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TOWARD AN EXCITING REBUILDING OF MODERN PHYSICS

2006

FORWARD

At the time factors of unknown origin and physical meaning (like β in the Lorentz transformation, the Dirac matrices, etc.) are embedded in some underlying equations and, by way of consequence, the physical significance of the terms of these equations rests undisclosed, we validate the principle of the physical determination of equations[1] in special relativity theory and relativistic quantum theory, as first step toward an exciting foundation of modern physics on this principle (yet all restraints of the principle are off in modern physics).

At the time science and secularization are on ascending trend, discarding any role to revelation (as disclosure by God) in the act of science[2], we give a rationale to Einstein's derivation of the Lorentz transformation from [1] which discloses both this role and its discarding as main source of the century-old hidden crisis of physics. With no role of revelation in the act of science, there is presently no expected role for the principle of the physical determination of equations in the future development of physics, so no way to remove the crisis.

At the time special relativity theory is discarding the concepts of absolute rest and absolute speed, and it is yet claimed that the two concepts are "completely foreign and unacceptable to physics" [2], we disclose both coordinate systems at absolute rest and absolute speeds in special relativity theory. Since the axes of these coordinate systems are not related to positions of bodies of reference frames, the principle of relativity is not violated. The absolute speeds are determinable in terms of measured light travel times (i.e., independently of any physical substratum) by the experiment just used to deduce the Lorentz transformation from [1]. Determined in this manner, the absolute light speed c assures the covariance of the equation $x=ct$. So it becomes evident in this book that the discarding of the concepts of absolute rest and absolute speed was equivalent to deleting vital passwords for accessing essential information for the advancement of physics.

At the time particle physicists proclaim that the whole information about 'elementary' particles is *exclusively* predicted by well-settled particle theories, and *exclusively* proved experimentally by the particle accelerator facilities, culminating with the Super Collider, we show that, through the principle of the physical determination of equations, the relativistic quantum theory provides genuine information, experimentally testifiable by radically new techniques. The relativistic mass arises to be the coupling constant of some constituents of the 'elementary' particles, and its value can be changed by acting upon the coupling of the constituents. So that, the standard particle theories, which can make no prediction on the nature of mass, are not so 'well-settled', and the particle accelerator facilities are not so 'exclusive' experimental tools. Moreover, the

[1] It every term of the underlying equations of any physical theory has incorporated an explicit physical significance. This is what we call the principle of the physical determination of equations. This principle was basic to develop classical physics. It should have been basic to develop modern physics, too. However, this principle was never defined in physics textbooks, and its special importance for the advancement of physics never pointed out.

[2] The birth of any new idea, or set of coupled ideas, contributing to the advancement of science is an act of science.

information obtained by colliding high energy particles is, by its limited diversity, mainly useless in the absence of the new information.

We prove that it all started wrong with the derivation of the Lorentz transformation in [1] keeping the Newtonian habit of determining absolute speeds by measuring the quantities appearing in the definition of speed, claiming that "no properties of phenomena attach to the idea of absolute rest" and disregarding the systematic change over time in direction and magnitude of the radius vectors of geometrical points moving with respect to inertial observers.

Tracing by physical signals such radius vectors, we determine their direction and magnitude at the time of their projection onto coordinate axes. So, by also assuming that identical inertial clocks run at the same rate and inertial meter-sticks keep their length unaltered, no matter of their speed, we deduce a new class of time-dependent coordinate transformations, which we call 'complementary time-dependent coordinate transformations'. Deriving, for light signals, the Lorentz transformation as a complementary time-dependent coordinate transformation, we disclose the objective reality warranting the manipulations of some equations that led to the Lorentz transformation in [1]. The correctness of the derivation of the Lorentz transformation in [1] and the validity of our assumptions within Einstein's special relativity theory follow. So there was no need to discard the concepts of absolute time, absolute rest and absolute motion at the foundation of the special relativity theory. Bringing into accord the tracing of radius vectors by light signals with the addition of travel times as scalar quantities, we obtain the meaning of 'Cartesian coordinate' for the term βx of the Lorentz transformation, and the meaning of 'Newtonian time' for the term βt of the Lorentz transformation -the only equations in special relativity theory with terms without physical meaning identified-, so remove the mysterious origin of β and validate the principle of the physical determination of equations in this theory.

Einstein's performing of manipulations of equations as if he knew their physical support, the development of special relativity theory without the derivation of the Lorentz transformation from [1] (in despite its correctness), and the missing of the principle of the physical determination of equations (essential for disclosing physical information vital to a true advancement of physics) from special relativity theory (which the manipulations of equations should validate) disclose the role played by revelation in the act of science.

The genuine subquantum information which we provide, and its application to radically new technologies -that should have been developed as early as the 1940's- put an end to the present nuclear era. It also illustrates the terrifiant effect of the crisis of modern physics, raised and maintained by the physicists' attitude toward revelation and the resulting uncontrolled mixture of revealed and rational acts in the act of science (mixture caused not only by denying the divine but also any rationale for the revealed knowledge), the foundation of the relativistic quantum field theories before wholly understanding the relativistic quantum theory, a systematic physics policy prohibiting disclosing its physical grounds and corruption, as well. The progress of the mankind is assured by the exploitation of the subquantum energy.

So, for contributing to a true advancement of science, physicists should define a correct attitude toward revelation, identify, like the classical physicists, the physical information incorporated in the terms of the underlying equations, and give a rationale for their work, or any work they investigate. Einstein's merit of turning parts of revealed knowledge (without being aware of dealing with it) into rational knowledge in deducing the Lorentz transformation in [1] proves that his genius was actually far more impressive than that just celebrated in the World Year of Physics 2005 [3]. Unfortunately, his resulting jumps over all explanatory steps have hidden his distinguished performance.

The book begins with an outline of the crisis of modern physics in chapter 1, and is divided into three parts. Every chapter is devoted to a small subject in order to make clear our insight into that subject. The first part, chapters 2 through 11, netly defines the 'complementary time-dependent coordinate transformations' (in Ch. 2), our working hypotheses (in Ch. 3), the concepts of space, reference frame and coordinate system (including the new concepts of 'abstract' coordinate system and 'abstract' coordinate system at absolute rest) (in Ch. 4) and our working method (in Ch. 5), then presents the derivation of both the 'complementary time-dependent coordinate transformations' and the Lorentz transformation as a complementary time-dependent coordinate transformation. The second part, chapters 12 through 26, applies the derivation of the Lorentz transformation as a complementary time-dependent coordinate transformation to Einstein's special relativity theory, determining the objective reality behind his manipulations of equations that led to the standard Lorentz transformation from [1], so proving the correctness of the derivation of the Lorentz transformation from [1] and the validity of the principle of the physical determination of equations in this theory. The third part, chapters 27 through 42, validates the principle of the physical determination of equations in the relativistic quantum theory, providing genuine information applicable to radically novel technologies. Conclusions are drawn in chapter 43. An epilogue on the transition from 'physics policy' to 'physics as policy' is added as chapter 44.

Readers will find some incipient ideas on the subject, and attitudes toward these ideas in, respectively, the copies of some of author's published papers (under the names A. Ceapa and A.C.V. Ceapa) and private letters included in Appendix.

CONTENTS

CHAPTER 1

PROLOGUE: OUTLINE OF THE CRISIS OF MODERN PHYSICS

REVELATION: DEFINITIONS OF, AND ATTITUDES TOWARD

I. Disclosed by God

General attitude: **non-shared**

II. A sudden, creative coming together of several previously uncorrelated lines of reasoning which are combined in a new synthesis (cf. English dictionary)

General attitude: **shared**

free from any suggestion that God has anything to do with the creative insight.

THE NON-VALIDATION OF THE CLASSICAL PRINCIPLE OF THE PHYSICAL DETERMINATION OF EQUATIONS IN EINSTEIN'S SRT

non-validation of the principle of physical determination of equations in relativistic theories

false predictions: length contraction, time dilation, twins paradox

conflicts with Newtonian concepts: universal time, absolute motion absolute rest

A. factors of unknown origin and physical meaning, *e.g* scalar $1/\sqrt{1-v^2/c^2}$ in SRT, or matrices α,β in Dirac equation

B. hyper-mathematization, *e.g.* equations and theories having nothing in common with objective reality, invoking only mathematical abilities, not physical or intuitive ones

C. undisclosed physical information, *e.g.* on the subquantum structure of matter, which needs testing by methods other than high-energy collision, and which provides basis for radically new technologies.

A+B+C LED TO THE CRISIS IN MODERN PHYSICS

Defining features: much high mathematics, little physical information

Development: first perceived: around the 1940's; really started: 1905

Root cause: physicists attitude concerning the role of revelation in 'the act of science'; *i.e.*, the birth of any new idea, or set of coupled ideas, contributing to the advancement of science.

(Reprinted from [4])

KEY CONTRIBUTORS TO THE CRISIS OF MODERN PHYSICS

I. A. Einstein: A religious man who believed that **no rationale** can be provided for revealed knowledge,

- was **aware** of the role played by revelation in the act of science,
- was **unaware** of the revealed nature of the mathematical decisions that led him to the Lorentz transformation in 1905.

⇓

the foundation of the standard special relativity theory on his 1905 paper on relativity bar the derivation of the Lorentz transformation in that paper

⇓

unknown origin and physical meaning of $\beta = 1/\sqrt{1 - v^2/c^2}$ in the Lorentz transformation

⇓

the **non-validity** of the principle of the physical determination of equations in special relativity theory

II. P.A.M. Dirac

•**obtained** some information about the quantum mechanical behavior of some particles,

•was **unaware** of both the role played by revelation in the act of science and the validity of the principle of the physical determination of equations in the relativistic quantum mechanics

⇓

missed **all** the information on the structure of those particles

III. B.L. van der Waerden

• was **unaware** of both the role played by revelation in the act of science and the validity of the principle of the physical determination of equations in the relativistic quantum mechanics

⇓

• missed **all** the physical content of the spinorial transcription of the Dirac equation

IV. Authors of advanced quantum theories

• All similarly **unaware**, have **ignored** both the role of revelation in the act of science and the principle of the physical determination of equations in founding their theories

⇓

i) hypermathematized theories ii) little physical information

CHAPTER 2

DEFINITION OF THE COMPLEMENTARY TIME-DEPENDENT COORDINATE TRANSFORMATIONS

We here obtain time-dependent coordinate transformations that are complementary to those already known as spatial translations and rotations. We name the new coordinate transformations 'complementary time-dependent coordinate transformations'. The complementary time-dependent coordinate transformations are derived by projecting onto coordinate axes the radius vectors of geometrical points in inertial spaces (defined in Ch. 4, Sect. 1.2) when traced by physical signals. Such radius vectors change systematically over time, in both direction and magnitude relative to inertial observers. Their tracing with physical signals just determines their direction and magnitude relative to an inertial observers at the moment of their projection.

CHAPTER 3

WORKING HYPOTHESES

Any physical theory is founded on principles, working hypotheses and a working method. The working hypotheses in developing special relativity theory were i) the removal of the concepts of absolute rest, absolute motion (absolute speed) and absolute time (by requiring that all inertial, identical clocks to run at rates depending on their speeds) and ii) the change in length of the meter-sticks in uniform rectilinear motion.
Hypotheses i) were consequences of the attempts to determine experimentally the absolute speed of light with respect to an unmovable physical substratum, according to the Newtonian definition of speed, and the lack of experimental proof for such a substratum in empty space. The lack of search for alternative ways to determine experimentally absolute speeds, and the lack of natural support for identical inertial clocks to run at different rates and inertial meter-sticks to change their length in terms of their speeds make these hypotheses suspect of arbitrariness.

Our working hypotheses to deduce the complementary time-dependent coordinate transformations are i) the concepts of absolute rest, absolute motion (absolute speed) and absolute time (all inertial, identical clocks running at the same rate, no matter of their speed) and ii) the same length of the meter-sticks, no matter of their speed. They are evidently the opposite of Einstein's hypotheses. We use the Newtonian definition of absolute speed with respect to a physical substratum only when a distance is measured with a meter-stick in permanent touch with a physical substratum. Whenever these distances identify with paths of physical signals, the absolute speeds are determined in terms of travel times. So there is no need to identify a physical substratum at absolute rest and discard, by way of consequence, the concepts of absolute rest, absolute motion and absolute speed.

These 'Newtonian' working hypotheses are validated by obtaining the standard Lorentz transformation as a 'complementary time-dependent coordinate transformation (Ch. 9). They are also validated in Einstein's special relativity theory by that our derivation of the standard Lorentz transformation discloses (Ch. 14) the physical grounds of his unmotivated manipulations of equations that led to the Lorentz transformation in [1].

CHAPTER 4

COORDINATE SYSTEMS AND REFERENCE FRAMES

The concepts of coordinate system and reference frame are often used in the literature with identical meaning. It is ignored with nonchalance the different nature of the two. The nonchalance is not so disinterested. Playing with the two concepts, false results are maintained in physics, altering substantially its development. It is the case of the reference frame at absolute rest and of the coordinate systems at absolute rest. The removal of the first from physics involved wrongly the removal of the last, distorting the development of special relativity theory and other theories in modern physics.

4.1. Cartesian Coordinate Systems

Cartesian coordinate systems are assemblies of three straight lines orthogonally crossing at a point -the origin. Cartesian coordinate systems are essential in deducing the complementary time-dependent coordinate transformations, so a better understanding of modern physics. It is for this reason that we consider them further in connection with reference frames, space (Newtonian space, Euclidian space, empty space) and inertial ("stationary" [1]) spaces. The 'abstract' coordinate systems (defined in Sect. 1.1) at absolute rest, which we associate to the inertial coordinate systems, will prove to be of particular importance.

4.1.1. Cartesian Coordinate Systems and Reference Frames

Reference frames are assemblies of four physical bodies fixed relative to each other. The bodies of the inertial ("stationary") reference frames move uniformly and rectilinearly as a whole. By the positions of three of these bodies with respect to the fourth one -the origin- are determined the axes of the Cartesian coordinate systems[3]. Inertial ("stationary") coordinate systems are Cartesian coordinate systems in uniform rectilinear motion. 'Abstract' coordinate systems are coordinate systems which axes are not determined by the bodies of the reference frames. Aimed by no motion at all, the 'abstract' coordinate systems at absolute rest[4] do not presume the existence in Nature of a reference frame at absolute rest. Unlike the general 'belief', the abstract coordinate systems at absolute rest will be seen further in this book to play a major role in correctly understanding special relativity theory, so modern physics.

4.1.2. Cartesian Coordinate Systems, Space (Newtonian Space, Euclidian Space, Empty Space) and Inertial ("Stationary") Spaces

Space (Newtonian space, Euclidian space, empty space) is the three-dimensional assembly of geometrical points endowed with no motion at all. Inertial ("stationary") space is an assembly of geometrical points at rest with respect to each other, aimed by uniform rectilinear motion as a whole. As all the geometrical points of a coordinate

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[3] Einstein's designation of the reference frames and coordinate systems by the same definition [5] was misleading because did not allow conceiving the 'abstract' coordinate systems (defined below in this Section).

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system are those of their axes, the Cartesian coordinate systems are embedded, respectively, in space and inertial spaces.

CHAPTER 5

OPERATIONAL METHOD

Our working method consists in tracing radius vectors of geometrical points in inertial spaces with physical signals. It involves experimental procedures for measuring travel times. It is for this reason an operational method. The source of the physical signals is attached to the origin of the observer's coordinate system. The source's emission is isotropic. It takes place when the observer's coordinate system coincides with a coordinate system at rest in the inertial space to which the geometrical points belong: Only one of the emitted signals will reach a point of this space. The origin of this signal is designated by a point in empty space, and the origins of the two coordinate systems are designated by points in the inertial spaces to which they belong. The first is a point at absolute rest, while the latter two are points aimed with uniform rectilinear motions. The three origins, and the geometrical point the radius of which was traced by signal, are joined together by a mathematical relationship which, in reduced form, associates abstract coordinate systems at absolute rest with the two inertial coordinate systems.

CHAPTER 6

ABSTRACT COORDINATE SYSTEMS AT ABSOLUTE REST

We give evidence for abstract coordinate systems at absolute rest associated to inertial coordinate systems called "at rest" [1] and abstract coordinate systems at absolute rest that professional inertial observers (professionals) associate to their own inertial coordinate systems. Professionals are common inertial observers (uselessly assumed till now to be innocent) *a priori* trained to investigate graphically both seen and unseen relative motions.

6.1. Abstract Coordinate Systems at Absolute Rest Associated to Coordinate Systems "at Rest"

Consider the diagrams in Fig. 1, with arrows temporarily ignored. In the first diagram, the coordinate system k is moving with constant speed v along the positive common x',x axis relative to a hypothetical coordinate system at absolute rest K. In the second diagram, k moves with the same speed relative to K_1, but k and K_1 are carried by an inertial space of speed w. The coordinate system k coincided with both K and K_1 at $t=0$. P(x') is a fixed point in k. At time t the second diagram differs from the first one in that everything is shifted right by a distance wt. The Galileo transformation

$$x' = x - vt \qquad (1)$$

is predicted by both diagrams. This fact 'entitled' observers to name their inertial coordinate systems "at rest", and to treat them as coordinate systems at absolute rest.

Consider further the same diagrams with arrows drawn. They stand for physical signals tracing radius vectors of geometrical points moving with respect to observer. Among all possible physical signals, *we here, and in subsequent diagrams, select light signals. We do it to pregnantly emphasize the deep connection of our results with*

Einstein's special relativity theory. The generality of all the obtained formulas is assured by changing c to v within them, where v stands for the speed of whichever signal.

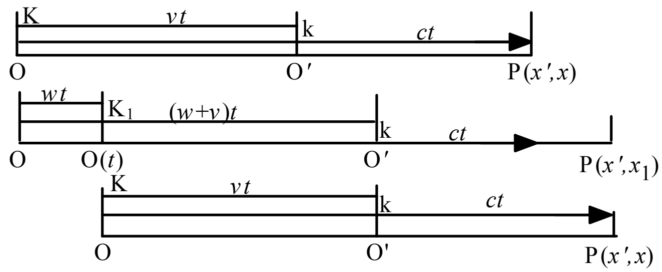

Figure 1.

Let the arrows on Fig. 1 stand for the light signal tracing the radius vector of P(x'). At time $t = 0$, this signal and the origin of k leave the origin of K, K_1, respectively, moving along the x', x axes with speeds c, v. At time t, they reach, respectively, P and O' in the first diagram, and we get Eq. (1) with $x = ct$. Also at time t, the path of the signal in the second diagram is ct, but both the origin of K_1 and P are shifted right to O(t) and P(x', x_1) for the distance wt. At time $t_1 = t + wt / c$ the light signal will reach P(x', x_1), but in the time wt / c, P(x') moved from P(x', x_1) to P(x', x_2) in the diagram of Fig. 2.

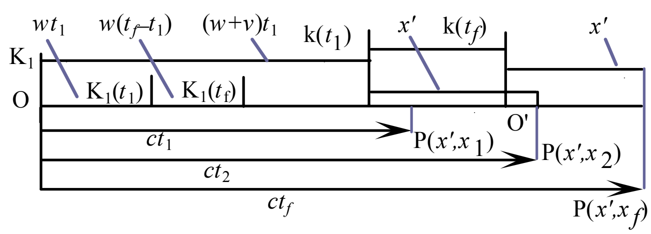

Figure 2.

At time $t_2 = t_1 + (w + v)wt / c^2$, the light signal will reach P(x', x_2), while k, K_1 and P(x') moved further to right by $(w + v)w^2 t / c^2$, and $(w + v)^2 wt / c^2$, respectively. So that, the time t_f, at which k and K_1 will reach positions denoted respectively by k(t_f) and K_1(t_f), and the light signal P(x') at P(x', x_f), tracing its radius vector relative to O, is given by

$$t_f = t + wt / c + (w + v)wt/c^2 + (w + v)^2 wt/c^3 + ...$$

$$= t + wt / c + (w + v)wt/c(c - w - v)$$

where the sum of an infinite geometric series of common ratio $(w + v) / c < 1$ was taken into account. At time t_f, the radius vectors of P(x') and of the origin of k, respectively, are located at

$$x_f = ct_f = ct + wt + (w + v)wt/(c - w - v)$$

and

$$x_{O'} = (v + w)t_f = vt + wt + (w + v)wt/(c - w - v).$$

So $x_f - x_{O'}$ reduces to Eq. (1) by removing the line segments OO(t) $= wt$ and $P(x', x_1)P(x', x_f) = (w + v)wt/(c - w - v)$ covered by the light signal and the origin of k, in accord with the second diagram in Fig. 1. The third diagram in Fig. 1 follows. By that the radius vector of the geometrical point P(x') is traced by the signal in time t, this diagram associates the 'abstract' coordinate system at absolute rest K to the observer's inertial coordinate system K_1.

Therefore, the very graphical and mathematical description of the uniform rectilinear motion of any object relative to an inertial observer is done with respect to the coordinate system at absolute rest associated to his inertial coordinate system. The 'relative' speed appears to be an absolute quantity (that is one defined with respect to a coordinate system at absolute rest).

6.1.1. The 'Relativistic' Law of Addition of Parallel Speeds

Consider now the diagrams in Fig. 3. The coordinate system at absolute rest K is that above associated to K_1. The k_A, k and K coincide at $t_0 = 0$. Just at $t_0 = 0$, k_A, k and a light signal, tracing the radius vector of P fixed in k, leave the origin O of K. They move uniformly along the common x', x'', x axis with speeds v, w and c, respectively. At time t, their origins and the tip of the signal reach, respectively, the points $O'_A(vt)$, $O'(wt)$ and $Q(ct)$ in the upper diagram. By diagrams like the last two in Fig. 1, with K_1, K changed to k_A, K_A, we turn the motion of k relative to k_A to one relative to the coordinate system at absolute rest K_A associated to the inertial k_A. To this end, the light signal and the origin of k must continue their motion an additional time vt/c, until reaching P and $O'[w(t+vt/c)]$, respectively.

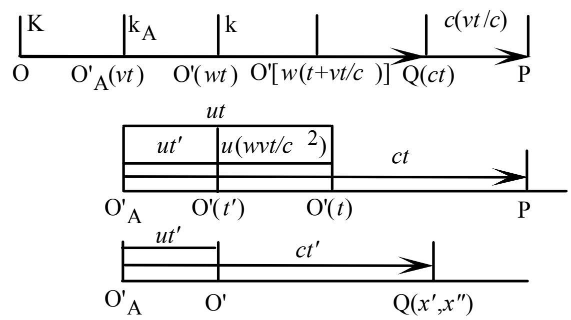

Figure 3.

Since O'_AP was traveled by the signal in time t, the bottom diagram in Fig. 1 is regained as the second one in Fig. 3, where $O'(t)$, $O'(t')$ stand for the origin of k relative to O'_A at times t, t', respectively. For a speed u of k relative to K_A, this diagram predicts the relationship $ut' = (w-v)t$ at the time $t' = t - wvt/c^2$ and, by simplification, the equation

$$u = (w-v)/(1-wv/c^2). \tag{2}$$

The speeds u, v, w in Eq. (2) are absolute quantities (as defined in Sect. 6.1). u defines the speed of motion of k with respect to the fixed point O'_A. All happens as if the origin of k_A was at rest at O'_A in the time *t*, and that of k moved at $O'(wt)$ with speed u in the time *t*'. u is a true speed: u, and not *w*-v, serves to calculate the kinetic energy of a body at rest in k, releasable with respect to k_A. It is this reason for which u given by Eq. (3) is used in the relativistic kinematics.

Therefore, for *c* changed to *v*, the 'relativistic' law of addition of parallel speeds given by Eq. (2) is specific to any theory in which the radius vectors are traced by physical signals.

6.*1.2. Complementary Time-Dependent Coordinate Transformation for Geometrical Points Located on the Observer's Direction of Motion: Particular Form*

Observe that the first diagram in Fig. 3 predicts for Q the set of equivalent equations

$$x' = x - vt,\ t' = t - vx / c^2. \qquad (3)$$

Also observe that, for a geometrical point -the origin O' of k- moving with the absolute speed *w*, the additional equation $x = wt$ assures the independence of Eqs. (3). So Eqs. (3) define a coordinate transformation. According to Ch. 2, this is a complementary time-dependent coordinate transformation connecting coordinates -defined with respect to the coordinate systems at absolute rest K and K_A- of geometrical points located on the observer's direction of motion. Since Eqs. (3) and the equations

$$x'' = x - wt,\ t'' = t - wx / c^2,$$

also predicted by the first diagram, give rise to the equations

$$x'' = x' - ut',\ t'' = t' - ux'/c^2$$

predicted by the last diagram, the coordinate transformations of type (3) form a group.

6.2. Abstract Coordinate Systems at Absolute Rest Associated to Coordinate Systems of Inertial Observers

A professional at rest with respect to the origin of k in Fig. 1, can always associate coordinate systems at absolute rest (K, Ξ) to, respectively, the inertial coordinate systems K_1 and k by reflecting at point P(x') fixed in k, the light signal tracing its radius vector, as depicted in the diagrams in Fig. 4. The first because, as a point of space, hence at absolute rest, the origin O'_o of the signal defines the origin O of K. The last in view of the equations

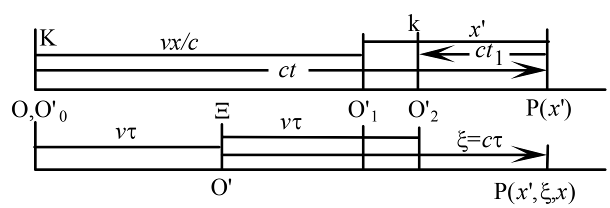

Figure 4.

$$x' = x - vt,\ x' = vt_1 + ct_1 \qquad (4)$$

having as solutions

$$t = x'/(c - v),\ t_1 = x'/(c-v). \qquad (5)$$

Thus defining

$$\tau = (t + t_1)/2,\ \xi = c\tau, \qquad (6)$$

he obtaines equations $\tau = \beta^2 x'/c$, $\xi = \beta^2 x'$, and implicitly

$$O'_oO'_2/2 = c(t-t_1)/2 = v\tau,\ x = ct = \xi + v\tau. \qquad (7)$$

Since x' is the abscissa of a point P fixed in k, it is constant. The quantities τ and ξ are also constants. Therefore, the point O' of abscissa $v\tau$ is a fixed point in K. Since ξ gives the position of P relative to O', the last of Eqs. (7) defines O' as the origin of a coordinate system at absolute rest Ξ associated to the inertial coordinate system k. As depicted in the second diagram in Fig. 4, Ξ is parallel to k and K, having in common the x', ξ, x axis. The radius vector of P relative to Ξ, ξ is traced by a light signal in the time τ of Ξ. By Eqs. (5), (6) and (1), and adding equations $\eta = y$, $\zeta = z$, he gets

$$\xi = \beta^2 (x - vt),\ \eta = \beta y,\ \zeta = \beta z,\ \tau = \beta^2 (t - vx / c^2), \qquad (8)$$

where $\beta = 1/\sqrt{1 - v^2/c^2}$, which connect coordinates of P relative to the coordinate systems at absolute rest Ξ, K.

CHAPTER 7

GRAPHICAL ADDITION OF TRAVEL TIMES AS SCALAR QUANTITIES

The parallelogram rule of addition of two vectors making the angle α with each other gives by the extended Pythagorean theorem

$$t=(t_1^2+t_2^2+2t_1t_2\cos\alpha)^{1/2} \tag{9}$$

as the formula for adding travel times elapsed by light along such vectors. Eq. (9) conflicts with the scalar feature of time, and must be abolished.

