Why No Einstein's laws? Part V
Einstein's Second postulate Of Light Constancy Is False
By Harry H. Ricker III, Email: kc3mx@yahoo.com

1.0 Introduction

This paper continues the series which discusses why Richard Kadel's proposal for three Einstein's Laws is a misconceived idea. Here the topic of discussion will be the proposed second law, which is commonly known as Einstein's postulate of light constancy. It will be shown that the proposed statement of this law given by Kadel is a false physical law, and to correct Kadel's misconceived law a correct law will be given which clears up over 100 years of controversy, confusion, and erroneous physical theory.

In the first paper of this series, it was stated that Kadel's proposed second law is the only one of his three laws which can clearly be attributed to Einstein as its author. Stated by Einstein as a "postulate" the proposed light constancy law is clearly the foundation of Einstein's special theory of relativity which sets it apart from or distinguishes it from the relativity theories of Lorentz and Poincare. It is also the main source of controversy, dispute, and argument over the validity of the special theory. The controversial aspects of the proposed second postulate will be reviewed, and the conclusion will be reached that this postulate continues to be a cause of disagreement over its exact meaning and physical interpretation which has not been resolved. This fact alone disqualifies it a law of physics, because one primary requirement of a law of physics is that it should have a clearly defined meaning and well understood physical interpretation.

2.0 Background

Given the ambiguity, obscurity, and confusion in Einstein's papers on the special theory, it is not surprising that the second postulate was not one of the first points of controversy that arose from opposition to his theory. All of this was complicated by a lack of a clear and precise statement of that theory, which Einstein never gave. Einstein abandoned special relativity just as its formal content was becoming clearly defined. Einstein left it to the lesser prophets to work out the final details. Thus creating a source of more confusion by allowing the lesser prophets to define the content of his theory through their, often different, interpretations.

History does not record major controversy over the meaning of the second postulate during the formative period of the theory up until 1911. Nor does there appear to have been any major controversy for many years after the theory became ordained physics. The major controversy appears much later beginning in the 1960s, when the historians began to write the first histories of relativity. This brought into immediate focus the different

views regarding the meaning of the second postulate. In the March 2006 issue of the American Journal Of Physics, Ralph Baierlein summarizes the results of the controversy over the interpretation of the second postulate. He asks the following question: "Does the phrase, "the constancy of the speed of light', have the same meaning today that it had when Einstein used it in 1905?" The surprising answer is a resounding, "No"! However, despite this, Richard Kadel has proposed as one of Einstein's "Laws" the exact phrase which recent scholarship has definitely shown to be erroneous. The situation is analogous to the situation discussed in a previous paper of this series, where is was shown that the interpretation of the Principle of Relativity has also been drastically changed.

3.0 The Falsity Of The Proposed Second Law

Although the scholarship leading to the conclusion given by Baierlein in his paper seems definitive, Richard Kadel has proposed a version of the second postulate which ignores this scholarship. Kadel's version is this: "The vacuum speed of light, c, is the same for all inertial frames." In this section we will investigate why this particular mode of expression or phrasing leads to false conclusions, and is therefore misleading and false. Because the proposed law is misleading it must be false.

The problem arises in this way. Suppose we take a stationary or rest frame, as Einstein does in his 1905 paper. We then transform using the Lorentz transforms for space and time to obtain the moving frame space and time. Now if we do this correctly, we transform time as $t'=\beta t$ and space as $x'=\beta x$. The resultant velocities in the moving frame are therefore all transformed invariantly as long as we only consider the velocity in the direction of motion. But in directions different from that of the relative motion, say in the y direction, we have the following result. $V_y'=y'/t'$ or $V_y'=y/\beta t$. hence $V_y'=\beta^{-1}V_y$. Therefore in general velocities not in the direction of motion do not transform invariantly, so we can not expect that light speed will be the same in all directions (isotropic) for all inertial frames. This simple fact has been overlooked by relativists, and it invalidates Kadel's proposed law.

4.0 The Corrected Second Law

This section discusses the correct version of the second law. This is not as simple as it seems at first, because of the usual confusion in the concepts of special relativity. In an earlier paper it was pointed out that the second postulate is really not needed at all, however, here we will give what is the most accurate statement of this law.

