SPACETIME AND CONSCIOUSNESS. PART I: STC, P-TIME AND THE PHYSICAL BASIS OF CONSCIOUSNESS. Edgar L. Owen, B.S.

Abstract: The 'STC' Principle underlying Special Relativity demonstrates that all physical entities continually move through spacetime at the speed of light. It is seen that this principle provides a firm scientific basis for the flow and arrow of time and requires the physical existence of a privileged present. A careful analysis of the 'twin paradox' demonstrates that clock time and 'p-time', the time defined by the present, are two very different kinds of time. These important new insights into the nature of time lead us to an elegant and wide-ranging cosmological model which sheds light on a number of perennial questions in physics, philosophy and cosmology, and naturally leads to a physically based theory of consciousness as well. The result is a broad new theory of reality firmly grounded in modern science and yet consistent with the deeper insights of human perception and reason. We conclude by commenting on the meaning of Zen Buddhism's 'seeing into the true nature of things'.

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INTRODUCTION

The papers in this series, of which this is the first, are ultimately the result of my own lifelong interest in reaching a deeper understanding of the true nature of reality. First and foremost, such an understanding must be based in the experimentally verified facts of modern science, and carefully reasoned thought, but it should also incorporate the deeper insights of direct awareness of the processes of the world and the mind. Perhaps the most profound lesson I have learned from my investigations is that there is no inherent division between the processes of the physical world and those of consciousness, and one of the achievements of this paper is to clearly demonstrate how this comes to be.

In a paper like this terminology is often a problem, as words must take on new meanings in the context of new understanding. I have taken special pains to present my ideas clearly and unambiguously, sometimes perhaps to the point of tedium. I hope the reader will be patient with me here, as sometimes the points are subtle. Let me just emphasize that when I speak of the 'physical world' I mean to exclude nothing and include everything. I merely imply by the use of this term, that there is a common and consistent scientifically accessible framework to all aspects of reality, and that they are all manifestations of a single unified cosmological process.

Throughout it is assumed that the reader is familiar with the basic terminology and concepts of modern science on at least the level of a popular exposition. This includes relativity, quantum mechanics and cosmology, as well as a basic knowledge of classical physics. In Part I, the little mathematics that is used is at the high school level, the steps of all derivations are given, and the meaning of all equations is also stated in English so as to provide maximum accessibility to the ideas at the root of the theory.

This paper is dedicated to all those who have sought a true and deeper understanding of this amazing world in which we find our existence. It is on their broad shoulders that this work stands. Lastly, let me express my profound thanks to those wonderful spirits who have supported and encouraged me in this task.

1. SPECIAL RELATIVITY IS THE CONSEQUENCE OF A SINGLE MORE FUNDAMENTAL PRINCIPLE

There is a single rather amazing fundamental principle that underlies the theory of special relativity, and of which special relativity is the natural consequence. This principle is that **all physical entities continually move through spacetime at the speed of light c!** For want of a better term, I will refer to this as the STC Principle or just STC. What this means is that the combined space and time velocities of every physical entity are always exactly equal to the speed of light at every moment of their existence.

If we simplify our discussion by assuming that any spatial velocity is directed parallel to the x axis, the STC Principle can be expressed mathematically as

$$\mathbf{v}_x + \mathbf{v}_T = \mathbf{c} \qquad (1.1)$$

Where $\mathbf{v}_x$ is the velocity through space along the x axis, $\mathbf{v}_T$ is the velocity through time, and $\mathbf{c}$ is the velocity of light. Writing the quantities in bold indicates that they are vectors, that is they have both a magnitude and a direction. Expressing the x velocity as a vector $\mathbf{v}_x$ is standard physics, however most physicists would probably recoil at expressing the velocity of time as a vector since it is normally considered to be what is called a scalar, a quantity having a magnitude but no direction. In fact though, time clearly does have a direction which is always along the time axis, and thus it is most certainly a vector. The addition of two vectors always produces another vector, so that the result of Eq. (1.1) is a vector *velocity* in a particular direction and the magnitude of that velocity is always the (scalar) *speed* of light.

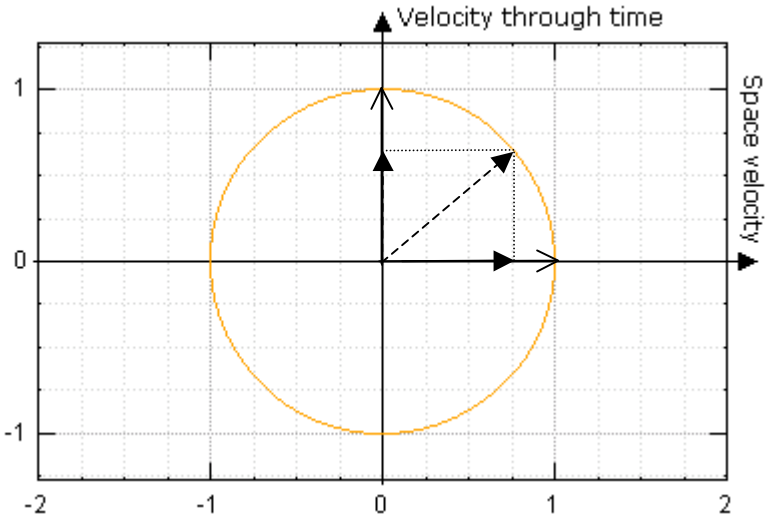

Fig. 1.1 The STC Principle. The vector sum of space and time velocities of every entity in the universe is always equal in magnitude to the speed of light c at every moment, as shown by the yellow circle. Arrows show the three possible cases. When there is no relative velocity in space all of an object's spacetime velocity is through time at the speed of light as shown by the open-headed vertical arrow. In contrast, light itself always travels with relative space velocity $v_x = c$ as represented by the horizontal open-headed arrow. In the third case, when $0 < v_x < c$, the spacetime velocity is the vector sum of the space and time velocities along their respective axes as shown by the dashed arrow. But in all cases the vector sum of space and time velocities is equal in magnitude to the speed of light as indicated by the yellow circle.

Eq. (1.1) can be easily understood graphically. In Fig. 1.1 the vertical axis is the velocity of time, and the horizontal axis is the space velocity along the x axis. When we plot Eq. (1.1), we get a circular arc of constant radius c = the speed of light. The graph shows an arbitrary example whose spacetime velocity vector extends from the origin to the circle along with the space and time velocity components whose vectors sum to it. It also shows the cases in which the c spacetime velocity is directed either entirely along the time or the space axis.

The mathematical rules of vector addition are just the expressions of simple geometry and the Pythagorean theorem so that we can alternately express Eq. (1.1) as

$$v_x^{\,2} + v_T^{\,2} = c^2 \qquad (1.2)$$

That is the sum of the squares of the x and time velocities is equal to the square of the speed of light. This is the more usual mathematical form equivalent to the vector form of (1.1).

From Newtonian physics we know that a velocity is the time rate of change of a distance so that the space velocity along the x axis could also have been written as dx/dt, the instantaneous rate of change of x distance with t time at any given moment.

Now what is meant by the velocity of time? The idea that we need to express, which we will understand more clearly in a moment, is that a moving clock runs at a slower rate than a stationary clock. So it makes sense to consider the rate at which the moving clock runs relative to the standard stationary clock as the relative velocity of the time displayed by the moving clock. We express this velocity as dT/dt, the time rate of change of the moving clock as measured by the stationary clock.

Another consideration is that distance in space is measured in space units such as meters, whereas distance along the time axis is measured in time units such as seconds. To have a meaningful equation in which both

types of distances and their velocities can be compared they must be expressed in the same units. This can be done by expressing both in a unit such as light seconds, the distance that light travels in a second, $\approx 3 \times 10^6$ meters. This is easily accomplished by substituting cT for T to express the distance along the time axis measured by the moving clock. This gives the equivalent time distance (seconds) in units of spatial distance (light seconds). With these additions we can now rewrite Eq. (1.2) as

$$v_x^{\,2} + \left(\frac{dcT}{dt}\right)^2 = c^2$$

and since for a constant c, dcT/dt = cdT/dt

$$v_x^{\,2} + c^2\left(\frac{dT}{dt}\right)^2 = c^2 \tag{1.3}$$

Rearranging and dividing both sides by c^2

$$\left(\frac{dT}{dt}\right)^2 = \frac{c^2 - v_x^{\,2}}{c^2} = 1 - \frac{v_x^{\,2}}{c^2}$$

and taking the square root of both sides we have

$$\frac{dT}{dt} = \sqrt{1 - \frac{v_x^{\,2}}{c^2}} \tag{1.4}$$

which gives the velocity of time (the relative slowing of its clock rate) for a clock moving at velocity v_x relative to a stationary observer's clock.

Now Eq. (1.4) is a fundamental equation of special relativity, an expression of the Lorentz transform, and from it all the standard effects of special relativity can be derived. (Except for $E = mc^2$ which follows with the addition of the standard classical principles of conservation of energy and momentum.) Thus we find that **the theory of special relativity is in fact a consequence of the STC Principle.** That the great importance of the STC Principle is little recognized or appreciated by physicists is quite surprising. Brian Greene (1999, p. 50), (2005, p. 49) is the only other author I'm aware of who even mentions the idea, at least in popular expositions, but he seems to treat it only in passing as something of a curiosity without developing its implications.

We will now explore some of the relativistic effects of STC. From Eq. (1.1) we see that the spacetime c velocity can be directed either entirely along the time dimension, entirely within the three spatial dimensions (along the x axis in our example), or shared between the time and space dimensions.

First note that since an observer cannot move in space relative to himself, his own STC velocity must always be entirely along the time dimension. We will use this as our definition of an observer. **An observer is a spacetime viewpoint (coordinate metric) that has no spatial or temporal velocity or displacement relative to itself**. Thus every observer's $\mathbf{v}_x = 0$ and his dT/dt will always be equal to 1, and he will continuously move through time at one light second per second according to his own co-moving clock. This is called an observer's 'proper time'. So **the STC velocity for every observer is always entirely along the *time* dimension at the speed of light c**.