To this end we first consider a sequence of collinear line segments OA_1, A_1A_2,…, $A_{n-1}A_n$ in empty space, and denote

$$OA_n = OA_1+A_1A_2+\ldots+A_{n-1}A_n. \tag{10}$$

Because the time in which a light signal travels any line segment is the difference between the times indicated by synchronous clocks located at its endpoints at the arrival of that signal [in our case $t(O)$, $t(A_1)$, … , $t(A_n)$], we always have

$$t(OA_n) = t(OA_1)+ t(A_1A_2)+\ldots+ t(A_{n-1}A_n) \tag{11}$$

with $t(OA_n) = t(A_n) - t(O) = OA_n/c$, $t(OA_1) = t(A_1) - t(O) = OA_1/c$, $t(A_1A_2) = t(A_2) - t(A_1) = A_1A_2/c$, …, $t(A_{n-1}A_n) = t(A_n) - t(A_{n-1}) = A_{n-1}A_n/c$.

When obtained dividing a geometrical equation like (10) by the speed of a physical signal (in particular that of light), Eq. (11) defines what we here call *graphical addition of travel times as scalar quantities*. The derivation of Eq. (11) from Eq. (10) is basic in a theory manipulating physical signals, as the special relativity theory is.

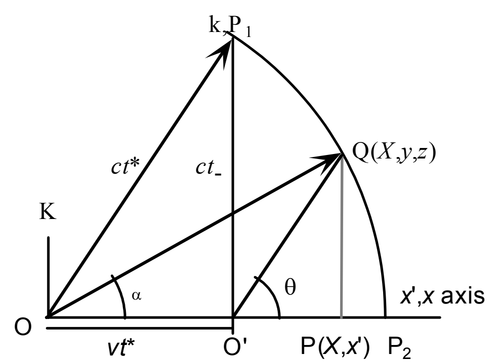

Figure 5.

The choice of collinear light signals in [1] has hidden the case of the collinear line segments which depend on travel times of non-collinear light signals, like those tracing the radius vectors OQ, O'Q in the diagram in Fig. 5, with k and K in Ch. 5 (Sect. 1.1). The collinear line segments OO', O'P and OP are covered respectively with speeds v, $c\cos\alpha$ and $c\cos\theta$ by the origin of k and the projections onto the common x',x axis of the tips of the light signals tracing OQ, O'Q. Therefore they depend on the travel times t^* and $O'Q/c$. Evidently, this prevents us from getting a time equation like (11) by simply dividing equation OO'+O'P=OP by c. In order to get such an equation, we need to express OP, OO' and O'P in terms of the travel time of one and the same light signal. This means that we need to relate them geometrically to the path of such a signal ($O'P_1$ in

Fig. 5). We name *time-axis* the direction orthogonal to $\mathbf{v}$. By applying the Pythagorean theorem to the right triangle OP_1O', we have

$$t^* = \beta t\_ \qquad (12)$$

Laying O'O and OP on the time-axis is straightforward. Similarly expressing O'P as the path of a light signal fails, in which case we must identify different geometry avoiding the dependence of O'P on O'Q/c.

Consider the diagram in Fig. 6, also with k and K in Ch. 5 (Sect. 1). Q, Q_1, and P(X), P(βX) as their projections, are fixed points relative to k. At time $t=0$, the origin of k and the light signal traveling to P(X) leave the origin O of the coordinate system at absolute rest K. At time T [(r/c)·cosα], they reach, respectively, O'_o and P(X). We lay the bottom diagram in Fig. 4 at O'_o on the time-axis $O'_oP'_1$ which means that we refer the motion of k to the coordinate system at absolute rest Ξ. For the reason leading to (12), from the right triangle $OP'_1O'_o$ we have

$$T = \beta t,\ X = cT = \beta ct = \beta x,\ OO'_o = vT = v\beta t. \qquad (13)$$

By Eqs. (4), (13) we further determine ξ and τ in terms of X and T. We get

$$\xi = \beta(X - vT),\ \eta = y,\ \zeta = z,\ \tau = \beta(T - vX/c^2). \qquad (14)$$

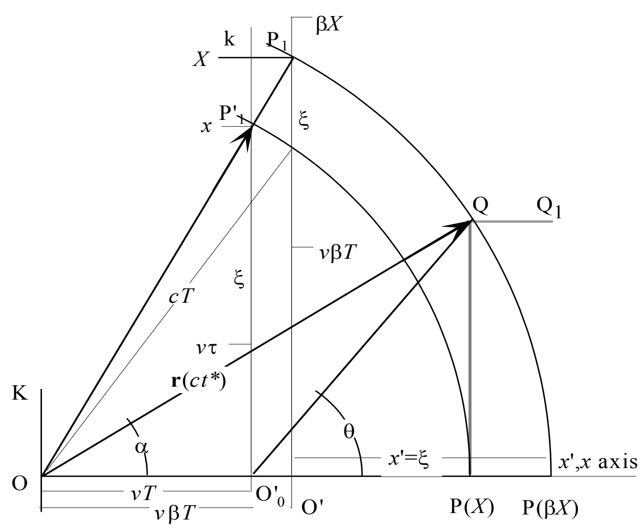

Figure 6.

Thus, by passing from Q to the geometrical point Q_1, we get rid of the dependence of the abscissa of P on the time O'_oQ/c. The abscissa of Q_1 relative to K is β times that of Q. It is ξ with respect to both k and Ξ: Since ξ is traveled by a light signal in time τ, the abscissa of Q_1 relative to k is also traveled in time τ.

Therefore, a time equation like that given by (11) follows immediately along the x',x axis, dividing by c the equation OO'+O'P(βX)=OP(βX). So we passed from Eq. (9) to one of type (11), adding Newtonian travel times as scalar quantities.

CHAPTER 8

COMPLEMENTARY TIME-DEPENDING COORDINATE TRANSFORMATIONS FOR GEOMETRICAL POINTS OFF THE OBSERVERS DIRECTION OF MOTION: GENERAL FORM

As a straightforward consequence of the graphical addition of travel times as scalar quantities (developed in Ch. 7), Eqs. (14) give, for any geometrical point P($x'.x$) and physical signal of speed υ, the set of equations

$$x' = \beta(x - vt),\ y' = y,\ z' = z,\ t = \beta(t - \upsilon x/v^2), \qquad (15)$$

with $\beta = (1-\upsilon^2/v^2)^{-1/2}$.

For Eqs. (15) to express a coordinate transformation, we must brake the equivalence of the first and the last of them. To this end, consider the Q's (implicitly their projections P) in Fig. 6 to move relative to the coordinate system k, which is also in uniform translatory motion relative to K. Identifying P with the origin of the coordinate system k, we are in the case pointed out in the last paragraph of Ch. 6 (Sect. 1.2). So, we pass from a description of the motion of Q relative to the inertial coordinate system k to one with respect to a coordinate system at absolute rest K_A associated to k just as it was associated to k_A in Ch. 6 (Sect. 1.1). By a diagram analogous to the last one in Fig. 3 and by the additional equation $x = wt$ analogous to that associated to Eqs. (3), we break the equivalence of the first and the fourth of Eqs. (15).

Thus, with the additional equation $x = wt$, Eqs. (15) give the general form of the 'complementary time-dependent coordinate transformations' due to the tracing of the radius vectors of moving geometrical points off the common x', x axis with physical signals. The term βx in Eqs. (15) is the Cartesian coordinate of a geometrical point associated to P($x'.x$) in consequence of the graphical addition of travel times as scalar quantities, βt is a Newtonian time -that in which the physical signal travels the coordinate βx -, while βvt is the Cartesian coordinate of another geometrical point -the origin of the inertial coordinate system.

CHAPTER 9

THE STANDARD LORENTZ TRANSFORMATION AS A COMPLEMENTARY TIME-DEPENDENT COORDINATE TRANSFORMATION

Tracing the radius vectors of moving geometrical points with light signals (as depicted in the diagrams in Figs. 5, 6), Eqs. (15), written for $v=c$, give the standard Lorentz transformation as a 'complementary time-dependent coordinate transformation'. As a 'complementary time-dependent coordinate transformation' connects finite Cartesian coordinates and Newtonian times, the standard Lorentz transformation connects evidently finite Cartesian coordinates[5] and Newtonian times (βx, βvt and βt, respectively) neither spatial and time intervals nor a coordinate (x) and a fictitious time (t) multiplied by a factor (β) of mysterious origin and physical meaning.

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5 Our derivation of the Lorentz transformation as a 'complementary time-dependent coordinate transformation' deny the claim in [6] that the Lorentz transformation would always connect "infinitesimals instead of finite" coordinates. For an observer attached to the origin of S′ (the equivalent of our k) in the diagram in [6], and tracing radius vectors by light signals, there is neither the claimed paradox nor the need that the Lorentz transformation to connect infinitesimals.

The derivation of the Lorentz transformation as a complementary time-dependent coordinate transformation validates our working hypotheses (see Ch. 3).

CHAPTER 10

OPERATIONAL DERIVATION OF THE VECTOR LORENTZ TRANSFORMATION

Consider the diagram in Fig. 7. The coordinate system k moves rectilinearly with constant speed v relative to the coordinate system at absolute rest K along the direction $\hat{\mathbf{v}} = \mathbf{v}/v$.

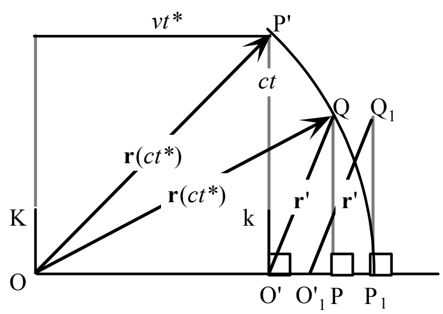

Figure 7.

A light signal traveling OP in time T is used, just like in Ch. 7 above (O'P' playing the role of time-axis) to remove the dependence of OP and O'P on t^* and O'Q/c, respectively. So we pass from Q and O' to Q_1 and O'_1 with $OP_1=\beta OP$ and $OO'_1=\beta OO'$. From the right triangles $O'_1Q_1P_1$ and OQP we have $\mathbf{r}'=\mathbf{Q}_1\mathbf{P}_1+\mathbf{O}'_1\mathbf{P}_1$ with $\mathbf{Q}_1\mathbf{P}_1=\mathbf{r}-(\mathbf{r}\cdot\hat{\mathbf{v}})\hat{\mathbf{v}}$ and $\mathbf{O}'_1\mathbf{P}_1=\mathbf{OP}_1-\mathbf{OO}'_1=\beta[(\mathbf{r}\cdot\hat{\mathbf{v}})\hat{\mathbf{v}}-\mathbf{v}T]$, that by noting, $t'=\mathbf{r}'\cdot\hat{\mathbf{v}}/c$ and $T=\mathbf{r}\cdot\hat{\mathbf{v}}/c$, provides the vector Lorentz transformation as

$$\mathbf{r}'=\mathbf{r}-(\mathbf{r}\cdot\hat{\mathbf{v}})\hat{\mathbf{v}}+\beta[(\mathbf{r}\cdot\hat{\mathbf{v}})\hat{\mathbf{v}}-\mathbf{v}T],\quad t'=\beta[T-\mathbf{r}\cdot\mathbf{v}/c^2]. \tag{16}$$

From a diagram analogous to that in Fig. 7, describing the rectilinear motion of constant speed $\mathbf{w}$ of a coordinate system k relative to the coordinate system at absolute rest K, we obtain analogously the vector Lorentz transformation

$$\mathbf{r}''=\mathbf{r}-(\mathbf{r}\cdot\hat{\mathbf{w}})\hat{\mathbf{w}}+\gamma[(\mathbf{r}\cdot\hat{\mathbf{w}})\hat{\mathbf{w}}-\mathbf{w}T],\quad t''=\gamma[T-\mathbf{r}\cdot\mathbf{w}/c^2], \tag{17}$$

where $\hat{\mathbf{w}}=\mathbf{w}/w$, $\gamma=1/\sqrt{1-w^2/c^2}$ and $T=\mathbf{r}\cdot\hat{\mathbf{w}}/c$.

The operational derivation of the vector Lorentz transformation validates our operational method

CHAPTER 11

OPERATIONAL APPROACH OF THE GROUP PROPERTIES

The main mathematical requirement for a set of coordinate transformations to form a group is that they to accomplish the transitivity property. This stipulates that, successively performed, any two of them engender an equivalent one; *i.e.* both collinear and non-collinear Lorentz transformations form a group. Proving this by the operational method developed in Chs. 7 to 9 requires tracing of radius vectors by light signals. Note that O'_{If} in Figs. 8 and 9 is the origin of the coordinate system at absolute rest K_A associated to k_A as in Ch. 6 (Sect. 1.1). Tracing $O'_{If}P_{IB}$ and $O'_{If}P_C$ in Figs. 8 and 9, respectively, one finds new transformations related to (16) and (17) and similar to them. The light signals will leave O'_{If} when O'_{If} and the origin of k_B in Fig. 8 (that of k'_B in Fig. 9) coincide. They will reach P_{IB} in Fig. 8 (P_{If}, P_C in Fig. 9) simultaneously with the light signal leaving O together with the origins of k_A and k_B, when the origin of k_B reaches O'_{IB} in Fig. 8 ($O'_{IB'}$, O'_{IB} in Fig. 9). As concerns the inverse transformation, it is associated with the motion with constant speed $-v$ of the origin of K from O' to O in Fig. 3 relative to the k now at absolute rest. It connects coordinates and times defining a different event. This because the coordinate system at absolute rest Ξ associated to the moving K by $\xi = \beta^2 x$ differs from that associated with the moving k by $\xi = \beta^2 x'$ [predicted by (25) in view of (24) and (3)].

11.1. For Collinear Lorentz Transformations

Consider the diagram in Fig. 8 for the collinear Lorentz transformations (16), (17). At $t = 0$ the coinciding origins of k_A, k_B and a light signal leave the origin O of the coordinate system at absolute rest K. The points O'_A, O'_B in Fig. 8 are reached by the origins of k_A, k_B, respectively, at time T, when the light signal reaches P(X). In accord with Ch. 6 (Sect. 1.1) above, the Lorentz transformations (16), (17) are written at the times βT and γT, respectively. The origin of k_A moves from O'_{IA} to O'_{If} in the time $\gamma T - \beta T$. Analogously to the motion of k relative to K_A in Ch. 6 (Sect. 1.1), we consider the motion of O'_{IB} in relation to O'_{If}. From Fig. 8 we have $\mathbf{r}'' = \mathbf{R} - \mathbf{O'}_{If}\mathbf{O'}_{IB}$ with

$$O'_{If}O'_{IB} = w\gamma T - v\gamma T, \ (\mathbf{R}\cdot\hat{\mathbf{w}}) = \gamma X - v\gamma T = \gamma(X - vT) = \gamma x'/\beta,$$

where x' is just ξ in (14), and

$$x'' = (\mathbf{r}''\cdot\hat{\mathbf{w}}) = \gamma x'/\beta - (w - v)\gamma T = \gamma x'/\beta - \gamma(w - v)\beta t' - \gamma(w - v)\beta v x'/c^2$$
$$= \gamma(x'/\beta)[1 - (w - v)v/(c^2 - v^2)] - \gamma\beta(w - v)t'$$
$$= \gamma\beta(1 - wv/c^2)x' - \gamma\beta(w - v)t'$$

where t' is just τ in (14).

With $\hat{\mathbf{u}}$ given by (4), $\hat{\mathbf{u}} = \mathbf{u}/u$, $\delta = 1/\sqrt{1 - u^2/c^2}$, and $\hat{\mathbf{v}}, \hat{\mathbf{w}}, \hat{\mathbf{u}}$ all parallel, the relationships

$$\gamma\beta(1 - wv/c^2) = \delta, \ \gamma\beta(w - v) = \delta u, \text{ and } \mathbf{r}'\cdot\hat{\mathbf{u}} = x' \quad (18)$$

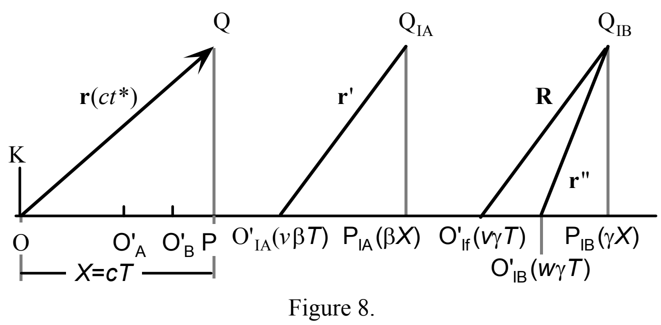

Figure 8.

follow. From the right triangle $O'_{IB}\,Q_{IB}\,P_{IB}$ and the right triangle $O'_{IA}\,Q_{IA}\,P_{IA}$ ($Q_{IA}P_{IA} = Q_{IB}P_{IB}$), we get the new vector Lorentz transformation

$$\mathbf{r}'' = \mathbf{r}' - (\mathbf{r}'\cdot\hat{\mathbf{u}})\hat{\mathbf{u}} + \delta[(\mathbf{r}'\cdot\hat{\mathbf{u}})\hat{\mathbf{u}} - \mathbf{u}t'], \ t'' = \delta[t' - \mathbf{r}'\cdot\mathbf{u}/c^2],$$

where $t' = \mathbf{r}'\cdot\hat{\mathbf{u}}/c$ and $t'' = \mathbf{r}''\cdot\hat{\mathbf{u}}/c$, which relates radius vectors of geometrical points relative to k_B and k_A. Thus the transitivity condition is proved for collinear Lorentz transformations. Therefore, they form a group.

So, together with the operational derivation of the vector Lorentz transformation, the proof that collinear Lorentz transformations form a group validate our operational method.

11.2. For Non-collinear Lorentz transformations

Consider the diagram in Fig. 9. At time $t=0$ the coordinate systems k_A and k_B, whose origins coincide with that of coordinate system at absolute rest K start moving along non-parallel directions with constant velocities $\mathbf{v}$ and $\mathbf{w}$, respectively. Also at time

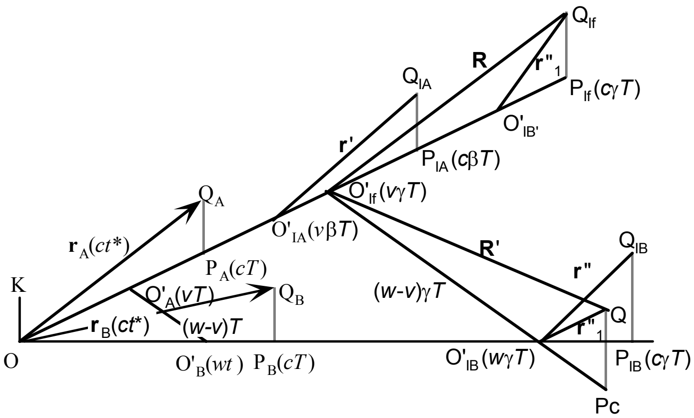

Figure 9.

$t=0$, light signals start traveling towards P_A and P_B, respectively.

To prove that the resulting non-collinear Lorentz transformations (16), (17) form a group, a light signal and a coordinate system parallel to k_B must move simultaneously at absolute speeds c and $|\mathbf{w}-\mathbf{v}|$ along $O'_AO'_B$ in the time T.

A new Lorentz transformation, in relation with (16) and (17) should follow. To this end, we further consider a coordinate system k'_B parallel to k_B which covers in the time T a distance equal to $OO'_A+O'_AO'_B$ along OP_A at a constant velocity $\mathbf{w}^*$. This coordinate system defines a coordinate system k''_B, also parallel to k_B. The origin of k''_B leaves O'_A at time $t=0$, and, moving with speed w^*-v, reaches O'_B at time T. So we pass from the relative speed $|\mathbf{w}-\mathbf{v}|$ to the relative speed w^*-v by $|\mathbf{w}-\mathbf{v}|\,T=(w^*\text{-}v)T$, and from the motion of k_B relative to k_A to one relative to the coordinate system at absolute rest K_A, associated to k_A by $(\mathbf{w}^*\text{-}\mathbf{v})T=(T\text{-}w^*vT/c^2)\,u\,\hat{\mathbf{u}}$ = with

$$u=(w^*-v)/(1-w^*v/c^2) \text{ and } \hat{\mathbf{u}} = (\mathbf{w}-\mathbf{v})/|\mathbf{w}-\mathbf{v}|.$$

Using

$$\mathbf{w}\text{-}\mathbf{v}=(w^*\text{-}v)\hat{\mathbf{u}}, \tag{19}$$

we have *the operational law of addition of non-parallel speeds*.[6]

At the times βT, γT the light signals that leave O simultaneously with k_A, k_B and k'_B reach, respectively, P_{IA} and P_{If}, P_{IB}. The origins of k_A and k_B arrive, respectively, at O'_{IA} and O'_{If}, O'_{IB}. In accord with Ch. 6 (Sect. 1.1), O'_{If} is the origin of the coordinate system at absolute rest K_A at time γT. By the above definition of k'_B and k''_B, the origin

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[6] This law has no physical grounding in common with the standard relativistic formula of addition of non-parallel speeds [7] -which predicted the famous, but contested [8] Thomas precession [9]. For the sake of mathematical generality, Thomas missed the physical meaning of the Lorentz transformation by the translation he associated to the vector Lorentz transformation [9]. It was under such condition that the usual matrix multiplication he used to made no physical sense.

of k'$_B$ finds at time γT at a distance equal to O'$_{If}$O'$_{IB}$ from O'$_{If}$ along OP$_{If}$, namely at O'$_{IB'}$ in Fig. 9. The light signals leaving O'$_{If}$ simultaneously with the origins of k'$_B$ and k"$_B$ will travel equal distances along the directions of motion of k'$_B$ and k"$_B$, *viz*. O'$_{If}$P$_{If}$=O'$_{If}$P$_C$. Since O'$_{If}$P$_{If}$ is the projection of $\mathbf{R}$ onto the direction of $\mathbf{v}$, O'$_{If}$P$_C$ will be the projection of the radius vector $\mathbf{R'}$ of magnitude R that makes with $\hat{\mathbf{u}}$ an angle equal to that $\mathbf{R}$ makes with $\mathbf{v}$. From O'$_{If}$P$_{If}$=$\mathbf{R}\cdot\hat{\mathbf{v}} = \gamma(\mathbf{r}\cdot\hat{\mathbf{v}} - vT)$ and an equation resulting from the first of Eqs. (16), $\mathbf{r'}\cdot\hat{\mathbf{v}} = \beta(\mathbf{r}\cdot\hat{\mathbf{v}} - vT)$, we have $\mathbf{R}\cdot\hat{\mathbf{v}} = (\gamma/\beta)\mathbf{r'}\cdot\hat{\mathbf{v}}$ with

$$(\mathbf{R}\cdot\hat{\mathbf{v}})\hat{\mathbf{u}} = (\gamma/\beta)(\mathbf{r'}\cdot\hat{\mathbf{v}})\hat{\mathbf{u}}\,. \qquad (20)$$

By inserting (20), the inverse of the last of Eqs. (16), and Eq. (19) into $(\mathbf{R}\cdot\hat{\mathbf{v}})\hat{\mathbf{u}} - \mathbf{u'}\gamma T$, we obtain:

$$\begin{aligned}
&(\mathbf{R}\cdot\hat{\mathbf{v}})\hat{\mathbf{u}} - (\mathbf{w}-\mathbf{v})\gamma T \\
&= \frac{\gamma}{\beta}(\mathbf{r'}\cdot\hat{\mathbf{v}})\hat{\mathbf{u}} - \hat{\mathbf{u}}(w^*-v)\gamma\beta t' - \frac{1}{c^2}\hat{\mathbf{u}}(w^*-v)\gamma\beta v(\mathbf{r'}\cdot\hat{\mathbf{v}}) \\
&= \frac{\gamma}{\beta}(\mathbf{r'}\cdot\hat{\mathbf{v}})\hat{\mathbf{u}}[1-(w^*-v)v/(c^2-v^2)] - \hat{\mathbf{u}}(w^*-v)\gamma\beta t' \\
&= \gamma\beta(1-wv/c^2)(\mathbf{r'}.\hat{\mathbf{v}})\hat{\mathbf{u}} - \hat{\mathbf{u}}(w^*-v)\gamma\beta t'
\end{aligned}$$

In view of Eqs. (20), also valid for w^*, we have:

$$\mathbf{O'}_{IB}\mathbf{P}_C = (\mathbf{R}\cdot\hat{\mathbf{v}})\hat{\mathbf{u}} - (\mathbf{w}-\mathbf{v})\gamma T = \delta[(\mathbf{r'}\cdot\hat{\mathbf{v}}) - ut']\hat{\mathbf{u}} = \delta[(\mathbf{r'}\cdot\hat{\mathbf{u}})\hat{\mathbf{u}} - \mathbf{u}t'].$$

Because Q$_{If}$P$_{If}$ = Q$_{IB}$P$_{IB}$ = QP$_C$ by virtue of Q$_A$P$_A$=Q$_B$P$_B$, and $|\mathbf{r}''_1| = |\mathbf{O'}_{IB'}\mathbf{Q}_{If}| = |\mathbf{O'}_{IB}\mathbf{Q}|$ with **O'$_{IB}$Q**=**QP$_C$**+**O'$_{IB}$P$_C$**, we have **QP$_C$**= $\mathbf{r'} - (\mathbf{r'}\cdot\hat{\mathbf{u}})\hat{\mathbf{u}}$ and

$$\mathbf{r}''_1 = \mathbf{r'} - (\mathbf{r'}\cdot\hat{\mathbf{u}})\hat{\mathbf{u}} + \delta\,[(\mathbf{r'}\cdot\hat{\mathbf{u}})\hat{\mathbf{u}} - \mathbf{u}t'],\ t'' = \delta[t' - \mathbf{r'}\cdot\mathbf{u}/c^2], \qquad (21)$$

where $t'' = \mathbf{r}''_1\cdot\hat{\mathbf{u}}/c = \mathbf{r}''_1\cdot\hat{\mathbf{w}}/c$. The resulting vector Lorentz transformation (21) proves that the non-collinear Lorentz transformations satisfy the transitivity property. Hence they form a group without requiring rotations of inertial coordinate systems in this aim.

This result validates the Lorentz transformation itself.

CHAPTER 12

APPLYING THE DERIVATION OF THE LORENTZ TRANSFORMATION AS A COMPLEMENTARY TIME-DEPENDENT COORDINATE TRANSFORMATION TO EINSTEIN'S SPECIAL RELATIVITY THEORY

We here apply to special relativity theory our derivation of the Lorentz transformation as a complementary time-dependent coordinate transformation[7]. We get i) the objective reality warranting Einstein's decisions to manipulate some equations that led to the standard Lorentz transformation in [1] -which proves the correctness of that derivation of the Lorentz transformation, ii) that the terms βx and βt in the standard Lorentz transformation are, respectively, the abscissa of a geometrical point and the Newtonian time in which a light signal travels that abscissa -which, by removing the mysterious origin of β, validates the principle of the physical determination of equations in Einstein's special relativity theory, and iii) the essential role played by revelation in the act of science. All these issues should be deeply joined together for a true foundation and development of modern physics. Ignoring subjective incongruence in understanding and interconnecting these issues gave rise to, and maintained the crisis of modern physics, which strongly altered the progress of the mankind.

CHAPTER 13

OUTLINE OF EINSTEIN'S 1905 DERIVATION OF THE STANDARD LORENTZ TRANSFORMATION

In his 1905 paper on relativity ([1], Sect. I.1) Einstein deduced the Lorentz transformation in view of the Gedanken experiment depicted in the upper diagram in Fig. 10[8], by manipulating three equations with no physical justification. So he defined identical clocks working in synchrony at points O', P "of space", *i.e.* at absolute rest, by the equation

$$\tau_0 + \tau'_0 = 2\tau_P, \qquad (22)$$

where τ_0, τ'_0 and τ_P are, respectively, times associated to the emission/arrival of a light signal at O', and its reflection at P. Then, disregarding that both the light signals and the reference frames travel through empty space independently, extrapolated the the validity of Eq. (22) to define inertial synchronous clocks attached to O' and P in the "stationary" coordinate system k (the first manipulation). From the upper diagram in Fig. 10 (with k and K in Ch. 6 (Sect. 1)), which differs from the upper one in Fig. 4 in that the signal was

[7] Our derivation of the Lorentz transformation followed a way independent of special relativity theory. We searched for a class of coordinate transformations which to prove if the weak gravitational waves are physical entities or not [10-14] (see also Ch. 22 (Sect. 3)). An application of our results to special relativity theory became evident examining the understanding of Einstein's derivation of the Lorentz transformation [15-27].

