Chapter 33

THE MEANING AND DISTORTION OF SPACETIME

The concept of 'Spacetime' is not contained in Einstein's 1905 paper on Special Relativity. Rather, it was invented during 1907 – 1908 by Hermann Minkowski (1864-1909), one of Einstein's mentors and colleagues.[1] *Spacetime is based solely upon Lorentz's* ad hoc *ether concepts of the contraction of matter and the Lorentz transformations, upon Einstein's* ad hoc *concepts of Special Relativity, and upon Minkowski's imagination and mathematics. For these reasons alone, Spacetime is* ad hoc*, empirically invalid and meaningless on its face. During the last century, Minkowski's Spacetime geometry has served as an inspiration for mathematicians to direct the course of physics, and as a mathematical tool to analyze, explain, expand, illustrate and attempt to confirm the various theories of relativity.*

A. Spacetime is *ad hoc*, empirically invalid and physically meaningless on its face.

Like many scientists of his time, Minkowski viewed Einstein's Special Theory merely as a generalization or elaboration of Lorentz's April 1904 theories.[2] (see Goldberg, p. 164; Dingle, 1972, pp. 167 – 169) In September 1908, Minkowski described and explained his geometrical concept of Spacetime to a gathering of German scientists. "It was a literal translation of the rigorous [relativistic] formalism that had been published earlier" by Minkowski in 1907. (Goldberg, p. 163)

Minkowski began his 1908 lecture with the following incorrect and misleading empirical statement:

> "The views of space and time which I wish to lay before you have sprung from the soil of <u>experimental physics</u>, and therein lies their strength."[3] (Minkowski,

[1] Actually, Poincaré suggested a similar concept in 1905 when he "combined the three spatial coordinates and time into a 'quadruple vector'…" (Folsing, p. 163)

[2] "From 1905 until…1919… 'the theory of relativity'…was regarded merely as a more obscure form of a theory that belonged to Lorentz." (Dingle, 1972, p. 167) Minkowski's similar conclusion shows his "lack of understanding of the important distinctions between [the work of] Lorentz and Einstein." (Goldberg, p. 127)

[3] Later in his lecture, Minkowski made another empirical statement: "Nobody has ever noticed a <u>place</u> except at a time, or a <u>time</u> except at a place." (Minkowski, 1908 [Dover, 1952, p. 76]) But this time-tested truism had little to do with his *ad hoc* mathematical Spacetime concepts, and a point in space is not a place.

1908 [Dover, 1952, p. 75])

On the contrary, and as we shall soon discover, Minkowski's geometrical views of space and time actually sprang from (and were completely based upon) Lorentz's *ad hoc* physical contraction of matter hypothesis and his April 1904 treatise; upon Einstein's *ad hoc* kinematic concepts of relativity, Length Contraction and Time Dilation; upon the meaningless co-variance of the empirically invalid Lorentz transformations; and upon Minkowski's own imagination and mathematics. Therein lie their physical and empirical invalidity and their meaninglessness for physics.

In fact, throughout his lecture, Minkowski tells us (in simple and straightforward language) the fundamental premises upon which his mathematical concepts of Spacetime are based. First of all, he asserted that Spacetime is premised upon the null results of Michelson's famous interference of light experiments, and upon Lorentz's contraction of matter hypotheses which he invented to explain such null results. (*Id*., p. 81) Minkowski conjectured that if we have a group of equations (the Lorentz transformation equations) for the propagation of light in empty space (G_c) where the velocity of matter is always less than c, and if we have a group of equations (the Galilean transformation equations) which state that the velocity of rigid bodies can be infinite (G_∞), then

> "it is easy to see…that we should be able, by employing suitable rigid optical instruments in the laboratory, to perceive some alteration in the phenomena when the orientation with respect to the direction of the earth's motion is changed. But all efforts directed toward this goal, in particular the famous interference experiment of Michelson, have had a negative result. To explain this failure, H. A. Lorentz set up an hypothesis, the success of which lies in this very invariance in optics for the group G_c.[4] According to Lorentz any moving body must have undergone a contraction in the direction of its motion, and in fact with a velocity

[4] Such invariance of the transmission velocity of light at *c*, of course, had nothing to do with Lorentz's contraction hypothesis. (see Chapters 6, 10, 12, 15 and 21)

> *v*, a contraction in the ratio $1:\sqrt{1 - v^2/c^2}$.[5] This hypothesis sounds extremely fantastical, for the contraction is not to be looked upon as a consequence of resistances in the ether, or anything of that kind, but simply as a gift from above,—as an accompanying circumstance of the circumstance of motion.[6]
>
> "I will now show by our figure [see Figures 33.1 and 33.2] that the Lorentzian hypothesis is completely equivalent to the new conception of space and time, which, indeed, makes the hypothesis much more intelligible."[7] (*Id*., p, 81)

On the contrary, as we have shown in Chapter 15, any concept of contraction of matter in the direction of motion is completely *ad hoc*, contrived and physically impossible. Lorentz's physical contraction of matter was also theoretically impossible because it depends upon the existence of ether, which does not exist. Not only that, but it was totally irrelevant and unnecessary in order to explain Michelson's null results.[8] (see Chapters 9, 10, 11 and 12) Thus, when Minkowski based his concepts of Spacetime on Michelson's null results and on the false necessity for a contraction of matter to explain such paradoxical null results, and mathematically constructed Spacetime geometry so that it would be consistent and 'completely equivalent' with respect to Lorentz's empirically false contraction hypothesis, the result was that Spacetime was based upon multiple false premises. Such false premises render the invention of Spacetime and all of its related concepts and mathematical consequences as physically invalid and empirically

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[5] Michelson's negative results, in conjunction with Lorentz's *ad hoc* hypothesis that the longitudinal arm of Michelson's apparatus had contracted in the direction of motion, were misinterpreted to mean that the velocity of light was always the same (or invariant) in all directions of the Earth's solar orbital motion.
[6] Minkowski criticized Lorentz's contraction hypothesis as being *ad hoc*, illogical, fantastical and a gift from God. But, he then dismissed these valid criticisms and proceeded mathematically as if he had never made them.
[7] This, of course, is *ad hoc* and mathematical circular reasoning.
[8] No contraction of matter is necessary to explain Michelson's paradoxical null results. The M & M paradox was caused by invalid theoretical measurements from stationary ether which mathematically resulted in a theoretically greater distance for a light ray to propagate in the direction of the Earth's solar orbital motion. Because stationary ether does not exist there can be no valid measurements from it, therefore such theoretically greater distance for light to propagate never existed either. It's just that simple. (See Chapter 12 for a full explanation of the M & M paradox.)

