conception; and call it 1, 2, 3, 4 space, according to the number of supposed independent directions.

A curved line or surface or solid we will call a 1, 2, or 3 thing, according to the number of dimensions in it.

A straight line is a 1 thing possible in 1 space. A circle is a 1 thing possible in 2 space. At any point of it a being in it is limited to motion in one direction, while the circle itself involves two dimensions. The surface of a sphere is a 2 thing possible in 3 space. The rind of an orange, or the orange itself, is a 3 thing possible in 3 space.

It will be observed that the surface of the sphere, although only a 2 thing, involves the conception of 3 space, and cannot be understood without the use of the idea of 3 space. It is a 2 thing because at any point of the surface a being can only move in two independent directions. A crooked line drawn on the surface of a sphere is a 1 thing in a 2 thing in 3 space.

Another very common misconception is occasioned by the use of a figure of this kind  to represent a "knot" in 2 space.

It obviously corresponds in 2 space to an iron rod welded together at the crossing place of the loop, so that it is indistinguishable which is the one free end, which the other. At the crossing point the two lines represented by the two ink marks must be absolutely one and the same.

If one line be supposed to go over the other, by however small a distance, it would leave the plane. It would suddenly become invisible to the creature in the plane, and it would appear again at the other side of the line it crossed as if it came from nowhere.

It would be as extraordinary a sight as if we saw a pole going up to a brick wall, then beyond the brick wall the rest of the pole appearing--not going through the brick wall, nor coming round it--but somehow appearing; part of the same pole moving when it moved, obviously connected with it, and yet with no joining part which we could possibly discover.

Again, it sometimes appears to be thought that the fourth dimension is in some way different from the three which we know. But there is nothing mysterious at all about it. It is just an ordinary dimension tilted up in some way, which with our bodily organs we cannot point to. But if it is bent down it will be just like any ordinary dimension: a line which went up into the fourth dimension one inch will, when bent down, lie an inch in any known direction we like to point out. Only if this line in the fourth dimension be supposed to be connected rigidly with any rigid body, one of the directions in that rigid body must point away in the fourth dimension when the line that was in the fourth comes into a 3-space direction. If the reader will refer back to the chapter on the plane world he will find a description of the means by which a being there might know that he was in a limited world, and that his conception of space was not of what was really the whole of space. but of the limited portion of it to which he was confined by his manner of being.

The test by which such a being could discover his limitation was this. He found two things, each consisting of a multitude of parts--two triangles; and the relationship of the parts of the one was the same as the relationship of the parts of the other. For every point in the one there was a corresponding point in the other. For every pair of points in the one there was a corresponding pair of points in the other. In fact, considered as systems made up of mutually related parts, each was the same as the other.

Yet he could not make these two triangles coincide.

Now this impossibility of bringing together two things which he felt were really alike was the sign to him of his limitation; and by reflecting on the similar appearance which would present itself to a being limited to a straight line--by thinking of two systems of points which were really identical, and which he could make coincide, but which a line being could not make coincide, he would be led to conclude that he in his turn was subject to a limitation.

Now is there any object which we know which, considered as a whole consisting of parts, is exactly like another whole, the two having all their parts similarly arranged, so as to form in themselves two identical systems, and yet the one incapable of being made to coincide with the other, even in thought?

Let us look at our two bands.

They are (except for accidental variations) exactly alike. And yet they cannot be made to coincide.

And here, if we reflect on it, is the sign to us that we are limited in our notions of space--that we are really in a four-dimensional world.

Watching a ship as it recedes from the shore we see that it becomes hull down before it vanishes, and know that the earth is round. And no less certainly do our two hands, in their curious likeness and yet difference, afford to us a perpetual proof of our limitation, and indicate a larger world.

This sign really tells us more than the mere fact of our limitation: it tells us where to look for the possibility of four-dimensional movements. It tells us that movements of any degree of magnitude relative to us are not possible in the fourth dimension. It tells us to look for four-dimensional movements in the minute particles of matter, not in the movements of masses of about our own size.

The task before us is difficult. We have to make up from the outside what the appearances of a higher space existence are to us in our space, and then we have to look at the facts of nature and see if they correspond to these appearances.

Let us take a few isolated points and look at them patiently.

To a being standing on the rim of a plane world a straight line absolutely shuts out the prospect before him. If the straight line is infinite it cuts his world in two; he can never hope to get beyond it.

It is to him what an infinite plane would be to us, stretching impassably in front of us, cutting us off from all that lies on the other side.

But we know that a point can move round this line. It can revolve round it by going out of the plane, and coming down again into the plane on the other side of the line.