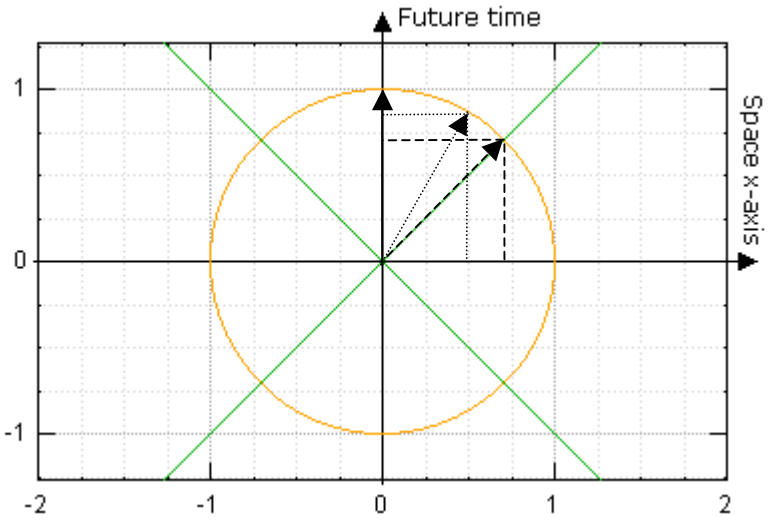

Fig. 1.2 Time and space. The graph shows time vertically and the x space dimension horizontally. The arrows show the time and space distances resulting from the STC spacetime c velocity in different directions over a period of 1 second. Arrows show the three possible cases. When there is no velocity through space, all of the spacetime motion is through *time* at the speed of light as shown by the solid vertical arrow along the time axis. Photons of light always travel with a *space* velocity v_x = c = 1 light sec/sec and thus follow one of the green light cones as represented by the dashed arrow. When the spactial velocity is between zero and c, the time velocity slows according to the Lorentz transform given by Eq. (1.4). This results in the time traveled on the moving clock being only the vertical distance from the arrowhead to the green light cone. However, the resulting x and time distances traveled (from a stationary observer's perspective) are shown by the axial components. Since the spacetime velocity is always equal to the speed of light, the spacetime distance traveled will be 1 light second in all three cases (again from a stationary observer's perspective).

In contrast photons of electromagnetic energy are always moving at the speed of light through *space* relative to any observer. Thus their STC velocity is taken up entirely by this velocity through space and they have no velocity along the time dimension. We can say that photons do not age; a hypothetical clock riding with a photon would always show the same time. By Eq. (l.1), a photon's $\mathbf{v}_x = \mathbf{c}$ and therefore its dT/dt = 0. Thus photons always move at the speed of light c through space because they have no time velocity. **Thus the constant c speed of light is a consequence of the STC Theorem.**

The velocity c should properly be called the speed of spacetime rather than the speed of light! Or, since the more fundamental proper spacetime velocity of every observer is entirely through time, c might better be called the speed of time. What is called the speed of light is actually just the speed at which everything, including light, travels through spacetime. It is only because all of light's spacetime velocity has been diverted away from time velocity, that its spacetime velocity becomes apparent to us as the speed of light through space.

2. THE STC PRINCIPLE PROVIDES A FIRM PHYSICAL BASIS FOR THE FLOW AND ARROW OF TIME

The STC Principle provides a firm physical basis for the flow and arrow of time. Henceforth there should be no more philosophical debate as to whether time actually flows (Davies, 2005), (Price, 1996), or whether it even exists! (Barbour, 1999), (Yourgrau, 2005). It does exist, and the flow of time is a real

physical phenomenon at the very root of reality. **Time flows because the structure of spacetime itself requires it to flow**. In particular **the theories of both special, and general relativity which is based upon it, could not be a true picture of the world if time did not flow in accordance with the STC Principle. The importance of this point cannot be overemphasized.**

Further, the constant STC flow of time for every physical entity requires that there must be a *privileged present* for every entity located at the point of that flow. As a consequence, the concept of 'block time', championed by many relativists, in which each past, present or future moment along the time axis has an equal and eternal 'reality' must be abandoned. **Block time is inconsistent with the STC Principle, and thus it is also inconsistent with relativity**.

The STC Principle contains within it all the ideas of special relativity, but because it also provides a firm physical basis for the flow and arrow of time and demonstrates the existence of a privileged present, it must be considered even more fundamental than special relativity itself.

Readers who are familiar with the popular literature know that a great many authors attempt to base the flow and arrow of time on the inexorable gradual increase in the total entropy of the universe. These efforts are misguided. First we have shown clearly that the flow and arrow of time derive directly from the STC Principle which underlies the experimentally verified theory of special relativity. There can be no question about this. But even in the absence of this it is not at all clear how the increase in entropy, which is statistical and non-uniform, and which in fact frequently reverses in areas of higher energy concentrations, could ever directly result in or be the cause of the apparent continuous smooth and constant flow of time. Also entropy is an emergent phenomenon which exists only among statistical aggregates at a macro level. It does not even exist at the level of individual particles, a level at which time most certainly does exist! **Therefore the increase of entropy must be a consequence of time's flow, not the other way around**.

3. IMPLICATIONS FOR THE STRUCTURE OF SPACETIME

Now we wish to explore in greater depth what STC can tell us about the structure of spacetime. Some of the thoughts in this section are a little more difficult but the rewards of understanding them are great, so I urge the reader to take the time to master them. Once they are understood, a much clearer picture of the nature of reality will emerge in the following sections.

We have seen that the STC Principle leads us directly to the relativistic equation that describes the change in the velocity of time as velocity through space changes. Now what can this tell us about the actual structure of spacetime?

Spaces can be described by the form that Pythagoras' theorem takes within them. The simplest example is that for normal flat Euclidean 3 space and can be written as

$$s^2 = x^2 + y^2 + z^2$$

where s is the distance between a point at the origin and any other point $P_{x,y,z}$. That the distance between any two points in the space is described by this equation is sufficient to characterize the space as a 3 dimensional Euclidean space. So to characterize the geometry of the 4 dimensional spacetime in which the STC Principle is true, we will need a similar expression for spacetime for the 'distance' between any two spacetime points. But what is the actual meaning of the distance between two points in spacetime?

Points in spacetime are called events, and every event has a unique location in both time and space, and the distance between any two events is referred to as the spacetime interval which we will denote by I_{st}. From basic physics we know that the concept of a distance between any two points a and b can be understood as the result of the uniform velocity it would take to move between them times the time taken. So we know

that the interval between the two events must involve both the time it takes and the velocity involved. This is all from the point of view of a stationary observer so we know that the time will simply be t on his clock. But what will the velocity be? It must be an expression that incorporates both the space and time velocities. Knowing this we see that the correct expression for the velocity is the previously derived velocity of time according to the clock moving between the two events, *as this is a function of the spatial velocity of the moving clock as well*.

So the spacetime interval can now be defined as

$$I_{st} = \frac{dT}{dt}t \tag{3.1}$$

That is the interval equals the velocity of time shown by a clock moving from a to b, times the time it takes on the stationary observer's clock. This velocity must be the constant 'straight line' or 'geodesic' velocity.

Substituting for dT/dt from Eq. (1.4) we have

$$I_{st} = t\sqrt{1 - \frac{v_x{}^2}{c^2}}$$

And since v_x=x/t

$$I_{st} = t\sqrt{1 - \frac{x^2}{t^2}\frac{1}{c^2}} = t\sqrt{\frac{c^2t^2}{c^2t^2} - \frac{x^2}{c^2t^2}} = t\sqrt{\frac{c^2t^2 - x^2}{c^2t^2}} = \frac{t}{ct}\sqrt{c^2t^2 - x^2} = \frac{1}{c}\sqrt{c^2t^2 - x^2}$$

and thus

$$c^2 I_{st}{}^2 = c^2t^2 - x^2$$

This equation can be simplified by expressing t and I_{st} directly in light distance units (light seconds), in which case we can drop the c's and we arrive at the equation for the geometry of spacetime given by special relativity

$$I_{st}{}^2 = t^2 - x^2 \tag{3.2}$$

or if we again include the y and z dimensions

$$I_{st}{}^2 = t^2 - x^2 - y^2 - z^2 \tag{3.3}$$

This equation tells us that the spacetime interval between any two events is the square root of the square of their time difference *minus* the square of their spatial distance. This is the spacetime equivalent of the Pythagorean theorem which enables us to calculate the 'distance' between any two spacetime events, and by doing so it uniquely defines the geometry of spacetime. This too has been derived from the STC Principle, by way of Eq. (1.4), and thus **the relativistic geometry of spacetime is a consequence of STC**.

Just as in 3 space the distance between any two points will be the same for any two observers even though their x, y and z may vary, we should expect that the spacetime interval would be the same for any two observers as well, and in fact this is the case though we will not prove that here. And this is true no matter what their spatial velocities are relative to the events.

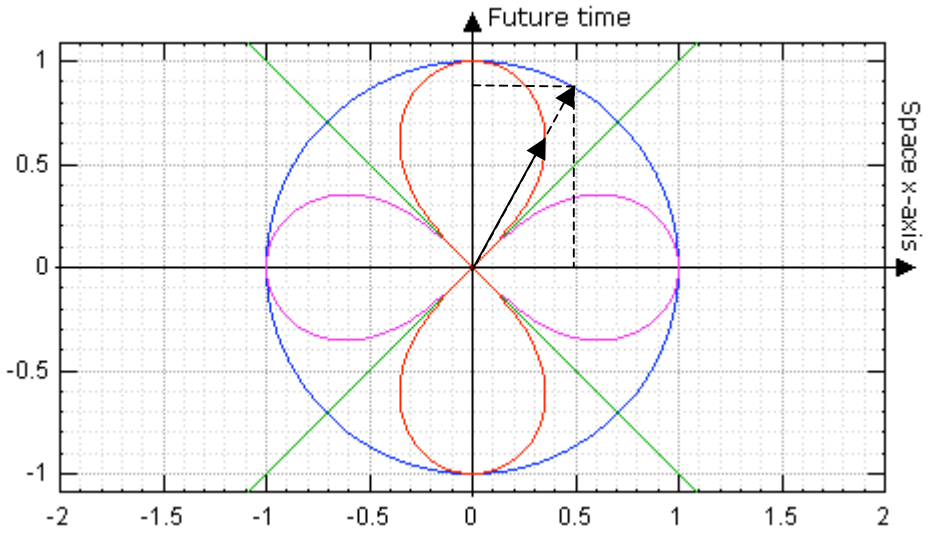

Fig. 3.1 Spacetime intervals. The graph of spacetime intervals in every direction from an event located at the origin forms a 'four leaf clover'. The green lines are the light cones which extend at the speed of light into the past and future from the origin which represents the present moment. The blue circle represents the space and time location of all events b_i whose time and space distances sum to 1 light second. A dotted arrow is drawn from the origin to an arbitrary event b_i on the circle. However due to the geometry of spacetime given by Eq. (3.3), the actual spacetime interval from the origin event to b_i extends along the same radius only as far as the clover curve. Time-like intervals are represented in red and are real, and space-like intervals are represented in violet to indicate they are imaginary in character since their values are square roots of negative numbers.

Eq. (3.3) can also be written as

$$I_{st}^{\,2} = x^2 + y^2 + z^2 - t^2 \qquad (3.4)$$

by just reversing the signs of the time and space terms and the interval and most other things come out the same, so to some extent the choice of signs seems arbitrary and there is no universal consensus among authors. The choice does however make a difference in whether time-like or space-like intervals end up being 'imaginary'. The choice we have made in Eq. (3.3) arises naturally from the STC derivation given.