The problem with Einstein's second postulate is that in his attempt to make it seem simple, Einstein in fact created a source of significant confusion. To correct this, the postulate should be stated as follows: When the standards of measure (time and space) are transformed by the Lorentz transformation equations, the velocities in the direction of the relative motion of the reference frames are transformed invariantly, so that when a velocity, in the direction of motion, defined in the stationary frame units of measure, is

transformed to the relatively moving frame, the resulting velocity in terms of the moving frame units of measure is the same as in the stationary frame. Simply put this means that c'=c, but not that the units of measure in which the two velocities are defined are the same, they are different. However, the numerical measure is the same in both frames. It should also be noted that this specifically rules out the implied isotropy of light velocity in all inertial frames as in Kadel's version. Light velocity is only isotropic in the stationary or rest frame. In the moving frames it is not isotropic in all directions.

The reader should note the very important difference between all of the earlier versions of the postulate and this version. In fact this version is really not a postulate at all, and this fact is the reason for the persistent confusion. In Einstein's version, he takes it as axiomatic that the velocity of light is a constant in the stationary and moving frames, and from this derives the Lorentz transformations. In the process, he fails to notice that the transformation which he imposes changes the units of measure in the two frames, despite the fact that he insists that space and time are different. This fundamental error has caused a lot of misinterpretation and argument. Einstein approaches the problem backwards. He uses the result to be achieved to derive the means by which the result is achieved. The result is therefore that the speed of light is numerically the same in the direction of motion, but this does not mean the same thing as in Richard Kadel's version. In the modern misinterpretation, the velocity of light is the same irrespective of the motion of the frame of the observer measuring it. This is of course a false interpretation. It is used to imply that time and space is somehow fundamentally different in the moving frame relative to the stationary one. But this is an illusion.

5.0 Einstein's Confusing Statements

As noted in the previous paper on the principle of relativity, Einstein never gave clear and consistent definitions of his principles. Here we will see that he gave different and consequently confusing definitions of his principle of light constancy in his many different publications. In his different papers he gives the following definitions:
(1a) 1905: "…light is always propagated in empty space with a definite velocity c which is independent of the state of motion of the emitting body."
(1b) 1905: "Any ray of light moves in the "stationary" system of co-ordinates with the determined velocity c, whether the ray be emitted by a stationary or by a moving body."
(2) 1907: "We now assume *that the clocks can be adjusted in such a way that the propagation velocity of every light ray in vacuum-measured by means of these clocks-becomes everywhere equal to a universal constant c.* Provided that the coordinate system is not accelerated." (Italics in the original.)
(3) 1910: "*A ray of light in vacuum always propagates with the same velocity c, which velocity is independent of the body that emits the ray.*" (Original in italics.)
(4) 1912: "There exists a coordinate system with respect to which every light ray propagates with the velocity c."
(5) 1915: "…every light ray in a vacuum always propagates (at least with respect to a certain coordinate system K) with the definite velocity constant c."
(6) 1917: "…relative to every inertial system -given the correct definition of time- the

theorem of the constancy of the speed of light holds true."

(7a) 1920: "…one has to accept as an expression of experience (e.g. from the Michelson experiment): the systems K and K' are equivalent with respect to the law of light propagation. Experience shows at least that also with respect to K', all directions are optically equivalent."

(7b) 1920: "In this conclusion, the validity of the principle of the constancy of the speed of light has been assumed -in agreement with the principle of special relativity- for both systems K *and* K'."

(7c) 1920: "…according to the principle of relativity the propagation of light must be the same relative to K as it is relative to K', the *same* process of propagation relative to K' must also be described by a spherical wave of propagation velocity c." (7 a, b, and c are all from the same paper, which does not give a formal definition of the principle. Note the change in emphasis that makes the principle of relativity superior to the principle of light constancy, which has been diminished in importance. In this paper, the light constancy postulate appears to be a consequence of the principle of relativity.)

These definitions are all defective for the following reasons. First, he never defines what he means by a coordinate system in a consistent way. Second, he never defines the units of measure that apply to the definition of the universal constant c. Third, he never clearly defines how the measurement of light velocity is defined in a consistent manner. This author believes that only the 1907 definition is stated correctly, and that statement needs more rigor.

It is surprising that the most correctly rigorous of these definitions, the one given in 1907, is not the universally accepted definition. That definition is not found in the above list. Where did it come from?