This movement would be inconceivable to a plane being; for he can only conceive it possible to get to the other side of the line by going to the end of it and coming back along the other side of the line.

Now take a piece of paper and put a dot right in the middle and suppose that it has no means of passing through the paper. We can only conceive the dot getting to the other side of the paper by passing round the edge and coming back again to the position underneath where it was.

But by a four-dimensional movement it can slip round the paper without going to the edge.

A set of words may help. In a plane a body rotates round a point--rotation takes place round a point. In space rotation is always round a line--the axis. In four-dimensional space rotation takes place round a plane.

To take a farther consideration of this point--a plane being can see one side or the opposite of a straight line. He can only see it in one direction or in the reverse direction. But we can look at a straight line from a direction at right angles to that in which a plane being looks at it. We can look at a straight line from points which go all round it.

Similarly, a being in four-dimensional space can look at a plane from a direction at right angles to that in which we look at it. If we try to think of this we shall imagine ourselves looking at the thin edge. But this is not what a four-dimensional being would mean. He would see the plane exactly as we see it, but it would be from a direction at right angles to that in which we look.

In working with four-dimensional models it is a curious sensation until we become used to it--that of looking at a plane at one time, and then looking at it again; and, although it seems just the same as square in front of us as before--realizing that we are looking at it from a direction at right angles to that of our former view.

And in four dimensions a point which is quite close to a plane can revolve round it without passing through it, thus presenting to us the appearance of vibrating across the plane, but not passing through it.

The appearance is as wonderful to us as it would be for a plane being to see a point which was in front of a line quickly passing behind it without having gone round the end. Such a point would appear to the plane being to vibrate across his line without passing through it.

Now if we stand in front of a mirror we see the image of ourselves. If we were to go round the mirror and take behind it the position which our image seemed to occupy, we should not be able to make ourselves coincide with it. In the mirror opposite to our left hand is the image of our left hand; but if we passed round, our right hand would be in the place in which we imagined we saw the image of our left hand. And thus we cannot make ourselves coincide with our image. But by a rotation in four-dimensional space we could put ourselves so as exactly to coincide with our image. This can be seen by referring to the case of the straight line, figure 17.

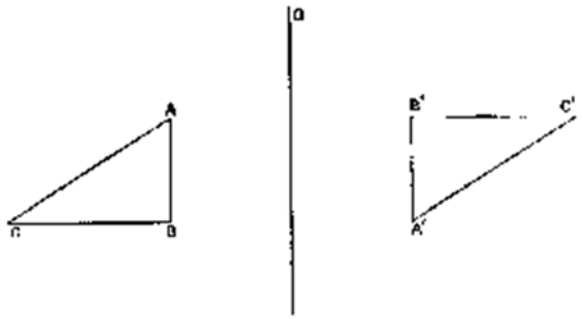


FIGURE 17

Let ABC be a triangle, and G a line. If ABC moves round the end of the line, it can take up the position A'B'C'; but it cannot anyhow be made to take the position shown in figure 18, A 'B 'C'.

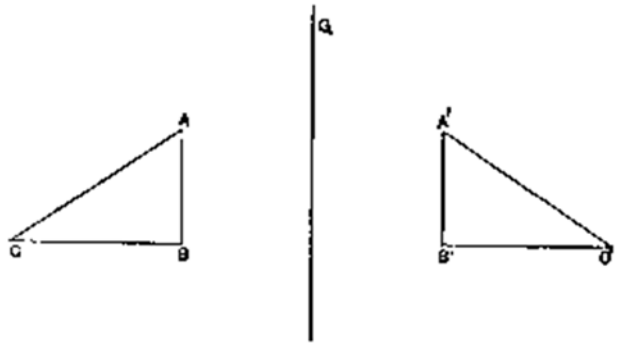


FIGURE 18

But if we move the triangle ABC out of the plane round the line G as axis, it will, in the course of its twisting round this axis, come into the position A'B'C'. It will come into this position when it has twisted half-way round. The point A, for instance, twists round in a circle lying in a plane

which contains the direction A to A', and the direction at right angles to the paper. Twisting half-way round in this circle, it becomes A', and so on for the other points. Now a being who did not know what a direction was which lay out of the plane would not be able to conceive this twisting and turning movement. It would be as impossible for him to conceive the triangle ABC turned into the triangle A'B 'C' as it would be for us to suppose ourselves turned into the looking-glass image of ourselves by a simple twisting.

Yet just as a thing inconceivable to the plane creature can be done, so we could be twisted round and turned into our image. But this only holds theoretically; our relation to the aether is such that we cannot be so turned, or any bodies of a magnitude appreciable to our senses.