Almost by definition for time and space to be merely different dimensions of a single spacetime structure they can only be essentially the same kind of 'stuff', and **their differences must be merely perceptual**. Why then do time and space appear so completely different to us? The reason seems to be only that **the matter itself of which we are composed has extension in the three dimensions of space, but not in time**. (Actually there is an extension in time of a different type, but for the moment we will ignore that). Thus our view as observers is only from material eyes constrained to the three space dimensions and it is this that accounts for our very different perception of the dimension of time. The fact that we exist only on the spatial surface of time limits our ability to view that dimension. (See also §4).

It is true that there is a common and useful abstraction in which relativistic objects are considered to consist of the traces of their 3 dimensional forms through time, but this concept derives from block time which is not compatible with STC, which tells us that objects actually exist only in the present and have no real extension in time.

As we will see shortly, even though time is a proper orthogonal dimension with its axis 90° to the three space dimensions, it is unique in that it is a radial or 'polar' dimension, and this must partially account for the difference in our perception.

We must also ask the physical meaning of the minus sign(s) in our spacetime equations. We have seen that this is a direct consequence of the fact that all physical entities continually travel through spacetime at the speed of light. If we adopt the convention of Eq. (3.4) the physical meaning of this minus sign might be taken as an expression of the fact that physical entities must always 'face' toward the past, that is along the negative time axis, even though they continually move in the opposite direction toward the future. Our view of time is rather like watching the landscape roll by from the rear platform of a moving train. Since all physical entities move along the time axis from the past toward the future in a moment called the present, and we have ruled out so called 'block time', we see that **the time dimension can only have actual physical extension toward the past or negative direction.** The negative sign of the time term in Eq. (3.4) might be taken to express this fact.

A striking difference between space and time is that physical entities do appear to travel only in one direction, and along a single dimension of time. Since we presume a single time dimension we arrive at a model whereby **the time dimension continually extends toward the future carrying the three space dimensions along with it as its surface, and that surface is what we call the present**.

'Proper time' is the term for the time measured by an observer's co-moving clock. Since an observer can never have spatial motion relative to himself, the entire spacetime c velocity for every observer is entirely along the time axis. So fundamentally the STC velocity **c is the speed of time**. It is only when some of this velocity through time is diverted into the three dimensions of space that relative spatial motion can occur, and when this occurs time must slow down accordingly. Since the time velocity seems primary, one might even say that motion through space *is* the diversion of an object's normal velocity through time.

It is important that proper time seems to continually pass at the same rate for every observer no matter what his state of motion or what gravitational potential he may experience. His clock rate may be slowed relative to that of empty space but he never notices any difference in his own frame of reference because all measuring devices including his own perception always slow at the same rate as his clock.

The choice of what clock time it actually is at any spacetime point is somewhat a matter of convention, of how one sets one's clock, though one might argue it should be set relative to the big bang! However the *clock rate* of time in empty space seems the obvious choice for a universal time. It is the natural standard reference for the passage of time. By this I mean the proper clock rate of any observer in empty space can be assumed to be identical to that of any other. All such clocks will tick at the same universal rate. All other clocks in relative motion or that experience the accelerations of gravitation or other forces will run slower but none can ever run faster. This is an important point. Clock time can run slower than the standard empty space rate but it can never run faster. **So the standard universal clock time rate is that of a co-moving clock in empty space**.

4. TIME AS DISTANCE – HOW WE DIRECTLY SEE OUR FOUR DIMENSIONAL WORLD

There has been considerable speculation as to how the 4^{th} dimension might be visualized (Kaku, 1994, chapter 3) but in a very real sense it is laid out bare in front of our eyes. We know that we do directly see down the time dimension toward the past as far as the most distant galaxies. So in actuality, the past time direction extends in every spatial direction from every observer's location into the distance; that is from every point in the three dimensions of space. **Thus we do directly see the time dimension as distance in every spatial direction**.

Some might argue that this is not really true, that it is just a consequence of the finite speed of light. That is true of course, but consider that our perception of the dimensions of space also depends on precisely this same phenomenon. We see that space is dimensional because our perception of light demonstrates this.

There is no difference in the perception of time as distance. Our perception of distance as the past dimension of time comes to us through this exact same mechanism of the transmission of light. Therefore it is clear that we do directly see the past dimension of time as well as the 3 dimensions of space.

Some will also argue that even if this were true it is only a partial view, since we can see only a particular *slice* of the past, namely that in which $\Delta t = \Delta r/c$ from our spacetime location where Δr is the radial distance in any direction from our eyes. Again this is true, but consider that we also see only a very particular selected slice of the three dimensions of space as well, namely that in which $\Delta r = c\,\Delta t$! Thus we must use a consistent criterion in both cases and conclude that **since we can see the three dimensions of space then we also see the past dimension of time because our perception of both involves precisely the same mechanism**.

We may summarize this argument by stating that we do directly perceive all four dimensions of spacetime, though only a selected slice dependent on our current spacetime position. This slice is referred to as our 'light cone', which is the four dimensional slice of spacetime from which emitted light is currently arriving at our spacetime position in the present moment. **Our light cone *is* our direct view of the four dimensions of spacetime**. The finite speed of light allows us to see the 4^{th} dimension of time as well as the 3 of space, but at a price, as it warps our view of space into the past so that we can never actually see the present at any distance from ourselves.

The consequence of this is that every observer must always be separated from every other entity in the universe both in time and in space. Everything we see in our present is as it was and exists not in the present, but in the past, even if ever so slightly. No matter how close something, even our best friend, is in space, they are always slightly in our past. Thus the observer exists in a sort of spacetime singularity in which no other object can completely participate. **The observer is the only thing that truly exists in his present.** It is this rather amazing fact that defines much of the magic of the observer and its importance in physical theory, and it also sheds light on the nature of consciousness as we will shortly see.

Note also the difference in the way we see the space dimensions and the time dimension. It is quite obvious that we see the time dimension extending radially outward from every point in space. **Thus the entire 4 dimensional spacetime geometry is clearly laid out in front of our eyes. And we do directly see that the time dimension is in fact a radial dimension. This is an extremely important insight, one so obvious as to have gone largely unnoticed.**

5. TOWARDS AN STC COSMOLOGY

Since by definition an observer can have no time interval, or distance in space, or motion relative to itself, the STC Principle requires that every observer continually moves only along the time dimension, and at light speed according to his own clock. If we make the standard assumption that there is only a single time dimension, we must conclude that **all observers continually move along the *same* time dimension at the speed of light according to their own clocks**. Now the fact that an observer continually moves along the time dimension means there is a unique present moment that he occupies at every time. And since this is true for all observers and there is only one time dimension, we must arrive at a cosmological picture in which **the present moment of the universe as a whole continually sweeps along the time dimension at the speed of light carrying the present moment of the three spatial dimensions with it**.

We know from observational evidence that the three dimensions of space are expanding in what is called the Hubble expansion, and that the universe is expanding outward from an initial big bang, roughly 13.7 billion years ago, at which time it was extremely small. All these lines of thought converge to suggest a simple cosmological model.

In this model the universe is a closed 4 dimensional hyperspherical spacetime in which time is the radial dimension, and the three spatial dimensions are its surface. In this model, the time dimension continually extends itself at the speed of light by adding the next moment of time. And **this continual extension naturally results in the STC Principle whereby everything in the universe must travel through spacetime at the speed of light since the universe itself is extending its time dimension at this velocity**.

This model is quite easy to visualize if we suppress one of the space dimensions. The result is something like an expanding balloon as it is inflated. The distance from the center to the surface represents the past portion of the time dimension which increases as more air (time in our example) is added. By simple geometry as the radial time dimension extends, the two spatial dimensions of the surface expand like the surface of the inflating balloon, and this occurs with exactly the same geometry as is seen in the Hubble expansion where the recession velocities increase linearly with distance from the observer.

This is a beautiful and elegant model that unifies all the concepts we have developed so far in a consistent cosmological picture of the universe. Unfortunately **there are some immediate problems with the model in this form** as it links the Hubble expansion rate H at which space expands, to the speed of light rate of extension of the time dimension. And if we take the age, which is the radius in this picture, of the universe as the generally accepted 13.7 billion years, it also results in a curvature of the spatial surface considerably too great to be compatible with observations. Nevertheless, the form of the model appears as a natural consequence of what we have discovered so far, and it has an obvious appeal, so we should not reject it out of hand.

The **key to resolving this problem comes from a deeper understanding of the 'twin paradox'**. Simply stated, the twin paradox tells us that according to relativity, if one twin travels on a journey through space and then returns to meet up with his stay at home twin, the clock of the traveling twin will have recorded the passage of less time than the clock of the stay at home twin. This is due to the general relativistic effects of the accelerations involved in the trip which slow his clock. Thus the traveling twin will have aged less than his stay at home twin. This effect is well confirmed by experiment and observation and normally the discussion ends here.

There is however a much deeper insight to be discovered in the twin paradox, something so obvious as to have remained invisible. **This key insight is that even though the twins' clocks read different times when they meet up again, *they always meet up again in the same shared present!*** Since the two clocks read different times, but the twins meet in the same present, ***the only possible conclusion is that there must be two different kinds of time*!** Though seemingly almost too obvious to mention, this is an extremely important insight which has far reaching implications.

Consider this. When the twins meet up again and shake hands, that constitutes a single spacetime event, therefore it must occupy a single unique spacetime location, with unique coordinates along both the time and space axes. Therefore, since the two clock times are different, it is impossible that clock times in general are always accurately aligned with the actual axis of the time dimension which demands a single point of time for the handshake, a time we call the present. Therefore it follows that **what we call present time defines the actual time dimension, rather than clock times which can vary from observer to observer based on their acceleration histories!** If clock time was the actual dimension of time, then rather than being a single linear axis, the time axis itself would have to continually split, differentially stretch, and then rejoin resulting in a vast non-linear tangle all across the universe! This obviously cannot be the case, therefore **it is the time that we experience as the continuous flow of the present, rather than the time our clock reads, that defines the axis of the actual cosmological time dimension.**

Now what are these two kinds of time? First there is **clock time**, which measures the rate at which all physical processes occur. This clock time is local and its rate is dependent on the location of the clock relative to accelerations, gravitation, and to its state of relative motion. Clock time obeys all the laws of special and general relativity. Since all physical processes move in unison with clock time it is impossible to measure any variation in clock time locally. Differences in clock time can only be measured relative to clocks in other states of motion or gravitational potentials.

The other kind of time will be referred to as 'p-time'. **By p-time we mean not just the present moment, but the actual cosmological time dimension created in its wake by its flow as it sweeps through the universe**. This is the experience of the present moving with a continuous rate which never varies even though one's clock time may actually be moving faster or slower relative to any other clock.

From the twin paradox it is clear that clock times are not absolute and universal. Thus clock time cannot be a valid cosmological 4^{th} time dimension. This is another reason why our cosmological model cannot be based upon clock time as its time dimension. A valid cosmological time dimension must be something universal in the sense that a single spacetime event such as the twins reuniting must occur at a unique location along the time dimension as well as the space dimensions. Since the twin's clocks read different times, clock time cannot be the cosmological time dimension.