meaningless.[9]

Secondly, if Spacetime was premised upon Lorentz's false concept of a contraction of matter depending upon a body's velocity, then it must also be based upon and consistent with the empirically meaningless Lorentz transformations.[10] Minkowski implies that this is the case because he refers to Lorentz's 1904 concept of 'local time' and to Einstein's 1905 interpretation of it. (Minkowski, 1908 [Dover, 1952, p. 82]) Minkowski also used equations with Lorentz's and Einstein's Lorentz transformation denominator ($\sqrt{1 - v^2/c^2}$) throughout his lecture. (see *Id*., pp. 81, 82, 87, and 90) A non-mathematical confirmation appears when Minkowski states that "natural phenomena do not possess an invariance with the group G_∞, but rather with a group G_c," which group G_c of transformations were obtained by Minkowski during the application of his Spacetime geometry. (see Figure 30.1) The 'invariance of natural phenomena' is just another way to describe the <u>co-variance</u> of physical phenomena when the Lorentz transformations are applied to them. (see Einstein, *Relativity*, pp. 47 – 48) If Spacetime is based on the *ad hoc* and meaningless Lorentz transformations, this is another reason why it is empirically invalid. (see Chapter 27)

Thirdly, Minkowski also premised his concepts of Spacetime upon Einstein's *ad hoc* 'relativity-postulate.' Minkowski stated that the radically changed mathematical concept of space which he was inventing might be considered "as another act of audacity on the part of the higher mathematics." (Minkowski, 1908 (Dover, 1952, p, 83)

[9] Since Spacetime geometry is empirically invalid on its face, we could end this chapter at this point. But that would leave the reader without a full understanding of just how *ad hoc* and artificial Spacetime really is. So we will continue with a more complete explanation of this totally meaningless mathematical concept.
[10] Many relativists agree with this conclusion. For example, see Feynman, 1963, pp. 17-1 through 17-8, and Dingle, 1972, p. 170.

"Nevertheless," said Minkowski:

> "this further step is indispensable for the true understanding of the group G_c, and when it has been taken, the word *relativity-postulate* for the requirement of an invariance with the group G_c seems to me very feeble. Since the postulate comes to mean that only the four-dimensional world in space and time is given by phenomena, but that the projection in space and in time may still be undertaken with a certain degree of freedom, I prefer to call it the *postulate of the absolute world* (or briefly, the world-postulate)." (*Id*.)

> "The validity without exception of the world-postulate, I like to think, is the true nucleus of an electromagnetic image of the world, which, discovered by Lorentz, and further revealed by Einstein, now lies open in the full light of day." (*Id*., p. 91)

Since we now know that any hypothesis for the contraction of matter in the direction of velocity is completely *ad hoc* and meaningless (Chapter 15), that the Lorentz transformation equations are completely *ad hoc* and empirically invalid (Chapters 16 and 27), that the concepts of Length Contraction and Time Dilation are completely *ad hoc* and physically meaningless (Chapters 26 and 28), and that Einstein's relativity postulate and his concept of co-variance are *ad hoc* and empirically invalid (Chapters 23, 24, 27 and 28), thus so must Spacetime and its world postulate suffer the same fate (because they are premised upon and totally consistent with the above relativistic concepts).

B. A brief description of Minkowski's Spacetime geometry.

Regardless of its empirical invalidity, the remainder of Minkowski's lecture was structured "along a purely mathematical line of thought to arrive at changed ideas of space and time." (Minkowski, 1908 [Dover, 1952, p. 75]) In Section I of his lecture, Minkowski began with the mathematical form of Newton's mechanics: the Galilean transformation equations. "Let x, y, z be rectangular coordinates for space,[11] and let t

[11] Never before did coordinates refer to space. Einstein only used them to refer to a material place. This abstract statement was as if Minkowski was referring to Newton's absolute space or stationary ether.

denote time." (*Id.*, p. 76)

> "A point of space at a point of time, that is, a system of values *x*, *y*, *z*, *t*, I will call a *world-point*.[12] The multiplicity of all thinkable *x*, *y*, *z*, *t* systems of values we will christen the *world*." (*Id.*)

Minkowski then described this world point in motion over time from -∞ to +∞; in other words, over eternity. The changed coordinate points dx, dy, dz and dt result in a 'world line.'[13] (*Id.*) He also abstractly illustrated the 'world' with four coordinate 'world axes' and a zero coordinate point in the center. (see Figure 33.3B)

Minkowski then asserted "that we may subject the axes of [spatial coordinates] *x*, *y*, *z* at $t = 0$ to any rotation we choose about the origin, corresponding to the homogeneous linear transformations of…x^2, y^2, z^2." (*Id.*, p. 77) This means that the algebraic form of Newton's laws of mechanics remains unaltered or invariant if we measure their spatial coordinates at any arbitrary position in any arbitrary linear direction from zero. (*Id.*, p. 75) But since "the zero point of time is given no part to play" in the Galilean transformation equations we have complete freedom to give "the time axis whatever direction we choose towards the upper half of the world" for any value of time greater than zero. (*Id.*, pp. 75, 77)

Minkowski's connection between the space axis and the time axis involved a positive parameter *c* and the graphic representation of $c^2t^2 - x^2 = 1$. To understand how Minkowski's geometry created a group of transformations (called G_c) which "associated the arbitrary displacements of the zero point of space and time" of any number of world points, see Figure 33.1. Group G_c was the geometrical equivalent of the Lorentz transformation equations, and they resulted in the 'invariance of natural laws.'

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[12] Each world point represented an event or an observer.

[13] Minkowski conjectured: "in my opinion physical laws might find their most perfect expression as reciprocal relations between these world-lines." (*Id.*, p. 76)

Minkowski also defined the 'value of *c*' as "the velocity of the propagation of light in empty space." (*Id*., p. 79)

At the end of Section I, Minkowski stated that we "have in the world no longer space, but an infinite number of spaces, analogously as there are in three dimensional space an infinite number of planes [or frames of reference]. Three dimensional geometry becomes a chapter in four dimensional physics." (*Id*., pp. 79 – 80)

Minkowski's "idea was very simple: since the Lorentz transformation on which the special theory of relativity is based involves a transformation of space as well as of time one may treat time just like another dimension of space, a fourth dimension, as it were.[14] This…idea of a four-dimensional 'space', three dimensions of ordinary space and one time dimension,[15] became known as *Minkowski space*."[16] (Rohrlich, p. 75)