If we consider the case of a being limited to a plane, we see that he would have two directions marked out for him at every point of the rim of matter on which he must be conceived as standing. This is up and down, and forwards and backwards--the up being away from the attracting mass on which he is.

Now, if he were to realize that he was in three-dimensional space, but confined to a plane surface in it, his first conclusion would be that there was a new direction starting from every point of matter, and that this new direction was not one of those which he knew. This new direction he could not represent in terms of the directions with which he was familiar, and he would have to invent new terms for it.

And so we, when we conceive that from every particle of matter there is a new direction not connected with any of those which we know, but independent of all the paths we can draw in space, and at right angles to them all--we also must invent a new name for this new direction. And let us suppose a force acting in a definite way in this new direction. Let there be a force like gravitation. If there is such a direction, there will probably be a force acting in it; for in every known direction we find forces of some kind or another acting. Let us call away from this force by the Greek word *ana*, and towards the center of this force *kata*. Then from every point in addition to the directions up and down, right and left, away from and towards us, is the new direction ana and kata.

Now we must suppose something to prevent matter passing off in the direction kata. We must suppose something touching it at every point, and, like it, indefinitely extended in three dimensions.

But we need not suppose it--this unknown--to be infinitely extended in the new direction ana and kata. If matter is to move freely, it must be on the surface of this substratum. And when the word surface is used it does not mean surface in the sense that a table top is a surface; it is not a plane surface, but a solid space surface. If from every point of a material body a new direction goes off, the matter which fills up the space produced by the solid moving in this new direction will have the solid it started from as its surface, and will be to it as a solid cube is to the square which bounds it on the top.

Now this body which extends thus, bearing all solid portions of matter in contact with its surface by every point of them, may be thick in the kata direction or thin.

If it is thick, then the influence of any point streaming out in radiant lines will pass as in all space directions, so out also in this new direction.

And then if its influence spreads out in this new direction, its effect on any particle near it will diminish as the cube of the distance; for, besides filling all space, it will have also to fill space extended in this new direction.

But we know that the influence proceeding from a particle does not diminish as the cube of the distance, but as the square of the distance.

Hence the body which, touching all solid bodies by every point in them, and supports them extending itself in the kata direction--this body is not thick in this direction, but thin. It is so thin that over distances which we can measure the influence proceeding from a body is not lost by spreading in this new kind of depth.

Thus the supporting body resembles, as far as we know it, a portion of a vast bubble. But moving on the surface of this bubble we can pass up and down, near and far, right and left, without leaving the surface of the bubble. The direction in which it is thin is in a direction which we do not know, in which we cannot move. But although we cannot make any movements which we can observe with our eyes in this direction, still the thin film--thin though infinitely extended in any way which we can measure--this thin film vibrates and quivers in this new direction, and the effects of its trembling and quivering are visible in the results of molecular motion. It only affects matter by its movement in directions at right angles to any paths which we can point to or observe, and these movements are minute; but still they are incessant, all-pervading, and the cause of movements of matter. It is smooth--so smooth that it hinders not at all the gliding of our earth in its onward path. Hence it does not transmit a direct pull or push in any direction from one particle to another; but by the twistings and vibrations of the material particles it is affected, and conveys from one to another these movements. Yet to bear up all matter, and thus hold it on its vast solid surface, it must be extremely rigid and unshatterable; and hence it cannot be permanently altered or twisted by an" force proceeding from matter; but receiving from matter any push or twist, it is impressed with it for some distance; then, reasserting itself, it produces an image displacement or twist, and this image it transfers to the particles of matter which it touches.

Sometimes, as when light comes from the sun, this displacement and image is repeated and repeated innumerable times before at last we, receiving it, become aware of the origin of the disturbance.

But the properties and powers of this solid sheet--this film quivering and trembling, yet infinite and solid--are too many to begin to enumerate. The aether is more solid than the vastest mountain chains yet thinner than a leaf; undestroyed by the fiercest heat of any furnace, for the heat of the furnace is but its shaking and quivering; bearing all the heavenly bodies on it, and conveying their influence to all regions of what we call space.

And by some mysterious action it calls up magnetism from electricity; by its different movements it gives the different kinds of light their being.

Of itself untrammelled and unclogged by matter, it vibrates and shakes with the speed and rapidity of the vibrations of light. But when matter lies on it--when air, even in its rarest condition, lies on it--its proper movement is damped and some of its quick shakings that are light, slow down to the obscure vibrations of heat. Thus of itself it will not take up the vibration of a hot body, but selects only those orbs which are glowing with radiant light wherefrom to take its thrilling messages. But when matter lies on it, it takes obediently the less vivacious movements of terrestrial fires.