[8] The upper diagram in Fig. 10 needs some details. For Einstein, K and k were inertial coordinate systems and v was a relative speed. For us, by virtue of the result in Ch. 6 (Sect. 1) that any uniform rectilinear motion relative to an inertial observer is graphically described with respect to an 'abstract' coordinate system at absolute rest (Ch. 4 (Sect. 1.1)), K is an 'abstract' coordinate system at absolute rest and v is an absolute quantity (as defined in Ch. 6 (Sect. 1)). k and the light signals perform independent motions in empty space. As origins of light signals, O'_o and O'_P are points of space, hence at absolute rest. The part of the diagram to the right of O'_o is just the upper diagram in Fig. 4.

emitted at time t when k and K didnot coincide, he defined and calculated τ (like time of k) in terms of the time t of K, and the coordinates of a point having P as projection. He inserted the times $\tau_0 = \tau(0,0,0,t)$ associated to the emission of a light signal at O'$_o$, $\tau_P=\tau[x',0,0,t+x'/(c-v)]$ associated to reflection at P, and $\tau'_0 = \tau[0,0,0,t+x'/(c-v)+x'/(c+v)]$ associated to its arrival at O'$_2$, where O'$_o$ to O'$_2$ are successive positions of the origin O' of k along the common x', x axis, in Eq. (22) and obtained for infinitesimally small x' the differential equation

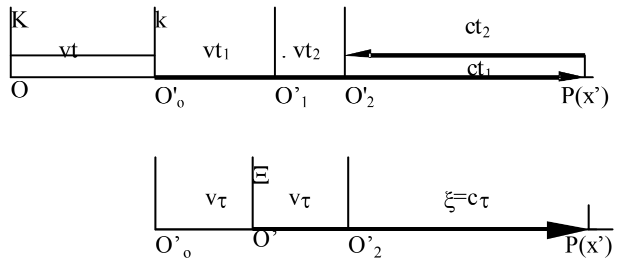

Figure 10.

$$\partial\tau/\partial x' + [v/(c^2-v^2)]\partial\tau/\partial t = 0.$$

Integrating this equation, he obtained

$$\tau = a[t - vx'/(c^2-v^2)], \tag{23}$$

with $a = \phi(v) = 1$ ([1] , Sect. I.3 for calculation details), and put

$$\zeta = c\tau. \tag{24}$$

Accepting Eq. (1), Eqs. (23), (24) predicted a set of equations linear in β^2 identical with Eqs. (8) (which Einstein didnot write down explicitly). The dropping of the square of β in Eqs. (8) with no justification[9] was the second manipulation. It is true of Eqs. (8), as well as of their counterparts linear in β, that the last one is the time-equivalent of the first one. Einstein did not point out this equivalence, or the way to break this equivalence for turning the linear equations in β into the Lorentz transformation. But he further added the equation $x = wt$ to the linear equations in β in order to deduce… the "addition theorem for speeds" ([1], Sect. I.5) (the third manipulation). The physical grounds of the three manipulations of equations, so their correctness, we disclose in the next chapter.

CHAPTER 14

PHYSICS WARRANTING THE MANIPULATIONS OF EQUATIONS THAT LED EINSTEIN TO THE LORENTZ TRANSFORMATION IN [1]

14. 1. Proof for Abstract Coordinate Systems at Absolute Rest in Einstein's Special Relativity Theory

Since the upper diagram in Fig. 10 is just the upper diagram in Fig. 4 shifted right by a distance vt, equations identical with Eqs. (4) to (7), with t, t_1 changed to t_1, t_2, $t_1=\tau_P$-

[9] Prokhovnik claimed in [28] that Einstein had included a β factor in Eqs. (8) in the function $\Psi(v) = \beta\phi(v)$. However, there is no function $\Psi(v)$ in [1]. Moreover, it is evident that Einstein did not include a β factor in $\phi(v)$, given that the $\phi(v)$ appearing in the equations linear in β that he finally wrote in [1] is just that which he formerly associated with Eq. (23).

τ_0, $t_2=\tau'_0-\tau_P$, and τ_0, τ_P, τ'_0 in Ch. 13, follow. There becomes evident that Eq. (23) does not prove that the identical synchronous clocks attached to k and K would run at different rates and measure different times. Just like in Ch. 6 (Sect. 2), the coordinate system at absolute rest Ξ, depicted in the bottom diagram in Fig. 10 is associated by Eq. (23) to the inertial coordinate system k. What the inertial synchronous clocks attached to O' and P in the bottom diagram of Fig. 10 measure (by Eq. (22) and the equation O'P+PO'=$2c\tau$) is the time τ of Ξ (while those attached to O, O'(O'$_o$, O'$_1$, O'$_2$) and P(x') in K measure the time of K). So *nothing has supported Einstein's fundamental claim that identical clocks in inertial reference frames in relative motion would run at different rates.* This claim, (like that the inertial meter-sticks would change their length) was misleading to understand special relativity theory. Einstein failed to see that, by extrapolating Eq. (22), has actually associated both 'abstract' coordinate systems at absolute rest and professionals to the inertial coordinate systems in the special relativity theory. He also failed to see that (as we pointed out in Ch. 15) his formulation of the light-speed principle in [1] (Sect. I.1) was actually done in relation to coordinate systems at absolute rest. The coordinates ξ,η,ζ in [1] were actually defined with respect to the coordinate systems at absolute rest Ξ.

14. 2. Proof of the Correctness of Einstein's 1905 Derivation of the Lorentz transformation

Behind Einstein's dropping of the square of β in Eqs. (8) lies the graphical addition of travel times like scalar quantities for non-parallel light signals (investigated in Ch. 7), a subtlety that escaped to him (however, he traced by light signals only abscissas of geometrical points, complying with its main requirement). Without the diagram in Fig. 6 for points out of x' axis, Einstein failed in understanding βx and βt as Cartesian coordinate and Newtonian time, respectively. Thus βx and βt were conceived, respectively, as a coordinate and a time multiplied by a mysterious factor β , which led to the famous FitzGerald- Lorentz contraction and time dilation. The last paragraph in Ch. 5 (Sect. 1) proves that the true role of the equation $x = wt$, imposed by Einstein, was to remove the equivalence of the first and the fourth of Eqs. (15) in order to turn them into a coordinate transformation. These physical grounds for Einstein's firm mathematical decisions prove the correctness of his derivation of the Lorentz transformation in [1] and (as shown in Ch. 20) their revealed nature. Their disclosure, in view of our derivation of the Lorentz transformation as a complementary time-dependent coordinate transformation (Ch. 9), validates our working hypotheses (Ch. 3).

CHAPTER 15

LENGTH CONTRACTION, TIME DILATION AND TWIN PARADOX

Understanding the terms x', βx and t', βt in the Lorentz transformation as, respectively, Cartesian coordinates and Newtonian times discloses that the FitzGerald-Lorentz contraction and the time dilation are not true physical predictions of the special relativity theory (recall that the tracing of x' and βx with light signals was required by the addition of travel times and scalar quantities (Ch. 7)). One can, of course, presume the intervals Δx', Δt', and associate $\Delta x'=0$, $\Delta t'=0$ with, respectively, measurements of times and lengths in a coordinate system in uniform rectilinear motion with respect to an observer but the writing of $\Delta(\beta x)$ and $\Delta(\beta t)$ as $\beta\,(\Delta x)$ and $\beta\,(\Delta t)$ (mathematically valid) is physically meaningless because

$$\Delta(\beta x)=(\beta x)_2-(\beta x)_1,$$

where $(\beta x)_1$ and $(\beta x)_2$ are abscissas of different geometrical points. As an additional remark, by involving the time τ of Ξ, Eq. (23) never supported Einstein's hypothesis that identical clocks in inertial reference frames in relative motion would run at different rates and measure different times. The FitzGerald-Lorentz contraction was never proved experimentally. The claimed experimental proof of the time dilation was not sustained [29]. What it was really proved experimentally was the increased lifetime of the relativistic particles with respect to identical rest particles. But, in view of Ch. 28, this result originates exclusively in relativistic mass as internal coupling constant: a larger speed involves a larger β, hence a larger relativistic mass, i.e., internal coupling constant, and a larger lifetime. Consequently, the twin paradox was just nonsense.

CHAPTER 16

LIGHT-SPEED PRINCIPLE

Einstein's assertion [1] that "The totality of physical phenomena is of such a character that it gives no basis for the introduction of the concept of 'absolute motion'" is contradicted by the result we just obtained in Ch. 14 (Sect. 1). We see that the simultaneous and independent motion of the line segment O'P in Fig. 4 along the x axis as a part of k alters the equality of the paths of the light signal from the origin of k to P(x') (O'$_o$P) and back to the origin of k (PO'$_2$), stipulated by the light-speed principle. It does not matter that isolated inertial observers are not aware of this alteration. It is their assumed lack of knowledge on the relative motion responsible for this fact. The experiment just proposed to determine absolute speeds proves it: For O'$_o$P to equate PO'$_2$, the light signal should have been made of elastic balls rolling *on* a surface embodying the $x'x$ axis from the origin of k to P(x') and back to the origin of k, which is not the case. Therefore, the light-speed principle was stated in relation to the coordinate system at absolute rest associated to the inertial coordinate system of the observer in Ch. 6 (Sect. 1). A glance at the ratio (light path)/(time interval) -defining the "fixed speed" of light with respect to "stationary" reference frames by the light-speed principle ([1], Sect. I.2)- strengthens the conclusion because -as just explained above- the end points of the path are points of space, hence at absolute rest. The rigor of the special relativity theory was assured just by his revealed hidden formulation of the light-speed principle, which tacitly imposed abstract coordinate systems at absolute rest to the inertial observers. In view of this result, as well as of those obtained in Ch. 6 (Sect's. 1, 2) and Ch. 17, Einstein's queer aversion for 'absolute motion' and coordinate systems at absolute rest was baseless and misleading.

CHAPTER 17

EXPERIMENTAL DETERMINATION OF ABSOLUTE SPEEDS IN EINSTEIN'S SPECIAL RELATIVITY THEORY

The absolute speeds of the bodies, sliding/rolling uniformly and rectilinearly along *the surface of a physical substratum* at rest in the reference frames of the Newtonian observers, are determined by measuring the quantities which define them ((covered distance)/(time interval)) with meter-sticks and clocks, complying with the working hypotheses in Ch. 3. Since light travels through empty space , and a universal immovable physical substratum could not be identified in nature, physicists claimed (instead of searching for an alternative experimental determination of the absolute speeds) that "*terms such as 'absolute rest' and 'absolute speed' are completely foreign and unacceptable to physics*" [2], with bandy impact.

That 'abstract' coordinate systems at absolute rest (defined in Ch. 4 (Sect. 1.1)) are proper to physics, we proved in Ch. 6. That such coordinate systems are also proper to Einstein's special relativity theory, we proved in Ch. 14 (Sect. 1). So the claim that "absolute rest is completely foreign and unacceptable to physics" is wrong. The experiment thought by Einstein to deduce the standard Lorentz transformation in [1] (Sect. I.3) also proves that the same claim is wrong when concerns the absolute speed. The upper diagram in Fig. 10 reduces to the upper diagram in Fig. 4. Eqs. (4) predict the absolute speeds

$$v = x'(t - t_1)/2tt_1 \text{ and } c = x'(t + t_1)/2tt_1. \quad (25)$$

So, unlike the innocent Newtonian observers, professionals (defined in Ch. 6) can -by means of their additional ability of representing graphically hypothetical relative motions and measuring travel times of light signals traveling to and fro *through empty space*- determine their absolute speeds and that of light, independently of any physical substratum, namely in terms of light travel times. To do it, each of them has to emit to P(x') at time $t = 0$ a light signal which origin, as a point of space (hence at absolute rest), defines the origin of an 'unseen' coordinate system at absolute rest K, coinciding with his k. When the measured times t, t_1 are equal, $v = 0$ and the light speed in empty space is just x'/t. The experiment must be repeated along other directions until v in (25) takes a maximum value. That value defines the absolute speed of k (of the observer), while the path of the suitable light signal determines its direction of motion. So the claim that the inertial observers cannot do any experiment which would distinguish being at rest from moving uniformly and rectilinearly is merely *false*.

Concerning the assertion that equation $x=ct$ would express a law of physics, equally right with respect to any inertial coordinate system by the principle of relativity, it makes sense *only* by recognizing the absolute speed in physics and the observer's ability to determine c independently of any physical substratum (both proved). This because *'equation' x=ct is just a different writing down of the Newtonian definition of absolute speed applied to light.* So long as the absolute speed *is "completely foreign and unacceptable to physics*", 'equation' $x=ct$ makes no sense (Einstein should discard the Newtonian manner to determine absolute speeds experimentally, not the concept of absolute speed). So long as the inertial observers cannot determine c experimentally in their reference frames, 'equation' $x=ct$ also makes no sense. Consequently, 'equation' $x=ct$ couldnot support Einstein's formulation of the light-speed principle in [1] (Sect. I.2), as it is usually claimed: the light speed is c exclusively with respect to empty space and coordinate systems at absolute rest, not with respect to inertial coordinate systems.

Concerning the relative light speeds $c \pm v$ are not true speeds, we show in view of the second diagram in Fig. 1. First presume that k is attached to an object M_2 moving rectilinearly with constant speed v_2 on the plane surface of another object M_1 (having K_1 attached), along the constant speed v_1 of M_1 or oppositely. The relative speeds $v_1 \pm v_2$ are true physical quantities: They appear as true speeds of M_2 in both its kinetic energy and linear momentum. Imagine that M_1, M_2 are moving rectilinearly, uniformly, simultaneously and independently in vacuum at speeds V_1 and $\pm V_2$, respectively. This time the relative speeds $V_1 \pm V_2$ are not true physical quantities: They do not appear as true speeds of an object. They manifest physically by transfer of linear momentum when the two bodies collide each other. The last is the case with the quantities $c \pm v$, appearing by the factorization mathematically required to resolve Eqs. (4) in terms of t, t_1, respectively: the simultaneous parallel motions, that of the light signal traveling in empty space between O'_o and $P(x')$, and that of k from O'_o to O'_1, are fully independent.

CHAPTER 18

MINKOWSKI SPACE-TIME AND SPACETIME

The mixture of spatial coordinates and Newtonian times in the Lorentz transformation originated in tracing by light the radius vectors of the geometrical points in uniform rectilinear motion with respect to inertial observers. The metric $ds^2=\eta_{\mu\nu}dx^{\mu}dx^{\nu}$, where $\eta_{\mu\nu}$ is the metric tensor and μ,ν=0-3, is just the result of this operational mixture of spatial coordinates and times. Defined by this metric, the Minkowski four-dimensional space-time has an operational nature, not a physical one. It means Euclidian three-dimensional space (Newtonian space) plus Newtonian time. Our derivation of βx and βt in the standard Lorentz transformation like Cartesian coordinate and Newtonian time (Ch. 9) shows that Einstein did not actually develop "a new view of space and time, now called the special theory of relativity", as it is claimed [30]: there is no true physical length contraction, no true physical time dilation, no true twin paradox, no conflict with Newton's view of space and time.

Newtonian concepts of space and time are kept unaltered in Einstein's theory, in deep agreement with everyday experience and common sense. They are independent of whether anything is in the universe or not and of what happens inside the universe. Minkowski space-time has no connection with the spacetime (sometimes also written as space-time) claimed to be a physical entity causing physical effects [31]: The spacetime is just a concept having no physical grounding and no physical effect. With this remark, the special relativity theory contributes to a unified theory of elementary particle interaction. The trend to describe the whole universe, including the microcosm, in terms of geometry of an unphysical spacetime and its 'quantum' nature dominates [31-34], against its striking failure [35].

CHAPTER 19

THE VALIDATION OF THE PRINCIPLE OF THE PHYSICAL DETERMINATION OF EQUATIONS IN EINSTEIN'S SPECIAL RELATIVITY THEORY

Applying the complementary time-dependent coordinate transformations to special relativity theory by the derivation of the Lorentz transformation as such a transformation, we proved not only the correctness of the derivation of the Lorentz transformation in [1] (Ch. 14 (Sect. 2)), but also that the terms βx and βt of the Lorentz transformation are actually Cartesian coordinate and Newtonian time. So, after βx and

βt past -for a century- for a coordinate x and a fictitious time t multiplied by the factor β of unknown origin and physical meaning, we removed by our derivation of the Lorentz transformation as a complementary time-dependent coordinate transformation the mystery on β. So all the terms of the equations constituting the Lorentz transformation get clear physical meaning now. Since these equations were the only ones in the special relativity theory with some terms without known physical meaning, our result validates the principle of the physical determination of equations in the special relativity theory: x' in the Lorentz transformation is, like x' in the Galileo transformation, a difference of Cartesian coordinates (by Ch. 9), while t' is a difference of Newtonian times. Recall that passing from a geometrical point of abscissa x to one of abscissa βx was required by the graphical addition of travel times as scalar quantities (Ch. 7).

The importance of the principle of the physical determination of equations for the advancement of physics consists in the physical information to be disclosed from the terms of the underlying equations in theories already built, or required to be in the terms of the underlying equations of the theories to be built.

CHAPTER 20

REVELATION'S ROLE IN THE ACT OF SCIENCE

A successful trend of both science and secularization accredited the idea that science and divine work would be antinomies. Physicists supported this idea by *a fortiori* interpreting failures of the theoretical work as natural steps toward the truth, so disregarding -against the evidences- the century-old crisis of physics.

No role is granted to revelation (as disclosure by God) in the act of science. A definition of revelation free from any suggestion that God has anything to do with the creative insight was put forward as "a sudden, creative coming together of several previously unconnected lines of reasoning which are combined in a new synthesis" (English dictionary). When faced up to the "incomprehensible" successful work of some among them, "who did not seem to be reasoning at all but who jumped over all intermediate steps to a new insight about nature" [36], physicists confined to name them "magicians", and 'felt' "compelled to redo the work of the magicians so that they seem like sages" [36] ("sages" are those physicists who "reason in an orderly way about physical problems on the basis of fundamental ideas of the way that nature ought to be" [37]). They claimed that "otherwise no reader would understand the physics" [36]. Then they established a 'prophylactic' editorial quarantine against new "magicians" (see Ch. 43).

This is the mainstream in modern physics. In despite its strategy, the crisis is evolving. It means that something is wrong with this strategy. Whether discarding any role to revelation in the act of science seemed to be a natural attitude when physics emancipated as science by measurements and elementary mathematics, it became questionable when syntheses of experimental data, novel ideas and advanced mathematics faced physics. To resolve the dilemma, a question is essential to be answered: Whether revelation (as disclosure by God) would play indeed a role in the act of science, could its mark be identified in the valuable works of the physicists denying its role, or just believing (like Einstein) that a revealed knowledge cannot be rationalized?

To this end, let us consider the derivation of the Lorentz transformation in [1]. By a deep insight into this derivation (Ch. 14), we conclude that Einstein was playing the role of a magician -the most important:

First, he “jumped over all intermediate steps” -consisting in the physical motivations of the manipulations of equations that led to the Lorentz transformation in [1] (see Ch. 13). It was by deducing the complementary time-dependent coordinate transformations (Chs. 2 to 8), and the Lorentz transformation as such a coordinate transformation (Ch. 9) that we identified the objective reality warranting the manipulations of equations (Ch. 14 (Sect. 2)). It was the tracing of radius vectors by light signals. Hence, in despite their strong appearance of mathematical tricks, the manipulations were not tricks at all. The derivation of the Lorentz transformation in [1] was correct.

Second, he “did not seem to be reasoning at all”. He discarded the concepts of absolute rest and absolute motion but described in detail a thought experiment which seems to be the only one enabling the ’blind’ inertial observers to determine absolute speeds in their reference frames (see Ch. 17). He proposed the experiment for deducing the Lorentz transformation in the idea that identical inertial clocks would run at rates depending on their speed (see Ch. 13). But, because he did not realize the role played by the light signals in this experiment, needed to manipulate some equations to this end. Unfortunately, he did not investigate further the diagram describing the experiment (the upper diagram in Fig. 10) to see that this diagram actually validated (see footnote 7 and Ch. 14 (Sect. 1)) the ’abstract’ coordinate systems at absolute rest (defined in Ch. 4 (Sect. 1.1)) in special relativity theory. There becomes evident that Einstein was not aware that i) by light signals has specified the time-changing magnitude and direction of the radius vectors of geometrical points moving with respect to inertial observers (which should lead him to the Lorentz transformation as a complementary time-dependent coordinate transformation) but he used light signals, ii) the graphical addition of travel times as scalar quantities (developed in Ch. 7) needed be developed in his theory but he worked only with light signals tracing abscissas of geometrical points and dropped the square of β in his equations linear in β^2, according to the graphical addition of travel times as scalar quantities, iii) the equation $x = wt$ assured the independence of the linear equations in β (making them a coordinate transformation) but he took into account this equation in order to obtain... the “addition theorem for speeds” ([1], Sect. I.5) (see Ch. 16) and iv) the coordinate system at absolute rest playes an essential role in his theory but he compensated its lack by consecrating a version of the light-speed principle ([1] (Sect. I.2)) (see Ch. 16) which saved his theory from the inconsistencies raised by the arbitrary removal of the coordinate system at absolute rest.

It is as if Einstein reconstituted by flashes in [1] a paper on the derivation of the Lorentz transformation as a complementary time-dependent coordinate transformation that pre-existed in his subconscious. The correctness of all the manipulations of equations (the clue of [1]) supports the revealed nature of the original paper. The lack of their physical motivation shows that Einstein turned into rational knowledge only pieces of the revealed knowledge. That is why he never became aware of the correctness of the derivation of the Lorentz transformation in [1], and, fatally, developed special relativity theory without the derivation of the Lorentz transformation in [1].

Einstein’s derivation of the Lorentz transformation in [1], and his later disregarding of it are the most striking proof that revelation plays an essential role in the act of science. Once we identified the mark of revelation in [1], it is (more or less) identifiable in the valuable work of any physicist. Unfortunately, when it happened, the identification of the mark of revelation was not followed by a rationale of the work. The ”jumps over the intermediate steps” of the authors were not filled with the missed information. The work identified as revealed (like [1]) became thereafter *unalterable*, of *eternal value*, completely foreign to the advancement of physics. The identification of the mark of revelation by authors themselves depends on their attitude toward revelation (see also [37-39]). The disclosing of the revelation role in the act of science allows physicists to take rational decisions which strongly disturb their revealed knowledge. So are raised the “jumps over intermediate steps” -particularly of explanatory nature- in their work, loosings and distortedly perceivings of esential physical information. The crisis of modern physics is the result of disregarding all these evidences. It is the unseen, dark face of the secularization. So fundamental for the eradication of this crisis is the physicists’ acception that revelation playes certainly the key role in the act of science.

Far -by his development of special relativity theory without the derivation of the Lorentz transformation in [1], and the foundation of modern physics on special relativity theory- Einstein was the main contributor to the crisis of modern physics. Other key contributors were the great physicists P.A.M. Dirac and B.L. van der Waerden (who disregarded revelation). Both they missed the subquantum information embedded in Dirac’s equation. Like Einstein, they failed in rendering conscious the whole information revealed them through their subconscious (*humans touch divine through subconscious*). Their work stands for proof (Chs. 28, 32) that they couldnot provide a complete rationale for the revealed knowledge. They, like all the “magician-physicists”, behaved as if have had accessed intermittently a superhuman database.

As to the impact of the missed revealed knowledge on the human progress, let us examine the consequences of the works of Einstein, Dirac and der Waerden if they gave a complete rationale in them. Most important, Einstein should obtain the terms of the Lorentz transformation as Cartesian coordinates and Newtonian times. There has been evident the lack of any conflict between his special relativity theory and the Newtonian mechanics. The principle of the physical determination of equations worked successfully in both theories. There has been no mental alienation by the famous time dilation and twin paradox. The validation of the principle of the physical determination of equations in modern theories concerning the quantum and subquantum structure of matter through the relativistic energy-momentum relationship should follow. Dirac and der Waerden should obtain genuine subquantum information. The application of this information (disclosed further in this book (Chs. 28 to 32)) to radically new technologies should happen as early as by the 1940’s. All these give the real dimension of the impact which the missed and distortedly perceived revealed knowledge had (still has) upon the advancement of physics, finally upon the progress of the mankind.

However, decoding the revealed knowledge is not so easy. Einstein’s failure in providing a rationale for the derivation of the Lorentz transformation in [1] points to the existence of some hardly to identify but easily ’deletable’ passwords for accessing the understanding of a revealed knowledge. The concepts of absolute rest and absolute speed prove to have been such ’passwords’. These ’paswords’ were ’deleted’ neither by

Einstein's followers nor by Einstein after ending special relativity theory but by Einstein in the preamble of his original paper on relativity [1], when stated that "no properties of phenomena attach to the idea of absolute rest". So that an undisturbed conversion of a revealed knowledge into a rational one is assured by a careful search for hidden passwords and a careful choise of decisions. Discarding or disregarding the role plaid by revelation in the act of science, so these requirements, substantially affects physicists' performance. Breaking (like individuals) the atheistic mentality (beneficiary of a formidable logistics), as well as the mentality that revealed knowledge cannot be turned into rational knowledge is needed to this end.

The rationale which we give for the first time to a revealed knowledge has also main religious impact. There becomes evident that by disclosing a rationale is substantially enriched our rational knowledge. This conclusion suggests that the Ten Commandments should also prepare people for accessing revealed knowledge benefic to the material progress of the mankind. Completely foreign to religion, the slogan "Do not search, believe!" has strongly distorted this mission. The claimed common successful trend of both science and secularization is based on a false -the hiding of the one century-old crisis of modern physics, against its just pointed out effects. The Malraux's revealed assertion "The 21st century will be a religious one or will not exist at all" becomes meaningful.

CHAPTER 21

THE CRISIS OF MODERN PHYSICS: HYPERMATEMATIZATION VS LITTLE PHYSICAL INFORMATION

Einstein's foundation of the special relativity theory on his 1905 paper on relativity bar the derivation of the Lorentz transformation in that paper strongly altered the physical grounds of both the special relativity theory and the relativistic physics, and so the development of modern physics. Although mathematically equivalent, the various derivations of an equation are not physically equivalent at all. The whole physical information embedded in the terms of the Lorentz transformation is exclusively provided by its operational derivation as a complementary time-dependent coordinate transformation. This information was hidden in Einstein's 1905 derivation of the Lorentz transformation, and did not exist at all in any other derivation of the Lorentz transformation. The meaning of Cartesian coordinate and Newtonian time of the terms βx and βt of the Lorentz transformation, disclosed by its operational derivation, validates the principle of the physical determination of equations in Einstein's special relativity theory. In lack of this principle, the special relativity theory developed by Einstein without the derivation of the Lorentz transformation in [1] was a mathematical structure filled deliberately with hypothetical contents having little or nothing in common with the objective reality. This theory worked well due to the coincidence of the denominators in the Lorentz transformation and the relativistic mass, but allowed predicting the famous time dilation and the metaphysical speculations on time, as well as passing from the Minkowski space-time to the spacetime (space-time) assumed to be a physical entity giving rise to physical effects [31-34].

Founding modern physics on Einstein's special relativity theory at the time the principle of the physical determination of equations was not validated in this theory also invalidated the principle in modern physics. All restraints required by this principle were off. Hypermatization flourished by redundancies of equations and mathematical theories having little in common with objective realities, while large amounts of physical information remained undisclosed in the terms of the true underlying equations. Ignoring revelation's role in the act of science, and "redoing" the revealed work of the "magician-physicists" also contributed to the crisis of modern physics. Corruption (see Ch. 43) just blew up the crisis.

Therefore, a policy of reviewing modern physics according to the principle of the physical determination of equations, and of wide-spreading the "magicians"' original work for deep investigation is required to put an end to crisis and assure a true advancement of physics (see also [4, 40-41]).