Finally, it should be noticed that in the definitions given in 7 a, b, and c, that Einstein assumes that his theory makes light velocity isotropic in all moving frames, but as noted above this does not appear to follow from the Lorentz transformation equations. It would appear that it is not true as Einstein claimed, without actually proving it, that light velocity is isotropic in all inertial frames. He relies on the Michelson experiment to justify this claim.

6.0 Interpretation Of The Light Constancy Postulate By The "Lesser Prophets"

This section examines the question posed above -Where did the commonly used definition of the light postulate come from?- since it does not seem to be stated in the same way as in Einstein's fundamental papers.

W. Pauli gives the following formal definition of the postulate in his influential book Theory of Relativity (1st ed. 1921): "*The velocity of light is independent of the motion of the light source.*" (Italics in original for emphasis.) He goes on to say "There is no question of a *universal* constancy of the velocity of light in vacuo, if only because it has the constant value c only in Galilean systems of reference."

Max Born, in another famous and highly influential book <u>Einstein's Theory Of Relativity</u>(1st ed. 1920), gives the following formal definition: "In all inertial systems the velocity of light has the same value when measured with rods and clocks of the same kind." This is essentially the same as Kadel's incorrect definition. But gives the added requirement, implicit in Kadel's, that the units of measure are identical in all of the inertial coordinate systems.

Leigh Page in his book <u>An introduction To Electrodynamics</u> (1922), follows Einstein's later works in making the principle of relativity the primary postulate, with the principle of light constancy subsumed into it.

The philosophers also took up relativity and the following definition is given by Ernst Classier in his book <u>Einstein's Theory Of Relativity</u> (1921): "…light in an empty space is always propagated with a definite velocity V independently of the body emitting it. From whatever system one made the observation and from whatever source the light issued there would always be found the same determinate value for its velocity of propagation." This is nearly identical to Einstein's definition 3 given above from his 1910 paper. But he goes on to imply that this result is universal for all observers using the same units of measure.

During the 1930s the uncertainty resulting in various different statements of the principle seems to have been narrowed down by a kind of consensus. The result is the modern form of the principle, which omits the requirement that the light velocity be independent of the motion of the emitting body and fails to note the crucial point that the specification is true by the definition of time as a result of the definition of simultaneity of distant events. The result was that no one seemed to really understand that what Einstein did was require that the velocity of light be identical in all inertial systems by fiat or more correctly, he defined time in such a manner through the definition of simultaneity, so that the time used in each observers coordinate system conformed to the result that he always measure the same numerical value for the velocity of light. Hence the postulate, which was used to derive the Lorentz transformations became a physically real fact of physics. Somehow the original interpretation became inverted and physics has been misusing this false interpretation ever since.

The correct facts are these. The principle of light constancy is, as Einstein puts it, a freely selected definition obtained by choice, so that the desired result, light constancy, is true by definition. What Einstein does is to choose a definition of time which produces a result consistent with the principle of light constancy. But the usual interpretation of this requirement is that it is true not because time was arbitrarily redefined, but because it is a physically true fact.

There is a flaw in all of this, which is that having redefined time, the theory should have defined units of time measure that are different in different coordinate systems, but the theory does not do this. So it falls into a contradiction. It claims that units of time measure for relatively moving observers are the same and then concludes that measures

of time are different. The explanation for this is that time is different for relatively moving observers because time is relative and not absolute. But this is a fatuous and meaningless concept.

7.0 Summary and Author's Comments

It is clear from an examination of the historical evidence that the proposed Einstein second law is not a correct statement. For one thing the proposed Einstein law is physically false. For another, it is clear that it is not stated in a manner that would have been used by Einstein. It lacks key elements of Einstein's definitions.

Probably the most compelling reason to reject Einstein's light constancy postulate as a valid axiom of the theory is that there is no clear unambiguous interpretation that can be assigned to it. This follows from the many different versions which Einstein himself gave. Hence it must be invalid.

The primary element that is missing from Kadel's proposed law is the requirement that time is redefined to conform to the requirement that light velocity is numerically the same for all inertial frames. A corrected definition of the second axiom is proposed that corrects the flaws in Einstein's work and the misinterpretations commonly found in physics books. However, it would be better if the second axiom is completely dropped from physics, because as Einstein recognized in his later papers, this principle can be subsumed into the principle of relativity and this may be necessary in order to correct the widespread misinterpretation that is prevalent in physics today.