A being able to lay hold of the aether by any means would, unless he were instantly lost from amongst us by his staying still while the earth dashes on--he would be able to pass in any space direction in our world. He would not need to climb by stairs, nor to pass along resting on the ground.

And such a being, even as thin as ourselves, and as limited, if not even in physical powers, but merely in thought he became aware of his true relation to the aether, he would see all things differently.

From all shapes would fall that limitation of thought which makes us see them differently to what they are; and in largeness and liberty of possible movement his mind would travel where ours but creeps, and soar and extend where ours journeys and diverges.

It is impossible in contemplating the rudiments of four-dimensional existence to prevent a sense of largeness and liberty penetrating even through the profoundness of our ignorance.

Whether we shall find beings other than ourselves, when we have explored this larger space, cannot be said.

But there is a path which holds out a more distinct promise.

When the conditions of life on a plane are realized it becomes evident that much of that which is to us merely natural--obvious from the very conditions of our life--could only be attained by beings on the plane as the result of artificial contrivances and modifications of their natural tendencies. In their progress and development they would, as it were, represent on the plane the features of the normal and undeveloped life of three-dimensional beings, and they would attain as a result of moral labor and energy, a position which children in our higher life are born to without trouble or thought.

And so we in our advancing civilization may to the eyes of some higher beings represent in our arrangements and institutions an approach to the simplest matters of fact in their existence. 'We are separated from such a view by our bodily conditions, but we are not to be prevented from taking it with our minds.

By building up the conception of higher space, by framing the mechanics of such a higher world, we may arrive at a fairly accurate knowledge of the conditions of life in it.

And then, with that element in our thought, with the reasoned-out characteristics present to our minds of what life on a higher physical basis would be, we may be able to judge amidst conflicting tendencies with more certainty and calmness.

In one of the following papers of this series an account will be given of some of the facts which we can discern about the machinery and appliances of four-dimensional beings.

But the work of real discernment belongs to those who will from childhood be brought up to the conception of higher space.

Appendix

A supposition can be made with regard to the aether which renders clearer an idea often found in literature.

This idea is that of the freedom of the will. If the will is free, it must affect the world so as to determine chains of actions about which the mechanical laws hold true. We know that these mechanical laws are invariably true. Hence, if the will is an independent cause, it must act so that its deeds produce to us the appearance of a set of events determined by our known laws of cause and effect. The idea of the freedom of the will is intimately connected with the assertion that apparent importance, command of power, greatness and estimation, are outside considerations, not affecting the real importance and value of any human agent. These ideas can easily be represented using the idea of the aether as here given.

For suppose the aether, instead of being perfectly smooth, to be corrugated, and to have all manner of definite marks and furrows. Then the earth, coming in its course round the sun on this corrugated surface, would behave exactly like the phonograph behaves.

In the case of the phonograph the indented metal sheet is moved past the metal point attached to the membrane. In the case of the earth it is the indented aether which remains still while the material earth slips along it. Corresponding to each of the marks in the aether there would be a movement of matter, and the consistency and laws of the movements of matter would depend on the predetermined disposition of the furrows and indentations of the solid surface along which it slips.

The sun, too, moving along the aether, would receive its extreme energy of vibration from the particular region along which it moved, and the furrows of the intervening distance give the phenomena actually observed of our relationship to the sun and other heavenly bodies.

Thus matter may be entirely passive, and the history of nations, stories of kings, down to the smallest details in the life of individuals, be phonographed out according to predetermined marks in the aether. In that case a man would, as to his material body, correspond to certain portions of matter; as to his actions and thoughts he would be a complicated set of furrows in the aether.

Now what the man is in himself may be left undetermined; but he would be more intimately connected with the aether than with the matter of his body. And we may suppose that the aether itself is capable of movement and alteration; that it moulds itself into new furrows and marks.

Thus the old woman smoking a pipe by the wayside years ago, and whom I somehow so often remember, is not much different from me--we are both corrugations of the same aether.

Now our consciousness is limited to our bodily surroundings. Vet it may be supposed that in an action of our wills we, whatever we are (and for the present let us suppose that we are a part of the aether), we may be altering these corrugations of the aether. A single act of our wills, when we really do act, may be a universal affair with quite infinite relations. Thus it may be the immediate presentation to us of an alteration proceeding from us of all that set of corrugations which represents our future life; it may be the whole disposition and lie of events, which are prepared for the earth to phonograph out, being differently disposed. And it evidently is quite independent of the particular furrows in which such alteration first occurs. That long strip of aether which is a very humble individual may, by an act of self-configuration, affect the neighboring long strips and produce great changes. At any rate the intrinsic value of the will is quite independent of the kind of furrows along which any material human body is proceeding.