Minkowski's new Spacetime geometry illustrated Cartesian coordinates; it used straight lines and was flat like Euclidean geometry. (D'Abro, 1950, p. 196) However, we shall "see that we are not dealing with ordinary Euclidean geometry." (Born, p. 305) Spacetime has its own special nomenclature, its own conventions, its own symbols and its own mathematical expressions. (see Dingle, 1972, p. 176)

In Section II of his lecture, Minkowski described an axiom, $c^2dt^2 – dx^2 – dy^2 – dz^2$, which he asserted means "that any velocity v always proves less than *c*." This was,

[14] In effect, Minkowski "suggested a geometric representation for relativity so that many of [Einstein's] strange relations between space and time can be pictured and much can be understood without the use of algebra." (Rohrlich, p. 75) However, "we cannot speak of anything changing or moving in a space and time diagram because time has already been used [as a dimension] and cannot be used twice." (Harrison, p. 131)

[15] "Time has only one dimension." (Harrison, p. 130) Its line from the past to the present to the future forms the continuum of eternity. (Figure 33.3A)

[16] The idea of four dimensions had long been used for depicting sets of connected events, of which time is a coordinate." (Goldberg, p. 163) "Space and time diagrams, with their events and worldlines, were used by the Medievalists, and there is nothing particularly difficult or novel about them. Until the beginning of [the 20th] century they were regarded as a convenient graphic way of illustrating the way things change. Then came special relativity and pictures of this kind acquired a new physical meaning." (Harrison, pp. 130 – 131)

of course, completely consistent with Lorentz's April 1904 treatise and with Einstein's Special Theory.

What did Minkowski mean that the world would have an infinite number of spaces? At the beginning of Section III of his lecture, Minkowski individualized space and time for each world point (i.e. each event or observer) by giving it its own set of four axes. (see Figure 33.3A) The 0 was the zero-point of Spacetime for each world point. Minkowski illustrated the velocity of light at *c* as a straight line (a 'light line') beginning at the zero (0) point of Spacetime and continuing at a 45° angle equidistant between the x (space) axis and the t (time) axis. (Figure 33.3B) If one passed this light line through a 360° rotation, the result would be a 'light cone' with the vertical time axis in the center and an infinite number of x and y axes in all possible directions on an xy plane.[17] (Figure 33.3A) Again, each event (or observer) in Spacetime has its own lightcones. (Rohrlich, p. 78) Since "three dimensional ordinary space…is infinite our symbolic picture of it [the xy plane is]…also infinite. But so is time." (Minkowski, 1908 [Dover, 1952, pp 83 – 84]) Thus we must also construct a light cone into the past, and we end up with a double light cone. (*Id*., p. 83) Each world point had a past light cone for all other "world-points which send light to 0," and a future light cone for all other "world-points which receive light from 0."[18] (Minkowski, 1908 [Dover, 1952, p. 83]) Everything that goes on [in Spacetime] must be judged relative to [each] cone." (Rohrlich, p. 78)

Because Special Relativity postulates that no material body can exceed the speed of light, "only light itself has a world line that is on the cone." (Rohrlich, p. 83) All other material bodies that have a velocity less than c remain inside each light cone and

[17] A spherical light wavefront emitted at the zero point of any frame would expand up the surface of the light cone each second in an ever-widening sphere.
[18] Figure 33.1 is situated above the 0 point.

must angle toward the time line; the closer these world lines are to the time line, the less is their relative velocity. These world lines are often called 'time-like'. The areas outside each light cone are *a priori* not accessible, and therefore "all accessible future events lie inside the future light cone, and all…[accessible past events] lie inside the past light cone." (*Id.*) The inaccessible future and past is sometimes called 'Elsewhere.'

In order to graphically illustrate Einstein's relativistic concept of relative motion and kinematics (length contraction and time dilation), Minkowski tilted both axes of the moving frame equally toward the light line. In other words, "observers in relative motion have worldlines inclined to each other." (Harrison, p. 132; see Figure 33.4A) The algebraic formula which "relates the intervals of time and space of observers in relative motion at speed v…[is the] Lorentz transformations."[19] (*Id.*, p. 133)

At the beginning of Section IV of his lecture, Minkowski conjectured the following:

> "To show that the assumption of group G_c for the laws of physics never leads to a contradiction, it is unavoidable to undertake <u>a revision of the whole of physics</u> on the basis of this assumption. <u>This revision has to some extent already been successfully carried out</u> for questions of thermodynamics and heat radiation, for electromagnetic processes, and finally, with the retention of the concept of mass, for mechanics.[20] (Minkowski, 1908 [Dover, 1952, p. 86])

Thereafter, Minkowski proceeded to mathematically revise the whole of physics with four equations (vectors) corresponding to the four axes of Spacetime.[21] Except for

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[19] The author does not expect the reader to fully understand Minkowski's Spacetime geometry from the above axiomatic descriptions. But such descriptions should give the reader an idea of just how abstract and *ad hoc* Spacetime geometry really is. See Sklar, pp. 56 – 61, for a short explanation of Minkowki's Spacetime.

[20] With regard to the theoretical unassailability of the Lorentz transformations, max Born stated as follows: "The simple fact that all relations between space co-ordinates and time expressed by the Lorentz transformation can be represented geometrically by Minkowski diagrams should suffice to show that there can be no logical contradiction in the theory." For Dingle's response, see Dingle, 1972, pp. 231 – 232.

[21] For a description of Spacetime, the relativistic 'four vectors' and four-vector algebra, see Feynman, 1963, pp. 17-1 – 17-8.

Einstein's and Minkowski's *ad hoc* assumptions that the empirically invalid Lorentz transformations should apply to physics, there would be no need to revise the whole of physics. The fourth equation turned out to be "the kinetic energy of the mass point

$$mc^2 \frac{dt}{d\Upsilon} = \frac{mc^2}{\sqrt{1 - v^2/c^2}}$$

…It comes out very clearly in this way, how the energy depends on the system of reference."[22] (*Id.*, p. 87)

At the end of Section IV,, Minkowski set forth an equation:

$$d\Upsilon^2 = -dx^2 - dy^2 - dz^2 - ds^2.$$

This equation (in various different algebraic forms) is now called the 'spacetime interval.'[23] Sklar asserts that "in Minkowski spacetime we do not discuss distances between events, but rather the interval between them [along a curve]. This Spacetime interval] is a number and which is an invariant property of the spacetime."[24] (Sklar, pp. 58 – 59) Thus, very happily for Einstein, the interval between events in Spacetime is always invariant, and the interval along a light line in Minkowski's absolute world is always zero.[25] (see Figures 33.4B and 33.5)

Why did Minkowski invent a 'fundamental invariant' for his absolute world? Because Einstein discovered that the classical absolutes of "lengths, durations and simultaneities were all found to…vary in magnitude when we:

"changed the constant magnitude of the relative velocity existing between

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[22] However, we ask the question: How can a system of reference determine a distant magnitude of energy?
[23] Minkowski stated that such equation 'becomes perfectly symmetrical in x, y, z, s [where s = $\sqrt{-1}$t, $\sqrt{-1}$ secs = 3.105 km, and *c* = 1]; and this symmetry is communicated to any law which does not contradict the world postulate." (Minkowski, 1908 [Dover, 1952, p. 88])
[24] If the number is positive it is called a 'space like separation'' if it is negative it is called a 'time like separation;' and if it is zero it is called a 'light like separation.' (Sklar, p. 59)
[25] Harrison asserts that: "spacetime contradicts ordinary common sense, and this has lead to the so-called twin paradox." (Harrison, p. 136) Likewise, "the answer to the twin paradox results from the geometry of spacetime." (*Id.*, p. 134) More circular reasoning.

