EN Tech. J., vol. 4, 1990, pp. 186–190

On the Compatibility of Special Relativity with a Decreasing Velocity of Light

B.D. JOHNSTON

ABSTRACT

This paper defends the conclusion that the mathematics of relativity does not preclude the hypothesis that the value of c has decreased since the creation.

INTRODUCTION

Setterfield has claimed, on the strength of observed data stretching back over 300 years or so, that the value of c has decreased with time.[1] He is not the first to advance such an hypothesis.[2] However, when this writer discussed this hypothesis with scientific colleagues, the reaction was to raise the objection that such a concept was surely contrary to the theory of relativity. Consequently, the writer would like to set out here a line of reasoning, which to his mind at least, overcomes the specific objection encountered. The raised objection does not stem essentially from General Relativity, therefore General Relativity, irrespective of questions of its validity, will not be discussed within the scope of this paper. Reference to 'relativity' throughout will essentially signify the special theory.

With reference to the theory of relativity, the investigation as presented in the paper distinguishes between: physics and metaphysics; mathematics and physical interpretation; kinematics and electromagnetism. Thus care is taken to differentiate between the positions of Lorentz, Einstein and Minkowski with respect to 'Relativity' — a distinction which is fundamental to a reconciliation with Setterfield's c decay hypothesis. Care is also taken to distinguish between sound mathematics and its speculative physical interpretation. The subject of relativity is properly identified as being kinematical in nature and independent of electromagnetic phenomena. All this clears the way for the coexistence of the concept of the velocity of light decaying over cosmic time and the theory of relativity.

THE HYPOTHESIS

Setterfield's contention is that the historical data on c, when the accuracy of the various methods is fully accounted for, shows a definite decay patterning. Best fit curves appear to be a damped oscillation or a simple polynomial.[3] In more detail, the c equation is expressed as:

$$c = \sqrt{[a + e^{kt}(b + dt)]}$$

where $k = -0.0048$,
$a = 9.029 \times 10^{10}$
$b = 4.59 \times 10^{13}$,
$d = 2.6 \times 10^{10}$,
and t = the year AD

or,

$$c = a + bT^2 + dT^8$$

where $a = 299792$,
$b = 0.01866$,
$d = 3.8 \times 10^{-19}$
and $T = (1961 - t)$.

If the velocity of light is not a universal constant, but has decreased in value over cosmic time, then the implications for modern science are fairly fundamental. Many of these are explored by Setterfield himself, leading to the discovery of much corroborative evidence.[4] The cosmological model which emerges is that of a now contracting universe which is only a few thousand years old. Redshifts are reinterpreted as being the net result of c decay and cosmological contraction; and so not indicative of continuing post-Big Bang expansion. Thus radical re-evaluation of previous thinking is required, but if the value of c has been very much higher in the past, the difficulty (for creationists) of huge astronomical distances and vast radiological ages both vanish. The claim that c was once much greater, offers a solution to the paradox of evidences both for a young and an old universe. It does so by distinguishing between two clocks: the dynamical clock (concerned with earth orbits around the sun) and the atomic clock (concerned with electron orbits around the atomic nucleus). Both clocks are currently reading different times and, based on the hypothesis, this is for the reason that the atomic clock has been running faster (when c was greater than its present value).

It has to be admitted that some hold an alternative viewpoint with respect to c decay and the red-shift. They propose that space is indeed expanding and that this changes the global value of the speed of light; this latter effect being by means of the insertion of more space between source and observer, thus causing a slowing down of the rate at which light reaches the observer. This has been discussed by Silverman.[5]

THE APPARENT PROBLEM

The encountered response to the above was: 'But doesn't the theory of relativity require c to be a universal constant?' This is made in the understanding that relativity has something profound to say on the nature of light and also on the nature of the universe.

