

Chapter 3

RELATIVISTIC SPEED OF LIGHT

The speed of light from a uniformly translating source can be deduced, rather than postulated. The deduction, based on the isotropy and the homogeneity of space, shows that the propagation of light is independent of its source motion (absolute propagation) only if the source is at relative rest. For a relatively translating source, the speed of light in etherless vacuous space depends on the motion of its source and is therefore relative and *not* absolute as Einstein postulated. The Lorentz transformations, which until now have been uncritically assumed to be *kinematically* consistent, are shown to be the identity transformations of statics. The symbol v in the Lorentz transformations, accepted as representing a speed of relative motion, is actually a hidden deception for zero.

INTRODUCTION

In the special theory of relativity the postulate that the speed of light in vacuum is independent of the motion of the emitting body means simply that the speed of light is absolute. Einstein noted in 1905 that the absolute light speed postulate “is only apparently irreconcilable”¹ with the principle that all other motion is relative. On page 57 of his autobiographical notes of 1949 Einstein noted that the two assumptions of relative material motion and absolute light motion “are mutually incompatible” but, “The insight which is fundamental for the special theory of relativity” is that the two assumptions “are compatible if relations of a new type (“Lorentz-transformation”) are postulated for the conversion of coordinates and times of events.”² The Lorentz transformations are based on the two postulates of relative and absolute motion. It is a baffling circular “insight” that requires the *postulation* of the Lorentz transformations to comprehend the stated mutual incompatibility of the two postulates on which the transformations themselves are based.

There have been numerous derivations of the Lorentz transformations that do *not* postulate the absolute speed of light, or the assumption that all other motion is relative. Instead, recourse is had to the postulates of covariance, the homogeneity of space and time, and the isotropy of space. Then—with an enviable exhibition of mathematical virtuosity—

efforts are made to put all the postulates needed for the Lorentz transformations into as exact a form possible, taking full advantage of group theory, matrix algebra, and general topology. Arzeliès provides a rather extensive bibliography on the subject.³ One of the more recent of such typical efforts⁴ derives—independently of the nature of light propagation—a speed “addition” formulation by means of the deduced principle of relative motion and the group property of general linear coordinate transformations:

$$w = (u + v)/(1 + kuv).$$

The factor k is determined by its *postulational choice* as c^{-2} for the Lorentz transformations, zero for the Galilean transformations, and $-c^{-2}$ for unpleasant transformations that are ruled out “as a purely mathematical operation that cannot be physically realized” It appears therefore to be a matter of taste; the mathematical one being the *postulational choice* of k , the physical one being that of postulating either an absolute or a relative propagation speed for light emitted from a uniformly translating source.

It is the purpose of this chapter to demonstrate, contrary to overwhelming consensus, that the two postulates of absolute light speed and relative material motion really are incompatible; of the two it is the essence of the old luminiferous ether hypothesis that needs be rejected; the speed of light is *not* absolute, it is relative like all other motion. But first, the significance of mathematical covariance under the subgroup of Lorentz transformations, as discussed in Einstein’s autobiographical notes, will be considered.

Mathematical form invariance or covariance under the Lorentz transformations is described by Einstein,² on page 57 of his autobiographical notes, to be “a restricting principle for natural laws, comparable to the restricting principle of the non-existence of the *perpetuum mobile* which underlies thermodynamics.” Twelve pages later Einstein reaffirms what Kretschmann⁵ first noted in 1917, and was concurred in by Einstein⁶ in 1918, concerning the demand for mathematical covariance. As Einstein restated it in 1949 on page 69 of his notes, “This demand by itself is of course not sufficient to serve as a point of departure for the derivation of the basic concepts of physics. In the first instance one may even contest [the idea] that the demand by itself contains a real restriction for the physical laws;”² Thus, on page 57 of his autobiographical notes covariance under the Lorentz transformations is stated to be “a restricting principle for natural laws,” but on page 69 “one may even contest” that the demand for covariance “contains a real

restriction for the physical laws.” The obvious contradiction expressed by Einstein in his autobiographical notes on the matter of covariance under the Lorentz transformations seems to have attracted little attention. The important fact is that Einstein did recognize, as Kretschmann pointed out, that mathematical covariance even under the subgroup of Lorentz transformations imposes no physical consequences at all. The Lorentz transformations’ prime *reason for being*, namely to render Maxwell’s field equations of electrodynamics covariant, is of no physical significance.