> ourselves as observers and the events observed. On the other hand, here at least was an invariant magnitude ds^2, representing the square of the spatial distance covered by a body in any Galilean frame, minus c^2 times the square of the duration required for this performance (the duration being measured, of course, by the standard of time of the same frame). It mattered not whether we were situated in this frame or in that one; in every case, if ds^2 had a definite value when referred to one frame, it still maintained the same value when referred to any other frame."[26] (D'Abro, 1951, p. 195)

This is nothing more than mathematical gibberish.

The mathematical justification for Minkowski's <u>absolute</u> Spacetime Interval ds^2 depended *inter alia* upon Einstein's relativistic concepts of kinematics, *inter alia*, the 'Relativity of Simultaneity' and the 'Relativity of Length,' and their mathematical counterparts 'Time Dilation' and 'Length Contraction.' (see Figure 33.4B) In previous chapters of this book we have explained why these *ad hoc* concepts are arbitrary, empirically invalid and meaningless. (Chapters 26 and 28) It also depended upon Einstein's impossible second postulate concerning the absolute propagation velocity of light at *c*, relative to everything, which we have also found to be empirically invalid. (see Chapter 21) Therefore, there is not even a valid mathematical justification for the Spacetime Interval ds^2.

Empirically, we also know that the time interval and the space interval for the transmission of light from one place to another, or from one star to the Earth, is not zero; rather it is *c*t. In the twenty-first century we can measure these real intervals with EM radiation (vis., radar, radio waves, and lasers), and we can detect and calculate such measurement data with sensors and computers. Therefore, the invariant Spacetime Interval (ds^2), which has an absolute relativistic value of zero, is empirically invalid and

[26] For more information about Minkowski's so-called 'fundamental invariant,' see Goldberg, p. 166; Cropper, p. 219; Harrison, pp. 131 – 135; Feynman, 1963, pp. 17-2 – 17-4; Einstein, EB 1969, Vol. 20, pp. 1071 – 1073.

meaningless in the real empirical world of space and time.[27]

In Section V of his lecture, Minkowski described what he called a striking advantage afforded by his world postulate; it involved "the effects proceeding from a point change in any kind of motion according to the Maxwell-Lorentz theory."[28] (Minkowski, 1908 [Dover, 1952, p. 88]) This was, of course, a generalization of Einstein's Special Theory which only involved inertial motion. Minkowski then proposed a new four dimensional law of attraction, which he claimed mathematically resulted in Kepler's laws. According to Minkowski, this new law of attraction, when combined with his new mechanics (reformed in accordance with the world postulate), was just as capable of explaining astronomical observations as Newton's laws.[29] (*Id*., p. 90) Finally, Minkowski ended his lecture with the assertion that he had just pre-established a "harmony between pure mathematics and physics." (*Id*., p. 91)

Why did Minkowski feel compelled to invent Spacetime geometry, with all of its bizarre mathematical concepts, axioms, conventions and consequences? Because this was the only way he could describe a multidimensional world that was governed by the Lorentz transformations, Special Relativity and mathematics. If we discard the *ad hoc* Lorentz transformations and Einstein's empirically invalid Special Theory, as we must, then the only remaining rationale for Spacetime geometry is a playground for pure mathematicians.

The reciprocal of this fact is that embedded in Spacetime geometry are the

[27] Nevertheless, in the tiny world of quantum mechanics, it might be interpreted to have an approximate validity and meaning.

[28] Minkowski thereafter claimed that: "the fundamental equations for electromagnetic processes in ponderable bodies also fit in completely with the world postulate." (*Id*., p. 90)

[29] What effect did those *ad hoc* claims by Minkowski have on Einstein and his quest for a new General Theory of gravity?

Lorentz transformation equations and the mathematical consequences of Special Relativity. Therefore, any Spacetime diagram is nothing more than a graphic representation of how a phenomenon or an event should look from the distorted perspective of Special Relativity. Spacetime geometry illustrates and demonstrates the mathematical consistency of Special Relativity, and vice-versa.

In other words, they are both mutually validating mathematical constructs. This *ad hoc* type of validation is both circular and meaningless. It is like demonstrating the validity of the Lorentz transformations with the mathematical consequences of Special Relativity, and vice-versa. The result is absolutely certain, but also worthless.

C. Conclusions Concerning Spacetime

Minkowski referred to Spacetime as an "independent reality" and implied that it was physically real;[30] whereas Dingle characterized Spacetime as 'metaphysics.' (Dingle, 1972, p. 169)

"Einstein was not at first impressed by Minkowski's mathematical recasting of special relativity theory. He found it 'banal' and called it 'superfluous erudition'. (Cropper, p. 220) Dingle describes the reception of Spacetime similarly:

> "The immediate effect…of Minkowski's paper was mainly one of mystification; Einstein himself is reported to have said that after reading it he felt he did not understand his own theory—which is not surprising, since Minkowski's 'time' was only 'eternity' and Einstein's was only 'instant' or 'duration'. (Dingle, 1972, p. 173)

However, as Einstein got involved with his General Theory of Relativity, Gaussian geometry and Riemann's concept of curved space, he found Spacetime to be

[30] Many other relativists also characterize Spacetime as physically real. For example: "Space…in conjunction with time,…possesses physical structure." (Harrison, p. 131) "Spacetime pictures…actually portray a four-dimensional physical reality." (*Id*., p. 132)

indispensable. By 1916, Einstein even devoted the entire Chapter 17 of his book *Relativity* to Minkowski's four-dimensional Spacetime, and toward the end he stated:

> "Without it the general theory of relativity…would perhaps have got no farther than its long clothes." (Einstein, *Relativity*, p. 63)

The reason why Einstein used Spacetime Euclidean geometry for his unnecessary and empirically invalid General Theory is because his General Relativity is in large part a theory of non-Euclidean geometry (if that statement makes any sense). He needed Spacetime, *inter alia*, to illustrate and explain his mathematical concepts of curved space and curved Spacetime (gravity), and his later mathematical model of a finite spherical universe. (Einstein, 1917 [Dover, 1952, pp. 177 – 188) However, one should remember that all of these contrived and interdependent relativistic and mathematical theories had their origin in Einstein's *ad hoc* Special Theory, and his failed attempt to justify his invalid and impossible second postulate: that the velocity of a light ray was always c for every inertial observer regardless of such observer's linear motion toward or away from such light ray.