CHAPTER 22

OPERATIONAL THEORIES

A physical theory is an operational theory if and only if the quantities entering its underlying equations are expressed in reference frames where measurements are performed [26, 42]. Essential for the inertial observers is to determine by own means durations of events at sites where phenomena happen. The Newtonian physics is evidently an operational theory: all measurements are performed in the observer's reference frame. As concerns the theories describing phenomena happened in inertial spaces, other than that of the observer, knowing the duration of such phenomena is done by physical signals connecting those spaces to that of the observer. Complementary time-dependent coordinate transformations are involved, and their time equations provide durations in terms of signal travel times. Einstein's principle of relativity, rewritten with respect to suitable complementary time-dependent coordinate transformations, is required for such theories to be operational theories.

22.1. Special Relativity Theory like Operational Theory

The special relativity theory was founded on the principle of relativity, but Einstein's interpretation of the durations (time intervals) elapsed in inertial spaces as time dilations has obscured its operational nature.

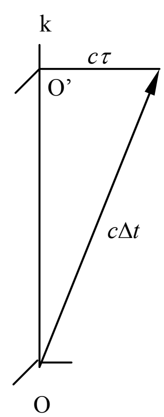

Figure 11.

It is our derivation of the Lorentz transformation as complementary time-dependent coordinate transformation corresponding to the tracing of radius vectors by light signals, that which enlightens this issue. Our proof that the terms βx and βt of the

Lorentz transformation are actually a Cartesian coordinate and the Newtonian time in which light travels this coordinate (Ch. 9) has removed the time dilation. Obtained from the diagram in Fig. 11, the equation

$$\tau = \beta\, \Delta t, \tag{26}$$

also predicted by the time equation of the Lorentz transformation, gives a duration τ elapsed in an inertial space (carrying the inertial coordinate system k) in terms of the travel time Δt of the helping light signal (this is the operational significance of the metric of the Minkowski space-time). It is with this operational meaning that Eq. (26) turns the special relativity theory into an operational theory.

22.2. Electromagnetic and General Relativity Theories like Operational Theories

To show that the electromagnetic and general relativity theories are operational theories, we must show that the 'retardation' of the electromagnetic and gravitational potentials is related to a complementary time-dependent coordinate transformation. To this end, we focus our attention on the mathematical quantities f and ξ^{μ} that appear in the two theories by the gauge transformations of their four-potentials. Observe that dependence of f and ξ^{μ} on $t - x/c$ has been historically obtained by imposing the Lorentz conditions $A^{\mu}{}_{,\mu}$=0 and its gravitational counterpart $\psi^{\mu\nu}{}_{,\nu}$=0 [43] (alternatively the transverse-traceless conditions $\psi^{\mu}{}_{\nu}u^{\nu}$ =0, $\psi^{\mu}{}_{\mu}$=0 [34]) on the four-potentials of the plane electromagnetic and gravitational waves, respectively, A^{μ} and $\psi^{\mu\nu}$, just to bring into accord the omnipresence of the 'retarded' potentials with experiment [44].

Since the waves carry an inertial coordinate system k at speed c along the x-axis, it is straightforward to conclude that A^{μ} and $\psi^{\mu\nu}$ are defined in k, and their dependence -implicitly that of f and ξ^{μ}- on time is determined by the complementary time-dependent coordinate transformation

$$x' = x - ct,\; t' = t - x/c, \tag{27}$$

obtained for $v = c$ from the particular complementary time-dependent coordinate transformation (3), associated to the diagram in Fig. 12. Thus, by relating the retardation

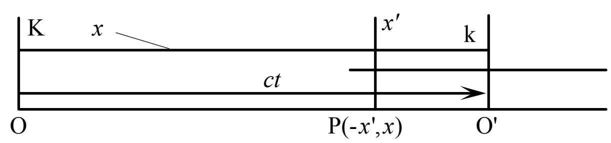

Figure 12.

of the potentials of the electromagnetic and general relativity theories to the complementary time-dependent coordinate transformation (27), we made these theories operational theories.

Concluding, all the theories of modern physics can be made operational theories by removing those mathematical conditions imposed exclusively to bring in accord the time dependence of their physical quantities with experiment. To this end, should be identified an inertial coordinate system, a suitable physical signal and its corresponding complementary time-dependent coordinate transformation.

22.3. Weak Gravitational Waves like Physical Entities

The main consequence of the foundation of the general relativity theory like operational theory is defining the weak gravitational waves -the solutions of Einstein's equations of the gravitational fields in vacuum, *viz*.

$$R_{\mu\nu}=0$$

where $R_{\mu\nu}$ is the Ricci tensor- as physical entities. Carried by wave, the k in Fig. 12 assures the dependence of the gravitational potentials on $t - x / c$ without additional mathematical conditions.

CHAPTER 23

EINSTEIN'S SPECIAL RELATIVITY THEORY IS IN FACT TWO THEORIES

Our 'reinstatement' of the derivation of the Lorentz transformation in [1] proves that Einstein launched actually two theories under the name of special relativity theory, namely: the special relativity theory introduced by his 1905 paper [1], and the subsequently developed special relativity theory (the standard theory) without the derivation of the Lorentz transformation from [1]. The first one is a theory which physical grounds existed, but remained not understood due to the deliberate ignorance of the derivation of the Lorentz transformation in [1]. The second one is a pure mathematical theory which physical content was replaced by the famous time dilation and length contraction, both physically untrue. In both cases the principle of the physical determination of equations did not work in the special relativity theory. The relativistic quantum theories were built without the principle of the physical determination of equations. The resulting lack of restraints upon the terms of the underlying equations of these theories raised the crisis of modern physics, with major human and technological consequences. Without deducing the Lorentz transformation as a complementary time-dependent coordinate transformation, and discerning between the two versions of Einstein's special relativity theory, the perennial criticism just failed in desuetude.

CHAPTER 24

FOUR-VECTORS, 'ABSTRACT' COORDINATE SYSTEMS AT ABSOLUTE REST AND THE PRINCIPLE OF RELATIVITY

The defining relationships of the four-vectors and four-tensors show that the mixture of their components originates in their dependence on coordinates and times connected by the Lorentz transformation, in consequence of tracing radius vectors by light signals. These relationships look like the Lorentz transformation, but are improperly called Lorentz transformation. As long as the speeds appearing in the Lorentz transformation and these relationships are relative speeds, they all support Einstein's principle of relativity. The principle is a law of nature, validating any physical theory for any inertial observer. However, the principle *does not require at all the removal of the concepts of absolute rest and absolute speed*. Such a requirement originated exclusively in wishing to determine experimentally absolute speeds with respect to a physical substratum (according to the Newtonian definition of absolute speed), and not in terms of travel times, specific to a theory manipulating light signals as special relativity theory is.

The removal of the concept of absolute rest involved not only the removal of the reference frame at absolute rest, but also the removal of the 'abstract' coordinate systems at absolute rest (defined in Ch. 4 (Sect. 1.1)), which altered a thoroughly understanding of special relativity theory. To this end has contributed the nonchalant use with the same meaning of the concepts of reference frame and coordinate system. However, the 'abstract' coordinate systems at absolute rest do not deny the principle of relativity. They are not associated (by definition) to the hypothetical physical reference frame at absolute rest. Writing physical laws with respect to them is nonsense.

But, associated to inertial coordinate systems, the 'abstract' coordinate systems at absolute rest enable observers to correctly describe graphically and mathematically uniform rectilinear motions relative to them (Ch. 6 (Sect. 1)). They also enable observers to determine physical quantities not only as relative quantities but also as absolute quantities (defined in Ch. 6 (Sect. 1)). The lack of the 'abstract' coordinate systems at absolute rest mainly altered the understanding of the concept of, and the exploitation of energy.

CHAPTER 25

ABSOLUTE RELATIVISTIC ENERGY

In special relativity theory, the energy of a particle (E) is relative quantity and mentioned with the linear momentum ($\boldsymbol{p}$) of the particle. Both of them are the components of the four-vector $p^{\mu}=(\boldsymbol{p},E/c)$ called four-linear momentum. Both E and $\boldsymbol{p}$ depend (by their defining relationships $E=\beta m_0 c^2$ and $p=\beta m_o v$) on the speed v of the particle with respect to an inertial observer. They change under the Lorentz transformation, but $p^{\mu}p_{\mu}$ is invariant, equal with the rest energy of the particle by the relativistic energy-momentum relationship

$$E^2/c^2\text{-}p^2= m_o^2c^2. \qquad (28)$$

The lack of the 'abstract' coordinate systems at absolute rest determined Einstein to consider the concept of proper frame. That his decision was a wrong one, is evident. By definition, the rest energy of a particle with respect to the proper frame is $m_0 c^2$. This is so because the particle is (by definition) at rest with respect to this frame. But as the reference frame at absolute rest was excuded from special relativity theory, the reference frame in which a particle is at rest is an inertial one. So the particle moves actually through space at the speed of this reference frame. If the 'blind' inertial observer cannot determine experimentally the state of motion of his reference frame, and so the energy and linear momentum through space of a particle at rest in this frame, is just the theory's fault. It is the reason for which we opted for professionals (Ch. 6) in special relativity theory.

As the energy of a particle is an objective quantity, its definition with respect to inertial reference frames was misleading. The only energies that an inertial observer could get practically, in consequence, were restrained to those he defined with respect to his reference frame, that is a part of the particles' kinetic energy. Einstein's definition of the rest energy with respect to the proper frame was merely wrong.

Validating both the 'abstract' coordinate systems at absolute rest and the absolute speed in special relativity theory, $m_0 c^2$ appears naturally as the energy of a particle at absolute rest, while $\beta m_0 c^2$, with v standing now for the absolute speed, as the energy of a particle defined as absolute quantity (Ch. 6 (Sect. 1)). As any inertial observer can determine experimentally absolute speeds, he can also determine the absolute energies of the particles. Consequently, he can develop adequate tools to exploit this energy. Einstein's arbitrary removal of the concepts of absolute rest and absolute speed just forbidden for a century the exploitation of the absolute energy.

CHAPTER 26

CONCERNING THE RELATIVISTIC ENERGY-MOMENTUM RELATIONSHIP

The relativistic energy-momentum relationship is far more subtle than it seems to be at a first sight. With the usual meaning of relative quantities of its terms, Eq. (28) was written exclusively with respect to the reference frames of the inertial observers Our identification of the terms in Eq. (28) also as absolute quantities [45-47] define also Eq. (28) with respect to coordinate systems at absolute rest. There becomes evident that β in E only coincides with the β in the Lorentz transformation, as long as an observer moving with absolute speed v also sees $\beta m_0 c^2$ as the energy of a particle at absolute rest. With the meaning of absolute quantities of its terms, the relativistic energy-momentum relationship validates the principle of the physical determination of equations in the relativistic quantum mechanics (Ch. 27). This means that genuine subquantum information, complementary to that obtained by colliding high energy particles, is to be disclosed from the terms of the underlying equations of this theory. We do it in the next part of this book. Most important is the information concerning the subquantum energy, on which will be founded radically new technologies like those pointed out in Ch. 41. Unfortunately, the way to disclose and apply such information is firmly forbidden by the perennial wrong physics policy based on disregarding the concepts of absolute rest and absolute speed.

Finally, we point out a peculiarity of Eq. (28). Observe that multiplyed by $\gamma^2=1/(1-v_1^2/c^2)$, where v_1 stands for the speed of a particle at rest in the one observer's reference frame, and putting $m=\gamma m_o$, $E=\beta mc^2$ and $p=\beta mv$, Eq. (28) is written with respect to the reference frame of the inertial observer. As concerns this multiplication, it is mathematically doubtless, but physically incomprehensible now. It is under this form that the relativistic energy-momentum relationship gives evidence for the subquantum nature of the relativistic mass in the manner in which it does it like Eq. (28) for the rest mass in Ch. 27.

CHAPTER 27

VALIDATING THE PRINCIPLE OF THE PHYSICAL DETERMINATION OF EQUATIONS IN RELATIVISTIC QUANTUM THEORY. TOWARD GENUINE INFORMATION ON THE STRUCTURE OF SOME 'ELEMENTARY' PARTICLES

The relativistic theories were built on Einstein's special relativity theory, and 'developed' at the time the principle of the physical determination of equations was not validated in the special relativity theory. As concerns the relativistic quantum mechanics, its underlying equations were deduced from, or in relation with the relativistic energy-momentum relationship by means of the principle of correspondence. Without a clear physical role and meaning associated, the matrices α, β of the Dirac equation seemed to confirm that the principle of the physical determination of equations would not be proper to the new quantum mechanics. So that, all the physical information that Dirac obtained for a free particles was by resolving the equation carrying his name, and concerned its quantum behavior. The Dirac particles remained further 'elementary' particles for him.

A major step further was done, in principle, by der Waerden. His revealed idea (revealed because he never became aware of its physical significance and consequences) of writing the term $\mathbf{p}^2$ in the relativistic energy-momentum relationship like $(\sigma\cdot\mathbf{p})(\sigma\cdot\mathbf{p})$, where $\boldsymbol{\sigma}=(\sigma_x, \sigma_y, \sigma_z)$ are the Pauli 2x2 matrices associated to the spin operator $(\hbar/2)\boldsymbol{\sigma}$ and $\hbar$ is the reduced Planck constant, rendered this relationship more fit to the internal structure of the Dirac particles. His derivation of the spinorial transcription of the Dirac equation confirms this assertion. Unfortunately, by virtue of the mathematical equivalence of all the transcriptions of the Dirac equation, der Waerden's derivation of the spinorial transcription rested as good as any other.

Since we validated the principle of the physical determination of equations in the special relativity theory, and the energy-momentum relationship is also basic for the relativistic quantum mechanics, this principle is (by Ch. 26) valid in the relativistic quantum mechanics, too. Therefore, we have to search for genuine physical information in the terms of the underlying equations of the relativistic quantum mechanics. This information concerns a level of structure of matter "even below that on which nuclear transformations take place" (Bohm, [48]).

Investigating the terms of the spinorial transcription of the Dirac equation as it was deduced by der Waerden, and the wavefunctions corresponding to opposite eigenvalues of both the helicity and velocity operators in which the Dirac wavefunctions are equally splitting, we obtain information condensed in one model of Dirac particle consisting of two coupled systems of subquantum particles spinning tangentially in opposite directions. Two systems of subquantum particles spinning in opposite directions we also identify inside photons, and suggest their existence inside spin-0 mesons. This model of 'elementary' particle has nothing in common with the mathematical standard model of 'elementary' particle, and is important by that it defines the relativistic mass as the coupling constant of the systems of subquantum particles, and allow developing radically new technologies by altering this constant.

CHAPTER 28

INFORMATION PROVIDED BY THE SPINORIAL TRANSCRIPTION OF THE DIRAC EQUATION

Consider der Waerden's derivation of the spinorial transcription of the Dirac equation [49] from the relativistic energy-momentum relationship written in the form

$$(E/c+\boldsymbol{\sigma}\cdot\mathbf{p})(E/c-\boldsymbol{\sigma}\cdot\mathbf{p})=m_o c^2 \qquad (29)$$

where c is light speed, E is the energy, **p** the linear momentum and m_0 the rest mass of a free particle. By applying the principle of correspondence, der Waerden passed from the physical quantities E and $\mathbf{p}$ in Eq. (29) to the suitable quantum operators $E=i\hbar\partial_0$, $\mathbf{p}=-i\hbar\boldsymbol{\partial}$, where $\partial_0=\partial/\partial(ct)$ and $\boldsymbol{\partial}=(\partial/\partial x,\partial/\partial y,\partial/\partial z)$. He applied the resulting equation to the two-component spinor ξ, and put

$$(i\hbar/m_o c)(\partial_o-\boldsymbol{\sigma}\cdot\boldsymbol{\partial})\xi=\eta, \qquad (30)$$

where ξ and η correspond to the same spin polarity. He thus obtained from Eq. (29) the set of equations

$$i\hbar(\partial_o+\boldsymbol{\sigma}\cdot\boldsymbol{\partial})\xi=m_o c\eta,\ \ i\hbar(\partial_o-\boldsymbol{\sigma}\cdot\boldsymbol{\partial})\eta=m_o c\xi \qquad (31)$$

which constitute the spinorial transcription of the Dirac equation, a step toward the covariant Dirac equation.

According to the validity of the classical principle of physical determination of equations in Einstein's special relativity theory, and despite the mathematical equivalence of all the transcriptions, we search for physical information on the internal structure of the Dirac particles in the terms of der Waerden's derivation of Eqs. (30). To this end, we first consider the equation

$$i\hbar\partial_o\psi_1=(E/c)\,\psi_1+(K/c)\psi_2, \qquad (32)$$

describing a weak coupling in the quantum mechanical formalism, where ψ_1 and E are, respectively, the eigenfunction and the suitable eigenvalue of the Hamiltonian equation while K and ψ_2 are, respectively, the coupling constant and the contribution of that coupling to the eigenstate ψ_1. By comparing each of Eqs. (31) with Eq. (32), we see that 1) Applied to ξ and η, the Hamiltonians $\pm\bar{\sigma}\cdot\mathbf{p}$ describe opposite spin-momentum couplings within a free particle of well-defined direction of the linear momentum, which means that two internal entities spin in opposite directions, 2) m_0c^2 is coupling the two entities, and 3) A leakage of subquantum constituents between the two entities is assumed. According to Bohm, m_0c^2 is the energy of a particle "having no visible motion as a whole" [48], and originates in "to and fro reflecting movements" [50]. Our result recovers m_0c^2 as the energy of a particle "having no visible motion as a whole", i.e., a particle at absolute rest, but discloses that m_0c^2 actually originates in the coupling of the particle's constituents, being a subquantum coupling energy. The particle rest mass m_0 is the true coupling constant. Our result does not presume the existence of a physical coupling between the particle spin and its linear momentum, but the effect that a change in the particle speed has upon its internal coupling. The two entities are systems of subquantum particles. Our result is refined to a semi-classical model of Dirac particle at absolute rest by regaining the maximal acceleration $\mathbf{a}_M=2m_oc^3/\hbar$ as a subquantum quantity (Ch. 29), and constructing the spinning frequency operator for Dirac particles (Ch. 33).

CHAPTER 29

MAXIMAL ACCELERATION AS SUBQUANTUM QUANTITY. SEMI-CLASSICAL MODEL OF DIRAC PARTICLE

Consider the maximal acceleration

$$a_M=2m_oc^3/\hbar.$$

It was derived by embedding an eight-dimensional metric in phase space, as well as by means of the Heisenberg uncertainty relations [51-54]. By its dependence on the reduced Compton wavelength $\bar{\lambda}_C=\hbar/m_oc$, and because $\bar{\lambda}_C$ is the reduced wavelength of the de Broglie wave of a particle at absolute rest (Ch. 30), a_M belongs to micro-world.

Our derivation of a_M as the acceleration of a spinning sphere of radius r= $\bar{\lambda}_C/2$ and peripheral speed *c* by $a=c^2/(\bar{\lambda}_C/2)$ confirms that a_M is a subquantum quantity. The acceleration a_M -due to the change in direction of its peripheral speed- belongs to a sphere the diameter of which is half that of a quantum particle. Therefore, our semi-classical model of Dirac particle at absolute rest consists of two coupled spherical systems of subquantum particles of radius $\bar{\lambda}_C/2$ that spin tangentially. To assure the stability of the particle, the two systems can spin only in opposite directions. The spinning frequencies of these systems are

$$\omega=\pm 2\omega_o=\pm 2m_oc^2/\hbar. \tag{33}$$

The equal writing of the relativistic energy-momentum relationship with respect to inertial observers (Ch. 26) extends the above results to the relativistic mass.

CHAPTER 30

COMPTON WAVELENGTH AS WAVELENGTH OF A DE BROGLIE WAVE

Yet it is stated in the literature that under its reduced form $\bar{\lambda}_C$, the Compton wavelength is just an useful physical constant. Yet there is, as we know, no search for its physical content. Here is the reason for which we were interested in this matter.

Consider the relativistically defined de Broglie relations

$$E=\hbar\omega,\ p=\hbar/\bar{\lambda}, \tag{34}$$

which associate a wave of frequency ω and reduced wavelength $\bar{\lambda}$ to any free particle of energy E and linear momentum **p**. When written for a rest particle of mass m_o, Eqs. (34) reduce to

$$\omega_o=c/\bar{\lambda}_C. \tag{35}$$

Eq. (35) shows that $\bar{\lambda}_C$ is the reduced wavelength of the physical de Broglie wave associated to a rest particle. With this meaning, $\bar{\lambda}_C$ associates by the right hand side of the second of Eqs. (34), and against the linear momentum p=0, the internal momentum (known as the Schrodinger microscopic momentum [55])

$$p_o=m_oc \tag{36}$$

to a particle at absolute rest. With these meanings, both λ_C and p_o are essential to obtain information on the internal structure of some quantum particles.

CHAPTER 31

QUANTUM MECHANICAL RELATIONSHIPS POINTING TO *c* AS SUBQUANTUM QUANTITY

The Dirac spin operator **S**=($\hbar$/2)Σ gives evidences for *c* as peripheral speed of the spinning systems of subquantum particles by the direct product in the defining relationship [56] $\Sigma=-(i/2)(\alpha x \alpha)=\begin{vmatrix}\sigma & 0\\ 0 & \sigma\end{vmatrix}$, and the commutation relations $[c\alpha_i,\Sigma_i]=0$ ($c\alpha_i$ is the velocity operator, i=1-3): While the defining relationship points to a motion of speed *c* in a plane orthogonal to the spin direction, the commutation relations show, according to the quantum mechanical theory of measurement, that components of the speed non-parallel to one of the spin can not be measured simultaneously with the last. *The validity of our result is supported by that both the Newtonian speed and acceleration as ratios of infinitesimal quantities*

CHAPTER 32

INFORMATION PROVIDED BY THE DIRAC WAVEFUNCTIONS

The undulatory phenomenon that de Broglie associated to the quantum particles seems basic for their mathematical description by wavefunctions, the statistical interpretation of the wavefunctions and experimental performances otherwise impossible to get. Therefore, the Dirac wavefunctions ψ should contain in their structural elements information on the constituents of the Dirac particles responsible for, or at least in interrelation with, the undulatory phenomenon. We just propose searching for such information.

32.1. Splitting the Dirac Wavefunctions in Components of Opposite Helicities

The splitting of the Dirac wavefunctions in wavefunctions of another operator is -by virtue of the principle of the physical determination of equations- essential to obtain information on the structure of the quantum particles. That information is to be identified in their elements.

Focus our attention upon the commutation relation

$$[H_D,h] = 0, \qquad (37)$$

where h is the helicity operator. Eq. (37) assures the existence of a complete set of eigenstates for H_D and h. Although helicity is a good quantum number, Eq. (37) does not specify if the energy eigenstates are helicity eigenstates or linear combinations. To discern between the two possibilities -found on equal footing in the literature-, we assume that all Ψ are also helicity eigenstates. For a free particle, Ψ is given by

$$\Psi=n \text{ x column } (\psi,k\psi) \text{ x } \exp(ip^\mu x^\mu/\hbar), \qquad (38)$$

where n is a normalization factor, ψ is -as usually- a two-component spinor and k is a constant to be determined. The pairs of non-zero values of k that the zero-valued determinants of the systems of second order equations in which Dirac equation splits by inserting Ψ deny such Ψ's.

Consider further the wavefunctions

$$\Psi=\text{column}\ (\xi,\eta)$$

of the Dirac equation

$$i\hbar\partial_o\Psi=(1/c)H_D\Psi, \qquad (39)$$

where

$$H_D=c\alpha\cdot\mathbf{p}+m_oc^2\beta$$

is the Dirac Hamiltonian, and

$$\alpha=\begin{vmatrix}\sigma & 0\\ 0 & -\sigma\end{vmatrix},\ \beta=\begin{vmatrix}0 & I\\ I & 0\end{vmatrix},$$

are the Dirac 4x4 matrices, in which Eqs. (31) were joined together.

The eigenfunctions of the equation with proper values associated to Eq. (39) are

$$\psi=\text{column}\ \{a,b,[(E+cp_3)a+cp_-b]/m_oc^2,[cp_+a+(E-cp_3)b/m_oc^2]\},$$

where a, b are components of ξ, $p\pm=p_1\pm i\ p_2$, and normalization factor was ignored.

By a simple calculation, we get -in accordance with (37)

$$\psi=\psi^-_h+\psi^+_h, \qquad (40)$$

where

$$\psi^-_h=(1/2p)\ \text{column}\{(p-p_3)a-p_-b,-p_+a+(p+p_3)b,[(p-p_3)a-p_-b](E-cp)/\ m_oc^2,[-p_+a+(p+p_3)b](E-cp)/m_oc^2\},$$

$$\psi^+_h=(1/2p)\ \text{column}\{(p+p_3)a+p_-b,p_+a+(p-p_3)b,[(p+p_3)a+p_-b](E+cp)/\ m_oc^2,[p_+a+(p-p_3)b](E+cp)/m_oc^2\}$$

are eigenfunctions of h, corresponding, respectively, to negative and positive helicities. The result is found to be independent of representation. As the direction of **p** in space is well-determined, this splitting proves that the Dirac wavefunctions actually provide information on the true existence of something spinning in opposite directions within a Dirac particle. The result becomes explicit for a particle moving along one of the coordinate axes, particularly along the third axis, when the eigenfunctions ψ^-_h, ψ^+_h are eigenfunctions of Σ_3.

Concluding, it is misleading to associate simultaneously to each of the directions of **p**, and to each state of helicity, positive and negative energy solutions of the Dirac equation. That the physical reality determining the Dirac Hamiltonian and wavefunctions consists in the systems of subquantum particles inhering in a Dirac particle, is best illustrated by Eq. (40): When written for **p**(0,0,p), Eq. (40) turns into a linear combination of eigenfunctions of Σ_3 corresponding to opposite eigenvalues.

32.2. Splitting the Dirac Wavefunctions in Wavefunctions of the Velocity Operator

A simple calculation -in accordance with the commutation relation $[c\boldsymbol{\alpha}\cdot\mathbf{p},\boldsymbol{\Sigma}\cdot\mathbf{p}]=0$- gives

$$\psi=\psi^-_\alpha+\psi^+_\alpha, \tag{41}$$

where

$\psi^-_\alpha=(1/2p)$ column$\{(p-p_3)a-p_-b,-p_+a+(p+p_3)b,[(p+p_3)a+p_-b](E+cp)/m_oc^2,[p_+a+(p-p_3)b](E+cp)/m_oc^2\}$,

$\psi^+_\alpha=(1/2p)$ column$\{(p+p_3)a+p_-b,p_+a+(p-p_3)b,[(p-p_3)a-p_-b](E-cp)/m_oc^2,[-p_+a+(p+p_3)b](E-cp)/m_oc^2\}$,

are eigenfunctions of the operator $c\boldsymbol{\alpha}\cdot\mathbf{p}/p$, which eigenvalues are opposite speeds along the direction of motion. Since the elements $+\boldsymbol{\sigma}$ and $-\boldsymbol{\sigma}$ of α act, respectively, upon ξ and η, and

$$(\boldsymbol{\sigma}\cdot\mathbf{p}/p)\xi^+=\xi^+\ [-(\boldsymbol{\sigma}\cdot\mathbf{p}/p)\eta^-=\eta^-],\ (\boldsymbol{\sigma}\cdot\mathbf{p}/p)\xi^-=-\xi^-,\ [-(\boldsymbol{\sigma}\cdot\mathbf{p}/p)\eta^+=-\eta^+],$$

the first two elements of ψ^+_h (ψ^-_h) are identical with the first two elements of ψ^+_α (ψ^-_α), and the last two elements of ψ^+_h (ψ^-_h) are identical with the last two elements of ψ^-_α (ψ^+_α). So that, the splitting of the Dirac eigenstates in helicity eigenstates corresponding to opposite speeds by (7) supports the understanding of *c* as a subquantum peripheral speed of the systems spinning oppositely in the above semi-classical model of Dirac particle.