The physical significance of the Lorentz transformations is, nevertheless, held to be found in their kinematic and dynamic consequences. The kinematic deductions that are obtained from the Lorentz transformations have in certain matters led to much heated discourse, but have not led to any fruitful, widespread application.

The dynamic consequence of speed-dependent mass has had far-reaching application in the form of particle accelerators and in nuclear physics. Surprisingly, the direct experimental evidence on mass variation has by no means been reliable and unambiguous, as has been shown by Faragó and Jánossy⁷ and by Raboy and Trail.⁸ In practice, the mass variation experiments involve inferences from electrodynamics and conditions of accelerated curvilinear motion of charged particles rather than uniform rectilinear motion. The experimental results can also be interpreted⁹ without the concept of variable mass ever being introduced, so that the experimental results are not unique to the special theory of relativity, and the dependence of nuclear physics on the special theory of relativity is much more tenuous than is generally recognized.

In order to avoid past arguments that have aggravated both protagonists and antagonists of the theory, no physical kinematics need be identified with the algebraic deductions that follow from the Lorentz transformations, especially as the kinematics require confirming experimental evidence which, contrary to almost universal opinion, does not exist in a definitive and unambiguous form. There are, in fact, experiments that clearly contradict Einstein theory kinematics.^{10,11} The “kinematics” of the special theory of relativity will be derived without any reference to the Lorentz transformations. It will then be shown that the speed of light from a uniformly moving source can be uniquely deduced and need not be postulated at all. The Lorentz transformations, taken at face value, will also be shown to be incompatible with the fundamental kinematic concept of uniform rectilinear motion.

It will only be assumed that etherless vacuous space is homogeneous and isotropic, as experimentally suggested by the reciprocity of

first-order Doppler effect observations, there being (see Chap. 6) no satisfactory second-order Doppler experiments. Time at any given place in space can be assumed to be measured by local identical clocks that run uniformly with constant periodic motion. The speed of light emitted directly from a stationary luminous source or secondarily from a stationary reflector will be a constant c —relative to its source regarded as stationary—everywhere and everywhen in vacuous space that is isotropic and homogeneous. The speed of light from a relatively moving source can then be deduced from elementary kinematics expressed only in terms of the variables of any particular reference system.

UNIFORMLY MOVING CLOCKS

Past exacerbating ambiguities, due to an utterly incorrect synonymy of the concepts of simultaneity and synchronicity,¹² will here be carefully avoided by considering *only two* identical clocks s and S , the faces of which are partial mirrors that reflect and pass equal amounts of incident light. Let these clocks face each other on the same straight line along which they recede from each other with uniform speed in vacuous pitch black space. The zero of time on each clock will be, arbitrarily but conveniently, taken as the moment on each clock corresponding to initial spatial coincidence. At some arbitrary subsequent s -clock moment t_1 , let an infinitesimally short flash of light be incident normally on only the s -clock surface. Let the passed light illuminating the indication t_1 be recorded on photosensitive film mounted behind the s -clock surface. The light reflected toward the receding S -clock will travel with speed c relative to its “stationary” s -clock source. The S -clock will have a speed of recession v relative to the “stationary” s -clock. The first reflected light will arrive at the S -clock at some later s -clock moment t_2 , bearing by virtue of reflection the previous indication t_1 that can also be recorded photographically at the S -clock together with the indication T_1 on the S -clock. The light reflected back from S toward s will now travel relative to S as a “stationary” source with the speed c in vacuous space. Its speed relative to s will be called c' , the as yet to be deduced speed, in specific contrast to assuming that it is identically c based on the absolute light speed hypothesis. The s -clock will recede at speed V relative to the S -clock when the S -clock is regarded as “stationary.” It will be deduced that v equals V . The light reflected from S , bearing as a result of two previous reflections the indications t_1 and T_1 , will arrive at s at the subsequent s -time t_3 and the S -time T_2 . The illuminated indications t_1 , T_1 , and t_3 would all be captured

photographically at s and would also be returned by reflection at s back to S where the four indications t_1 , T_1 , t_3 , and T_3 would be photographed and reflected back to s . The repeated reflections can be depicted graphically relative to s and S in Fig. 1 and Fig. 2, respectively. The light reflected back at t_3 from s toward S will travel from the point of view of S regarded as "stationary" with the as yet undetermined speed C' , since the equality of v and V has yet to be obtained. Einstein's absolutivity postulate requires that $c' = c = C'$ for any real values of v and V . In a very real sense Einstein's theory of relativity is a misnomer, it should be called a theory of absolutivity.