Most of Einstein's followers blindly accepted all of the above esoteric and amorphous mathematical theories as physically real and empirically true. The result is that Spacetime geometry, along with Special Relativity and General Relativity, are taught to students as required courses in many of the world's universities. These *ad hoc* mathematical theories have almost universally become accepted as valid science. They are currently the primary foundation and justification for uncountable pure mathematical theories concerning the universe and the quantum world. (For example, see Wheeler's 1999 book, *Journey Into Gravity and Spacetime*) The Big Bang, singularities, the spherical universe, the expanding universe, the expansion of space, quantum mechanics, particle physics, quantum field theories, and the Superstring theories are only some of the most notable examples. They form the top of the current theoretical and relativistic house of cards. This is not physics; this is not science; it is not even science fiction…it is pseudo-science.

Minkowski began Section I of his 1908 lecture with the statement: "I should like to show how it might be possible, setting out from the accepted mechanics of the present day, along a purely mathematical line of thought, to arrive at changed ideas of space and time." (Minkowski, 1908 [Dover, 1952, p. 75]) Somewhat later in his lecture, as Dingle points out, Minkowski chided his fellow "mathematicians for not anticipating physicists [i.e. Lorentz and Einstein] in arriving at the Lorentz transformations as a physical transformation." (Dingle, 1972, p. 170) Minkowski stated:

> "since G_c is mathematically more intelligible than G_∞, it looks as though the thought might have struck some mathematician, fancy-free, that after all, as a matter of fact, natural phenomena do not possess an invariance with the group G_∞, but rather with a group G_c, c being finite and determinate, but in ordinary units of measure, *extremely great*. Such a premonition would have been an extraordinary triumph for pure mathematics. Well, mathematics, though it now can display only staircase-wit, has the satisfaction of being wise after the event, and is able, thanks to its happy antecedents, with its senses sharpened by an unhampered outlook to far horizons, to grasp forthwith the far-reaching consequences of such a metamorphosis of our concept of nature." (Minkowski, 1908 [Dover, 1952, p. 79])

Dingle agreed with Minkowski and asserted: "Reduced to its essence, Minkowski's paper is a piece of pure mathematics." (Dingle, 1972, p. 169) Dingle also concluded:

> "the process of allowing mathematics to direct physics, which began with Maxwell…had now reached a point at which it is taken as the proper function of mathematics to order physics along the path which mathematics points out, and mathematics is chided for neglecting this duty and allowing physics to choose its own way. The return to medieval scholasticism, against which the protest of Bacon and the other pioneers of modern science was thought to have been finally

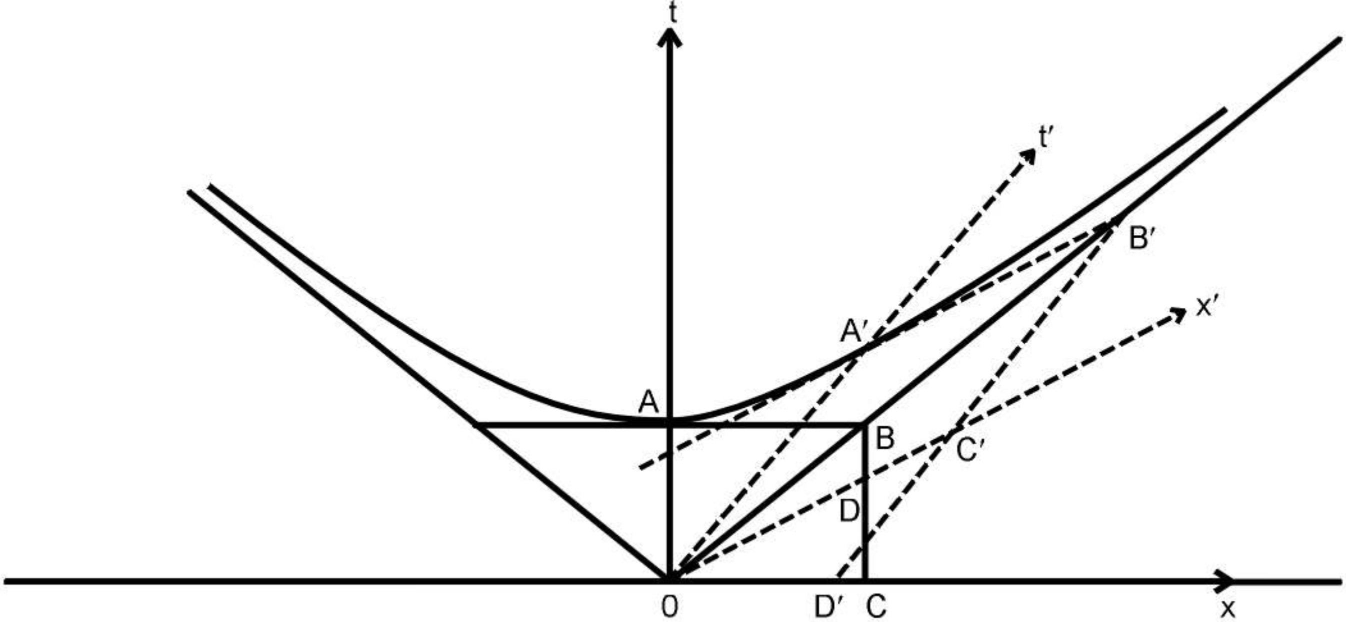
> successful, was now complete. With Minkowski's work physics had escaped from experiment and been captured by mathematicians." (*Id*., pp. 170 – 171)

> "[Spacetime] contributed perhaps more than any other single factor to the transformation of mathematics from the servant into the master of physics, and introduced more false ideas into the subject—pre-eminently the totally irrelevant idea of time (eternity)—than anything else. It is to Minkowski that we owe the idea of a 'space-time' as an objective reality—which is perhaps the chief agent in the transformation of the whole subject from the ground of intelligible physics into the heaven (or hell) of metaphysics, where it has become, instead of an object for intelligent inquiry, an idol to be blindly worshipped." (Dingle, 1972, p. 169)

All of Dingle's conclusions are euphemistically wrapped up in Minkowski's final conclusion in his lecture: that his Spacetime geometry creates "a pre-established harmony between pure mathematics and physics." Minkowski ended this lecture with the following statement:

> "The validity without exception of the world-postulate, I like to think, is the true nucleus of an electromagnetic image of the world, which, discovered by Lorentz, and further revealed by Einstein, now lies open in the full light of day." (Minkowski, 1908 [Dover, 1952, p. 91])

Needless to say, Minkowski's *ad hoc* Spacetime geometry is empirically meaningless and must be discarded by everyone (other than pure mathematicians) before it can cause more mischief for physics.