P-time does however qualify as a valid cosmological time because wherever any two or more observers come together they always share the same present. **Thus p-time must sweep through the universe as a whole at the same rate for all observers**. The time that is unique at the twins' reunion event is the shared present time. Thus **p-time is the cosmological time dimension common to all observers, and it is p-time that can work as the time axis in our cosmological model!**

The concept of a separate p-time dimension distinct though related to clock time is subtle and not easily grasped and it can easily lead to confusion if not properly understood. It is important to understand that our *experience* of the rate of passage of time is unvarying because all physical processes including those of our senses always continue to run at the same rate relative to our clock time rate. So even though our clocks may slow in a gravitational field relative to a clock in empty space we notice no difference. However, it is the experience of the present which continues to constitute our reality, and in which our consciousness exists. And that present continues to move *at the same invariant rate we notice no change in*, *though that underlying rate is not directly measurable to us because all our instruments measure only clock time rates*.

Imagine you are the traveling twin. You know your clock time rate is running slower but you notice no difference and you can measure no difference because the rate of all physical processes always runs at the clock time rate. But *what is the underlying rate we notice no difference in?* The important point is that there is such an underlying rate that does not seem to change. During the entire trip you notice no change in your time rate at all, your clock always seems to run at the same rate and you exist only in your present moment with its perceived time rate throughout the entire trip. But when you reunite with your twin, your clocks read different times though your presents are exactly the same shared present. Thus it must be that the unchanging present time flow rate that both twins experienced for the duration of the trip that is the underlying invariant cosmological time rate. **This invariant rate is precisely the experience of the present rate of time. It is in fact the p-time rate.**

It might be asked again why, if the p-time rate is running at a different rate than one's clock rate, we never notice any difference, and it is a subtle point that deserves another reiteration. We know that no matter what one's clock time rate is, one never notices any difference because everything we could use to notice is also running at that same clock rate. But the question is what sets the mysterious underlying rate that never seems to change? In other words if clock rates can vary wildly, why is there a single *perceived* rate that never seems to change? What sets *that* rate? The answer is that **this fundamental unchanging perceived rate is the experience of the underlying uniform p-time rate. It is the experience of the present moving uniformly through p-time.** This is yet more evidence that p-time is a real physical phenomenon.

To grasp the concept of p-time one needs to understand that no matter where or how fast space travelers may travel they always remain in their present moment and when and wherever they meet that present moment is always common to both no matter what their clocks say. Therefore that shared common present must in fact be universal and cosmological. It is clearly impossible by any means to escape the present moment in which we must always exist.

With the concept of p-time, the previous problems with our cosmological model now have possible solutions. The Hubble expansion rate H is no longer tied to c, and the length of the spacetime radius can

potentially be much greater than it would be if it were the clock time Hubble age of the universe. And this in turn would result in a much smaller curvature to space which might be consistent with observation.

6. THE P-TIME METRIC

From a cosmological perspective we now seem to have a solid candidate for a time that qualifies as the radial dimension of the universe. Now let's return to our hyperspherical geometry, this time with p-time as the radial dimension rather than clock time. Relativity tells us that there is actually a sort of standard cosmological *clock time*, namely a clock co-moving with an observer in empty space. (Actually space is not completely empty.) It is important to remember that relativistic clock time rates can run any amount *slower* than this standard empty space clock, *but never faster*, so we have an upper limit on how fast relativistic clocks can run. We know that the rate of p-time must be at least as great as this maximum clock time rate, otherwise there could always be a relativistic clock that would not end up at the same p-time present.

Since our only quantitative measure of the passage of time is that given by some clock time, we have the problem of determining a metric for p-time, that is, determining how much p-time has passed between any two events, and what the p-time age of the universe, the radius of the universe along the p-time dimension, might be. Stated this way it becomes clear that the radius of the universe, and thus the p-time metric, might be derived from the curvature of space. If we know the curvature of the surface of the spatial hypersphere we then have its circumference which is the expanse or size of the universe, and thus its radius in p-time units which is its age. The radius or age of the universe in p-time units then becomes simply $A_{p\text{-}time} = Size/2\pi$ assuming a reasonably perfect hypersphere. Unfortunately astronomical observations do not yet provide us with reliable or even consistent values for the curvature. We know only that the curvature seems to be very small, much smaller than it would be if the radius were only the Hubble age of around 13.7 billion years. This is no doubt why cosmologists do not seem to have given serious consideration to the simple and elegant hyperspherical cosmology with time as the radial dimension.

We are assuming here a *closed* hyperspherical universe with $\Omega > 1$, omega being a measure of the curvature of spacetime relative to what is called its critical density $\Omega = 1$ which is the case of a flat universe with no curvature. Most current observations suggest a value for Ω very close to 1. Why assume a closed hyperspherical geometry as opposed to the flat Euclidean case or an open hyperbolic universe with $\Omega < 1$? First, because it falls out naturally from our development of STC, but also because both of the other alternatives result in either a spatially infinite universe, or a universe in which space has an edge. If one really gets one's mind around what infinity means, it becomes pretty clear that **infinity cannot have any physical reality**. An infinite universe is incompatible with a universe with a beginning including a big bang. If a universe has a beginning then no matter how much time you have and how fast you add time and space, you would always have to add more to get to infinity. Thus the only remaining option is a closed hyperspherical universe, as this is the only possible simply connected topology with four dimensions.

So it does seem quite reasonable to conceive of the universe as a 4 dimensional hypersphere with p-time as its continually extending radial dimension. The surface of this universe is simply the three dimensional world *at the present moment* in which we exist. In this view it is only the surface of the balloon that exists in the normal sense of that word. As opposed to the relativistic concept of 'block time' in which each moment of time past, present or future, has equal reality, in our model only the surface is 'real', only the surface 'exists' and has being, and it is precisely this expanding surface of reality that is the present in which we exist and are conscious. This is clearly a view that has a remarkably intuitive resonance with our common sense, and yet it also perfectly incorporates relativity which continues to function flawlessly in terms of the local clock time metrics. These clock time metrics may stretch locally to varying degrees relative to p-time, and this stretching results in the local clock times running slower at different rates relative to p-time.

Though we now have a cosmological geometry consistent with what is known, we need to have more accurate astronomical measurements to refine our notion of the size and p-time age of the universe and to confirm its hyperspherical topology. We would also like to be able to compare the rates of the upper relativistic limit on clock rate with the p-time rate. It appears that even the upper relativistic limit for clock time must be considerably slower than the p-time rate to be in accord with both the Hubble age of the universe and the very slight (if any) curvature of space.

At first, one might be tempted to think that the Hubble expansion *rate* would give the rate of the expansion of the p-time radius, and thus a measure of the p-time metric, but then one remembers that the Hubble expansion *rate* is measured by the cosmological *clock rate*, not the p-time rate, and so this does not help.

Some might level the criticism that in p-time, we are postulating something which cannot be measured, and which is thus outside the realm of science. True it is a difficult concept, and true it is not easily measurable, but we were driven to it as the only proposal that consistently explains the deeper meaning of the twin paradox and is compatible with STC and relativity, and it does provide a simple and elegant cosmology, which though untested, provides a clear and intuitive synthesis of all these lines of thought.

In summary p-time seems to offer us the possibility of an absolute cosmological geometry with a radial time dimension unaffected by relativity, but within which all physical processes occur relative to local clock time metrics according to relativistic law.

7. CURVED LIGHT CONES

As we have seen, an observer's light cone is the composite path that light arriving from all directions at the observer's present moment would have taken through spacetime. It is in fact our actual current view of our local environment as well as the universe as we look out in all directions in 3 space, and it forms a 3 dimensional cone or slice of 4 dimensional spacetime. In our 2 dimensional graphs, where 2 of the spatial dimensions must be suppressed, it appears as 1 dimensional lines intersecting in the observer's present moment. Since from a stationary observer's viewpoint, light travels the same distance in space as it does in time these lines form 45° angles equidistant between the space and time axes as shown in Fig. 3.1. If we take our graph and add another space dimension back to it by rotating it around the time axis we see that these lines do indeed form a 2 dimensional conic surface in 3 dimensions.

Up to now our figures have portrayed the present surface of the universe as flat, and we know that this is true at least from a local perspective where the radius of curvature must be small, but in a hyperspherical universe with a curved surface, the light cones must be curved to maintain the constant 45° angle between the radial time axis and the circumferential space dimensions as the time axis rotates with the extension of the light cone. This is shown in Fig. 7.1 where the outer surface represents curved 3 space, the two 45° lines show how the light cones would look in the absence of curvature, and the inward spiraling yellow curves are the actual light cones in a hyperspherical universe. Only by spiraling in toward the center can the cones remain within the bounds of the universe as it becomes progressively smaller and smaller further back in time.

This is of course a problem also for standard cosmologies which expand from an initial big bang, though it is rarely addressed. Illustrations of light cones invariably show them as expanding 45° lines even though this is impossible in a universe which becomes progressively smaller as one goes back in time. Inflation provides a sort of fix for this problem by postulating that soon after the big bang, the universe had already expanded close to its current spatial expanse. We will address the problems that this raises at another time.

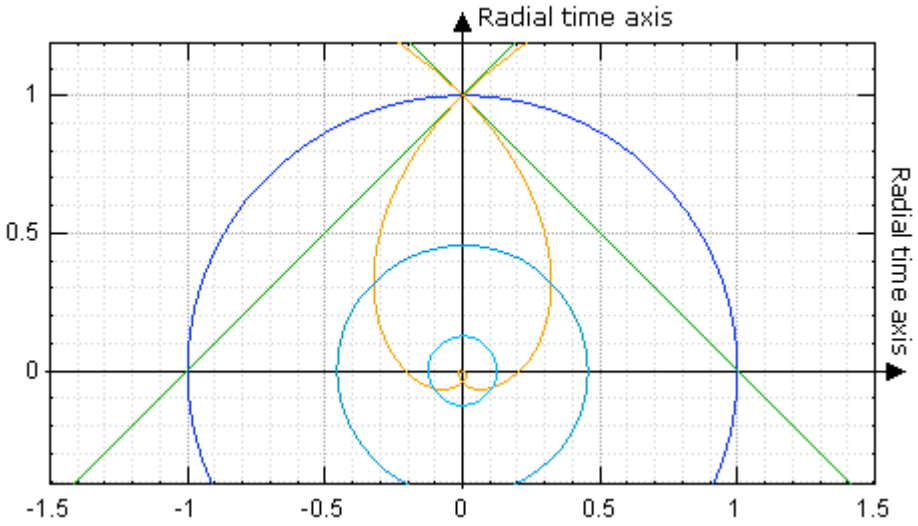

Fig. 7.1 Curved light cones in a hyperspherical universe. The outer blue circle represents the present 3-space (two dimensions suppressed) surface of the universe which has expanded outward from a big bang at the origin as shown by the successive circles. Green lines represent the light cones extending at equal velocities in time and space as they would appear in a flat universe, but due to the curvature of the surface, light follows the curved yellow lines representing the actual light cones in this universe. Since the light cones curve there is a theoretical limit to the spatial distance we can see. This is the distance measured along the spatial arc of the middle circle to the inflection points of the light cones. In our graph this occurs at a time about 45.56% the present age of the universe though actually it will be considerably different if the correct light cone angle(s) were known. Any objects we might see beyond the inflection point would be seen when they were closer in space to us rather than farther! Since we see no curvature, evidence suggests we are only seeing a short distance down the cones if they are curved. This is consistent only with p-time rather than clock time as the radial time dimension.