The odd subscript clock indications, photographically recorded at both the s -clock and the S -clock, would be the observed "experimental"

data resulting from the repeated light pulse reflections and could be tabulated as shown in Table 1 in either the s -system or the S -system.

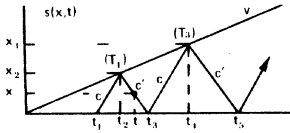


Fig. 1. Reflections relative to s .

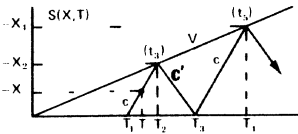


Fig. 2. Reflections relative to S .

TABLE 1

Recorded Clock Indications

t_1	—	t_1
T_1	—	t_1, T_1
t_3	—	t_1, T_1, t_3
T_3	—	t_1, T_1, t_3, T_3
t_5	—	t_1, T_1, t_3, T_3, t_5 , etc.

The inferred even subscript time values can be expressed in terms of C' , c' , V , v , and the recorded odd subscript time values immediately before and immediately after a particular inferred even time value. Fig. 1 and Fig. 2 depict the kinematics of the propagation of light and the relative motion of the two clocks in terms of the variables unique to each respective system s and S . The following kinematics, relative to each individual system, is readily deduced from the figures, which are predicated on the assumptions of isotropic and homogeneous space:

$$x_2 = vt_2 = c(t_2 - t_1) = c'(t_3 - t_2) \quad (1a)$$

and

$$x_4 = vt_4 = c(t_4 - t_3) = c'(t_5 - t_4), \quad (1b)$$

$$-X_2 = VT_2 = c(T_2 - T_1) = C'(T_3 - T_2) \quad (1c)$$

and

$$-X_4 = VT_4 = c(T_4 - T_3) = C'(T_5 - T_4). \quad (1d)$$

From (1a,b), with $\beta = v/c$ and $\beta' = v/c'$, find

$$t_1 = t_2(1 - \beta), \quad t_3 = t_2(1 + \beta'), \quad (2a,b)$$

$$t_3 = t_4(1 - \beta), \text{ and } t_5 = t_4(1 + \beta'). \quad (2c,d)$$

From (1c,d), with $B = V/c$ and $B' = V/C'$, find

$$T_1 = T_2(1 - B), \quad T_3 = T_2(1 + B'), \quad (3a,b)$$

$$T_3 = T_4(1 - B), \text{ and } T_5 = T_4(1 + B'). \quad (3c,d)$$

With (2a,b,c,d) find

$$(1 + \beta')/(1 - \beta) = t_3/t_1 = t_4/t_2 = t_5/t_3, \quad (4a)$$

and with (3a,b,c,d) find

$$(1 + B')/(1 - B) = T_3/T_1 = T_4/T_2 = T_5/T_3. \quad (4b)$$

Light reflected from s at the instants t_1 and t_3 is subsequently received and reflected back from S at the respective instants T_1 and T_3 (see Fig. 1). The physical nature of this can be recognized as the generic Doppler effect for light propagated from s to S . If light of period $t_3 - t_1$ were emitted from s it would be received at S as the Doppler period $T_3 - T_1 = D(t_3 - t_1)$, where D is the Doppler coefficient for light propagated from s to S . Similarly, light of emitted period t_1, t_3, t_5 , etc. would be Doppler shifted to the respective periods T_1, T_3, T_5 , etc. Thus,

$$D = T_1/t_1 = T_3/t_3 = T_5/t_5, \text{ etc.} \quad (5a)$$

and, similarly,

$$D' = t_3/T_1 = t_5/T_3, \text{ etc.}, \quad (5b)$$

where D' is the Doppler coefficient for propagation from S to s . It follows from (5a,b) and (4a,b) that