Much confusion exists as to what Einstein's work proves, and what it does not prove. At the risk of over-simplification for the non-specialist, let us briefly attempt to summarise what Einstein did achieve, and what relativity, in essence, is about. It concerns things (in particular coordinate systems) which move relatively to each other. Reference frames in relative **uniform** motion are known as **inertial.** In classical mechanics, Newton's three laws of motion are **invariant** with respect to different inertial frames (observers). That is, they assume the same form in the different coordinate-systems. This is on the basis of certain assumptions or ideas of how distance and time measurements are related between frames.

For example, consider two reference frames moving relatively with speed u in the direction of the x-axis. In classical physical theory space and time measurements in the two frames are related by the Special Galilean Transformation: $\bar{x} = x - ut. \bar{y} = y, \bar{z} = z, \bar{t} = t.$

Now Einstein was seeking to reconcile Newtonian mechanics and electromagnetism; the first could not distinguish between states of uniform motion including rest, but the latter did. He latched onto the idea that what was required was a different definition of time-instants at a distance. Newton had assumed in effect that you could simply obtain that by a procedure involving transporting clocks at uniform speed. Lorentz was the first to challenge this, stating that the motion of the clock through the ether would affect its rate. Einstein claimed the right to define time at a distance in such a way as to save electromagnetism without violating the principle of relativity of motion. He elected to use light in a synchronisation procedure to determine a unique value for time at a distance.

However, he required to know the speed of the earth through the ether. This the famous Michelson-Morley experiment failed to determine. From its null result, Einstein concluded that there was no ether (and so no absolute standard for velocities), and that he could have a many-valued definition of time at a distance. From the starting point of two axioms (the relativity postulate — no ether, and the signal postulate — c is constant independent of source motion) he developed different ideas on how distance and time measurements are related in different frames. Compare the Special Lorentz Transformation to the transformation for the same scenario stated earlier:

$$\bar{x} = \frac{x - ut,}{\sqrt{(1 - u^2/c^2)}} \qquad \bar{y} = y,$$

$$\bar{z} = z, \qquad \bar{t} = \frac{t - (ux/c^2)}{\sqrt{(1 - u^2/c^2)}}$$

On this basis, in special relativity, he put all physical laws in an invariant form with respect to inertial frames. And, in general relativity, he succeeded in making all physical laws invariant with respect of all frames, via a description of gravity in geometric terms. Thus, in essence, his work showed that there was no such thing as a privileged observer; the laws of physics being the same for all irrespective of their motion.

Towards a reconciliation of the c decay concept and the mathematical content of 'relativity', the reader is now invited to consider the distinctions made below.

THE DISTINCTION BETWEEN PHYSICS AND METAPHYSICS

Although it might be thought that Einstein's and Setterfield's theses are incompatible, it is the assertion of this paper that, even if Einstein's thesis is maintained, the concept of c decaying as a function of time since the creation is not precluded. It is the metaphysical mists of Minkowski that require to be cleared out of the way. Due to Minkowski, most relativists have a metaphysical belief in the objective existence of the so-called 'space-time continuum'; wherein space and time have no separate identity. Reasoning from abstract mathematics to define the nature of the universe is absurd. Mathematics must conform to nature; not nature to mathematics. It cannot be over-stressed that the theories of Lorentz, Einstein and Minkowski are not one and the same. While Einstein, although initially confused by it, came to accept Minkowski's mathematical formulation of his theory; Lorentz, to the writer's knowledge, did not accept Einstein's theory of relativity (see later discussion). In the Minkowski-Einstein theory it is held that c(x) = c, that is, c is constant for all observers. This is Einstein's second postulate which Minkowski invoked in his derivation of the mathematics of relativity. The Lorentz Transformation, being a key part of that, in Minkowski parlance, is made to infer that time and space, as dimensions, are inextricably linked together. Thus if $c(x) = c$, then automatically $c(t) = c$. And so Setterfield's hypothesis of c decaying as a function of cosmic time (time lapsed since the creation) is destroyed. Or, in slightly more detail, the argument runs something like this: let there be two observers (strictly frames of reference) moving relatively to each other. In these frames clocks ran at different rates, because special relativity teaches that a moving clock runs slow, resulting in a different determination of the time elapsed since creation, and so of c, if it is a function of the time elapsed as Setterfield claims. But c is the same for all observers (Minkowski-Einstein), hence contradiction, and thus 'relativity and c decay are incompatible'.