In our model, the equation that describes the curved light cones in 2 dimensions is the equiangular spiral

$$r = r_0 e^{\Theta \cot(\alpha)} \tag{7.1}$$

where r is the radius (p-time age) to the curved cone at any angle Θ, r_0 is the current radius (p-time age) of the universe, e is the base of natural logarithms, and α is the constant 45° angle the light cone makes with the tangent of the circular surface at any radius. In Fig. 7.1 we have set the current p-time age of the universe, $r_0 = 1$ for convenience. (We have also simplified Fig. 7.1 by drawing the cones as if p-time were equal to the cosmological clock time of empty space which gives the 45° angles. Actually the p-time age must be much greater than the clock time age, though we do not yet know how much greater, and the relationship will not be linear, so that the angles in p-time would vary).

How are we to interpret the light cone curve? Recall that the light cone is our current view of the universe from our location in time and space at the present moment where it intersects the surface. It is down this light cone that we simultaneously look both out into space and back in time. The rest of the actual cosmological present surface of the universe in blue is invisible to us until our light cones intersect it sometime in the future. Compared to the straight light cones of a flat Euclidean universe, in a curved universe, as we look progressively further out along the light cone, we are actually seeing less far out in space because the universe had not expanded as much and was smaller at earlier times; and we are also looking proportionally farther back in time than we would expect. This is our view of the universe, and it is along the light cones of course that all Hubble expansion measurements are made.

Now the interesting thing is that because of the inflection point shown on Fig. 7.1, as we view the light from smaller and smaller past universes, we are no longer seeing farther and farther out in space but *seeing things that at that time were closer and closer to us!* Thus the oldest things we can see in space should appear to be larger than what we would expect. This effect should be observable as an increase in the angular size of galaxies with age over the expected linear reciprocal of distance for a flat universe. The paradox is that no matter how far we appear to be seeing back in time, we do not see this effect, and since we do not see this apparent angular increase we see no evidence for curvature of the light cones, and thus none for the curvature of the surface of the universe.

Since such an effect has not been observed as far as I am aware, we must assume a p-time age of the universe very much greater than its Hubble age and assume that even though we are able to see back perhaps to the CMB roughly 300,000 years after the Hubble big bang, that this actually corresponds to only a short distance down the light cones relative to the p-time age of the universe.

Now how can this be reconciled with conventional cosmology? The obvious avenue we should explore is inflation. If we were to assume that the inflationary rate of expansion was the same in p-time as the current rate, then this would correspond to the passage of an enormous amount of p-time, in what inflationary theory says was an almost infinitesimal clock time. So if the estimated 10^{-33} seconds of clock time that inflation took actually corresponded to many billions of years of p-time we could still have a consistent hyperspherical geometry with almost no observable curvature.

Is this at all reasonable? First remember that clock time is the time that all physical processes run at so there should be little effect on standard inflationary theory. The effect should be seen only in the much greater resulting diameter of the universe which appears to be the case.

And we have a possible explanation of the p-time clock time disparity as well in the incredible concentration of all the energy (matter was presumably not yet in existence) in the universe in an inflationary universe very much smaller than an orange. This because by general relativity, *it is precisely the gravitation resulting from the concentration of energy or matter that slows down clock time.* And during inflation there was an unbelievable such concentration of energy. Even though early gravitation might have been repulsive in nature (see below), repulsive gravitation also has the effect of slowing clock time (Vilenkin, 2007).

There was in fact a much more extreme concentration of energy than is necessary to produce a black hole, and one could ask how inflation could ever expand a universe much much smaller than the Schwarzschild radius of its contents. The usual reason given (Susskind, 2006) is just that the Schwarzschild solution does not apply to the case of expansion. In other words because it *was* expanding, it *could* expand, which can only be true *if the expansion began prior to the existence of attractive gravitation*. This of course begs the question as to what the initial motive force of that expansion was that was able to effortlessly overcome the Schwarzschild radius.

Alex Vilenkin (2006) is one of those who attributes the initial inflationary expansion to repulsive gravity. Though Vilenken does not mention it, the repulsive gravity theory has an additional plus in that it addresses a problem Penrose (2005, chapter 27) raises without being able to offer a solution. Penrose points out that for entropy to be continually increasing in the universe, the universe could only have begun in an almost unimaginably improbable initial low entropy state at the time of the Big Bang. This is because it is only where entropy can progress from a lower to higher state that any organized physical processes can occur, so the known history of the universe requires that entropy must have been increasing from an original low state ever since it began.

The fact that the stuff of the original universe, as revealed by the WMAP survey of the CMB, seems to have been very homogeneous and isotropic *in the presence of attractive gravity* is correctly seen by Penrose as an extremely unlikely highly ordered low entropy state. A number of theories have been proposed to explain this initial 'smoothness' of the early universe. But I believe there is a very economical and likely explanation; namely that this initial smoothness arose prior to gravitation, or at least prior to

gravitation in its attractive form. If this is true then the perceived problem of initial low entropy immediately vanishes.

In the *absence* of attractive gravity, the initial homogeneity is exactly what we would expect as by far the most likely state, and represents in fact the expected state of highest entropy! Soon thereafter, the appearance of attractive gravitation instantly changes the rules of the entropy game. The initial high entropy, in the presence of newly emerged attractive gravitation is transformed into a state of extremely low entropy, and it is just this entropy flip that has powered the development of the universe ever since, as it is only the ability of energy to flow from low entropy to high that allows the universe to evolve. Thus it is precisely the appearance of attractive gravitation within a previously existing homogeneous universe that 'winds' the clockwork of that universe and sets the cosmos into motion.

In fact it is not unreasonable that we should expect something like this to occur. We believe that the strong, weak and electromagnetic forces seem to have all been bound together into a single force in the early universe and only separated out as the universe expanded and the temperature dropped low enough in a process known as spontaneous symmetry breaking. One could reasonably expect that this might be true of the gravitational force as well. Since it is by far the weakest of the four forces, it may well have separated out later than the others. Or alternately, if gravitation was initially a repulsive force, and the cause of the initial inflation, then the ending of the inflationary period could have been the point at which gravitation became preponderantly attractive in nature. The evidence that attractive gravitation might have appeared at some time after the initial smoothness occurred needs to be further explored.

8. WHAT ABOUT TIME TRAVEL?

It will be useful now to consider the possibilities for time travel in our cosmology, as this will clarify some aspects of spacetime in the universe. First it is quite clear that time travel does exist in the sense that our present continually moves through clock time at the speed of light. Thus according to STC as well as common sense, it is obvious that we are always *traveling* in time. **Time travel is what we do; it is the natural state of our existence!** So the real question is not whether time travel is possible, but what are the constraints on this travel?

If there is a universal p-time present which sweeps through time, then that present is in a very real sense the only moment in which things can exist, in which there is 'being'. Wherever we are by definition we take the present with us. **The present is defined by our existence within it, just as the present defines our existence**. So we must be careful about speaking of time travel as going to 'the past' or 'the future' since by definition we always are in the present and cannot leave it. Given this, then what are the possibilities for time travel? It is clear that though we must always exist in the present moment, that present moment can be in different locations relative to clock time metrics. **So what we must mean by time travel involves the movement of the p-time present to another location on a clock time metric**.

Clock times are metrics that determine and measure the rate of physical processes for different observers. **Clock time itself does not define a unique or privileged present moment, instead giving all locations on the metric equal weight,** and this seems to be the root of physicists' erroneous acceptance of block time as a reality. However it is always the particular point on a clock time metric that is aligned with the p-time present that defines 'where the present is with respect to that particular clock time' or 'what clock time it is at the present moment'. And since there can be many different local clock times, but only one p-time present, the present p-time moment will be at different 'times' on different clock time metrics. So the question of time travel becomes how can clock times move relative to the p-time present? There are several possibilities to consider. The speeds and directions a single clock time metric can move with relative to p-time. Whether clock time metrics can form closed loops or be discontinuous with respect to p-time. And what are the speeds and directions that two or more clock times can move with respect to each other.

Consider the twin paradox again. We could say, loosely speaking, that based on their different clock times, the traveling twin has in a sense traveled into the stationary twin's *clock time* future and vice versa, while they still share the same universal p-time present. Precisely speaking, they have both time traveled but at

different rates relative to each other. So what clock time it actually is anywhere seems merely a matter of convention. **So it is clear that things may time travel at different rates in clock time but not in p-time**. This follows directly from our original definition of p-time. And this is of course experimentally verified.

How flexible are clock time metrics relative to the universal radial p-time dimension left behind the extending flow of the present? A twin accelerating at a very high rate to nearly the speed of light and back again for an extended journey could theoretically return very much younger than the stay at home twin. So the twins' time travel into each other's *clock time* past or futures could be extreme, even though their *p-time* presents remained the same throughout the journey. This type of time travel is clearly possible, if only perhaps for inanimate objects that could stand the g-forces involved.

Traveling into one's own clock time past would either require an observer's local clock time metric to reverse direction relative to the present time axis, or to loop back upon itself and intersect its own past. This would be a way of recycling an observer's own clock time 'past' again into the universal present, which of course he never leaves. There are some indications this might be theoretically possible in areas of rapidly rotating universes, based on the work of Gödel (Yourgrau, 2005), or extreme gravitation and 'wormholes', (Greene, 2005, §15). However it is unclear to me how this could correspond to any physical reality, as it would require that an observer's clock time past enter the p-time present from the p-time future, which does not even exist in the STC cosmology, since the p-time future corresponds to an area outside the current bounds of the universe!

The essential problem with traveling to one's own past is that it assumes a block time past that still exists, and this is inconsistent with our p-time cosmology. Even if it were possible to reverse the direction of movement of a clock time metric relative to p-time, one would not expect to travel back into a pre-existing past even though one's clocks ran backwards, but rather into a new p-time present in which cause and effect and all physical processes might run backwards. Would that result in the re-creation of past events from the future? Unlikely, given the probabilistic nature of quantum processes. And if all one's physical processes ran backwards it might be impossible to even notice that fact locally. One might expect it would be observable to an observer in forward flowing time, but the extreme gravitation necessary to cause the reversal would probably produce a horizon that would render it beyond observation as light would flow backwards *into its sources* and never emerge from that area of darkness. One wonders about a possible connection to dark matter?