CHAPTER 33

INFORMATION PROVIDED BY THE SPINNING FREQUENCY OPERATOR

The standard way to prove the existence of some physical quantity in quantum mechanics lies in constructing an observable that can, at least in principle, be measured. Accordingly, we define the ‘frequency’ operator

$$\omega'_i=P_+\omega_iP_++P_-\omega_iP_-.$$

$P_\pm=[1\pm\text{sign}(E)]/2$ are projectors onto positive and negative energy states, ω_i are components of the operator [56] $\omega=-2c\gamma^5p/\hbar$ and γ^5 is the chirality operator. By the relationships

$$P_\pm\omega_iP_\pm=\pm[(\omega_rS_r)\omega_i/E]P_\pm,$$

resulting from a simple but long calculation, we get

$$\omega'_i=(\omega_rS_r)\omega_iH_D/E^2. \tag{42}$$

The suitable form of the Dirac Hamiltonian

$$H_D=\mathbf{S}\cdot\boldsymbol{\omega}+m_oc^2\beta$$

in terms of ω'_i is

$$H_D=E^2(\omega'_rS'_r)/p^2c^2,$$

where

$S'_i = P_+ S_i P_+ + P_- S_i P_- \equiv S_i$,

for massic particles, and

$H^o{}_D = \omega'_r S'_r$,

for massless particles.

Since

$$[H_D, \omega'_i] = 0, \qquad (43)$$

ω'_i is a constant of motion. The eigenvalues of ω'_i and H_D are simultaneously measurable. Both $\boldsymbol{\omega}$ and H_D are four-dimensional operators. Their two-dimensional components stand for the two coupled, opposite spinning motions in a Dirac particle. While H_D stands for the total energy of the two systems as the particle energy, and $\boldsymbol{\Sigma}$ is defined by Pauli matrices preceded by the same sign, $\boldsymbol{\omega}$ stands, by its two-dimensional elements preceded by opposite signs (involved by γ^5), for some opposite quantities definitory for the two systems. So, for states of well-defined energy, the eigenvalues of ω_i to be taken into account are, unlike those of H_D, just those of its two-dimensional components. For a particle at absolute rest of Schrodinger's microscopic momentum $p_o = m_o c$, the eigenvalues of ω'_i are given by (33). They are also given by (33) for a free particle of linear momentum $\mathbf{p}(0,0,p)$, when

$$\omega'_i = 2p^2c^2 H_D \Sigma_i / hE^2. \qquad (44)$$

Therefore, the physical quantities associated to the two-dimensional components of ω'_i are frequencies. Their coincidence with the frequencies (33) validates the semi-classical model of Dirac particle obtained in Chs. 28, 29 as a quantum model.

Since Eq. (44) was obtained by adding the operators

$P_\pm \omega P_\pm = \pm 2p^2c^2 \Sigma P_\pm / hE$,

the only energy states $\Psi_\pm$ satisfying the eigenvalue equation of ω'_i are those also satisfying equation $h\Psi_\pm = \pm\Psi_\pm$. More generally, by Eqs. (44), the eigenvalues of ω'_i are simultaneous with those of H_D in two cases: i) for states which energy and helicity are both either positive or negative, ii) for mixed energy states and mixed helicity states. Since the Dirac eigenfunctions are linear combination of states of opposite helicities, this means that a state of 'well-defined' energy is actually an unbiased mixture of sub-states of opposite energies associated to opposite sub-spins. No evaluation of these sub-spins of the systems of subquantum particles is known at this stage of our investigation. The main result is that the particle mass appears for the first time to be the coupling constant of these sub-spins. The particle energy appears as their coupling energy.

In accord with the commutation relations $[\omega'_i, \alpha_i] = 0$ and $[S_i, \alpha_i] = 0$, the eigenvalue equations of the operators $P_\pm \alpha P_\pm = \pm(cp/E)P_\pm$, associate the speeds $\pm c$ to these systems. The Zitterbewegung frequencies of the operators α_i, S_i and ω_i between states of identical p but opposite energies [57] coincide with the spinning frequencies of the model's systems. So Zitterbewegung is the rapid motion performed by peripheral subquantum particles about the systems of opposite energies, just as it is seen by an observer watching the projections of their speeds onto the coordinate axes.

CHAPTER 34

SUBQUANTUM DETERMINATION OF DIRAC WAVEFUNCTIONS

We have shown in Ch. 32 that the Dirac wavefunctions actually contain information about the subquantum structure of the particles which they describe. To get further insight into their structure, we now relate the Dirac wavefunctions to parameters that could characterize this structure by Eqs. (31) in view of Eq. (32). Concerning a free particle moving along the third axis of coordinates, Eqs. (30) reduce to

$$i\hbar(\partial_3+\partial_o)\xi=m_oc\eta,\ i\hbar(\partial_3-\partial_o)\eta=-m_oc\xi, \qquad (45)$$

under the action of σ_3 on the spinor part of ξ and η.

The analogous Eqs. (31) and (32) enable us to describe the weakly coupled systems of subquantum particles of a Dirac particle by

$$\xi=(\rho_R)^{1/2}\exp(i\theta_R),\ \eta=(\rho_L)^{1/2}\exp(i\theta_L), \qquad (46)$$

where -as functions of space and time- the densities ρ_j and the phases θ_j (j=L,R) determine by their variation the motion of the subquantum particles. Thus, by inserting (46) in Eqs. (45), and collecting the resulting real and imaginary parts, we get

$$\partial_o\rho_j=\varepsilon_j[\partial_3\rho_j+(2K\kappa/hc)\sin\theta],\ \partial_o\theta_j=\varepsilon_j\partial_3\theta_j-(K\kappa/hc\rho_j)\cos\theta,$$

where $\varepsilon_j=+1$ for j=L, $\varepsilon_j=-1$ for j=R, $\kappa=(\rho_L\rho_R)^{1/2}$ and $\theta=\theta_L-\theta_R$ is the relative phase. The stationary state defined by $\rho_L=\rho_R$ is governed by the equations

$$-\partial_o\rho_L=\partial_o\rho_R,\ \partial_o\theta=\partial_3(\theta_L+\theta_R).$$

The subquantum determination of the wavefunctions by (46) was lost by their normalization.

CHAPTER 35

PHOTON'S MODEL

The Hamiltonian [58]

$$H_{Ph}=c\cdot\text{rot}=\omega_iS_i,$$

where rot stands for rotor, $\omega_i=cp_i/\hbar$, $S_i=\hbar s_i$ and s_i are the spin matrices

$$s_1=\begin{vmatrix}0&0&0\\0&0&-i\\0&i&0\end{vmatrix},\ s_2=\begin{vmatrix}0&0&i\\0&0&0\\-i&0&0\end{vmatrix},\ s_3=\begin{vmatrix}0&-i&0\\i&0&0\\0&0&0\end{vmatrix}.,$$

is the analogous of H^o_D. The writing of H_{Ph} as a rotor, and of its wavefunctions as a superposition of wavefunctions of opposite polarizations, suggest that any photon consists of two physical entities spinning in opposite directions. The e^+-e^- annihilation suggests that these entities are also systems of subquantum particles spinning in opposite directions.

CHAPTER 36

SUGGESTED MODEL OF SPIN-0 MESON

In view of the physical meaning of Zitterbewegung deduced in Ch. 33, the Zitterbewegung provided by the two-dimensional matrices of Sakata-Taketani equation [59] describing spin-zero mesons suggests the existence of oppositely spinning systems of subquantum particles also within these 'elementary' particles.

CHAPTER 37

OUR MODEL OF ‘ELEMENTARY’ PARTICLE VS THE STANDARD MODEL

We built a model of ‘elementary’ particle (consisting of two systems of subquantum particles spinning in opposite directions) exclusively from the physical information identified in the terms of the equations describing Dirac particles and photons. We did it (Chs. 28 to 36), according to the principle of the physical determination of equations, just validated in the relativistic quantum theory (Ch. 27). No additional conjecture was needed to obtain this model. So, for any new theoretical or experimental information to contribute to the ‘standard model’ of ‘elementary’ particle, it must be in accord with this information, not vice versa. Although incomplete (e.g., by the lack of predictions on the electric charge), this model is basic. It is important by that i) all ordinary matter is composed of Dirac particles and photons, and ii) disclose the nature of mass (Ch. 28).

As concerns the standard model of particle physics, it is a relativistic field theory which disregards the principle of the physical determination of equations, so essential subquantum information. The model of ‘elementary’ particle which it predicts is at least incomplete. The theory has no mechanism accounting for the particles mass. The claim that the neutron and proton masses arise mostly from strong forces that hold the quarks together seems ridiculous, as long as the mass of the relativistic neutrons and protons, and the mass of the relativistic electrons obey the same relativistic formula of mass. A true, main contribution of the strong forces to the neutron and proton mass should make the relativistic neutron and proton mass obey a formula differing from that obeyed by the relativistic electron mass, which experiments deny. One claiming that the nucleons masses “arise mostly from strong forces that hold the quarks together” [60], must admit that the same subquantum particles with a complex structure really constitute both nucleons and electrons.

On way of consequence, unlike the standard model, which has no mechanism accounting for the particle mass, our model of ‘elementary’ particle provides the sub-quantum nature of mass -the same for all Dirac particles (it is to be further searched for all quantum particles)-, as well as a subquantum experimental technique -challenging that consisting in accelerating particles- of changing the mass, so proving this nature.

CHAPTER 38

REMARK CONCERNING CAIANIELLO’S PHASE SPACE

Our derivation of the Lorentz transformation as a complementary time-dependent coordinate transformation proves that the Minkowski space-time is an operational entity, not a physical one. Mixing coordinates and times, the Lorentz transformation assures the invariance of its defining metric. Due to their dependence on time, physical quantities form four-vectors and four-tensors. Thus the Minkowski space-time is a suitable rigorous framework for describing the physical reality filling space.

Beside the Minkowski space-time there is the four-space, also formal, associated to the four-momentum $p^{\mu}=(p,E/c)$ just as the former was attached to the four-vector $x^{\mu}=(x,ct)$. This is the energy-momentum space which Caianiello joined with the Minkowski space-time into an eight-dimensional space, and which metric enabled him to deduce the maximal acceleration a_M [61]. The endowing of phase space with a metric is raised by the spinning systems of subquantum particles, just as it is the quantum behaviour of the particles.

CHAPTER 39

SUBQUANTUM DETERMINATION OF THE SPACE-TIME GEOMETRY

Our derivation of the maximal acceleration a_M as a subquantum acceleration (see Ch. 29) reconciles the a_M derived by Caianiello as a 'macroscopic' quantity with its dependence on $\bar{\lambda}_C$. It also explains the factor 2 formerly inserted 'for convenience' in a_M [53].

But, unlike Caianiello -who needed to postulate that a quantum particle is an extended object for getting a_M-, we had at our disposal our model of 'elementary' particle, deduced by applying the principle of the physical determination of equations to the relativistic quantum theory (Ch. 28). It is this model of 'elementary' particle which predicts, by the diagram in Fig. 13, the Schwartzschild radius $R_{Sc} = 2Gm_o/c^2$, where G is the gravitational constant and m_o is the particle rest mass, according to the relationship

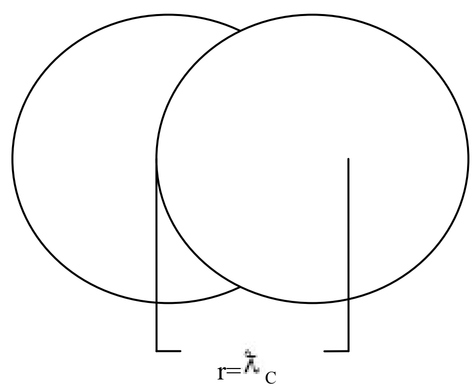

Figure 13.

$$2Gm_o^2/r^2=m_oc^2/r,$$

with $r=\bar{\lambda}_C$ [51].

As the stability of the coupled, oppositely spinning systems of subquantum particles can be related to the stability of two spinning physical systems interacting by gravitational waves (by the validity of the theory of such an interaction [62-63], no matter of the level of structure of matter to which the systems belong), a curved space-time associates to any massic 'elementary' particle.

The metric of this space-time enabled Caianiello to succeed in reproducing the position-momentum commutation relations by embedding a hermitian metric in the phase space [64].

The appearance of components of the metric tensor defining weak gravitational waves in its metric [64-65] suggests the subquantum nature of gravitation and questions the quantization of the gravitational fields. The identification of the a_M derived from the position-momentum and time-energy uncertainty relations with the acceleration of the spinning systems of subquantum particles suggests that the quantum rules must be determined by rules governing the subquantum structure. The most important sub-quantum rule seems to govern the coupling between the ω's of the spinning systems of subquantum particles. So the physical information derived from the geometry of the curved space-time originates in the determination of this space-time by the subquantum structure of matter. Both, the derivation of a_M by Caianiello [51], and the regaining of Sacharov's absolute maximal temperature of thermal radiation in terms of a_M [66] are only very few examples of such a determination. By the light-speed principle, we meet in Einstein's special relativity theory *c* with meaning of speed of a physical signal used as a tool, and of speed governing the subquantum world.

CHAPTER 40

SOME CONSIDERATIONS ON CURVED SPACE-TIME AND WEAK GRAVITATIONAL WAVES

The only connection of the curved space-time with the macroscopic physical world concerns the motion of bodies and particles along geodesics around massive bodies. The non-Euclidian geometry of the space-time just assures the description of such motions, telling nothing about the nature of mass, 'gravitational energy' and the physics of the gravitational interaction. All these follow from special relativity theory via relativistic quantum theory (see, e.g., Chs. 27, 28). The curved space-time, like the Minkowski space-time in the special relativity theory, has just an operational origin.

A sudden breaking in the state of energy of a massive body is described by a free Riemann tensor defining a weak gravitational wave as a physical entity (Ch. 22 (Sect. 3)), but this does not support the claim that the Riemann tensor is a true physical force exerted by the wave upon test particles of unit mass [67]. The gravitational wave is just an amount of energy traveling through empty space at a given speed -let it be c. Some comments on generating and detecting weak gravitational waves we gave in [68-82].

The effects of the gravitational field of a massive body upon 'elementary' particles, particularly upon photons, suggests the subquantum nature of the wave energy. What was named 'gravitational energy' is subquantum energy. Otherwise such effects would not exist. This conjecture coincides with our derivation of the relativistic mass as the coupling constant of the systems of subquantum particles constituting Dirac particles (Ch. 28), and requires for checking the general validity of this result. A true generation and detection of weak gravitational waves as carriers of subquantum energy[10] becomes feasible in laboratory conditions [82-91] by altering the mass of some quantum particles [92]. This because the potentials of the gravitational waves depend on the time rate of

[10] The term 'subquantum' defines the level of structure of matter at which must be acted to release the energy, as well as to possible peculiarities of the energy released by such an action.

change of the mass density [93]. The claim that the curved space-time would be "endowed with physical qualities" [31] was misleading and remains as such.

CHAPTER 41

ON THE ETHER

By the negative result of the Michelson-Morley experiment, Einstein felt entitled to deny ether and use in his special relativity theory light signals traveling to and fro through space.

However, a subquantum nature of the hypothetical physical entity named ether may explain the lack of experimental evidence, as well. So long as the light's photons are stable particles, no experiment manipulating light signals traveling through space will give evidence for the ether. Even if filled with subquantum energy, space behaves as empty space with respect to light. So Einstein's decision to use light signals as if space was empty was right. It validates our tracing of radius vectors by light, too.

An experimental checking of the hypothetical subquantum nature of the ether will become feasible just after experiments on releasing subquantum energy will be successful.

CHAPTER 42

TESTING EXPERIMENTS AND POTENTIAL APPLICATION TO RADICALLY NEW TECHNOLOGIES

'Elementary' particles get currently excited by accelerating to relativistic speeds. No explanation of the phenomenon was provided. The model of 'elementary' particle, just obtained in Chs. 28-36, provides a subquantum origin of mass which enables us to propose a challenging techniques of exciting particles, namely by altering the coupling of their spinning systems of subquantum constituents. Because it is presumable that magnetic momenta are associated to these spinning systems just as they are associated to the spin of the particles, adequate patterns of magnetic fields can act directly upon these magnetic momenta. There results a change in the angles made by the frequencies $\boldsymbol{\omega}$ of the systems with the particle spin **S**, and according to Eqs. (29), (30) and the 'precession' equation

$$d\mathbf{S}/dt = \boldsymbol{\omega} x \mathbf{S},$$

a mass change simultaneous with a spin time rate of change.

The energy gained by excitation can manifest by interaction or be released for well-defined ratios ξ/η of the spinors describing the coupled systems of subquantum particles (emission ratios). So are obtained both excited particles and sources of subquantum energy. Some of the ratios ξ/η can be given in terms of the speeds reachable by particles under acceleration. The releasable amounts of energy are absolute quantities. They can overcome the upper limits set by the feasible accelerating facilities. It is however a hard experimental work to subquantumly excite 'elementary' particles, investigate their interaction and change into each other (as suggested by the systems of subquantum particles predicted to exist in both Dirac particles and photons) when excited, and the effect which the radiated subquantum energy [13, 16, 17, 94, 95] may have upon exciting, destroying or condensing matter (especially the nuclear charge of the missiles). Even if the structure of the nucleons is actually more complex than it is predicted by the Dirac equation, the presence of e^- and e^+ in their interchange is enough for the subquantum energy released by e^- and e^+ to excite nucleons and produce such effects. There is a suitable energy for breaking any sort of atomic nucleus.

Radically new technologies exploiting effects of the subquantum energy become feasible by altering the internal coupling of the basic particles constituting matter. Some of them, like condensing matter (cold fusion [96], superconductors at normal temperatures [97]), most powerful lasers and hypermagnets are foreseeable. There is almost nothing in common between the actual trend in these fields and the new trend. Other technologies are hard to be imagined now. Unknown rules which to govern the alteration of the coupling of the systems of subquantum particles, and so the quantum behaviors of matter are to be disclosed experimentally. Even Pauli's exclusion principle may probably be altered experimentally [63]. A rough calculation shows that one cubic centimeter of a metal can release an energy of 10^{13}J [98].

CHAPTER 43

CONCLUSION

The radius vectors of geometrical points moving uniformly and rectilinearly with respect to inertial observers change systematically over time, in both direction and magnitude. To know their direction and magnitude when projecting them onto coordinate axes, we need to trace such radius vectors by physical signals. So we obtained the new class of 'complementary time-dependent coordinate transformations'. The working hypotheses consisted in recognizing i) the concepts of absolute rest and absolute speed, ii) the running at the same rate of the identical clocks at absolute rest or in uniform rectilinear motion at different speeds, and iii) the same length of the meter-sticks, no matter of their speed.

Obtaining, for light signals, the standard Lorentz transformation as a complementary time-dependent coordinate transformation, we confirmed our working hypotheses. Moreover, by disclosing the objective reality warranting the manipulation of some equations that led to the standard Lorentz transformation in [1], the derivation of the standard Lorentz transformation as a complementary time-dependent coordinate transformation undoubtedly proved the validity of our working hypotheses in special relativity theory. As the same objective reality explained the origin and meaning of the factor β in the Lorentz transformation -the only unintelligible equations in special relativity theory-, it also proved the validity of the principle of the physical determination of equations in special relativity theory, with essential consequences upon all subsequent theories concerning the quantum and subquantum structure of matter, earlier founded upon special relativity theory.

Opposite working hypotheses led Einstein to develop the standard special relativity theory without the derivation of the Lorentz transformation in [1] as a, physically misleading, theory in which the principle of the physical determination of equations didnot work. This theory wrongly predicted the famous time dilation, twin paradox and FitzGerald-Lorentz contraction as physical phenomena. Both the mathematical logic and the coinciding denominators in the Lorentz transformation and the relativistic mass raised an apparent understanding of the theory, just as the unknown subquantum nature of the same mass (that we just identified) has assured the 'experimental proof' of the time dilation.

The relativistic theories concerning the quantum and subquantum structure of matter, built upon the developed special relativity theory, i.e., without the restraints required by the principle of the physical determination of equations, missed essential physical information incorporated in every term of their underlying equations. So much the more adequate experimental techniques to prove the unknown information were not developed. The 'standard model' of 'elementary' particle was obtained in such conditions. The crisis of physics has installed.

There is presently no expected future development of physics without the principle of the physical determination of equations which to break the crisis. It is for this reason that our way to prove the validity of this principle in Einstein's special relativity theory, and its resulting validity in the relativistic quantum theories are so important. On the one side, we could remove the vicissitudes of special relativity theory. On the other side, we identified genuine subquantum information in the terms of the underlying equations of the relativistic quantum theory. We condensed this information in a model of 'elementary' particle, consisting of two spinning systems of subquantum particles (valid for Dirac particles, photons, etc.). The relativistic mass appears as the coupling constant of the two systems, and it can also be changed by acting upon these systems.

There results exciting possibilities of releasing energy, exciting quantum particles and make them interact, and of destroying and condensing matter by acting upon the constituents of the 'elementary' particles. Adequate facilities to testify experimentally and exploit technologically the subquantum energy are to be developed with priority. This because, no matter of the power of the particle accelerator facilities, the subquantum information missed by ignoring the principle of the physical determination of equations in founding the relativistic theories, can not be obtained by colliding high energy particles. But there are also major philosophical reasons for which our validation of the principle of the physical determination of equations is so important.

Since, by the graphical addition of travel times as scalar quantities (Ch. 7), the terms βx, βvt and βt in the Lorentz transformation are, respectively, Cartesian coordinates and Newtonian time, the meaning of the Newtonian concepts of space and time is kept unaltered in special relativity theory, in deep agreement with everyday experience and common sense. Like Galileo's transformation, the spatial equation in the Lorentz transformation connects Cartesian coordinates. So Einstein's special relativity theory proves to be just a chapter of the classical physics, based on manipulating light signals to measure distances and times. The mixture of coordinates and times in the Lorentz transformation, and, by way of consequence, in the metric of the Minkowski space-time originated just in tracing radius vectors by lights signals. So the Minkowski space-time has an operational nature: The Euclidian three-dimensional space and Newtonian time are layed by. Therefore, the human alienation raised by the fictitious time dilation, twin paradox and FitzGerald-Lorentz contraction should end. Philosopher's endeavor to explain, without understanding, the space-time as an objective reality should end too.

By identifying the 'abstract' coordinate systems at absolute rest in special relativity theory, all inertial observers can connect physical quantities which they measure in their reference frames to quantities defined in coordinate systems at absolute rest also by the Lorentz transformation. So Einstein's special relativity theory is a *theory* *of the absolute*. This conclusion is supported by limits that our confirmed working hypotheses set to Einstein's statement [99] that "The name 'theory of relativity' is connected with the fact that motion from the point of view of possible experience always appears as the relative motion of one object with respect to another. Motion is never observable as 'motion with respect to space' or, as it has been expressed, as 'absolute motion'." Even though motion always appears, from the point of view of experience, as the relative motion of one object with respect to another, this happened only because the inertial coordinate system attached to the latter object was named "at rest" and erroneously treated as a coordinate systems at absolute rest. So the special relativity theory cannot be further in the service to of those justifying 'scientifically' the almighty misleading relativism governing the 20th and now 21st century, except for its title.

It is the essential role played by revelation in the act of science that became strikely evident. It was by that Einstein has deduced the Lorentz transformation in [1] manipulating some equations, jumped over any physical explanation of the manipulations, then ignored this derivation of the Lorentz transformation during all his life, although, as we proved in this book, it was so important for the physical foundation of special relativity theory. Since the discarding of his 1905 derivation of the Lorentz transformation has entailed the crisis of modern physics, there results that he was never aware of both the correctness and the worthwile of this derivation of the Lorentz transformation in [1]. Wherefrom we concluded the revealed nature of his manipulation of equations that led to the Lorentz transformation in [1]. On the scientists attitude toward the role of revelation in the act of science depends the amount of information that will remain undisclosed in the terms of the underlying equations in various theories.

By disclosing the objective reality behind Einstein's manipulation of equations in [1], we provided for the first time a rationale for the revealed knowledge. It is this rationale that scientists should give in their works for a true advancement of science to be achieved. It should be understood that science and religion are not antinomies, as they seemed to be in the break of science.

Turning back to the principle of the physical determination of equations, all the advanced relativistic theories concerning the quantum and subquantum structure of matter must be rebuilt according to this principle, till now true exclusively in classical physics. Reducing the equations of the quantum theories to field equations just falsified both the development and the understanding of physics. The genuine information on the subquantum structure of matter should be normally obtained as early as by the 1940's… and it is yet forbidden by a wrong physics policy. It is real the danger that a physics policy disregarding the key role played by revelation in the act of science, and claiming further that "*terms such as 'absolute rest' and 'absolute speed' are completely foreign and unacceptable to physics*" [2], to further hinder a whole understanding of Einstein's original paper on relativity, so the recognition of the validity of the principle of the physical determination of equations in special relativity theory and relativistic physics, prohibiting any true advancement of physics and true technological progress. The concepts of absolute rest and absolute speed should be understood as passwords. Their deletion from special relativity theory just cut off the access to a true advancement of modern physics.

CHAPTER 44

EPILOGUE: FROM 'PHYSICS POLICY' TO 'PHYSICS AS POLICY'

'Physics policy' should define the contest for funds turning research projects into main contributions to progress. But once modern physics was founded disregarding the principle of the physical determination of equations, which associates physical significance to every term of the underlying equations, the only criterion for evaluating most research projects became just the beauty of their mathematical grounds. Bit by bit, mathematics has developed from a subordinate tool for obtaining physical information into the 'authorized', omnipotent tool for making physical predictions. The physical information obtained *using* mathematics as a subordinate tool, and that predicted by sophisticated mathematical theories having little to nothing in common with the objective reality, are on equal footing. So, in lack of funds, the chanes that the first information to be experimentally tested are substantially diminished by the 'prestige of the rigor' and the redundancy recommending the last information foe experimental testing.

Leading physicists have become aware of the resulting lack of finality of most projects, which has scaled up the crisis of modern physics (risen from the physicists' attitude toward the role played by revelation in the act of science and the resulting uncontrolled mixture of revealed and rational knowledge in their minds (Ch. 20)). But, instead of identifying the causes of the crisis (which we pointed out in Prologue), and eradicating them (as we partly did in this book), they have opted for substantial funds by launching big, expensive projects with feeble experimental results. Directed against the true advancement of physics, this procedure was a typical act of corruption that blew up modern physics.

What happened is best evidenced in particle physics. Important information on the structure of the 'elementary' particles was obtained by colliding them at relativistic speeds. Theories trying to connect and explain the obtained information were developed, and a 'standard model' of 'elementary' particle followed. But the 'standard model' is far from complete; much more subquantum information is needed for completion. The particle physicists proclaimed two key ideas for thrusting the project (the same for any particle accelerator facility): 1) that *all* subquantum information would be exclusively obtainable by colliding high energy particles; and 2) the particle theories would then be 'well-settled'. Particle accelerator facilities were further overbid and the Super Collider was proposed as source of ultimate information. Massive funds for it were sought.

But both assertions were quite false. Relativistic theories constructed without the principle of the physical determination of equations (and the particle theories *en vogue* are indeed such theories) are *not* 'well-settled': they have incomplete physical foundations (Ch. 21), and, consequently, miss the essential subquantum information embedded in the terms of their underlying equations. Without the missed information, the information they provide, as well as the information provided by the particle accelerator facilities cannot be understood. The last information is mainly useless. So the particle theories are true puzzles, and the 'standard model' of 'elementary' particle is incomplete, if not false. The missing information needs that radically new experimental facilities to be developed for its testing and exploitation (Ch. 41). So particle accelerator facilities, particularly the Super Collider, are presently unsuitable to develop.