"To establish the connexion, let us take a positive parameter *c*, and consider the graphical representation of

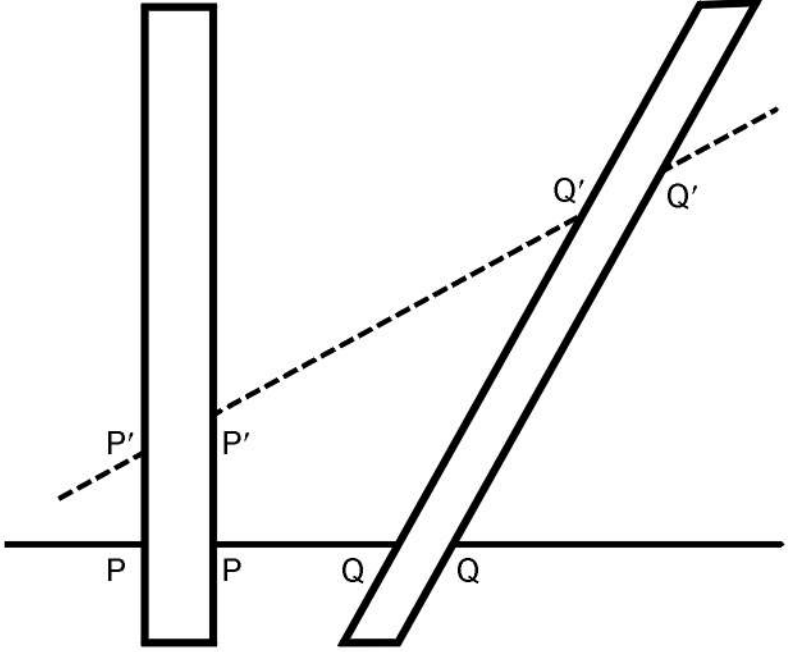
$$c^2t^2 - x^2 - y^2 - z^2 = 1.$$

"It consists of two surfaces separated by t = 0, on the analogy of a hyperboloid of two sheets. We consider the sheet in the region t > 0, and now take those homogeneous linear transformations of *x*, *y*, *z*, *t* into four new variables *x′*, *y′*, *z′*, *t′*, for which the expression for this sheet in the new variables is of the same form. It is evident that the rotations of space about the origin pertain to these transformations. Thus we gain full comprehension of the rest of the transformations simply by taking into consideration one among them, such that *y* and *z* remain unchanged. We draw...the section of this sheet by the plane of the axes of *x* and *t*--the upper branch of the hyperbola $c^2t^2 - x^2 = 1$, with its asymptotes. From the origin 0 we draw any radius vector OA′ of this branch of the hyperbola; draw the tangent to the hyperbola at A′ to cut the asymptote on the right at B′; complete the parallelogram OA′B′C′; and finally, for subsequent use, produce B′C′ to cut the axis of *x* at D′. Now if we take OC′ and OA′ as axes of oblique co-ordinates *x′*, *t′*, with the measures OC′ = 1, OA′ = 1/*c*, then that branch of the hyperbola gain acquires the expression $c^2t'^2 - x'^2 = 1$, $t' > 0$, and the transition from *x*, *y*, *z*, *t* to *x′y′*, *z′*, *t′* is one of the transformations in question. With these transformations we now associate the arbitrary displacements of the zero point of space and time, and thereby constitute a group of transformations, which is also, evidently, dependent on the parameter *c*. This group I denote by G_c.

"If we now allow *c* to increase to infinity, and 1/*c* therefore to converge towards zero, we see from the figure that the branch of the hyperbola bends more and more towards the axis of *x*, the angle of the asymptotes becomes more and more obtuse, and that in the limit this special transformation changes into one in which the axis of *t′* may have any upward direction whatever, while *x′* approaches more and more exactly to *x*."

Figure 33.1

Source: Minkowski, 1908 [Dover, 1952, pp. 77, 78])



"If for simplicity we disregard *y* and *z*, and imagine a world of one spatial dimension, then a parallel band, upright like the axis of *t*, and another inclining to the axis of *t*...represent, respectively, the career of a body at rest or in uniform motion, preserving in each case a constant spatial extent. If OA′ is parallel to the second band, we can introduce *t′* as the time, and *x′* as the space co-ordinate, and then the second body appears at rest, the first in uniform motion. We now assume that the first body, envisaged as at rest, has the length *l*, that is, the cross second PP of the first band on the axis of *x* is equal to *l*. OC, where OC denotes the unit of measure on the axis of *x*; and on the other hand, that the second body, envisaged as at rest, has the same length *l*, which then means that the cross section Q′ Q′ of the second band, measured parallel to the axis of *x′*, is equal to *l*. OC′. Lorentzian electrons, one at rest and one in uniform motion. But if we retain the original co-ordinates *x*, *t*, we must give as the extent of the second electron the cross section of its appropriate band parallel to the axis of *x*. Now since Q′ Q′ = *l*. OC′, it is evident that QQ = l. OD′. If *dx/dt* for the second band is equal to *v*, an easy calculation gives

$$OD' = OC\sqrt{1 - v^2/c^2},$$

therefore also PP : QQ = 1 : $\sqrt{1 - v^2/c^2}$. But this is the meaning of Lorentz's hypothesis of the contraction of electrons in motion. If on the other hand we envisage the second electron as at rest, and therefore adopt the system of reference *x′t′*, the length of the first must be denoted by the cross section P′P′of its band parallel to OC′, and we should find the first electron in comparison with the second to be contracted in exactly the same proportion; for in the figure

$$P'P' : Q'Q' = OD \,;\, OC' = OD' : OC = QQ \;:\, PP."$$

Figure 33.2

Source: Minkowski, 1908 [Dover, 1952, pp. 78, 81 - 82])