The encountered objection to Setterfield's hypothesis is not simply that the signal postulate demands c to be constant, for that can be quickly disposed of since the constancy requirement there is with regard to source motion, not cosmic time. However, it must be noted that it is not sufficient simply to reply that Einstein only demands $c(x) = c$ and not $c(t) = c$, for as has just been shown, relativists use the Lorentz Transformation — the idea of a single space-time continuum — to allege that $c(t) = c$ follows. Thus the objection is as set out in the previous paragraph. Basically the reasoning is: $c(x) = c$ implies (on the grounds of the Lorentz Transformation) that $c(t) = c$. However, both that premise and the implication are discussed in this paper and it will be shown that the premise requires careful consideration (see later), and, much more significantly, the implication is invalid (see below).

For, all that the Lorentz Transformation actually says is that on translating from the coordinates of one system to those of another, it is not possible to measure distance without involving the measurement of time. To infer from the Lorentz Transformation the objective reality of the so-called space-time continuum, is to extrapolate the discussion from the relationship of the measurement of distance and time in different frames, to the nature of the relationship between the dimensions themselves. After all, pressure and volume do not change independently with changing temperature, and yet this is not normally taken to imply that only some union of pressure and volume has any objective existence! It is the exposé of this subtle extrapolation which shows that the implication ($c(t) = c$), based on the Lorentz Transformation, is invalid. In Lorentzian or Einsteinian terms, as opposed to Minkowskian, the Lorentz Transformation poses no threat to the c decay concept.

THE DISTINCTION BETWEEN MATHEMATICS AND PHYSICAL INTERPRETATIONS

The above section has distinguished between Einstein/Lorentz and Minkowski. In this section we proceed to distinguish between the theories of Einstein and Lorentz. Either is compatible with c decay.

We have already commented that both the kinematics of Lorentz and of Einstein's special relativity differ from that of Isaac Newton. They are based on the Lorentz Transformation rather than the Galilean. However, although the mathematical content of the theories due to Lorentz and Einstein is the same, the physical interpretations contained in these theories are radically different. In fact, although often referred to as such, the theory due to Lorentz is not a relativity theory at all. Lorentz believed in the ether and accordingly his theory is impossible without an ether (serving as an absolute standard); while Einstein's is impossible with one. It is significant that as great a mind as Lorentz did not accept Einstein's theory of relativity. As far as Lorentz was concerned, while the Michelson-Morley experiment did not prove the existence of the ether, it did not prove the non-existence of it either. With others, he suggested that motion through the ether produced a physical effect on bodies (Fitzgerald contraction) and so was undetectable. He viewed the Lorentz Transformation as an 'ether correction' (while Einstein viewed it as a 'relativity correction'). As far as the writer is aware, Lorentz did not change his views.

The invariance of the Maxwell-Lorentz electromagnetic equations with respect to this transformation made it impossible to detect whether a body was at rest, or moving uniformly with respect to the ether. (In this sense electromagnetics now embodied a relativity principle similar to that possessed by Newtonian mechanics). By this invariance is meant that if for x and t in the Maxwell-Lorentz equations, we substitute the x and t values given by the Lorentz Transformation, we obtain identical equations with $\bar{x}$ and $\bar{t}$ taking the place of x and t, and u changing to -u. This guarantees that all measurements made on either of two bodies, in uniform relative motion with velocity u (or -u), when interpreted in terms of the Maxwell-Lorentz theory, would be related in the same way, so that no physical observations confined to either body could distinguish the motion of that body from the motion of the other. It would still be possible, of course, by comparing observations on the two bodies, to detect effects of their relative motion, but experiments such as the Michelson-Morley experiment (and subsequent similar experiments) confined to earth, would not reveal the motion of the earth.