As to **traveling into one's own future,** loosely speaking we do that all the time through the standard passage of time, though that future has not existed until we get there, and then it is the present. Is it possible then that we could travel into the future more quickly? Yes, if we mean into the clock time future of a location with a less extreme acceleration history. But not into our own futures, as that would imply that the local clock rate of our bodies slows down relative to the local clock rate of our immediate surroundings, and this would require extreme local differences in gravitation which seems impossible, or acceleration which would quickly make the effect non-local. There is also no indication that clock time metrics can be discontinuous other than possibly at spacetime singularities or event horizons, so that 'jumping' from one clock time to another also seems to be a physical impossibility.

To summarize: We continually exist in the p-time present, and we continually time travel as our present moves toward the p-time future. This future does not exist as it is outside the bounds of the universe. The next moment of time is continually created in the present moment as the radial p-time dimension of the universe extends by adding on new moments of time. Clock times can move at different rates relative to p-time, but the clock time rate can never be faster than the p-time rate. Thus it is possible to time travel to another clock time future or past when clock time rates both move *forward* at different rates. We are always time traveling towards a non-existent clock time future, but we always remain in our p-time present. It may be theoretically possible to travel to our clock time past according to relativity, but this seems physically impossible in the STC cosmology.

9. EXISTENCE, BEING AND REALITY

We will defer a complete analysis of the reality of being to later parts of this work when we explore the nature of matter and energy and the nature of illusion and reality in more detail. In this section however we examine the question in the context of what we have learned so far.

The STC cosmology tells us that **only the present moment is real**, and that this present is the surface of the universe as it continually extends p-time. The surface of this 4 dimensional universe is the present moment of the 3 dimensional space in which we exist. Thus it is clear that things have existence only within the present moment which is the universe as it exists in the present. So only the present moment constitutes 'reality', and it is only in the present that things can have 'being'. The present defines reality or *is* reality; it is the only abode of being and existence. Likewise, everything within the present has existence and being, and is part of the reality of the present. Once again we arrive at a cosmologically based theory very much in tune with our common sense view of the world.

Now it is quite true that **the past has a kind of shadow reality** in that the particular form of the present has resulted from the processes of the past, from causes and effects and quantum probabilities. It is clear as well that it is enormously useful both in science and in daily life to imagine the entire time dimension as an **abstract or remembered reality that extends through time** in a unified conceptual framework that includes the past, present and future on an equal footing; but it must be clearly recognized that the past no longer has any real substance, any being, or any energy to give it life or existence. The existence of the past is entirely in its effect on and remembrance in the present.

If material things had being and existence in the past we would quickly run into serious problems with our physical picture of the world. For example, conservation laws would break down as new mass would be being added at every new instant of time as new versions of things came into existence while their past versions continued to exist. At first blush this may sound like an ignorant misunderstanding of physics as conservation of energy is through time. But a moment's thought shows that this requires *the vanishing of the existence of the mass or energy of the previous moment*. Thus the existence of mass and energy can only be in the present moment. Things can only have their 'being' in the present moment. Our convenient modes of thinking in terms of our conceptual model of the past must not be confused with the existence of an actual past. Such conceptual models must be clearly distinguished from the actual living reality of the present.

The block time concept of reality in which things have equal existence at every moment of time also leads immediately to time travel paradoxes. If we assume block time in which all slices of time are eternal real present moments then since every version of ourselves at every moment is an actual living self, we must in a very real sense have already time traveled into every future moment from every past moment and vice versa. In such a world there either can be no reliable cause and effect, and physics as we know it quickly breaks down or it requires a totally deterministic world incompatible with quantum reality as we will see in Part II. Assuming that we are eternally alive and conscious in every past and present moment will not work. Assuming things have being or existence in any moment other than the present will not work. The existence of the past is in its effects, including remembrances, in the present and only that.

There is also a clear difference between the past and future 'regions' of the universe. **In the STC cosmology, the 'future' is outside and beyond the present surface of the universe and thus has never had existence**, while the interior past of the universe is a sort of ghostly trace of its previous existence states whose effects and light are still arriving at observers in the present. This trace exists only in the present effects of past events which constitute the records of its existence. At best one might say it exists only as forms without substance, or effects of vanished causes, whereas the future has none of these, and does not even correspond to an area within the bounds of the universe. This picture will do for now, but will be substantially refined when quantum mechanics is incorporated into our cosmology in Part II.

The nature of light cones should be clearly understood in terms of the existence and reality of past and present. Recall that the light cone is the present view each observer has of the universe, and that it extends

outwards in all directions from the observer simultaneously out into distance and back into time. It is extremely important to understand that the reality of the light cone is actually occurring not out in space and back in time, **but entirely at its arrival in the present and at the observer's location. Importantly this is confirmed by Eq. (3.2) which tells us that the actual spacetime interval from the observer to any point along his light cone is zero! (**see Fig. 3.1). **This is true no matter how far distant in space or back in time that event may be located.** Thus it is actually only the *arrival* of the light at the observer's location that exists in the present. In other words our perception, our experience of the world, is entirely the existence of traces of distant and past events as they reach our present singularity along our light cone.

Thus our visual and mental and even our scientific view of the world as having spatial and temporal expanse is entirely a construction based on events which have actual being and existence only at the spacetime singularity we call our self, more precisely at consciousness within the present moment. The actual *reality of the perception* of a galaxy viewed in space is the arrival of its light at the observer in the present moment. This is not to say that the galaxy does not have a real existence in its own p-time present co-temporal with ours, we must assume it does, but of that we cannot be directly aware, nor in fact can we ever be directly aware of the present reality of anything in this sense other than ourselves! Everything other than us in the universe exists *to us* only as seen in the past, though we assume also in its own present, co-temporal yet un-sharable, which exists in a sort of quasi or imaginary future to us. This area of spacetime located between our light cone and the co-temporal p-time present, is the area in which events that have already happened but are as yet unknowable to us lie. It is only the effects, including the arriving light, of past things that can exist in our experience of the present. Thus in an actual physical sense, the reality of existence and being of the world *as it is experienced*, occurs only within our center in the present, at the spacetime singularity that defines us as an observer.

It is clear then that only the present and its contents exist and have being; that the present and its cosmological flow is the only reality. **But we must carefully distinguish between the cosmological present surface of the universe, which we assume exists but can never directly experience, and the present that we do directly experience, that located at the singularity that defines our self as an observer**. This singularity is the only 'true' reality in the sense that it is all that we directly experience, it is all that is actually alive to us. All else is, in the final analysis, only supposition.

10. A MAP OF THE STC UNIVERSE

Every spacetime point within the universe is called an event, and the 'distance' between any two events is called their spacetime interval. Since the surface of the universe is the present moment, this is the only area of the universe which has reality. Things have existence or being only in this present moment in 3 space. Observers have existence in the p-time present on the surface. Due to the finite speed of light, each observer's view of the universe is not along its surface but along his light cones as shown by the yellow curves extending downward from an observer located at the top point of the surface in Fig. 10.1. Each observer continually sees his private slice of all four dimensions of the universe down his light cone. However what he sees is the *arrival* of the light up the light cones in his location in the present so that the reality of the light cone is only at the point occupied by the observer in the present. Thus the observer is a singularity in spacetime. His true experience of reality exists only at this point which defines him as an observer. This can be called the **observable present** or the **singularity-present**.

According to STC cosmology, the entire surface of the universe, the **cosmological present**, has a real p-time co-temporal existence, though it is currently unknowable, as observers can know the present only at their own singularities. However, since the spacetime intervals down the light cone are zero, we can refer to the light cone slice of the universe as an observer's **zero-interval past**, that part of the past he sees in the present. This is the common sense world that observers believe they live within in daily life, even though their actual existence is only at their precise present singularity in time and space.

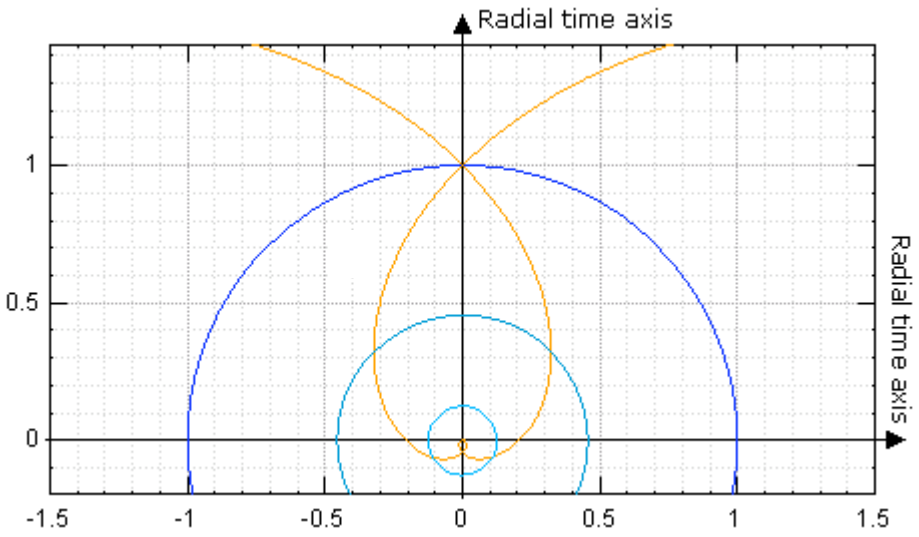

Fig. 10.1 Map of the STC universe. Graph showing the various regions of spacetime according to the STC cosmology. The outer circle represents the present moment of our hyperspherical universe. This surface is the actual 'real' region of the universe. The radial dimension from the origin to the circumference is the p-time dimension, while the distance along the circumference is the space x dimension which corresponds to the 'size' of the universe. The two y and z spatial dimensions have been suppressed for clarity but if one imagines the circle as a spherical expanding balloon that will help. The surface of the balloon is the present moment of the 3 spatial dimensions of the universe, it is the location of the cosmological p-time present. This surface is continually extending outward by the addition of new moments of time. This continuing extension of p-time results in the uniform expansion of the surface dimensions of space which is observed in the Hubble expansion. The center of the circle is its origin, the p-time location of the big bang.

The area within the light cone is an observer's **affective past** which consists of all events he could have become aware of or that could have affected him in his **actual or singularity-past**, which is the spacetime trace back through time and space of his singularity. In Fig. if he had remained at the same space location, this would be the vertical line from his current present location on the surface back towards the origin. Of course since his existence quickly ceases, this trace extends only a short distance in time for any observer.