The US Senate did vote against the project of the Super Collider, mainly due to the refusal of some physics leaders to accept diminished funds for other projects that they considered to be just as important as the particle physics [100]. The vote did not acknowledge the falsified grounds of the project. There still firmly persists an unfair fight to impose both the standard particle theories and the particle accelerator facilities (in particular the Super Collider). It is mainly manifested by the global editorial policy of academic publishers who, by rejecting without scientific review (e.g., [101-104]) or with reviews *falsifying* the authors' original ideas (e.g., [105-108]) (sometimes injuriously [106])[11] any papers and books that challenge the two issues, and publishing instantly denigratory papers written by 'authorities', hide challenging results. Particular attention is paid to prohibit works deepening the understanding of Einstein's special relativity theory, the heart of any particle theory. Claims that challenging results did not exist at the time are evidently false[12]. This policy is accomplished by rejecting either without scientific review (e.g., [101-104]) or with reviews *falsifying* the authors' original ideas (e.g., [105-108]) (sometimes injuriously [106])[13] in papers and books submitted for publication. So the standard particle theories and the Super Collider survive without rivals.

They invented stereotype formulas of perennial use, like i) "Physical Review Letters does not consider articles which propose a *speculative alternative* to a *widely accepted* theory"[14], ii) "Physical Review D does not publish papers that present *alternative investigations* of old and *well-established* concepts", iii) "I do not accept your paper for publication. *I have reached this decision because certain statements and terms, such as 'absolute rest' and 'absolute speed' are completely foreign and unacceptable to physics… Your arguments are not understandable to me, and very likely to the large community of physicists who have learned about motion in first year courses*" (A. Degasperis, coeditor for Europhysics Letters [2]), iv) "*We were unable to publish your paper because it claims to find problems with the theory of special relativity and the Lorentz transformation*. Both the physics and mathematics have been extensively explored over the past century. The observational predictions of special relativity are proved and reproved hundreds (why not thounds?) of time everyday around the world (confirmed by [29]!)… The theory has been formulated in many different ways and there are no inconsistencies or mathematical problems. *For these reasons the paper is*

[11] There are also reports claiming the 'need to protect readers' [2] and "the journal scientific prestige" [106] or merely stating that by accepting these results, 'we' would loose the control on their consequences.

[12] Our model of 'elementary' particle was the subject of former papers [101-104] submitted for publication to mainstream journals of physics, and automatically rejected. When presented at a conference [16], any comment of the audience on paper [104] was forbidden by a supervisor APS, and followed by an official teaching, standing for the editorial policy just pointed out.

[13] There are also reports claiming the 'need to protect readers' [2] and "the journal scientific prestige" [106] or merely stating that by accepting these results, 'we' would loose the control on their consequences.

[14] Like Phys. Rev. A and Phys. Rev. B, the Phys. Rev. Lett. requires, "in light of many experiments over the past century that have confirmed its whole validity" (see also [29]) that "any manuscript which attempts to show a contradiction in special relativity to meet a very high standard of proof". It is a false and cynical requirement. First because any deepening in understanding Einstein's special relativity theory is systematically qualified as pointing to a 'contradiction', and treated as such. Second because the reaching of a "very high standard of proof" of a paper is actually unwished: "the manuscript has been rejected (just by the editorial letter requiring the "very high standard of proof"!) and hence we can not consider a revision there of".

incorrect and can not be published." (Classical and Quantum Gravity - CQG/120174/PAP/22 Dec. 2000), v) "*Your paper has not been considered for publication* in CQG *because it concerns the understanding and formulation of special relativity*. *This is not within the scope of CQG which publishes only original research results*" (Editorial Policy of CQG Senior Publisher), vi) "Editor thanks… but regrets that *he is unable* to publish it… that *he can not* enter into further correspondence on this matter" (Nature Administration) [102], vii) "It is not our policy to give explanations in every case as to why a manuscript may not be suitable for the Physical Review, nor do we request formal reports on every manuscript submitted. This is the summation of the Editor's judgement in the light of the advice from *chosen* consultants and the requirements of the journal. Your manuscript *was judged to be unsuitable on the basis of its subject matter*; *no evaluation was made on the correctness of the manuscript*" [109], viii) "If in the *judgement* of the editors a paper is *clearly unsuitable* for Phys. Rev. D, it will be *rejected without review*" (statement of Editorial Procedures, webpage), and ix) "It is Nature Physics' policy to return a substantial proportion of manuscripts without sending them to referees. Decisions of this kind are made by the editorial staff when it appears that papers are unlikely to succeed in the competition for limited space. In the present case, while your findings may well prove stimulating to others' thinking about such questions, I regret that we are unable to conclude that the work provides the sort of firm advance in general understanding that would warrant publication in Nature Physics." [110-111]. By such formulas, they clearly forbidden the deepening in understanding the physical grounds of Einstein's special relativity theory, which is the keystone for the true advancement of physics.

Most explicit stereotype formulas are the editorial 'reports' [112-114] concerning papers [115-116]. Although I have deduced that 'abstract' coordinate systems at absolute rest (also defined and distinguished from reference frames in Ch. 4 (Sect. 1.1)) can be associated to inertial coordinate systems (see also Ch. 6) without violating the principle of relativity, proved (see Ch. 6 (Sect. 1)) that any relative motion is described with respect to such a coordinate system at absolute rest, and identified such a coordinate system at absolute rest in [1] (see Ch. 14 (Sect. 1)), although I defined the professional inertial observer (see also Ch. 6) and proved that absolute speeds can be determined experimentally by the inertial observers without referring to a physical substratum (see Ch. 17), it was claimed, respectively, that i) I "assumed that an absolute reference frame exists and can be determined by 'professionals' (also defined in Ch. 6), violating not just the results of special relativity but one of the two fundamental principles on which the theory is based" [109], ii) I "failed to prove that an inertial observer (what is a professional observer?) can always describe the motion of an object with respect to a coordinate system at absolute rest", rather I "assumed that *such things* as 'absolute rest' and 'absolute velocity' exist and can be measured. This assumption though violates a fundamental prediction of special relativity. Since at the present time *there are no experimental which contradict any prediction of special relativity*, it is accepted as the correct description of the reality" [112], and iii) I "introduced *a common absolute rest frame* with respect to which physics is referred" [113]. So it was concluded, respectively, that [115] "contradicts special relativity" [112] and "the conclusion of [116] is not correct" [114]. So [112-114] prove that *the clue procedure of the global editorial policy* consists in *mystifying* the main ideas of a paper, adding that "*special relativity theory has* *been experimentally confirmed about as much as any theory CAN be*" [112], then claiming that the "manuscript's results are wrong and *it is not publishable in this or any other journal*"[112]. To the magnificence of the special relativity theory, incontestably proved by us that it is the only theory providing the physical foundations of modern physics, this policy opposes (*why?*) its "survival for the best part of a century, despite many challenges based on alleged discrepancies in its application, or on *apparent* inconsistencies in its *accepted* (*by whom*?) interpretation" [117].

Moreover, rejecting by this procedure an experimental proposal (the inertial observers ability to determine absolute speeds) [112], and adding that "If relativity is ever found to be incorrect, it will be because of experimental data" [112], there becomes evident that by decisions based on mystification (like [109-113]) *the editorial policy really stifles obtaining experimental data incontestably proving both the absolute rest and the absolute speeds in special relativity theory.*

Since these results (clearly proved in Chs. 14, 17) are basic for disclosing the validity of the principle of the physical determination of equations in Einstein's special relativity theory and relativistic quantum theories, so obtaining genuine information on the subquantum structure of matter, the editorial policy prohibits the way toward getting and applying this information. Any presumption that the aim of the common strategy of the editorial policy of APS, EPS, IOP, etc. would be that of keeping unaltered Einstein's fame is just a false. All the rejected results, now included in this book, like those in [101-104, 115-116], prove undoubtedly that Einstein's genius is actually far beyond that just celebrated in the 'World Year of Physics 2005'.

The fight to impose the standard particle theories and the Super Collider was successfully repeated bit by bit in connection with another relativistic theory -the general relativity theory. This time the imposed project was the cryogenic bar detection of gravitational waves. A dependence on speed of the gravitational wave interaction with test particles [68], which pointed to a diminished efficiency of the cryogenic detectors, raised doubts. But the doubts were deftly discredited by one short paper, published simultaneously in two physics journals [118-119], promising [119] a full paper soon. The project was launched, and the promised full paper never published in the following 27 years; its promise has been enough. Also no paper on the subquantum nature of the gravitational waves, except [83-85][15], was accepted for publication in the mainstream journals of physics. The short paper [89] has appeared initially in a mutilated form [88]. It becomes evident that in this case, like in that of the Super Collider, the global editorial policy has contributed mainly to, not the advancement of physics, but rather the crisis of physics. Truly shocking is the destiny of the peer reviewed science journals which referees refuse to change at command their decisions on the publication of correct papers. Such journals are merely dissolved[16]. Faced with this policy, there is no place for innocence.

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[15] By the way, 'accidentally', the ISI did not register the citation of [83] in [120] ("More interesting approaches have been discussed by… and Ceapa").

[16] It is the case of the online 'Journal of Theoretics', now dissolving. After the referee's aproval, a paper of mine has appeared in vol. 5-5 of the journal in mutilated, unintelligible form [121]. The 'mistake' was justified [122, 123] by the additional changes operated by author. The paper was withdrawn, on request, by three weeks later [122, 123]. A new version and reviewing process were claimed by the editor [122]… by courtesy. Referee has renewed his decision of publication, while editor downrighted his policy of discrediting the paper. Against the referee's decision acknowledged to me [123, 124], paper [22] did not

All the cases cited mark the turning of 'physics policy' into 'physics as policy' by those responsible for making the decisions about which topics in physics get supported. 'Physics as policy' means physics as source of funds for boosting doubtful careers and maintaining good jobs. 'Physics as policy' deserves exclusively group interests. So 'physics as policy' is a deonthological, social and political exercise. It is contrary to the advancement of physics and technological progress. It was assured by imposing a training system based on excessive repetition, which to relativize the scientific truth and inculcate into the minds of subsequent generations of physicists the belief in the relativistic theories, disregarding their foundations. The discretionary physics policy is maintained by the lack of any dialogue between the community of the physics researchers and people 'contributing to the development' (i.e., to the crisis) of modern physics, who falsely invoke the human lack of time [129]. It is actually the refusal with arrogance by those 'contributing to the development' of modern physics to investigate the correctness of their "understanding of the pattern of scientific explanation" before claiming in its name that "alternative ideas (perhaps most of them) are not worth pursuing" [129]. Their self-imposed 'professional' authority has prohibited systematically testifying and developing new ideas, so maintaining the crisis of physics.

We have to disappoint those suspecting that behind the turning of 'physics policy' into 'physics as policy' one would find the hiding of top-secret military researches. The project of the Super Collider was started indeed under President Regan's administration [130]. However, the particle theories on which this project was founded crowned the modern physics, which crisis prohibited the development of technologies having nothing in common with contemporary technologies, so tacitly undermined (at least) the US military power and security after the 1940's.

The 'religious' disregard of the concepts of absolute rest and absolute speed, promoted by APS, EPS, etc. through any means, seems to protect groups already exploring some of the physics which we just outlined in this book. The scenario looks very much like that of persuading Stalin in 1951 to stop launching officially the computer technology programme under the 'iron curtain'. Then it was altered a supreme decision, now are altered the physicists' individual decisions. Then it was 'kept unaltered the purity' of the communist doctrine, now it is 'kept unaltered the purity' of Einstein's doctrine (a doctrine from which the derivation of the Lorentz transformation in [1] was 'accidentally' wholly discarded!). So the turning of 'physics policy' into 'physics as policy' may be followed by a boom on the world market of novel technologies (not just one as in the case of the computers) and products with maximum of profit -one fabulous by comparison with the profit afforded by assuring the security of a state.

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appear in vol. 5-6 on 01Dec03 [125]. It was added to vol. 5-6 by two weeks later, after altered versions of [22] were added succesively on 02Dec03 [123, 124], 03Dec03 [126] and 06Dec03 [127]. There was no acknowledgement of the readers about the 'editorial error' ("I cannot"). Moreover, after [121] has been removed from vol. 5-5 on 21Oct03, it was put back in vol. 5-5, in archives, on 01Dec03, and maintained there until 10Feb04 [128] Commanded discreditation fully accomplished. The title of [22] tells us all: the concept 'absolute rest' being proclaimed as "completely foreign and unacceptable to physics" [2], and papers on absolute rest frame (to which the abstract coordinate systems at absolute rest are reduced by mystification) "are not publishable in this or any other journals" [112], the abstract coordinate system at absolute rest should also be stifled in the Journal of Theoretics. Otherwise…

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APPENDIX

With

copies of some papers published by the author and some private letters

True Rationale for Celebrating Einstein’sSpecial Relativity Theory

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In the year of physics 2005, the anniversary of a century from the publication of Einstein’s original paper on relativity would be all the more significant by celebrating it along with the recognition of both the accuracy of the derivation of the Lorentz transformation in that paper and its revealed nature. Ignoring of the two issues raises the perennial criticism of the special relativity theory (SRT) and the crisis of modern physics as well. That recognition would enable physicists to 1) recognize the validity of the classical principle of the physical determination of equations in SRT, implicitly in modern physics, with the latter providing genuine information on the subquantum structure of matter, and 2) understand correctly some apparent dysfunctions in the SRT. It is through both above statements that the contribution of Einstein’s theory of relativity to the progress of science and mankind is truly accomplished.

The birth of a new idea or set of coupled ideas promoting the advancement of science is an act of science. The ignorance of revelation in the act of science was in accordance with the foundation of physics as a science on measurements and elementary calculation, but such ignorance has altered dramatically the further development of physics when syntheses of experimental data and advanced calculations have been involved.

Many personalities in the history of science, particularly in that of modern physics, have obtained worthy and valuable results under revelation. However, the prevailing idea that science and divine work are antinomies made them unable to provide any rationale for them [1, 2]. Consequently, they wholly or partly discarded such results for worse ones. That is what has happened to Albert Einstein when he tacitly discarded the derivation of the Lorentz transformation (LT) in the paper now celebrated [3]. As I have proved by deducing the LT as a time-dependent coordinate transformation (required by the need to determine the direction and length of the radius vectors of the moving geometrical points by light signals tracing them) [4], despite their apparent want of justification, all the mathematical fiats that he used to obtain the LT in [3] were accurate as being physically determined. So that, Einstein’s derivation of the LT in [3] was right. Moreover, by predicting the terms □x, □t like a Cartesian coordinate and the time in which light travels that coordinate, respectively, the derivation of the LT in [3] removes the mystic of the factor □, proving to be the only one to validate the classical principle of the physical determination of equations within the special relativity theory (SRT). The principle stipulates that each term of an equation describing a physical phenomenon is in correspondence with a facet of that phenomenon [5, 6]. Unfortunately, Einstein was aware neither of the accuracy of his derivation of the LT in [3] nor of its unique and essential role in validating that principle in SRT and the relativistic physics that followed -what proves clearly the revealed nature of his mathematical fiats and explains his foundation of SRT on [3] less the derivation of the LT in [3]. Also unfortunately, within a century’s span, no such principle has been recognized in SRT. Neither has it been recognized in the modern physics relied on Einstein’s theory. No textbook paid any attention to this principle.

Consequently, with the ignorance of this principle 1) SRT predicted -as part of a ‘new view of space and time’- the unrealistic time dilation, that had nothing to do with the larger lifetimes of the ’relativistic’ particles (being actually related to the subquantum nature of the mass [7]), 2) the relativistic quantum theories missed major physical information, and 3) the mathematical models devoted to describe some unconventional experimental results failed to give evidence for the common subquantum nature of the phenomena they were concerned with, and, so, to refine such experiments into radically novel technology. It is here where the crisis in modern physics has risen from, as much as the crisis in technology.

‘Rehabilitating’ the derivation of the LT in [3], and validating the classical principle of the physical determination of equations in SRT, I have opened the way towards removing both crises: The classical principle of the physical determination of equations in Einstein’s SRT prompts the inference of further physical information regarding the subquantum structure of matter [7, 8] from the terms in the basic equations of the relativistic quantum theories. Such novel information is complementary to the old one provided by the Copenhagen school interpretation, and indispensable in understanding and exploiting that obtained by colliding relativistic particles. There arises the magnificent role of the SRT in physics and the key role of the revelation in the act of science. A reviewing of the modern physics -built by ignoring the revelation role in the act of science- in the light of the classical principle of the physical determination of equations needs be effected by looking for the information hidden in the terms of the basic equations and removing the useless ascendancy that mathematics gained over physics. The resulting information that feeds radically new technologies (and not its ‘survival for the best part of a century’ [9]) is that providing the rationale for a true celebration of Einstein’s SRT.

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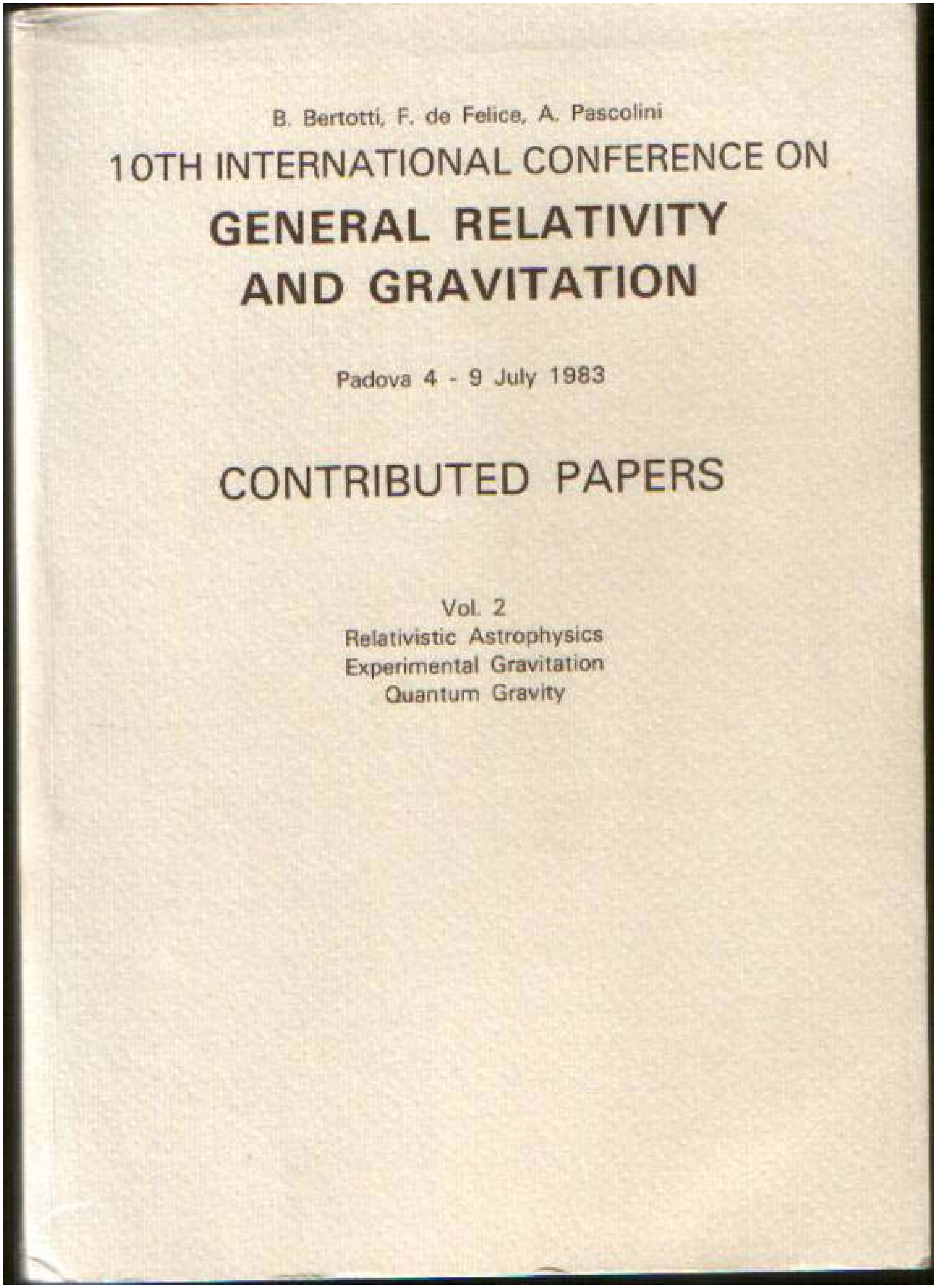

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OPERATIONAL LORENTZ TRANSFORMATIONS. CONSEQUENCES ON GWs AND THEIR CRYOGENIC DETECTION.

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A basical idea of the earlier remarks [1] on cryogenic bar detectors of gravitational waves (GWs), namely that of operationally defined Lorentz transformations (LTs), is defined. Both, its special and general - relativistic consequences are pointed out.

The coordinates of a geometrical point P being (as projections of its position-vector onto the coordinate-axes) measurable lengths, the operational method one applies for disclosing their eventual changes under a uniform relative motion of the coordinate systems S',S (inertial reference frames), is operations by which they are recorded. In that case, the length and sometimes also the direction of the vector OP (Fig.1) giving the position of a moving P (carried by S') in the reference frame S of an observer are time-dependent. As result OP is traced, for any relative velocity v, by a light signal and a coordinate transformation becomes possible only when this signal reaches P. Recorded like light travel-time, the duration of the S'-S relative motion follows to arise in coordinate transformations.

An operational rederiving of LTs which to explicitate the meaning of their terms supports this reasoning. In this purpose is

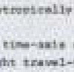

Fig. 1. Sketch defining the time-axis by means of OP. Arrows denote rays of light.

used a front of light isotropically radiated by a source placed at O (Fig. 1).

It determines a fictious time-axis on which are made the algebraic operations with light travel-times which the additivity of the geometrical transformations involves. The recorded light travel-time $\underline{t}$ (Fig. 1) takes on this "axis" the value $t/\sqrt{1-v^2/c^2}$, where t is the "time-coordinate" and c the speed of light (hence there is no time-dilation!). The suitable travelled space $c\underline{t}$ is translated on the x-axis like $x/\sqrt{1-v^2/c^2}$ and

gives that x which can physically be related to the x' of P at an instant of the S'-S relative motion.

The resulting diagrams (Fig.2) reproduce the standard LTs :

$t'=t/\sqrt{1-v^2/c^2}-(vx/c^2)/\sqrt{1-v^2/c^2},\ x'=x/\sqrt{1-v^2/c^2}-vt/\sqrt{1-v^2/c^2},\ y'=y,\ z'=z.$ (1)

The 2nd terms on the rhs of x',t' are the distance covered by the origin O' of S' until the signal reaches P, and the suitable time, respectively,

(O,O' coinciding initially).

Fig.2. Diagrams equivalenting sketch 1, that give LTs(1). O_t', O_t denote time-origins.

As seen, the mixing of the time with space-coordinates does not follow from a physical 4-dimensional spacetime but, on the contrary, determines it as an operational concept.

Fig.3. Diagrams predicting LTs(2) as $x'=x-vt$, $t'=t-vx/c^2$,...

A 2nd set of LTs, viz.

$t'=t-vx/c^2,\ x'=x-vt,\ y'=y,\ z'=z,$ (2)

equally relates S',S when OP can be traced by a light signal propagating along their coinciding x',x-axes because x=ct (Fig.3).

Fig.4. Sketch based on Zeno's paradox which predicts (2). O_1', O_2',... are successive positions of O'. $t=t'(1+v/c+v^2/c^2+\cdots)=t'/(1-v/c) \Rightarrow t'=t-vx/c^2$.

It is regained from a calculus based on Zeno's paradox of the arrow (Fig.4), what strengths that LTs relate coordinate systems found in relative motion. More useful, the LTs

$t'=t-x/c,\ x'=x-ct,\ y'=y,\ z'=z$ (3)

got from (2) for v = c, are regained from Fig.5. They show that particles moving at speed c relative to S, have proper frames S'.

Fig.5. Diagrams predicting LTs (3) as $x'=x-ct$, $t'=t-x/c$,...

A lapse of time in S' is recorded by an observer found in S as the rhs of the time-relation of (3), known as retarded time in electromagnetic and gravitational theories. The physical lack of advanced quantities originates in the fact that no observer is carried by S at speed c, and proves that the operationality of these theories follows from the Lorentz conditions or equivalents of them. The time dependence given by (3) shows that constant electromagnetic and gravitational fields also travel at speed c.

The proper frame S' of a gravitational field helps to define in the weak-field approximation of general relativity the GP (plane) as an physical entities.

It consists in conceiving u^μ, introduced by the orthonormality conditions [1] $\bar{h}^{\mu}_{\nu}u^{\nu}=0$ (4) like the wave 4-velocity.

Receiving directly the GWs, an observer found in S relates the potentials $\bar{h}^{\mu\nu}$ (defined by $\bar{h}^{\mu\nu}=h^{\mu\nu}-\frac{1}{2}\eta^{\mu\nu}h^{\alpha}_{\alpha}$) as well as the infinitesimal components $h^{\mu\nu}$ of its metric tensor in the frames S, S' by

$\bar{h}^{\mu\nu}=a^{\mu}_{\alpha}a^{\nu}_{\beta}\bar{h}^{\alpha\beta'}$ (5) and $h^{\mu\nu}=a^{\mu}_{\alpha}a^{\nu}_{\beta}h^{\alpha\beta'}$, (6)

respectively, with the a's given by (3). Calculating, as seen from (4)-(6), for u^μ given by (o,o,o,c) and (o,o,o,c) in S', S, respectively, both the orthogonality of the GWs potentials and their invariance by

$h^{\prime}_{22} = h_{22} = - h_{33} = - h^{\prime}_{33}$, $h^{\prime}_{23} = h_{23} = h_{32} = h^{\prime}_{32}$, $(h^{\mu}_{\mu} = 0)$.

Obtained without imposing the physical meaningless conditions $\bar{h}^{\mu}_{\nu} = 0$ (naturally involved by the above reasoning), which restrained the GPWs existence to an arbitrary coordinate system, these relations support the requirement (8) of [1] and consequently the velocity- dependent excitation of the antenna by GPWs.

It follows, as earlier pointed out [1], that the attempts of improving the sensitivity of GWs bar detectors by their cooling at temperatures near 0°K is not supported by an operational review of their theory.

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DETECTION OF GWs BY JOSEPHSON JUNCTIONS

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Related by the generalized momentum, the general theory of Josephson junctions and the Lagrangian theory of spinless and spin -1/2 particles found in curved space-time predict the detection of gravitational waves (GWs) by Josephson extra-currents they induce.

The extra-currents originate in the shift, ε, of the phase difference, Ψ ($\Psi = \Psi_0 + \varepsilon$), between the quantum waves of the electric charge carriers across the junction under the action of physical fields, given by [1]

$\nabla_i \Psi = p_i / \hbar$, (1)

where $\nabla_i = \partial/\partial x^i$ is the gradient operator, p_i is the generalized momentum and $\hbar$ is the Planck constant $h/2\pi$.