Electromagnetic observations which support Einstein's theory are equally supportive of the mathematically identical, but physically quite distinct, theory of Lorentz. As to the validation claims that are made for special relativity, observations and inferences that are made concerning hypothetical particles (with all the inherent literal interpretation of metaphors, e.g. mass, that is involved), which are first analysed in terms of Maxwell-Lorentz theory, and then corrected by special relativity, are indeed found to be in accord with this latter theory. However, as Professor Dingle observes, this only proves that Special Relativity achieves the correction it was designed to produce![6]

So, in summary, the theories of Lorentz and Einstein have the same mathematical structure, but divergent physical interpretations.

THE DISTINCTION BETWEEN KINEMATICS AND ELECTROMAGNETICS

Einstein's theory is wholly kinematical, having nothing at all to do with the nature of light. The connection with electromagnetism was simply that it was the desire to justify the Maxwell-Lorentz equations that provided the motivation for the conception of Einstein's special relativity. His second, or signal postulate, namely that c is independent of source motion, is in fact non-essential for relativity. This we have called 'the premise' (c(x) = c). Relativity without light is possible, since the theory is capable of being developed on purely kinematical grounds without reference to light. Papers by Terletskii,[7] Breitenberger,[8] Mermin[9] and Singh[10] have shown that it is possible to have relativity without light in the sense that, using the relativity postulate and certain other assumptions, but without using the signal postulate, it is possible to derive the Lorentz Transformation having a universal kinematic limit velocity c_o (however it is not necessary, at least 'a priori', that $c_o = c$, the signal postulate).

ASIDE ON THE VALIDITY OF RELATIVITY

We have been considering an objection to the c decay concept from relativity, and have seen that, in reality, it poses no difficulty. However, as an aside, it is interesting to note an objection which Professor Dingle has raised to relativity itself.[11] Some readers will be familiar with it, and will also feel that it can be readily disposed of. The present writer is not convinced that this is indeed the case. Here then is Dingle's objection: the Lorentz Transformation, at the heart of the mathematical content of relativity, implies that 'a moving clock runs slow'. So, if the motion of two clocks is purely relative (that is, either can be regarded as the stationary one with equal validity), then the theory requires that each clock runs both faster (if it is regarded as the stationary one) and slower (if it is regarded as the moving one) than the other!

It might at first be objected that Dingle is being naive. Does not Einstein's theory require clocks merely to appear to behave in the above manner? Is it valid, or even possible, to make a direct comparison? Can it not be that Dingle's commonsense approach to clock behaviour is simply a manifestation of the Newtonian concept of absolute time, which the theory of special relativity has replaced?

But, Dingle's reasoning does not appear to be flawed. It is clear from Einstein's own example, which compares the rates of polar and equatorial clocks, that he himself considered it to be a real effect, and yet offered no justification for arbitrarily choosing the clock he did choose to be the stationary one. Further, as Dingle argues, the rates of two clocks can be compared, for this is the very purpose for which a synchronisation method is devised in the theory. Finally, and most significantly, Einstein's own work (as distinct from Minkowski's reformulation of it) deals only with the measurement of time, although it is popularly perceived (such is the influence of Minkowski) to describe the nature of time. Thus either the concepts used in special relativity, or the concept of normally running clocks, must be abandoned. This is exactly how Professor Synge, a leading authority on relativity summed it up in a published letter to Nature:

'As the result of a lengthy correspondence with Professor Dingle, I am of the opinion that the contradiction described by him in Nature, 216 (1967), p. 119 is due to the incompatibility of

(a) the concepts used in the special theory of relativity as ordinarily understood, and

(b) the concept of clocks that run regularly, as understood by Professor Dingle.

I believe that Professor Dingle agrees that this is a correct diagnosis of the contradiction. To resolve it, one must abandon either (a) or (b).'[12]

So we must make a choice! Philosophically stated, Dingle's contention is that mathematical truth is more general than physical truth. He himself illustrates what he means by the familiar algebraic forms of practical problems leading to quadratic formulae with equally valid mathematical solutions of 8 and -3 say. However, if in the problem x was representative of people, then physically -3 must be discounted and 8 accepted. This, he claims is exactly analogous to the problem of finding the relationship between rates of clocks in relative uniform motion with respect to each other. There are two mathematical solutions, viz. the Galilean Transformation (used in Newtonian mechanics) and the Lorentz Transformation (used in relativistic mechanics). The Lorentz Transformation is a satisfactory mathematical solution, but is it a valid physical solution if the clock motion is assumed to be purely relative? It must be stressed that it is not the Lorentz Transformation on its own, but only in conjunction with the relativity postulate, that leads to what has been described above as a contradiction.