The area above the light cone but below the present surface of the universe is the location of events that have occurred but are as yet unknowable to the observer. They are in the cosmological p-time past as they have already occurred and gone, but in a sense they are in the observer's future since he cannot as yet experience them. So this area of the cosmological p-time past we can call the observer's **imaginary future** since spacetime intervals from the observer to events in this area are imaginary. (refer to Fig. 3.1). These are examples of what are called space-like intervals in relativistic terminology.

The area of the future outside the present surface of the universe is an area which does not exist. Though we might think that the p-time dimension is continually extending into this area, this is really just a convenient way of speaking, as this 'area' does not even exist in time and space and is not something which can be extended into. What actually occurs is that new time is added to the universe thereby increasing its age and circumference, but since it is 'everything', it is not extending into anything. So we may speak of the 'area' beyond the surface only as a convenient abstraction. It does not correspond to anything that has reality or existence. Thus we can call this 'area' the **non-existent future**.

As shown in Fig. 10.1 the yellow lines above the surface are the observer's light cones extending into the future and are the paths that light leaving the observer's present point will take as the surface of the universe extends in time. Spacetime intervals to events along the cone in all directions are called **light-like intervals**. The area within the rising cone lines can be reached by effects issuing from the observer's current position so this area is called the **affective future** since it can potentially be influenced by the

observer. The spacetime intervals to events in this area are time-like. However the area beyond the surface but outside these lines is beyond the possibility of such influences and may be called the **non-affective future**. The intervals to events in this area are space-like. All three of these areas are part of the non-existent future.

Because the surface of the universe is expanding as its radius extends, points along the observer's light cone are seen to be receding away from the observer at a velocity proportional to their distance. As the speed of this recession grows greater with distance there is a point at which it equals the speed of light. This is called the particle horizon and beyond this nothing can be seen. It is an effective edge to our view of the universe and the area within an observer's **particle horizon** is his observable universe. If the universe expands at a constant rate, the horizon remains at the same distance, but over time it will become a smaller and smaller portion of the whole universe that is visible as the galaxies one by one cross over the horizon and disappear.

11. A PHYSICAL THEORY OF CONSCIOUSNESS

The idea that will be explored in this section is that **consciousness is the experience of the present by an observer. And that the particular form that consciousness takes in a particular observer is a function of the relevant structures of that observer**. As such, human consciousness is just a particular manifestation of a fundamental cosmological process, namely the ability of things in the universe to affect and be affected by other things in the present. This 'process' is the flow of the present through time that allows change and the interactions of things to occur, and which forms the network of cause and effect.

In this view, the ability of things in the universe to affect other things due to the flow of the present is what underlies all consciousness. Let us begin with the notion that all the effects of things on any one thing in the present is the most elementary form of consciousness. It is how that thing 'knows' or experiences the world in which it exists. We will refer to this elemental consciousness as **'Big C'** or just C (uppercase to distinguish it from the speed of light c). By properly understanding big C, we will quickly come to an elegant understanding of the nature of human consciousness.

Big C can be generalized by noting that every effect of a thing upon another thing is similar in form to an observer making an observation of an observable that conveys information about an object. But here we do not restrict the notion of observer to that of a human observer, but allow it to be any part of the universe as it is affected by any other part. The affected entity plays the role of observer, *the affect* the observable, *the effect* the observation, and the entity or process producing the effect, the object. The result is the conveyance of some information, though that information is always translated through the receiving structures. The important point is that the underlying mechanism is common to all process.

Now the particular form an affect produces on any particular thing will obviously depend on the structure or 'nature' of that thing. For an elementary particle the effects will be a simple change in state or motion and that will be it. From the point of view of the particle it could even be said to have a rudimentary memory of that event (see Part II for a discussion of quantum entanglement for more on this) as the event is 'remembered' or recorded in the effect(s) it produced, and certain portions of that information are carried and can be retrieved. For example, an electron's quantum jump to a higher orbital state does record the energy that caused the jump. Of course the particle has no structure capable of recording and recalling its affective history in any organized way, nevertheless **there is no doubt that the present state of every entity in the universe is precisely the sum of all the effects encountered throughout its history**. The basic mechanism of memory does exist at the level of elementary big C processes. **Big C 'memory' is the information carried by effects about the affects which caused them**.

Objects at all levels of the physical world participate in big C processes as they continually 'experience' their world through the effects it produces upon them according to their structures. In general such objects

exhibit increasingly complex organized structures as their sizes increase and as they incorporate a greater variety of chemistry. In such objects effects on a subset of its particles begins to produce a cascade of subsequent internal effects which affect the structures themselves. Thus the 'experience' of their world by such objects quickly becomes much more complex with increase in structure. But even a stone can be said to 'experience' its world through the gradual effects of environmental processes over the ages. This 'knowledge' is not something it can tell us in English of course, but it is contained in the effects on the stone's form and structure, and geologists have become quite expert at deciphering it.

Biological organisms of course have been able to evolve specialized structures capable of selectively sensing, recording and organizing effects important to their survival to form knowledge based models of their environments. The particular manifestations of their consciousnesses are dependent on the forms of their particular structures, but the basic mechanism of this consciousness is still just big C, the process of effects on entities due to the flow of the present.

Human consciousness is a particular manifestation of this same phenomenon. It is again simply the experience of the present in terms of our uniquely human biological structures. As with other biological organisms, many of those effects originate from within the organism itself, as sensations of the state of the organism, and as memory retrievals and comparisons from stored models of the world, but it is again the same basic big C process of effects on structures that is at work here.

Thus in big C we have a unifying concept of the underlying process of consciousness. We arrive at the insight that **consciousness in its broadest sense is an intrinsic aspect of the universe itself, namely the flow of the present moment in which process occurs. It is just the experience of things happening in the present, at whatever level, which is consciousness**. And the particular nature of that consciousness depends simply on the structure of the thing that experiences it – of the observer in the most general sense.

But there is more to consciousness than just the experience of particular effects, or even the sum of those experiences. **The fundamental experience of consciousness seems to be of the present itself; the flow of time through the present moment, or more accurately, the experience of the continuous creation of new time in the present**. This is evidenced as the experience of 'pure' consciousness seems to become more and more intense as the individual particulars of experience become fewer and fewer. This is the experience of deep meditation in which one is aware of the intense conscious content of the present in the absence of particular sensations or thoughts. So the experience of the present itself seems to be the fundamental experience of consciousness and this then is the theater within which the particulars of conscious experience may appear.

Thus we may say that **the flow of the present moment itself is consciousness**, and that **consciousness, being the present itself, is an intrinsic physical aspect of the universe**. It is clear then that as the present moment of consciousness sweeps through the universe it is continually being experienced by the myriad individual big C consciousnesses of all things according to their natures. It is quite satisfying that this view is in accord with modern science, certain ancient philosophical traditions and deep inner awareness as well.

It is also this big C process at the root of consciousness that gives the universe its intrinsic 'knowability', as C involves the transfer of information or knowledge. In a fundamental sense we can say that 'knowledge' of the universe spreads through it as the sum of the effects of all its constituent parts upon each other. The very fact that science has been able to understand in amazing detail conditions in the fartherest reaches of the universe, and even to understand much of the history of the universe back to its earliest beginnings, is testament to the amazing knowability inherent in the structure of our universe. One of innumerable examples of this knowability is the wealth of information carried in the spectra of light. Due to quantum effects, the Fraunhofer spectral lines carry detailed information about the matter and processes that produced the light, or that it passed through on its journey to the observer. It certainly doesn't seem like the universe had to be designed this way.

We can imagine a universe in which such depth and breadth of knowledge would be impossible, in which effects and the information carried by them would not propagate widely across the universe, and affects might not carry the great wealth of detail science finds hidden within them. We are truly blessed by our

universe, in the vast knowability it contains. As far as we look, in every nook and cranny, it seems that more knowledge waits there to be discovered. One can only wonder though, what aspects of the universe might be forever unknowable to us due to lack of any effects observable to us. Certainly black hole event horizons and the particle horizon of the visible portion of the universe seem to limit the knowability beyond, and perhaps there are processes going on which are intrinsically unknowable, or at least very poorly so, for if they were absolutely unknowable it would be equivalent to their having no effects at all.

Because biological organisms have been able to evolve structures to optimize the receipt, storage and manipulation of big C effects, they have become able to function more effectively in their environments. But at the same time this evolution has increased and spread the knowledge of the universe itself. It seems that the direction of biological evolution is to produce systems that are increasingly able to tap into the intrinsic knowability of the universe. Perhaps this is the ultimate function of biology – to evolve structures able to increase and clarify this consciousness of the universe by its parts, so that over time the universe as a whole becomes more and more aware of itself, more and more conscious of itself.

We can even wonder if the universe might itself be evolving from the bottom up (or perhaps designing itself from the top down?) by fostering the evolution of biological systems capable of realizing or experiencing its latent conscious content. Considering the nature of emergent processes (see Laughlin, 2005 for a good popular treatment) in which each level evolves structure invisible to lower ones, this might eventually result in transforming a universal un-self-realized consciousness to an increasingly self-aware universe. From this perspective the present could be seen as the mind of the universe, in which all affective processes play the role of thoughts, and the evolution of the universe tends towards its gradual awakening.

To continue the metaphor, all things that partake in big C consciousness could be considered as sense organs of the universe, and constituents of the total consciousness of the universe. The effective purpose of human existence then might turn out to be to become increasingly effective sensory organs (include all our scientific instruments here) and distributed consciousnesses of such a universal mind. Seen in this light, it is doubly tragic that so much of this potential is currently misdirected and wasted. However, as communication grows exponentially with new technologies we do see a sort of planetary mind emerging, through which both we and perhaps the universe are able to increasingly know ourselves. Are we humans destined to be only a temporary means to this end? Perhaps this process is much further advanced in other regions of the universe and it is our eventual destiny to merge our consciousness with those.

In ending this section we note that numerous theories of consciousness have been advanced. In general, the modern ones fall into two categories (we ignore the religious variety here). The first, with many variants, seeks an anthropocentric explanation in human biological and cognitive structures in isolation from the physical world. The other typically seeks an explanation in quantum mechanics. Penrose and others have attempted to base theories of consciousness on the fact that quantum processes produce random results, and that such quantum processes may account for consciousness. Penrose (1994) in particular argues that these quantum processes occur in relatively large scale microtubules within the neurons.

Whether or not this is true, at best the quantum randomness arguments might lend some support to free will, in that events in the brain may be non-deterministic, though it is not at all clear why *random* decisions would be any more 'free' in terms of personal volition than pre-determined ones! There seems to be hidden here the (false) assumption that consciousness is somehow controlling the results of certain random quantum processes. In any case the quantum arguments shed no light at all on consciousness itself, as they merely argue for the possibility of free will, but *say nothing at all about what consciousness actually is*. In sharp contrast the theory presented here provides a clear physical basis for consciousness in accord with both science and a careful analysis of consciousness from within.