They are yielded by substituting the integrated Ψ into the current-phase relationship

$J = J_0 \sin \Psi$, (2)

where J_0 is the critical current, in the approximated form

$J_\varepsilon \cong J_0\, \varepsilon \cos \Psi_0$, $(\varepsilon \ll \Psi_0)$. (3)

Eq. (3) provides a simple way to test the GWs existence by Josephson junctions. In this aim p_i is estimated from the Lagrangian describing spinless particles (as the Cooper pairs are) [2] in the curved space-time of a weak gravitational field, like*)

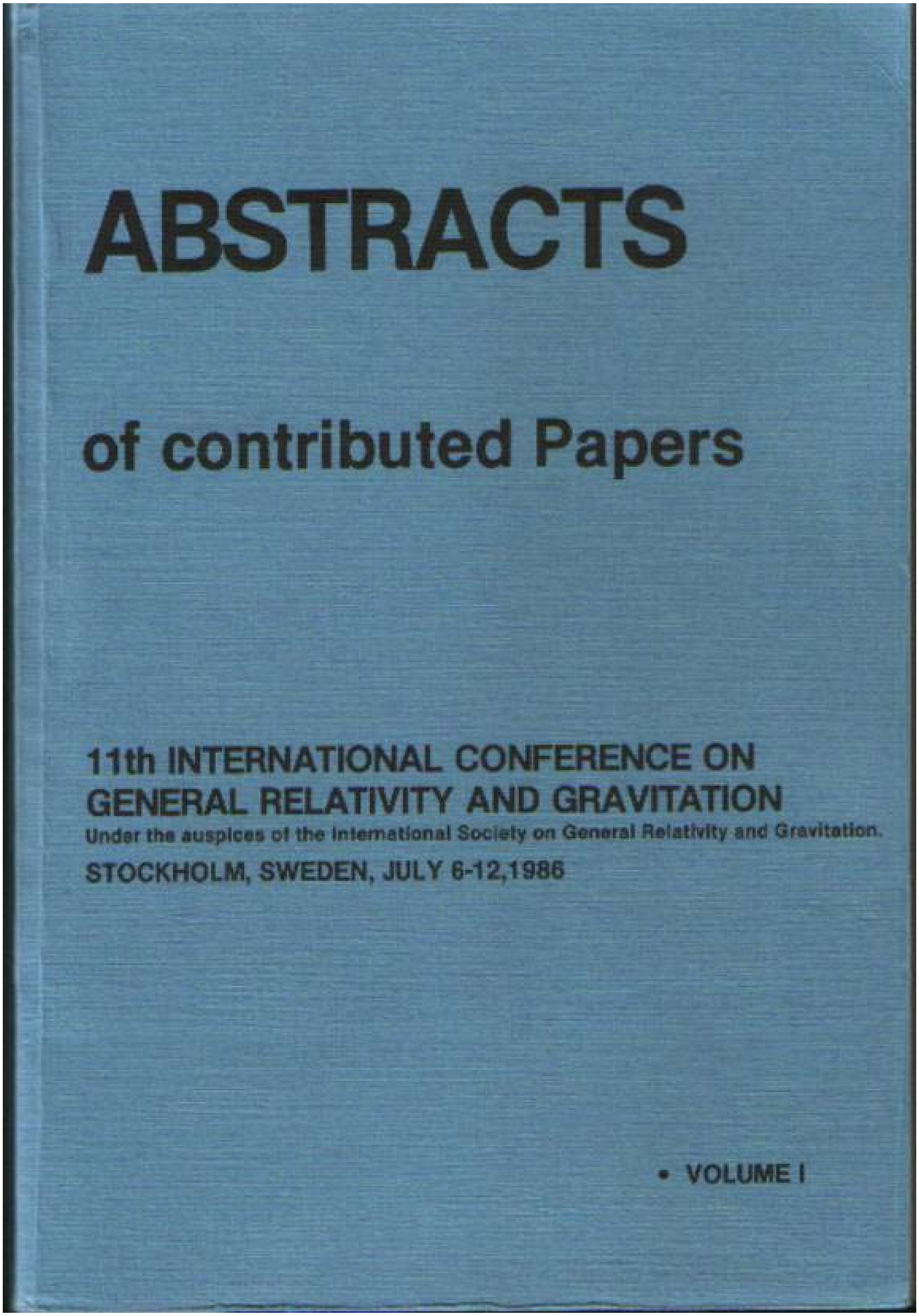
$p_i = p_{0k} (\delta_{ik} + \delta_{kj} h_{ij})$, (4)

where p_0 is the particle initial momentum, δ_{ik} is the Kronecker symbol, and h_{ij} is the infinitesimal part of the metric tensor. The suitable J_ε is easily obtained from (1) and (3):

$J_\varepsilon \cong J_0\, p_{0i}\, h_{ik}\, l_k\, \hbar^{-1} \cos \Psi_0$, (5)

where l_k is the thickness of the junction. For a GP (plane) physically defined [3-4] propagating along the x-axis, the only non-zero h_{ij} (the GW potentials) are: $h_{22} = -h_{33}$, $h_{23} = h_{32}$. They define two states of tensorial polarization of amplitudes $A_+, A_\times$, respectively, related through a rotation of 45°, each of which represents opposite forces the wave exerts upon electric carriers along 2 orthogonal directions laying in a plane transverse to its wave -

*) Greek indices run from 0 to 3; Latin indices run from 1 to 3.


ABSTRACTS
of contributed Papers
11th INTERNATIONAL CONFERENCE ON
GENERAL RELATIVITY AND GRAVITATION
Under the auspices of the International Society on General Relativity and Gravitation.
STOCKHOLM, SWEDEN, JULY 6-12,1986
• VOLUME I

1

MORE ABOUT OPERATIONAL LORENTZ TRANSFORMATIONS AND THEIR CONSEQUENCES

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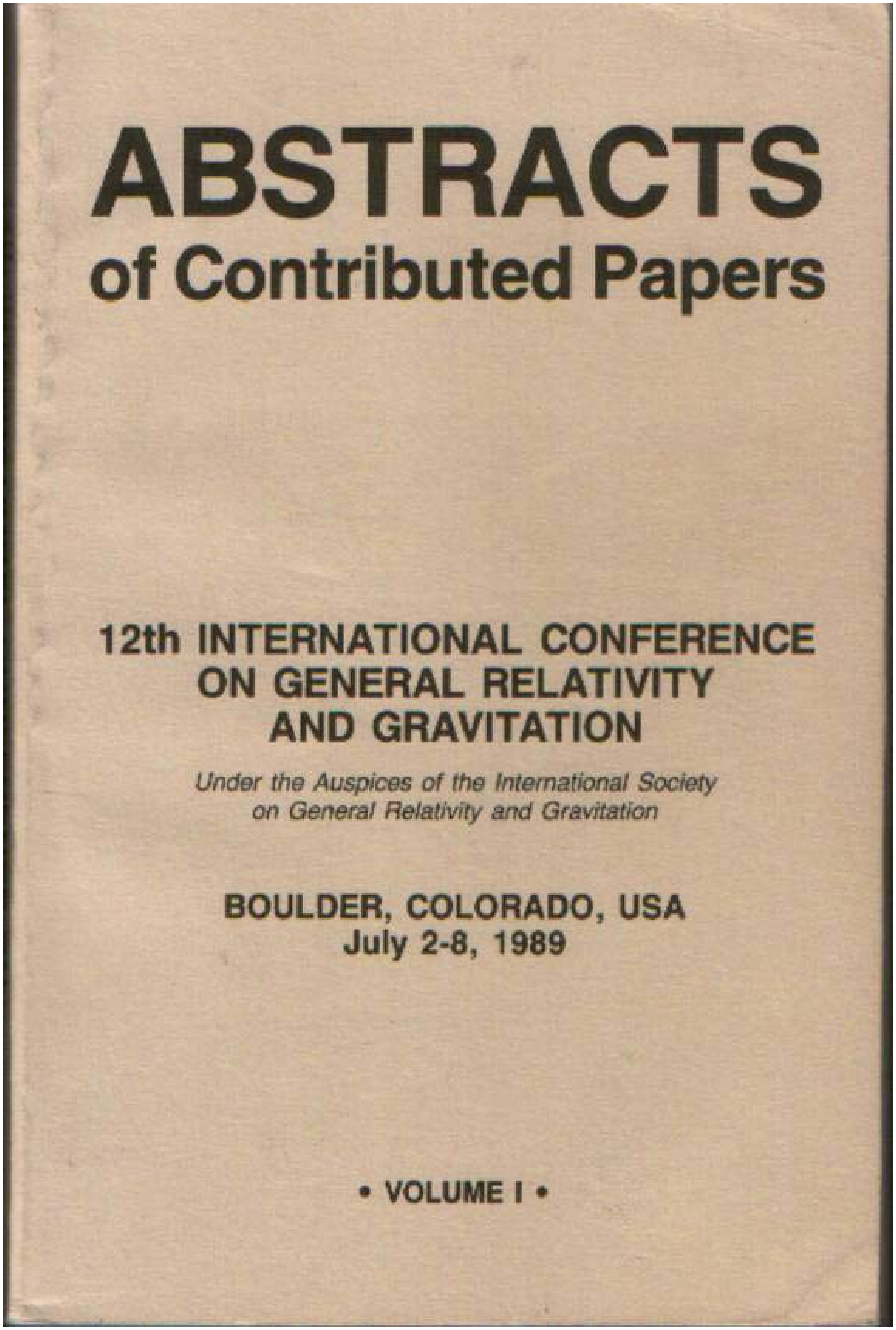
I showed[1] that : 1) Lorentz transformations relate steady-moving coordinate systems 2) as P is a unfixed point of the moving systen S',its position vector (pv) in S is traced by a ray of light and depends on its travel time (tt) 3) for keeping unaltered the usual operations with times, when defined like tts along arbitrary directed pvs, it needs a time-axis (ta) defined as a time-equivalent of the coordinate axis on which pvs can be embeded parallely 4) the tt appearing in Lts gives them the denominator $\sqrt{1-v^2/c^2}(=1/\beta)$ it gets when refered to the ta, what removes the time-dilation 5) the time-Lt is a time-equivalent of the Lt written along the direction of relative motion. All these results are also proved by regaining the general Lts: $\vec{r}'=\vec{r}-\vec{v}t+(\beta-1)(\vec{v}/v^2)[(\vec{v}\vec{r})-v^2t]$, $t'=\beta(t-(\vec{v}\vec{r})/c^2]$,
from Fig.1 by $\vec{r}=\vec{OP}_1+\vec{P_1P}$, because i)$OP_1$ being orthogonal to $O'P'$ (which predicts ta) undergoes a change[1] by its tt which is refered to the ta ii) P_1P being parallel to $O'P'$ rests unchanged.
Since the space and the time are entities related only by the physi-

Fig.1

cal tracing of pvs, these results involve an operational understanding of the special relativity 4-dimensional formalism. For this plead, too, the singular Lts[1] $x'=x-ct,\dots t'=t-x/c$, which: 1) refer to S' carried by fields propagating with speed c 2) have no inverse, $x=x'+ct',\dots,t=t'+x'/c$ corresponding to another P 3)predict the omnipresence of the retarded potentials in both em. and gravitational theories because the travelling directions of the fields coming to a terrestrial observer are spread in a solid angle of at most 2π sterad ($t'=t+x/c$ refers to another S', moving ~~with speed =c) 4) time-eqn.~~ follows from the suitable eq. (2) involving the law of Hubble, $c\Delta\lambda/\lambda=Hx$, with $H=v/\lambda$ which also derived by another method shows that $\Delta\lambda$ originates in the recoil of a microscopic source of light when it emits $\varepsilon\lambda$, what agrees with stellar data 5) giving in S the time measured by a clock attached to S', show that the Lorentz conditions are those required for founding theories which to express physical quantities in the observer frame, i.e. operational theories.
The Lts belong to the class of physical transformations obtained by tracing the P's pv in S by any physical signal of constant speed.

[1]*A.Ceapa,Contrib.Papers,10th Internatl.Conf.GRG v2,p.904, 1983.*



ABSTRACTS
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12th INTERNATIONAL CONFERENCE ON GENERAL RELATIVITY AND GRAVITATION

Under the Auspices of the International Society on General Relativity and Gravitation

BOULDER, COLORADO, USA
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• VOLUME I •

RELATIVISTIC THEORIES LIKE OPERATIONAL THEORIES

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A physical theory is an operational theory if and only if the quantities entering its equations are expressed in reference frames (rfs) S of the inertial observers measuring them. Hence both em and gravitational(gr) field theories as well as the special relativity, whose quantities are defined in rfs S' moving uniformly with respect to S, need to be founded as operational theories. Naturally the Lorentz covariance of their eqs. cannot serve this aim. Only the Lts giving S-equivalents of distances and times elapsed in S' without observers[1], enable us to express quantities defined in S', i.e. depending on x,t, with respect to S. Relevant is eq. $\bar{t}=t(1+2\varphi/c^2)^{1/2}$ $\sqrt{(1-v^2/c^2)^{1/2}}$, φ is the Newtonian potential) appearing in the linearized form of the general relativity, which is usually reduced to $\bar{t}=t(1+2\varphi/c^2)^{1/2}$ (2) by imposing $dx^i=0$ in metric, since in view of[1] $\Delta t=\Delta t/\gamma$ it reveals that $\bar{t}$,t of (2) are estimated in S. Looking carefully at the rhs of Lts (3)[2] on one side, and to the argument of F(t-x/c) (F stands for potentials, fields, etc) as well as to that of the functions f, ζ^{μ} (μ=1-4) appearing in the gauge transformations of the fields 4-potentials on the other side we see that both em and gr theories tended historically to become operational theories by imposing the mathematical Lorentz condition $A^{\mu}{}_{,\mu}=0$ and its gr counterpart $\psi^{\mu\nu}{}_{,\nu}=0$. As A^{μ}, $\psi^{\mu\nu}$ are defined in S', f and ζ^{μ} are defined in S', too. It is evident from (3)[2] that in a theory valid in S they must depend of (t-x/c). Empirically felt, this could not be realized without accepting eqs.(3)[2] as Lts. As S' in Fig.5[2] can be related to S by lrs only for P=(0;0), no matter of its direction of motion, without altering the time-Lt(3)[2], the assertion[3] that nature prefers retarded quantities is proved[4].

In special relativity we need to define 4-vectors and 4-tensors in relation to the Lts(2),(3), too, by postulating that $\bar{r}$,t form a 4-vector (x^{μ}). Invariants containing $\bar{r}$,t and suitable physical quantities lead to 4-vectors indeed. E.g., the invariant action given by [illegible] in the proper [illegible] of S' between [illegible], [illegible] by Lts (1)-(3)[2], implying p^{μ} = =(E/c,iE),k^{μ}=(ω/c,ik). The transformation [illegible] of [illegible] are related to the way to get such Lt. Since the Lt of x^{μ} has an operational origin and the metric of the minkowskian space time is $ds^2=g_{\mu\nu}dx^{\mu}dx^{\nu}$, the last is an operational concept. The method in record[1] $\Delta t'$ in S by relating it to ds^2 written in S motivates the use of d/ds in eqs. and the rising in S of $1/\gamma$ at quantities defined in S'. These results extend to the general relativity formalism. I notice that both these theories have an inner determination, too. Plane gr waves were operationally defined[2]. Derived by means of the Lts (2), the Hubble law questions the galaxies receding from the Earth[2,5].

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(Erratum Line 6: "unfixed" droped. Lines 30-31: "involves" should read "follows from the suitable eq.(2)[1] involving").
[5]A.Ceapa, Ann.N.Y.Acad.Sci. v.470 (1986) 366.

Some details concerning operational Lorentz transformations

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A.Einstein : "At last it came to me that time was suspect".

An operational approach to the Lts is required by the necessity of inertial observers to measure lengths and times elapsed in natural reference frames (rfs) without observers, which move uniformly with respect to them. All rfs are 3-dimensional coordinate systems (css). The observers'rfs are equipped with clocks, meter-sticks and isotropic sources of light. Lts arised as coordinate transformations (cts) relating css aimed by uniform relative motions.

At last it came to me that time recording was really suspect.

The operational origin of the Lts derived from two ideas: i) The position vector $\bar{r}$ of a geometrical point P of a cs S' moving relative to a cs S depends on time. A ct is performable when P is traced by a light ray (lr). ii) Time defined as a scalar quantity conflicts with the usual practice to put on equal footing travel times (tts) of lrs along arbitrary directions as if they all would travel the same direction.

Point ii) led me to the time - axis [illegible] as a time equivalent of a coordinate axis (ca) orthogonal to $\bar{v}$. The resulting relation between O'P' and r (Fig.1)[1,2], which associates a tt along a ca to each tt along arbitrary directions, being independent of the ca in relation to which it was determined enables us to lie O'P' along the x-axis and to consider it the x-coordinate of a P. With respect to this x is determined that associated to the tt of $\bar{r}$, t/γ ($\gamma=(1-v^2/c^2)^{1/2}$) at which a ct can be performed, as x/γ. It is the $P(x', x/\gamma)$ that for which the Lts

$$t'=t/\gamma - (vx/c^2)/\gamma \quad , \quad x'=x/\gamma-vt/\gamma \quad , \quad y'=y, \quad z'=z \qquad (1)$$

where t is the tt of O'P', are valid. As any P can be traced by a lr, eqs.(1) are satisfied by all P of S'.

Eqs. $\Delta t'=\Delta t/\gamma - v\Delta x/c^2\gamma$, $\Delta x'=\Delta x/\gamma-v\Delta t/\gamma$, ... (2)

derived by subtracting eqs.(1) written for P_1, P_2, which relate times intervals and distances, differ from eqs.(1) by that the 1st of eqs.(2) is not the time-equivalent of the 2nd eq., as happens with eqs.(1). This because $\Delta x'/c \neq \Delta t'$.

Since $\Delta x'$ is measured at the reaching of a single P by a lr, $\Delta t'=0$, $\Delta x=\Delta x'/\gamma$ (3) gives the S-equivalent of $\Delta x'$ as a consequence of the time scale change, not as the Fitzgerald-Lorentz contraction. The S-equivalent of $\Delta t'$, viz. $\Delta t=\Delta t'/\gamma$ (4) is obtained by joining a rl emitted from O (Fig.1)[1,2] with the path travelled along OP by a lr during $\Delta t'$ given by a clock in S'. Time runs uniformly. Eqs.(3), (4) enable one to know $\Delta x'$, $\Delta t'$ by measuring Δx, Δt in S. We do this when we record lifetimes of the quantum particles.

By inserting a cs S'' in Fig. 1[1] that moves relative to both S and S', we refind operationally the group properties of the Lts, plus the relativistic law of adding velocities.

The covariance of both em and gr theories in relation with (1) and not with Lts (2),(3)[1] corresponding to P placed on the x-axis has a natural origin.

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Physics Essays volume 4, number 1, 1991

Coordinate Transformations Between Coordinate Systems in Relative Motion

Alexandru C.V. Ceapa

Abstract

Coordinate transformations between coordinate systems in relative motion are obtained. Using them we (1) reveal that Einstein's special relativity has had success since its inception, because by way of its postulates it also took into account the subquantum structure of matter, (2) outline an operational foundation of modern physics, and (3) rederive the Hubble law.

Key words: coordinate transformation, Lorentz transformation, coordinate systems in relative motion, absolute reference frame, subquantum structure, relativistic energy-momentum relationship, time measurement, time dilation, operational theory, Hubble law

1. INTRODUCTION

The purpose of this paper is to investigate the coordinate transformations between coordinate systems in relative motion and their impact on modern physics.

Consider the orthogonal three-dimensional coordinate systems $S'S$. If $S'S$ are at rest with respect to each other, then a geometrical point P belonging to $S'(S)$ is also at rest with respect to $S(S')$. As a result, the radius vectors $\mathbf{r}'$, $\mathbf{r}$ of $P(\mathbf{r}', \mathbf{r})$, the coordinates of which are defined as projections of $\mathbf{r}'$, $\mathbf{r}$ onto coordinate axes, and the corresponding coordinate transformations are all time-independent. If otherwise, $S'(S)$ moves with mean velocity $\mathbf{v}_M$ relative to $S(S')$ (Fig. 1), and point P moves relative to $S(S')$. Therefore, P's $\mathbf{r}(\mathbf{r}')$ relating $S'(S)$ to $S(S')$, as well as P's coordinates with respect to $S(S')$, change in time. As for the corresponding coordinate transformation, the general change in time of the direction of $\mathbf{r}(\mathbf{r}')$ requires that the drawing of $\mathbf{r}(\mathbf{r}')$ be preceded by a determination of the direction of $\mathbf{r}(\mathbf{r}')$, identified as the direction of travel of that of the physical signals, spread out isotropically by a source placed at the origin $O(O')$ of $S(S')$, reaching the moving point P [a signal of length $r(r')$], the coordinate transformation becomes a mixture of coordinates and travel times. As will become evident below, this tracing of $\mathbf{r}(\mathbf{r}')$ by a physical signal is responsible for the time dependence of the coordinate transformation between coordinate systems in relative motion, distinguishing such a transformation from the standard transformations between coordinate systems at rest.

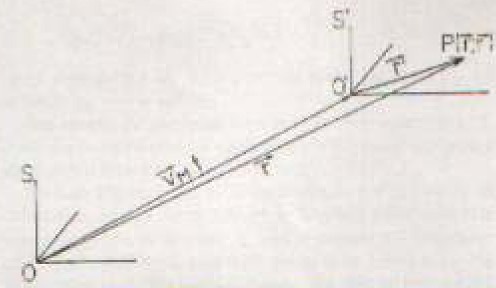

Figure 1. Parallel coordinate systems $S'S$ in arbitrary relative motion. Arrows represent physical signals connecting O to O' and P.

The coordinate transformations obtained here correspond to the following situations: (1) $S'(S)$ moves with mean velocity $v_M(-v_M)$ with respect to $S(S')$ along a common $x-x'$ axis (Sec. 2), and (2) $S'(S)$ moves with mean velocity $\mathbf{v}_M(-\mathbf{v}_M)$ along an arbitrary direction (Sec. 3). For $|\mathbf{v}_M| = v_M = c$ = const and light signals, two of these transformations reduce to the usual Lorentz transformations and so become useful for strengthening the grounds of special relativity by expanding the meaning

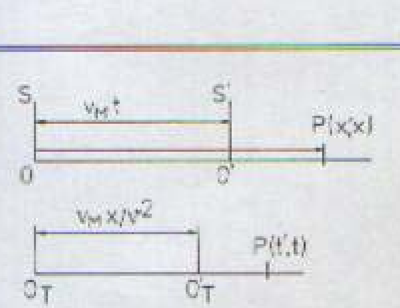

Figure 2. Prediction of Eqs. (1). On the time axis (bottom figure) are times elapsed by physical signals traveling along the x-axis as line segments proportional to their paths.

of its postulates (Sec. 4). Consequences of the new coordinate transformations on measurement of time and distance are further considered (Sec. 5). A review of the retardation appearing in both the electromagnetic and gravitational theories revealing their foundation in reference frames, whose observers measure physical quantities, leads to the concept of operational theory (Sec. 6). Finally, the Hubble law is rederived.

2. COORDINATE TRANSFORMATION (CASE 1)

Proceeding to calculate coordinate transformations between coordinate systems in relative motion, we see from Fig. 2 that the simplest of them, that is,

$$x' = x - v_M t, \quad y' = y = 0, \quad z' = z = 0, \quad t' = t - v_M x/v^2, \quad (1)$$

where v is the speed of the physical signal, and t', t are suitable travel times, is obtained for $P(x', x)$.

Although simple, Eqs. (1) embody the main features of the new class of coordinate transformations: (1) the time dependence of the relation between coordinates taken along the direction of motion, and (2) the appearance of an additional relation as the travel time equivalent of the equation from point (1). The last equation follows by adding travel times of the physical signals propagating along a coordinate axis. It is obtained by drawing a time axis (of origin O_T) parallel to the x-axis (the bottom figure of Fig. 2) on which lay the time equivalents of the distances covered by signals.

The derivation of Eqs. (1) from Fig. 3 depicting an S' moving with a constant velocity v illustrates all the above considerations on the coordinate transformations between coordinate systems in relative motion. It is based on the reasoning of Zeno's paradox of Achille and the tortoise. Indeed, a glance at the top figure in Fig. 3 shows that while a physical signal travels the distances $x', x_0 x_1, \ldots, x_{n-1} x_n, \ldots, P(x')$ covers the distances

$$vt' = x'(v/v),$$

$$(vt'/v)v = x'(v/v)^2, \ldots, x'(v/v)^n, \ldots,$$

becoming, respectively, $P(x', x_1), P(x', x_2), \ldots, P(x', x_n), \ldots$. Hence the x at which the physical signal joins P is given by the infinite geometric series

$$x = x' + x'(v/v) + x'(v/v)^2 + \cdots + x'(v/v)^n + \cdots,$$

of common ratio $v/v < 1$, which converges to $x = x'/(1 - v/v)$. Thus

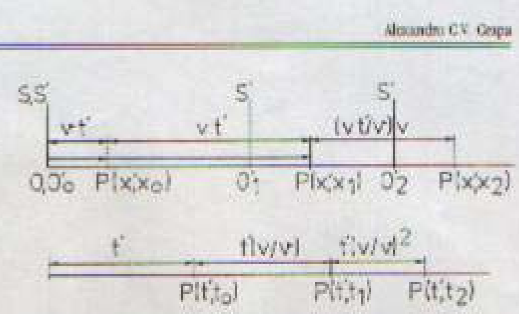

Figure 3. Illustration of Zeno's reasoning that implies Eqs. (1).

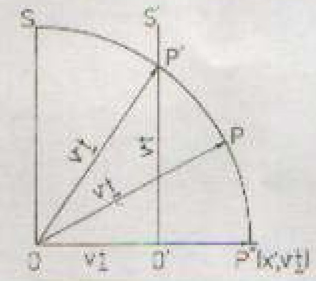

Figure 4. Illustration of a time axis parallel to O'P' leading to (2) and, implicitly, to (3). (Note in Figs. 4, 6, and 7 the t with the tilde beneath it is represented by $\bar{t}$ in the text.)

we rederive the first of Eqs. (1) for $v_M = v$. Similarly, from the infinite geometric series derived from the bottom figure in Fig. 3,

$$t = t' + t'(v/v) + t'(v/v)^2 + \cdots + t'(v/v)^n + \cdots,$$

which converges to $t = t'/(1 - v/v)$, we rederive the last of Eqs. (1) written for $v_M = v$, as well.

Next, consider the geometrical points $P(\mathbf{r}', \mathbf{r})$. Their coordinates in S', S will also be related when the radius vector $\mathbf{r}(\mathbf{r}')$ is traced by a physical signal emitted from $O(O')$ when O, O' coincide.

The main difficulty is this: unlike the above case, $\mathbf{r}$, $\mathbf{r}'$ and $\mathbf{v}_M$ are not defined along the same direction. So, we are faced with adding travel times elapsed along arbitrary directions. In order to overcome this difficulty, we need to find a procedure to point $\mathbf{r}(\mathbf{r}')$ and v_M in the same direction. The simple outline of Fig. 4 is helpful in this aim. The paths OP, OP', and OP'' of the physical signals spread out isotropically by a source placed at O when O, O' coincide enable us, indeed, to relate the travel time $\bar{t}$ elapsed along an arbitrary $\mathbf{r}$ (see the triangle OP'O') to that (t) elapsed if the physical signal travels the path O'P' along a coordinate axis (which is why I defined the time axis as parallel to O'P', hence orthogonal to $\mathbf{v}_M$) by

$$\bar{t} = \beta t, \quad (2)$$

where $\beta = (1 - v_M^2/v^2)^{-1/2}$, and enables us to place $\mathbf{r}$ on the x-axis. Time $\bar{t}$ is the time at which the coordinates of P can be mathematically connected by a coordinate transformation, while t is the time at which the

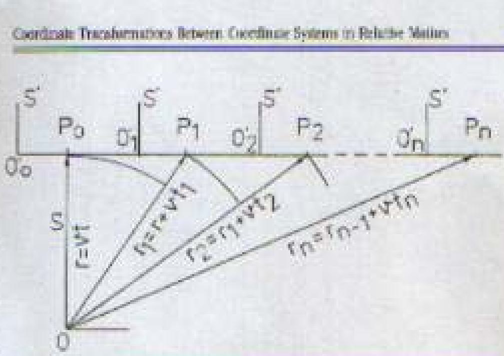

Figure 5. A depiction, based on Zeno's reasoning, that leads to relationship (2).

coordinates of a geometrical point $P''(x', x = vt)$ given by $OP'' = O'P'$ could be related by (1) if the physical signal traveled along the x-axis and not along the arbitrary direction of $\mathbf{r}$. Equation (2) is also obtained from a figure based on the same reasoning as Zeno's paradox associating to a time $\bar{t}$, elapsed along an $\mathbf{r}$ of arbitrary direction joining P to O (see Fig. 5), a travel time elapsed along a coordinate axis. While a physical signal travels the distances (Fig. 5) OP_0, OP_1, OP_2, …, OP_n, …, a geometrical point P belonging to S' changes its position, respectively, from P_0, to P_1, P_2, …, P_n, …, of vector radius

$$r_1 = r_0(= vt) + vt_1,$$

$$r_2 = r_1 + vt_2, \ldots,$$

$$r_N = r_{N-1} + vt_N, \ldots$$

This gives

$$\bar{t} = t + t_1 + t_2 + \cdots + t_N + \cdots = r_N/v.$$

By means of the relation $r_N^2 = OP_0^2 + P_0P_N^2$, implied by the right-angle triangle OP_0P_N, we immediately rederive Eq. (2). This has the merit of simultaneously taking into account the motion of P relative to S and the propagation of physical signals tracing the radius vectors of its intermediary positions.