$$DD' = t_3/t_1 = T_3/T_1 = t_4/t_2 = T_4/T_2, \text{ etc.}, \quad (6a)$$

and

$$DD' = (1 + \beta')/(1 - \beta) = (1 + B')/(1 - B). \quad (6b)$$

The inferred instants t_2 , t_4 , etc. can be expressed in terms of T_1 , T_3 , etc. from (5a) and (2a,c) as

$$d = t_2/T_1 = t_4/T_3, \text{ etc.}, \quad (7a)$$

where

$$d = 1/D(1 - \beta). \quad (7b)$$

Similarly, from (5b) and (3a,c)

$$d' = T_2/t_3 = T_4/t_5, \text{ etc.}, \quad (7c)$$

where

$$d' = 1/D'(1 - B). \quad (7d)$$

From (7b), (7d) and (6b) it follows that

$$dd' = [(1 + \beta')(1 - B)]^{-1} = [(1 + B')(1 - \beta)]^{-1} \quad (8a)$$

and that

$$d/d' = (D'/D)(1 - B)/(1 - \beta). \quad (8b)$$

RELATIVITY OF MOTION

The isotropy and homogeneity of space are physically substantiated by the reciprocity of the Doppler effect, which is the same from s to S as it is from S to s ; thus, $D' = D$. Similarly the general reciprocity of kinematic effects in isotropic and homogeneous vacuous space means that $d' = d$. It then follows from (8b) that $B = \beta$ and $V = v$, which simply means that, in an isotropic and homogeneous vacuous space, motion is relative. Since $B = \beta$, it follows from (6b) that $B' = \beta'$ and therefore $C' = c'$, since $V = v$; (6b) and (8a), respectively, reduce to

$$D = D' = \sqrt{[(1 + \beta')/(1 - \beta)]}, \quad (9a)$$

and

$$d = d' = 1/\sqrt{[(1 + \beta')(1 - \beta)]}. \quad (9b)$$

An exception to the relativity of motion expressed explicitly in (9a,b) is Einstein's second postulate on the absolute speed of light. According to this postulate $c' = c$ and $\beta' = \beta$, so that (9a) becomes the Einstein-Doppler coefficient for light traveling parallel to the direction of the relative uniform translation of a source and a receiver; (9b) becomes the expression for the relativity or the reciprocity of the contraction-dilation coefficient. The Einstein theorem for the "addition" of parallel speeds is shown in the appendix to be readily derived from Einstein-Doppler coefficients, even though Pauli¹³ asserted that the one has nothing to do with the other.

The basic "kinematics" of Einstein's special theory of relativity (absolutivity) has therefore been obtained without the need of coordinate transformations in general or the Lorentz transformations in particular. In addition, there has been no need for concern about simultaneity, synchronization, or the relative phases of a system of uniformly moving clocks as only two relatively translating identical clocks have been considered in the derivation. The concepts of time-dilation and length-contraction as possible physical entities have been shown elsewhere¹⁴ to be both unobservable and experimentally unsupported (see Chap. 4 and Chap. 6).

UNIVERSAL TIME IN HOMOGENEOUS ISOTROPIC SPACE

Certain kinematic relations will now be noted as a consequence of the equalities $D = D'$, $d = d'$ and $v = V$. Thus from (5a), (2a), and (3a)

$$D = T_1/t_1 = T_2/t_2, \quad (10)$$

since $B = \beta$. Next, with (10) and (5b) together with (7a) and (7c) it follows that

$$1 = D'/D = t_2 t_3 / T_1 T_2 = t_1 t_3 / T_1^2 = d/d' = 1. \quad (11a)$$

This means that T_1 is the geometric mean to t_1 and t_3 . Similarly, $T_3^2 = t_3 t_5$, $T_5^2 = t_5 t_7$, etc. The geometric mean to t_2 and t_3 denoted as t' is equal to the geometric mean to T_1 and T_2 denoted as T' ; i.e.,

$$t' = \sqrt{t_2 t_3} = \sqrt{T_1 T_2} = T'. \quad (11b)$$

Similarly, $t_4 t_5 = T_3 T_4$, etc. It is a consequence of the relativity of kinematic effects expressed as $D' = D$, $d' = d$, and $v = V$ that there is a whole spectrum of distinct specific instants in s and S that are identical and therefore simultaneous on the s -clock and S -clock. The simultaneous