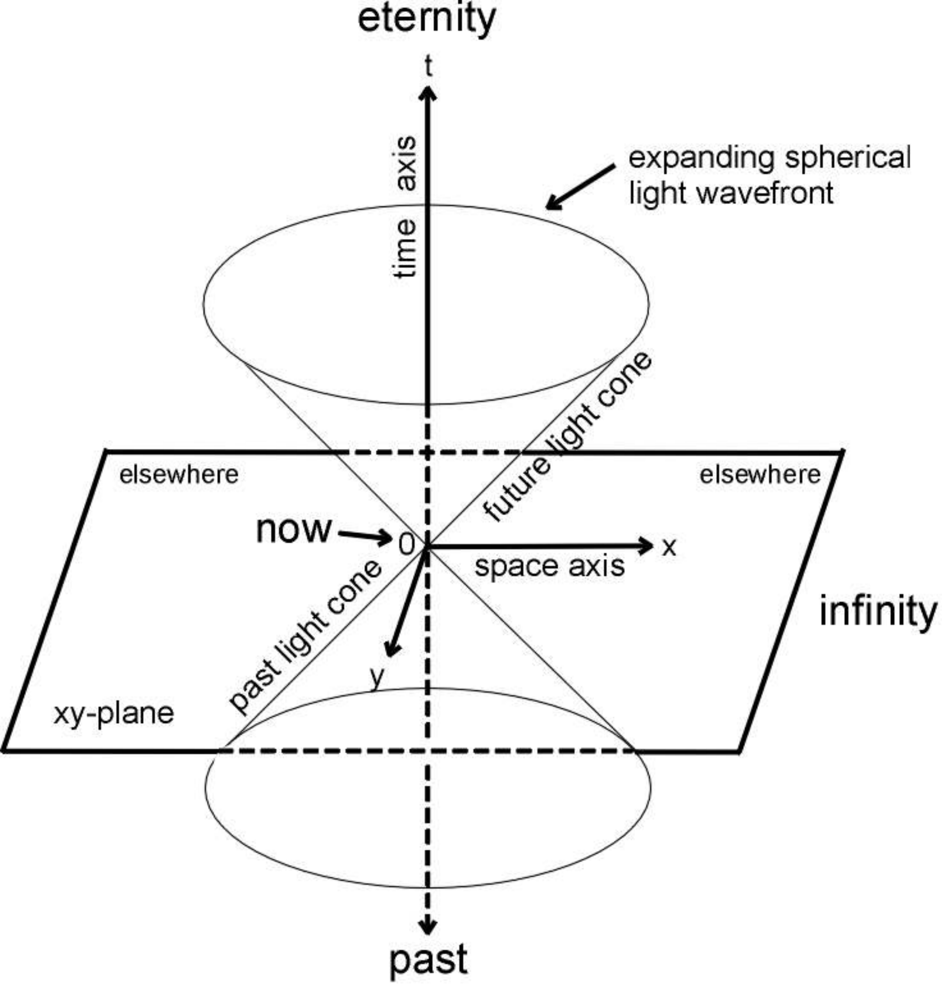


Figure A. A Spacetime frame in multiple dimensions

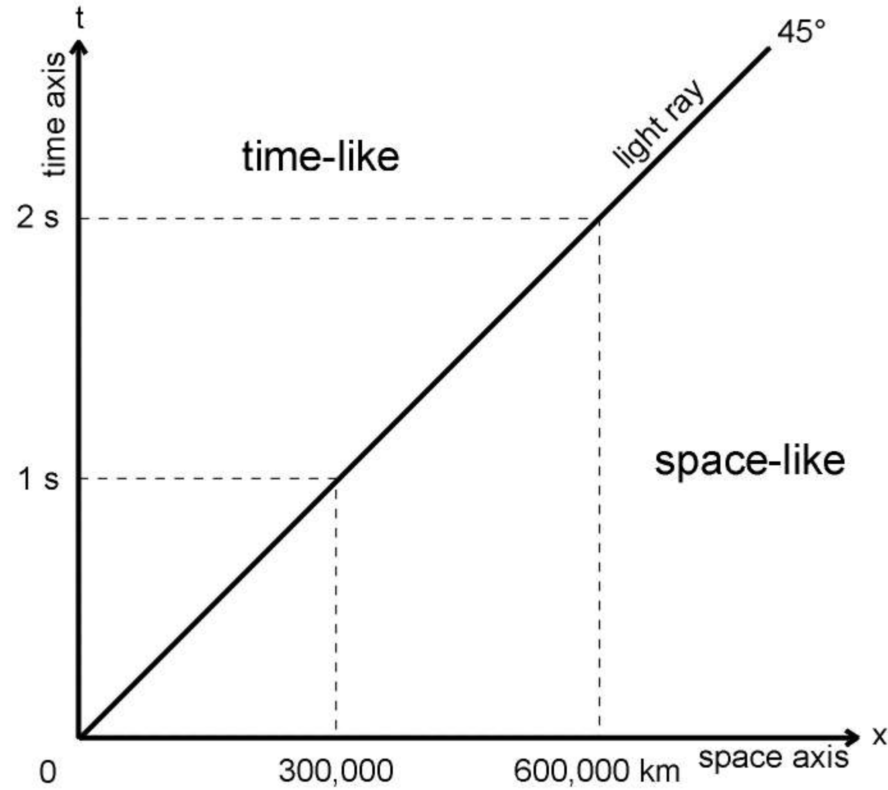


Figure B. A Spacetime frame

One second of time along the time axis equals 300,000 km along the space axis.

Figure 33.3 Basic Spacetime Diagrams

Partial Source: Rohrlich, pp. 76, 77

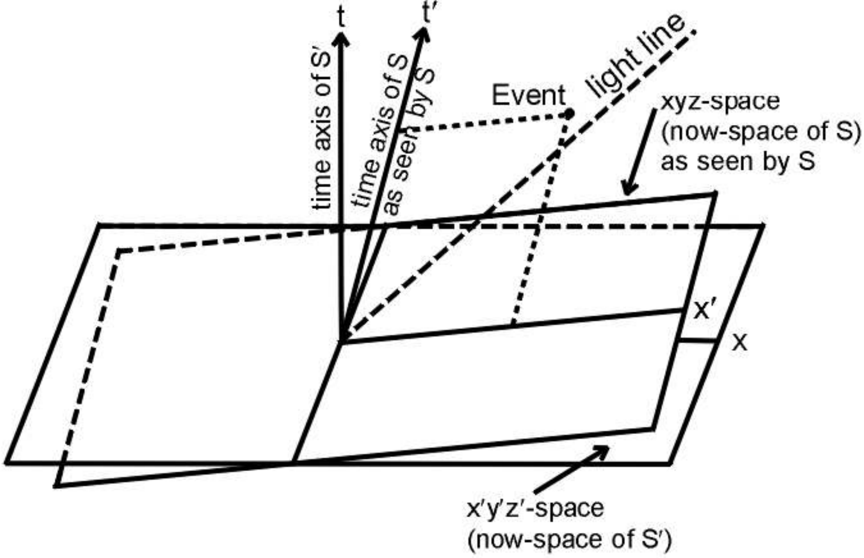


Figure A
Tilted frames indicating simultaneity and proper measurements in a moving frame (relativistic kinematics) Partial Source: Rohrlich, p. 85.