The possibility of relating P to $P''(x', \beta x = \beta vt)$ by (2) immediately gives the coordinate transformation

$$x' = \beta(x - v_N t), \quad y' = y, \quad z' = z, \quad t' = \beta(t - v_N x/v^2). \quad (3)$$

Since any $\mathbf{r}$ can be traced by a physical signal, Eqs. (3) are satisfied by all the P's of S'.

Finally, we observe that the inverses of Eqs. (1) and (3) are obtained by changing v_N to $-v_N$ and by interchanging their primed and unprimed quantities. Evidently these equations follow from figures analogous to Figs. 2 to 5, corresponding to the motion of S with respect to S'.

3. VECTOR COORDINATE TRANSFORMATION (CASE 2)

The vector coordinate transformation follows from Fig. 6 by applying the previous results: (1) the travel times elapsed along an arbitrary direction

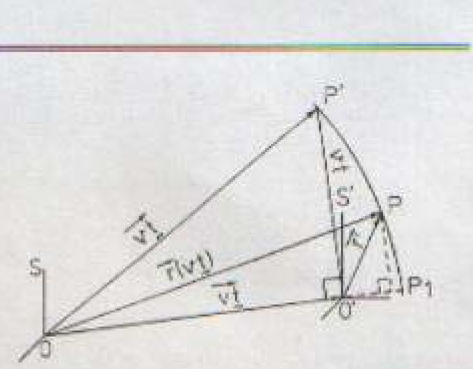

Figure 6. Prediction of Eqs. (4). The time axis orthogonal to $\mathbf{v}_N$ is introduced by $O'P'$. $O'P_1$ and P_1P are the orthogonal components of $\mathbf{r}'$.

change by Eq. (2), and (2) the travel times elapsed along the direction orthogonal to $\mathbf{v}_N$ (i.e., parallel to that defining the time axis) rest unchanged at, respectively, the vectors

$$\overline{O'P}_1 = (\mathbf{r}\cdot\mathbf{v}_N)\mathbf{v}_N/v_N^2 - \mathbf{v}_N t$$

$$\text{and} \quad \overline{PP}_1 = \mathbf{r} - (\mathbf{r}\cdot\mathbf{v}_N)\mathbf{v}_N/v_N^2;$$

from which $\mathbf{r}'$ is

$$\mathbf{r}' = \overline{O'P}_1 + \overline{PP}_1. \quad (4)$$

From (4) we get the vector coordinate transformation

$$\mathbf{r}' = \mathbf{r} - \mathbf{v}_N t + (\beta - 1)(\mathbf{v}_N/v_N^2)[(\mathbf{v}_N\cdot\mathbf{r}) - v_N^2 t],$$
$$t' = \beta[t - (\mathbf{v}_N\cdot\mathbf{r})/v^2] \quad (5)$$

The second of Eqs. (5) is the time equivalent of the first of Eqs. (5), and it was derived by projecting the last equation onto the direction of $\mathbf{v}_N$ and defining t', t, respectively, by $(\mathbf{r}'\cdot\mathbf{v}_N)/v_N v$ and $(\mathbf{r}\cdot\mathbf{v}_N)/v_N v$.

As a corollary to Secs. 2 and 3 we remark that for an S' moving at constant velocity ($v_N = v$) and light rays tracing $\mathbf{r}$ ($v = c$ = speed of light), Eqs. (3) and (5) reduce to the standard Lorentz transformations, respectively,

$$x' = \gamma(x - vt), \quad y' = y, \quad z' = z, \quad t' = \gamma(t - vx/c^2), \quad (6)$$

$$\mathbf{r}' = \mathbf{r} - \mathbf{v}t + (\gamma - 1)(\mathbf{v}/v^2)[(\mathbf{v}\cdot\mathbf{r}) - v^2 t],$$
$$t' = \gamma[t - (\mathbf{v}\cdot\mathbf{r})/c^2], \quad (7)$$

where $\gamma = (1 - v^2/c^2)^{-1/2}$. The inverses of Eqs. (6) and (7) are obtained from those of Eqs. (3) and (5) in the usual way pointed out in Sec. 2, and they are also associated with the motion of S with respect to S'. For the sake of simplicity and for the well-known homogeneity of the standard Lorentz transformations, I required the initial coincidence of O,O'. Simply replacing $\mathbf{r}'$ by $\mathbf{r}' - \mathbf{r}_0'$ and t' by $t' - t_0'$ in Eqs. (5) leads to the inhomogeneous Lorentz transformations, which otherwise required removing the initial coincidence of the two origins in the previous calculation. The four-dimensional space-time is a straightforward consequence of the origin of Eqs. (6) and (7).

4. SOME SPECIAL RELATIVISTIC CONSEQUENCES OF THE NEW COORDINATE TRANSFORMATIONS

By recognizing in Sec. 3 that the standard Lorentz transformations are true coordinate transformations, we define the covariant and contravariant components of a 4-vector, respectively, A_μ and $A^\mu (\mu = 0, 1, 2, 3)$, by their transformation laws[1]

$$A_\mu = (\partial x'^\nu / \partial x^\mu) A'_\nu, \qquad A^\mu = (\partial x^\mu / \partial x'^\nu) A'^\nu \tag{8}$$

under Eqs. (1), (3), and (5) and their inverses for $c_M = c = \text{const}$ and $v = c$.

Rederiving the transformation law for the contravariant components of the energy-momentum 4-vector p^μ by substituting Eqs. (1) and (3) and their inverses in the invariant action written

$$E't' - p'x' = Et - px \tag{9}$$

for a free particle of energy $E'(E)$ and momentum $p'(p)$ in relation with $S'(S)$ shows that Eqs. (8) are actually determined by specific transformations of coordinates.

Indeed, combining (9) with (1) and (3), as well as with their inverses, we get, respectively,

$$E = E' + p'v, \qquad p = p' + E'v/c^2, \tag{10a}$$

$$E = \gamma(E' + p'v), \qquad p = \gamma(p' + E'v/c^2) \tag{10b}$$

and

$$E' = E - pv, \qquad p' = p - Ev/c^2, \tag{11a}$$

$$E' = \gamma(E - pv), \qquad p' = \gamma(p - Ev/c^2). \tag{11b}$$

Similarly, combining (9) with the covariant form of Eqs. (1) and (3) and their inverses, we obtain the transformation law for the covariant components of p_μ, respectively,

$$E = E' - p'v, \qquad p = p' - E'v/c^2, \tag{12a}$$

$$E = \gamma(E' - p'v), \qquad p = \gamma(p' - E'v/c^2) \tag{12b}$$

and

$$E' = E + pv, \qquad p' = p + Ev/c^2, \tag{13a}$$

$$E' = \gamma(E + pv), \qquad p' = \gamma(p + Ev/c^2), \tag{13b}$$

and thus a new corroboration of (8).

Moreover, since Eqs. (1) and (3) and their covariant forms refer to a moving S', the resulting Eqs. (10) and (12) connect quantities existing in a moving system to their values recorded in S. Furthermore, since the inverses of both Eqs. (1) and (3) and their covariant forms refer to an S' at rest, Eqs. (11) and (13) connect quantities existing in a system at rest to their values recorded in S.

For a particle at rest in $S' (p' = 0)$, the first of Eqs. (10) to (13) becomes

$$E = E', \tag{10c}$$

$$E = \gamma E', \tag{10d}$$

$$E' = E/\gamma^2, \tag{11c}$$

$$E' = E/\gamma, \tag{11d}$$

$$E = E', \tag{12c}$$

$$E = \gamma E', \tag{12d}$$

$$E' = E/\gamma^2, \tag{13c}$$

$$E' = E/\gamma, \tag{13d}$$

the second of Eqs. (10) to (13) reducing to $|p| = vE/c^2$.

According to the above remarks on Eqs. (10) to (13), observe that the quantity E' appearing in (10c),(10d) and (12c),(12d) characterizes a particle that moves together with S', while E' appearing in (11c),(11d) and (13c),(13d) characterizes a particle at rest in S', which in turn is also at rest (S moving with respect to S' now). If it is evident that in the last case the particle energy is given by

$$E' = m_0 c^2, \tag{14}$$

where m_0 is the particle rest mass, the usual requirement that the particle energy be $E' = m_0 c^2$ in the former case, too, is not at all evident. Even the standard definition of the 4-momentum p^μ discussed in the Appendix and the experimentally found dependence of the particle mass m on its state of motion by $m = m_0 \gamma$ plead against such a requirement. Therefore, in view of this,

$$E' = m_0 c^2 \gamma \tag{15}$$

in Eqs. (10c),(10d) and (12c),(12d), regardless of the S considered.

Let us now discover the impact, in view of (15), that Eqs. (10c) to (13d) could have on the relativistic energy-momentum relationship. Proceeding to calculate the difference $E^2/c^2 - p^2$ by (10c), (11d), (12c), (13d), and (14), (15), we get

$$E^2/c^2 - p^2 = m_0^2 c^2. \tag{16a}$$

Similarly, by (10d), (11c), (12d), (13c) and (14), (15) we get

$$E^2/c^2 - p^2 = m^2 c^2. \tag{16b}$$

Equations (16) yield the relativistic energy-momentum relationship with the difference that (16b), which represents Eq. (16a) multiplied by γ^2 and embodies a change of origin on the energy scale, has previously been missed due to the assumption that E' is also given by (14) for a particle at rest in a moving S'. Recall that Eqs. (16) have been involved by (1) Eqs. (3) and (1) with $v_0 = v$ and $v = c$, (2) the experimentally found relations (14) and (15) giving, respectively, the energy of a particle at rest and one moving at velocity v, and (3) a rigorous approach to the definition of $p^\mu = m_0 c u^\mu$ (see, also, the last sentence of Sec. 6).

By obtaining the Lorentz transformation as a coordinate transformation between coordinate systems in relative motion [by (7)], it appears quite naturally by the square of p^μ, viz. $p^\mu p_\mu = E^2/c^2 - p^2$, which is an invariant under coordinate transformations, that Eqs. (16) should be valid not only for (3) but also for (1) with $v = c$.

Therefore, Eqs. (16) do not originate in the square root appearing as the denominator of (7). In other words, Eqs. (16) reveal an intrinsic property of matter, which is related by (15) [which was crucial in determining (16)] to the experimentally found dependence of m on the particle velocity.

Since Eq. (16a) led to the prediction of coupled systems of subquantum particles rotating oppositely inside a Dirac particle[3)–(4)] [Eq. (16b) does the same with respect to S_1, given in the Appendix], as well as to the coupling constant m_0c^2 [mc^2 is involved by (16b)] between the two systems, Eqs. (16) appear as a straightforward consequence of the subquantum structure itself. Therefore, successful relativistic quantum mechanics embodying the Dirac equation suggests by its foundation on Eq. (16a) that subquantum particles should be inherent in all the particles its equations describe, and that the quantum rules could result from rules governing the subquantum dynamics. Furthermore, it becomes evident now that the incorrect belief that Einstein's relativity theory does not take into account a subquantum structure of matter represents the underlying reason for the divergence it brought in the microscopic domain, since it permitted particles to occur as point singularities of the field. This shows the importance to physics of experimental tests of the subquantum structure of matter. Since this subject is discussed elsewhere,[5] I here confine myself to point out that by sudden reversals of its electron spins, a metal can release an energy density of the order of 10^{17} J/cm^3. This is about 0.1 as large as that initially released by an atomic bomb. The thought experiment is based on the possibility of altering the coupling between the systems of subquantum particles inherent in electrons, while the above estimate corresponds to the limit situation, i.e., the breaking of the coupling. It is also of interest at this stage to outline the subquantum origin of both electromagnetic and gravitational fields as it follows from writing the sourceless Maxwell equations as an equation analogous to the second of Eqs. (2) of Ref. 4, with ψ^T changed to ψ = column $(H_1 - iE_1, H_2 - iE_2, H_3 - iE_3)$, where H_i, E_i (i = 1, 2, 3) are the components of the electromagnetic field, and three-dimensional spin matrices stand for the Pauli matrices, as well as by the coupling constant of the subquantum particles (14) and (15), which as a component of the momentum-energy tensor is also a source of gravitational fields. Since H_i, E_i are interrelated with spinors describing the subquantum rotations, while a gravitational field is related to their coupling constant, there is no support for the electromagnetic nature of gravitational fields. The analogous mathematical description of both the electromagnetic and weak gravitational fields seems to be determined exclusively by subquantum laws.

Returning to Eqs. (15) and (7), we note that the coincidence of their denominators has assured the first successful agreement between the predicted subquantum structure of matter and Einstein's special relativity. Unfortunately, not clearly understood at that time, this coincidence hid the fact that the transformation laws of the quantities making up 4-vectors relate not only quantities measured in coordinate systems in relative motion, but also quantities existing in such systems which observers in these systems cannot estimate by their defining relations. The latter is, of course, the case of the energy of a particle at rest relative to S' and moving with S' relative to S [see point (2) above]. Our assertion that the energy of a particle in relation to S' is identical with that estimated in relation to S fully agrees with the fact that energy is a state function. Thus among Eqs. (10c),(10d) to (13c),(13d) only Eqs. (11c),(11d) and (13c),(13d) rigorously relate the energy of a particle at rest to its S equivalent.

As a second, main agreement between the subquantum structure of matter and special relativity, we note the identity of the speed predicted[(3)–(4)] for subquantum particles with that of light. Since c is the object of the postulates of special relativity, it means, also in view of our first agreement, that by these postulates Einstein has actually incorporated the subquantum structure of matter in this theory, which made it successful. Therefore, the day the subquantum rotations are experimentally proved will mark the full triumph of Einstein's intuition of genius, which led him to the postulates of special relativity concerning the speed c which led this theory to embody the subquantum effects described above. Equations (14) and (15) are witness to this statement. Moreover, Eq. (15) reveals the interrelation existing between the subquantum dynamics of a particle and its state of motion.

As a result of the identification of the speed of light with that of the subquantum particles, any attempt to overcome the value of c fails. The search for physical signals traveling through free space at speeds $v > c$ seems unnecessary, and, therefore, our initial assumption that in principle there is no upper limitation on v is not valid. Equations (1), (3), and (5) are always valid for $v = c$. Thus the physical signals that we can use to join $S'(S)$ to $S(S')$ are rays of light (electromagnetic signals), gravitational waves, or neutrinos.

We can use, of course, Eqs. (1), (3), and (5) for $v < c$, too, but their predictions have nothing to do with the subquantum structure of matter. For example, when applied to acoustical signals, the time equation (1) and its inverse predict for $t' = T'$, $x' = \lambda'$ and $t = T$, $x = \lambda$ the well-known Doppler formulas $\omega' = \omega/(1 \pm v_s/v)$ and $\omega' = \omega(1 \pm v_0/v)$, where v_s and v_0 are, respectively, the source and observer velocities.

5. MORE ABOUT MEASUREMENT OF TIME AND DISTANCE

Brief considerations on the new coordinate transformations are still required. They concern the measurement of time and distance involved in these transformations, in connection with the usual representations of time dilation and the Fitzgerald-Lorentz contraction.

A major consequence of our need to trace the radius vector of a geometrical point moving together with $S'(S)$ relative to $S(S')$ by a ray of light before performing a coordinate transformation is that only those coordinate systems $S(S')$ in which are instruments like clocks and metersticks as well as sources of light radiating isotropically are entitled to be called reference frames.[6] Commanded or handled by people, these instruments (the observer) provide data, which by Eqs. (1), (3), (5) or their inverses, as well as by the transformation laws of the physical quantities making up 4-vectors and 4-tensors, give information from locations in the universe unattainable by man and our instruments.

Since the light travel times appear in all these equations, the way in which the elapsed time in a moving system $S'(S)$ is recorded in the reference frame $S(S')$ is essential. Figure 7, where the path $O'P$ is traveled by a ray of light emitted from O' as long as a clock attached to S' records a duration, outlines such a way. Hence, by the recorded T, we can always express in $S(S')$ a

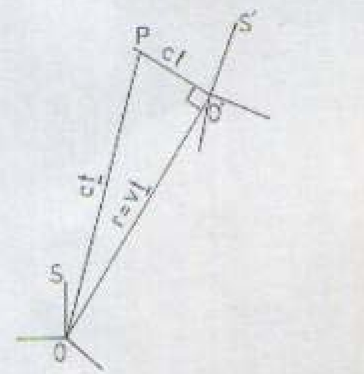

Figure 7. Prediction of the S equivalent $\bar{t}$ of the time t measured in S' by connecting S' to S by a physical signal.

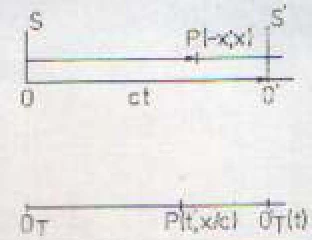

Figure 8. Prediction of Eqs. (18). The x' is a negative quantity since only geometrical points P ∈ (O',O) can be physically connected.

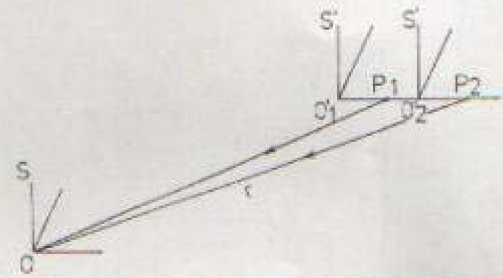

Figure 9. Prediction of the time relation (19). The time t is measured by a clock started by a ray of light emitted in P_1 and stopped at the extinction of that emitted in P_2.

time elapsed in S'(S) by (2). Equation (2) excludes any time dilation. It is a simple consequence of the fact that we cannot compare times elapsed in two coordinate systems S, S' in relative motion when we wish, but only at that instant $\bar{t}$ at which the moving system S' is connected by a ray of light to S. Therefore, to a time t elapsed in S' there always corresponds a time $\bar{t}$ in S. Unfortunately, the common point of view on comparing times elapsed in moving frames is that we can compare or relate such times whenever we wish and not only when a ray of light emitted from O(O') reaches a suitable geometrical point moving with S'(S), which leads to a time dilation. Therefore, as long as in the analysis of the experiments "proving" the dilated lifetime of the μ mesons the S-coordinates of the particle and the suitable time elapsed in S are not compared with those existing in the system S' of the particle when a ray of light emitted from O reaches it, these experiments do not predict a true time dilation. They only confirm the validity of (2) for relating times measured in coordinate systems in relative motion.

Concerning the measurement of distance, I first point out that unlike the time relation embodied in Eqs. (1) and (3), the time relation embodied in the equations derived by subtracting, respectively, Eqs. (1) and (3) written for two points P_1, P_2, does not represent the time equivalent of the relation between distances, because $\Delta x'/c \neq \Delta t'$. Since $\Delta x'$ is measured when a ray of light, emitted from O, reaches P (P_1), $\Delta t' = 0$ and Δx follows as $\Delta \bar{x} = \Delta x'$ and

$$\Delta x = \gamma \Delta x', \tag{17}$$

respectively, by (1) and (3). Equation (17) shows that Δx is the S equivalent of $\Delta x'$ by virtue of (2), and not a Fitzgerald-Lorentz contraction.

6. OPERATIONAL THEORIES

Equations (1), (3), and (5) for $v_x = v$ = const and $v = c$ enable an observer to express in his reference frame physical quantities defined in coordinate systems moving uniformly with respect to him through the dependence of these quantities on both time and coordinates.

A particular coordinate transformation derived from (1) for $v = c$, as well as from Fig. 8, viz.

$$x' = x - ct \tag{18a}$$

$$t' = t - x/c, \tag{18b}$$

which connects a coordinate system S' traveling with speed c relative to a coordinate system S associated with an observer should naturally do the same. [Do not identify (18b) with the time relation

$$t' = t - r/c,$$

which connects a time t' elapsed in S' (between the bursts of light spreading out, respectively, from P_1 and P_2) to its equivalent in S, t (recorded by a clock in O operated by rays of light of the two bursts having reached O) without belonging to a coordinate transformation. See Fig. 9.]

Since mathematical and physical quantities appearing in both electromagnetic and gravitational theories depend on $t - x/c$, we focus attention of these theories for revealing what led historically to this dependence and if it can be readily related to (18b). Consider in this aim the mathematical quantities f, ξ^{μ} appearing, respectively, in the electromagnetic and gravitational theories[7] by the gauge transformations of their 4-potentials. Observe that the above time dependence of f, ξ^{μ} has been obtained by imposing the Lorentz condition $A^{\mu}{}_{,\mu} = 0$ and its gravitational counterpart $\Psi^{\mu\nu}{}_{,\nu} = 0$

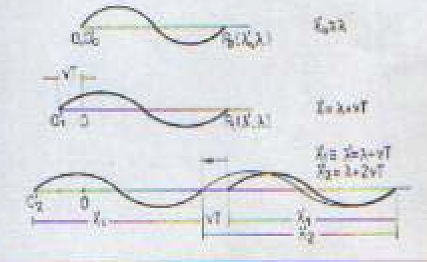

Figure 10. Illustration showing that the Hubble law is determined by repeated broadenings of value vT of the wavelengths λ of a wave train either under the recoil that a microscopic source of light undergoes during the emission of each λ (see, e.g., λ'_1, λ'_1) or under both that recoil and a wave train keeping force (see, e.g., λ'_2; the force is represented by the arrow pointing to the left in the bottom figure). After n wavelengths λ have been emitted, the first emitted wavelength of the train will be broadened by $\Delta\lambda = nvT$, which involves the Hubble law $c(\Delta\lambda)/\lambda = Hr$, with $H = v/\lambda$ and $r = n\lambda$. Here, v is the recoil velocity of the source, and T is the period of the wave.

on the 4-potentials of the plane electromagnetic and gravitational waves, respectively, A^μ and $\Psi^{\mu\nu}$.

Since A^μ, $\Psi^{\mu\nu}$ are defined in coordinate systems S' in waves moving at speed c, the time dependence of f, ξ^μ, as well as that of their 4-potentials, follows in view of (18b) to originate just in the motion of S' at speed c with respect to S. Moreover, because f and ξ^μ belong to the mathematical basis of the two theories, the time dependence historically imposed on them is equivalent to the more general requirement, namely, these theories are developed in the reference frames whose observers perform measurements of physical quantities. Therefore, Eq. (18b) accounts for the retarded potentials, whose omnipresence has been until now only in agreement with experiment,[18] in that they are defined in coordinate systems S' traveling at speed c and measured by observers in inertial frames S [S', S can be physically connected only for geometrical points $P \in (0', 0)$].

Extending these conclusions to the role played by Eqs. (18) in founding the two theories to the full class of coordinate transformations between coordinate systems in relative motion, I propose the concept of operational theory[4]: a physical theory is an operational theory if and only if the quantities entering its equations are expressed in reference frames (here, the definition of the reference frame is that given in Sec. 5) whose observers perform measurements.

The main consequence of this concept is that the foundation of modern physics is considered as an integrated system of operational theories, to be fully applicable. This means implementing the new theories as operational theories and removing from the existing theories those mathematical conditions imposed exclusively for obtaining the time dependence of the physical quantities required by experiment. Both the definition of p^μ investigated in the Appendix and the subsequent rewriting of the equations of relativistic quantum mechanics in S_i, also pointed out in the Appendix, as well as the derivation of the Hubble law[9] (which does not predict the receding galaxies which correspond to the furthest quasars recently discovered) by means of Eq. (1) written for $v = c$ (see, also, Fig. 10), represent the first steps in doing so. It is interesting to point out that by obtaining the properties of the potentials defining a plane gravitational wave,[18] as well as the conversion of the equation

$$t' = t(1 + 2\phi/c^2)^{1/2}(1 - v^2/c^2)^{1/2},$$

giving the effect of the Newtonian gravitational field of potential ϕ on an elapsing of time to

$$t'_1 = t(1 + 2\phi/c^2)^{1/2} \approx t(1 + \phi/c^2),$$

by taking into account Eq. (18b) (t' defined in the coordinate system S' associated with the field, t'_1 defined in the coordinate system associated with an observer), and by not imposing prior mathematical constraints (respectively, the transverse-traceless conditions[11] $\Psi^\mu_\nu u^\nu = 0$, $\Psi^\mu_\mu = 0$ and[12] $dr^i = 0$ in metric), we extend the operational approach to the weak-field approximation of general relativity.

7. CONCLUSIONS

The established coordinate transformations relating coordinate systems in relative motion expand the grounds and the meaning of Einstein's special relativity theory and propose a rigorous approach to modern physics on an operational physics.

APPENDIX

Written as $u^\mu = (dx^\mu/d\tau)/c$, the 4-velocity u^μ appears to be simultaneously defined with respect to both S (by dx^μ) and S' (by $d\tau$). Indeed, in view of (2) and (17), we have

$$u^\mu = [dx^\mu/(d(\gamma t)/\gamma)]/c = \gamma(dx^\mu/dt)/c$$

$$= [(\gamma dx'^\mu)/d\tau]/c \equiv \gamma(dx'^\mu/d\tau)/c.$$

Therefore, the 4-momentum

$$p^\mu = m_0 c u^\mu \qquad \text{(A1)}$$

predicts the same energy and linear momentum, viz.,

$$E = m_0 c^2 \gamma, \qquad p = m_0 v \gamma \qquad \text{(A2)}$$

for a particle at rest in an S' moving with velocity v relative to S, as well as for one moving at the same velocity in S', with the difference that an observer in S' cannot identify or measure them in the first case. Continuing this reasoning, we find from (A1) that the energy $m_0 c^2$ corresponds to a particle at rest in an S' which is at rest with respect to any S. In this case the coordinate systems S are those moving relative to S'; therefore, this S' is actually the absolute reference frame S'_{abs} with respect to which is defined the state of absolute rest or motion of any particle. Therefore, both the energy and momentum predicted by (A1) are estimated in relation with S'_{abs}. Since the square of p^μ gives the energy-momentum relationship, the equations of relativistic quantum mechanics and, implicitly, the coupling constant $m_0 c^2$ between the systems of subquantum particles they involve, are defined in relation to this absolute reference frame.

However, by changing m_0 to $m_i = m_0/(1 - v_i^2/c^2)^{1/2}$ in (A1), we observe that both p^μ and the equations of relativistic quantum mechanics can be defined in relation with reference frames S_i moving at velocity v_i relative to S'_{abs}, as well. Since the physical observers are associated with S_i

and not with S'_{abs}, the writing of these equations in S_r is equivalent to the foundation of relativistic quantum mechanics as an operational theory, in full agreement with the definition of such a theory given in Sec. 6.

Concerning the new coupling constant between the systems of subquantum particles $m_0c^2/(1-v_i^2/c^2)^{1/2}$, it reveals an extra coupling between these inner systems and the state of motion of the quantum particle defined by v_i. It is this extra coupling that proves the existence of an absolute reference frame in physics despite the impossibility of identifying it in nature as a system of reference bodies.

The usual work with Eq. (16a) and, implicitly, with the equations of the relativistic quantum mechanics defined in relation to S'_{abs} originates in both our possibility of dividing Eqs. (16b) by γ_i^2 and the smallness of v_i. However, in its full form Eq. (16b) is essential for testing the subquantum structure of matter.

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Résumé

Des trasformations de coordonnées entre systèmes en mouvement relatif sont obtenues. A partir de celles-ci nous (1) découvrons que la relativité spéciale d'Einstein a eu tant de succès dès le tout début parce-que par ses postulats elle tenait en considération la structure subquantique de la matière, (2) esquissons une fondation opérationnelle de la physique moderne, et (3) redérivons la loi d'Hubble.

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