Arguments from the first category that attempt to 'understand' consciousness only in the context of the human being, are likewise doomed to failure, for their type of understanding always involves the analysis of consciousness into its components, and **as an intrinsic fundamental aspect of the universe, the flow of the present, consciousness itself has no constituent parts**. It is important to understand that **consciousness is not something that originates within the human being; rather it is the fundamental process of the universe itself, of which humans partake according to their natures.** Of course we can

always discuss the details and forms of particular consciousnesses in terms of the structures which manifest them, but consciousness itself is primal, fundamental and importantly, physical, and *can only be known through direct experience*, specifically the direct experience of the creation of new time in the present moment viewed from the singularity of one's self as an observer. This is precisely the reason for Zen's unrelenting insistence on direct experience (Suzuki, 1956).

Lastly, it is important to understand that by consciousness we do not mean 'self' consciousness here, which many mistakenly confound with consciousness itself. As we have seen, consciousness exists even in the absence of a concept of self. We will subsequently see how the concept of self arises as a unique type of object within consciousness, but as an object among other objects (Piaget, 1960). This will be explored in detail in Part III.

12. SEEING INTO THE TRUE NATURE OF THINGS

Buddhist philosophy, and Zen in particular, states that man lives in a world of illusion and that the goal is to see into the true nature of things (Suzuki, 1956)**.** Zen argues that the illusion is the true nature of things, but only when the illusion is seen as illusion, and is seen as such in a moment of perfect clarity of consciousness, in which the clarity itself is paramount. In this section we will comment on how our cosmological model might be seen from this perspective, and begin to shed some light upon the nature of the illusion, as well as the reality behind the illusion. In Part III we shall have much more to say about the nature of illusion, and how human nature both conceals and reveals the truth behind it.

Perhaps the most important lesson of this paper's new view of physical reality is that consciousness, the primary experience of our existence, is in fact identical to the fundamental cosmological process of physical reality! That is the continual flow of the present moment through time at the speed of light is the direct experience of the ongoing extension of the universe in time. Further, that this present moment is what is real, is the only locus of being and existence, and this is precisely the stuff of consciousness in which all things, inanimate and animate, participate according to their physical structures. This sweep of the present through time is the continuing extension of the radial dimension of the universe itself and is the same process responsible for the recession of the most distant galaxies in space. This experience of the present moment is the basic fact of our and every existence; it is the field of consciousness which defines our being.

Thus consciousness, the experience which persists in the absence of all others, is the theater within which all events and perceptions make their appearance. This is equally true both within our minds and in spacetime itself. It is the most basic fact of the universe, and it is the most basic fact of our existence. So that seeing into the true nature of things is first and foremost, the direct experience of this experience in itself, independent of self, independent of whatever particulars might appear upon its stage, whether they be 'external' or 'internal' in character. It is this pure experience of consciousness itself, of the present sweeping through time at the speed of light, creating new time as it flows, and of the life and being that exists only within this ongoing moment, that is the fundamental reality and the true nature of things.

In the reality of direct experience, we exist totally alone within our singularity as an observer at a single infinitesimal point of spacetime. But the structure of our mind seems to open that point in space and in time by projecting the constantly arriving light back onto a mental world of our own construction which has extent in time and space. The result is that we seem to exist within a spacetime sphere of consciousness that incorporates our current instantaneous experience of the universe to the current horizon of our senses and our cognitive model of the world. Nevertheless each of us as an observer actually exists only as a spacetime singularity in which neither time nor space has extension. Here is only the raw flow of the direct totally unorganized experience of the present. Here we exist alone within our own direct experience of the present moment, at the center of consciousness. This is all that truly exists in our direct experience of the world. Certainly that consciousness may incorporate other beings and external events, as well as our own objective

concept of our self, but these things exist only as traces of the past, and other mental constructs within the present.

This is not to say that sharing consciousness is totally impossible, indeed the highest experience of love is in the seeming merging of consciousness in a shared present with that of the lover. But there is another more lasting and profound experience, which might be thought of as sharing love with the purity and emptiness of consciousness itself, in which the sphere of consciousness is filled with the experience of love, of the pure beautiful energy of the sweep of the presence of the present, of the life force of the universe itself in the continuous process of renewal in the creation of new time in the moment. It is then, that total aloneness becomes total love and one's being and all things, illusion or no, exist experienced as the pure energies of which they ultimately consist in the essence of their beings, that pure energy which is the life force of the universe, which when accepted completely becomes the stuff of purest love within the hermetic sphere of the eternal consciousness singularity of the present.

In Part III, we will explore the functional aspects of what may appear within the sphere of consciousness. We will see that to varying degrees all particulars within the sphere of consciousness can be considered as illusion in the sense that they are filtered and organized though the structure of our physical being into maps or models of the raw reality that induce them. In general the best that we can expect is that the logical structures of our model will reflect the logical structures of the reality accurately enough that we may effectively function in the 'illusory' world view in which we exist. In some sense then **it must be the logico-mathematical forms themselves that along with the pure energy of being that is the essence of things, that constitutes the primary reality, that which most accurately embodies the reality behind the illusion**. And these forms are not static forms, but the dynamic, time mutable forms that constitute the processes of the universe, and that in their totality can be thought of as the music of the Uni-Verse.

It is profoundly gratifying that the great thinkers of the past, especially those of the Zen tradition, even though they knew nothing of modern cosmology, could have come to essentially the same view of reality as we have. **That the direct experience of consciousness in the eternal flow of the present moment as it creates new time is seeing into the true nature of things**. The unity of these views will become even clearer in Parts II and III.

SUMMARY

A brief review of the main points of this paper:

- The STC Principle. All physical entities in the universe continually move through spacetime at the speed of light in clock time.
- The STC Principle provides a firm physical basis for the flow and arrow of time.
- Every individual observer experiences his own spacetime velocity as a continual movement through time at the speed of light.
- Since every entity moves through time at the speed of light according to its own proper time, it can only be at one location in time, and that location defines the existence of a unique and privileged present moment of time.
- Since there is a single time dimension and the STC Principle applies to all entities there must be a single cosmological present that continually sweeps through time at the speed of light.
- There are two kinds of time, clock time which is local and can vary according to relativistic law, and p-time which is the experience of the present and is the same for all observers. These two times may run at different rates.
- All observable physical processes run at their local clock time rate in accordance with the laws of relativity.
- The present, which is co-temporal for all observers, is absolute and universal. The trace of the common present through time defines the p-time dimension which is the common cosmological time dimension.
- Individual clock time metrics may differentially stretch relative to the p-time dimension resulting in the slowing of clock time rates relative to p-time and each other.
- It seems possible to construct a consistent cosmological geometry in which the universe is a four dimensional hypersphere whose radial dimension is the continually extending p-time dimension, and whose three dimensional surface is the three dimensions of space in the present moment. In this cosmology, the radial p-time dimension continually extends outward via the creation of new moments of p-time. This outward radial extension results in the Hubble expansion of the 3 space surface.
- All four spacetime dimensions are directly visible to us through the identical mechanism of the transmission of light. The past direction of the time dimension is directly visible as spatial distance in all directions from every present point. We do directly visually confirm that the time dimension is a radial dimension. This view of his world is called an observer's light cone.
- An observer is defined as an entity which cannot have space or time motion or separation relative to itself.
- Though the cosmological present exists as the entire surface of the hyperspherical universe, each observer experiences only the single present point of this surface at which he is located. Thus the observer exists as a singularity in spacetime. The light cone which is his view of spacetime, actually exists only as the arrival of its light at this singularity. The observer is the only point that exists in the present as he experiences it. All other entities in the universe exist in the observer's past and at distance.
- The present, the hyperspherical surface of the universe, is what is real. All things have existence and being only within this present surface. Being, existence and reality are defined by what is located within the present surface of the universe. Though we must assume this cosmological surface exists, its actual existence is unknowable to any observer due to the finite speed of light, and his confinement to his singularity.
- All entities in the universe, as they are able to be affected by other things, have what we call a big C type of consciousness, which is how those effects are 'known' by them. This is process, and cause and effect, and is a fundamental physical aspect of the universe. It is change.
- It is only because the present sweeps through time that effects occur, and thus the present itself is the stuff of consciousness, is consciousness itself. The movement of the present is consciousness.

- The natures of individual consciousnesses are determined by how particular entities experience or partake of the effects of the present moment according to their structures.
- Human consciousness too is the experience of big C consciousness filtered through the particularly human biological structures. Human consciousness, like the consciousness of all the entities of the universe, is the experience of the flow of the present.
- **The most fundamental experience of human existence, of being conscious in the present moment as it moves through time, is also the fundamental cosmological reality, namely the continual extension of the radial p-time dimension of the universe**.
- To directly experience this reality is the essence of what Zen calls 'seeing into the true nature of things'.

Some additional conclusions:

- Since time and space are just different dimensions of a single spacetime they must be the same 'stuff'.
- Matter has extension in space but not in time. The differences between space and time are primarily perceptual due to the fact that the matter of which we are composed has this property.
- Block time, the theory that every moment of time; past, present and future, has an eternal and equal existence, must be rejected.
- The increase of entropy cannot account for the flow of time, it is the result of the flow of time.
- The universe cannot be infinite because infinities can have no physical reality. This is one of several reasons that lend support to a hyperspherical topology.
- An absence of attractive gravitation in the earliest universe can explain how the initial low entropy state that set the universe in motion arose. It also explains how the initial expansion could have overcome its Schwarzschild radius and not instantly become a black hole.
- We are always time traveling towards the (non-existent) future. It is possible to time travel to the past or future relative to another clock time as long as neither clock reverses. It is not possible to travel to one's own past.
- Quantum randomness cannot explain consciousness.
- Theories that seek anthropocentric explanations of consciousness can never capture its true essence.

BIBLIOGRAPHY

Barbour, Julian. *The End of Time*. Oxford University Press, 1999.
Davies, Paul. *About Time*. Simon and Schuster, 2005.
Greene, Brian. *The Elegant Universe*. Norton, 1999.
Greene, Brian. *The Fabric of The Cosmos.* Vintage Books, 2005.
Kaku, Michio. *Hyperspace*. Oxford University Press, 1994.
Laughlin, Robert B. *A Different Universe*. Basic Books, 2005.
Penrose, Roger. *Shadows of The Mind*. Oxford University Press, 1994.
Penrose, Roger. *The Road to Reality*. Knopf, 2005.
Piaget, Jean, *Logic and Psychology*. Manchester University Press. 1956.
Piaget, Jean. *The Child's Conception of The World*. Littlefield, Adams & Co., 1960.
Price, Huw. *Time's Arrow and Archimedes' Point*. Oxford, 1996.
Susskind, Leonard. Unpublished email to the author. 2006.
Suzuki, Daisetz. *Zen Buddhism*. Doubleday, 1956.
Vilenkin, Alex. *Many Worlds in One*. Hill and Wang, 2006.
Vilenkin, Alex. Unpublished email to the author. 2007.
Yourgrau, Palle. *A World Without Time*. Basic Books, 2005.