OVERALL SUMMARY AND CONCLUSIONS

Setterfield's hypothesis and its apparent conflict with relativity has been discussed.

It has been shown that, shed of its associated metaphysical notions, the Lorentz Transform is no obstacle to the concept of c decay over cosmic time.

The Lorentz Transform is essential to two mathematically identical, but physically distinct, theories due to Lorentz and Einstein. Both emerged as a result of the Michelson-Morley experiment. While Einstein ex-

Lorentz and Einstein. Both emerged as a result of the Michelson-Morley experiment. While Einstein explained the null result in terms of non-existent motion, Lorentz concluded that the motion was merely non-detectable. Einstein discarded the idea of an ether, while Lorentz retained such a concept (and so with this as an absolute standard, his is not strictly a relativity theory at all). Lorentz saw his transform as an ether correction; Einstein viewed it as a relativity correction.

Whichever interpretation of the mathematics we favour (of course Einstein's is almost universally acclaimed) both are equally consistent with the c decay idea (although some may not be convinced that special relativity in the sense of Einstein's theory does not appear to lead to physically absurd results).

It has also been noted that relativity is kinematical, can be developed without light, and has therefore nothing to say on the **nature** of **light** (just as we observed that the Lorentz Transform itself made no statement on the **nature** of **space** and **time).** The signal postulate can thus be relaxed (and even dropped as a required axiom).

And so returning to the anticipated argument against Setterfield's hypothesis, that is, c(x) = c implies c(t) = c, we have seen that not only does the premise, c(x) = c, need careful consideration, but the implication is invalid, or rather is only valid if one makes the metaphysical extrapolation from relationships between time and space measurements, to the nature of the relationship between the dimensions of space and time.

It was also observed in passing that the constancy assumed in the signal postulate is independent with respect to source motion, and not with respect to cosmic time. Having said that, it follows that dropping this axiom does not itself demonstrate the compatibility of c decay. Minkowskian metaphysical ideas must be abandoned (noting that Einstein himself was considering time in the sense of instants and intervals, not in the sense of the essence or nature of time).

Thus, overall, this paper reaches the conclusion that the **mathematics** of 'relativity' is compatible with the concept of c decay.

REFERENCES

1. Norman, T. and Setterfield, B., 1987. The Atomic Constants, Light and Time, Stanford Research Institute International, Invited Research Report, Menlo Park, California.
2. DeBray, M. E. J. G., 1931. The velocity of light. Nature, 127: p. 522.
3. Norman and Setterfield, Ref. 1.
4. Norman and Setterfield, Ref. 1.
5. Silverman, A. N., 1986. Resolution of a cosmological paradox using concepts from General Relativity. American Journal of Physics, 54 (12): pp. 1092–1096.
6. Dingle, G., 1972. Science at the Crossroads, Martin Brian O'Keeffe, London.
7. Terletskii, Y. P., 1968. Paradoxes in the Theory of Relativity, Plenum, New York.
8. Breitenberger, E., 1984. The status of the velocity of light in special relativity: Precision measurement and Fundamental Constants II. In: B. N. Taylor and W. D. Phillips (eds), National Bureau of Standards (U.S.), Special Publication 617.
9. Mermin, N. D., 1984. Relativity without light. American Journal of Physics, 52(2): pp. 119-124.
10. Singh, S., 1986. Lorentz transformations in Mermin's relativity without light. American Journal of Physics, 54(2): pp. 183–184.
11. Dingle, Ref. 6.
12. Cited from Dingle, Ref. 6, pp. 76–77.