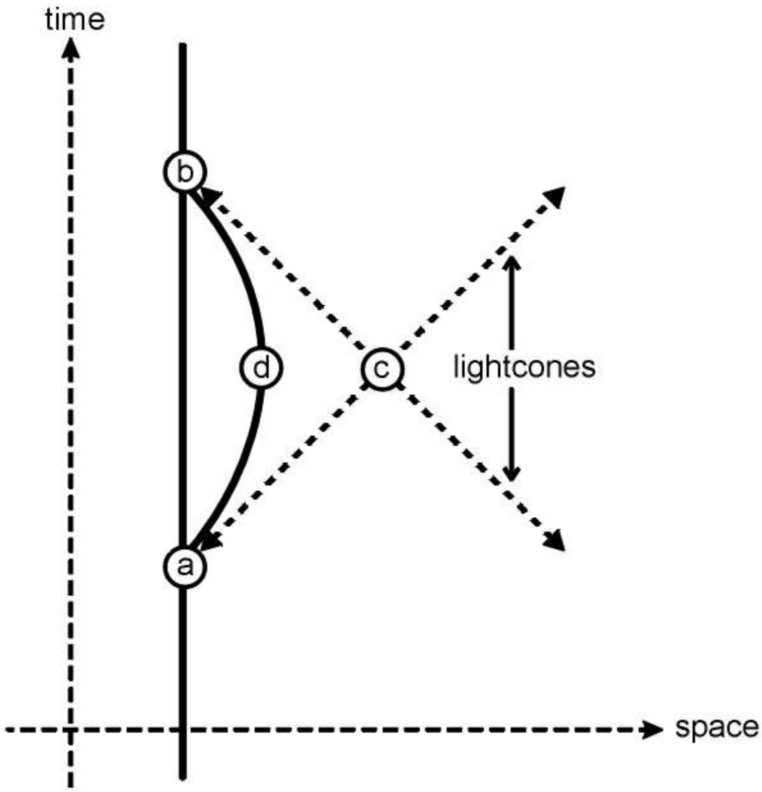
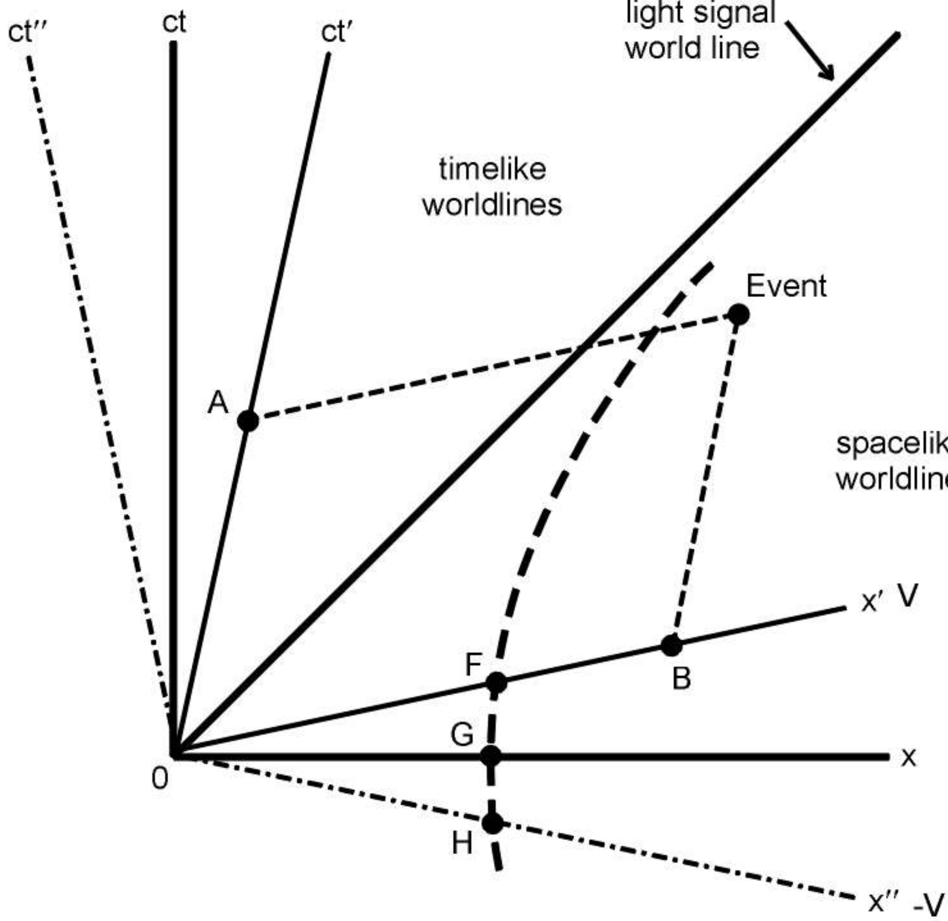


Figure B Time Dilation
"The straight worldline between a and b is the longest distance. The lightcone distance acb (i.e. a to c and then c to b) is of zero length. The nearer the bent worldline adb approaches the lightcones acb, the shorter its length. A person's time is measured along his or her worldline (intervals of experienced time are actually equal to intervals of length of the worldline), and the time taken to go from a to b is the length of the worldline. The longest time is along the straight worldline, and the time taken gets shorter as the worldline adb approaches acb. This explains the twin paradox." Source: Harrison, p. 135

Figure 33.4 Tilted Frames & Time Dilation



Frame S represents the relatively stationary system, tilted frame S′ represents a positive velocity along x, and tilted frame S″ represents a negative velocity in the opposite direction. The calibration hyperbolic curve F, G, H defines the unit distance interval along x for each system. French, p. 83. This is, it "defines a particular relation between *x* and *t* for an infinite number of different events as described in the single frame *S*, is also the locus in space-time for all events representing time zero and *x* coordinate equal to unity in different inertial frames." (*Id.*, p. 84)

Figure 33.5 A Minkowski Spacetime Diagram Showing An Invariant Interval

Source: French, p. 83, 84