On the Relativistic Principle of Time Dilation

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The relativistic phenomenon of time dilation has been verified in countless experiments. This short paper examines this phenomenon from an engineering point of view; specifically, from the viewpoint of modern electronic communications. It is shown that Einstein's "grandiose view" about the nature of time has unnecessarily overshadowed what is in reality a very simple engineering problem. Accordingly, the dangerous path of thinking that physics has taken for the past 100 years -including such flawed ideas as the effect of travel on aging- will have to be reconsidered.

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Introduction

One hundred years ago, confronted with the experimentally confirmed fact that the speed of light always appears to be the same for different observers regardless of their relative states of motion, Albert Einstein reached the radical conclusion that "time" must have a different "rate of flow" for each different observer, thereby chattering classical mechanics and ushering a new era of controversy and debate that has not abated since. Interestingly, amidst all the controversy of the past century, it seems that the physics community has overlooked one critical fact: Einstein's conclusion is indeed the only conclusion that can be reached if we fail to recognize one very important problem, namely, the synchronization problem. By "synchronization problem", we mean how the "events" described by Einstein in his 1905 paper will be communicated between the different frames of reference. As we shall demonstrate, Einstein did in fact fail to recognize this important problem.[1] Even more interestingly, if we do take into account the synchronization problem, the mathematics of Special Relativity (SR) will not be altered, but, as we shall conclude, the radical physical principle that time has different "rates of flow" for different inertial observers will no longer be true! Instead, what will emerge is a very simple engineering problem that is totally solvable by classical mechanics (and the solution is indeed nothing but the Lorentz γ factor).

In the following discussion, we shall adopt a rather simplified version of the problem that Einstein described in his 1905 pa-

[1]Einstein considered in his paper what it means for two clocks in the same reference frame to be synchronized. He never considered, however, the problem of synchronization between two different reference frames.

per, which we shall call the "Einstein scenario": let a velocity v be imparted on a rod of length x' at $t = 0$. At the same instant, a photon is sent propagating along the direction of motion of the rod, x. Assume that the rod is equipped with an observer, a device for measuring the time, and a photo-detector that is placed at the end of the rod. Let us call the stationary frame S and the moving frame S', according to the current terminology. When the photon is detected by the detector at the end of the rod, the moving observer reads the time t' that is displayed by his clock. Einstein called the arrival of the photon at the detector an "event". Now, the observer in the stationary frame can immediately state what the $x-$coordinate of that event will be: it will be given by $x = vt + \gamma x'$, where t, of course, is the time in the stationary frame (the Lorentz γ factor here accounts for Einstein's hypothesis of length contraction[2]). But how the time t will be determined? Essentially, the observer in the stationary frame S must receive information (by some means) that the photon has been observed by the detector in the moving frame S'. When such information is received, the stationary observer will then simply read his clock to determine what the time t is.

In his scenario of 1905, Einstein made the following crucial (and very simplistic) assumption: the occurrence of that "event" (that is, the detection of the photon by the moving detector) will be known or communicated to the observer in the station-

[2]Einstein's hypothesis of length contraction does agree with the predictions of wave mechanics. However, lots of debate does exist in the literature about whether length contraction is real for macroscopic bodies. Length contraction is not discussed in this paper.

ary frame *instantly.*[3] Given that assumption, and given the very important, experimentally verified relationship

$$\frac{x}{t} = c = \frac{x'}{t'}$$

(the law of the constancy of the speed of light c in all inertial frames), we have no choice but to conclude that a clock in the moving frame S' must run slow with respect to an identical clock in the stationary frame S (the concept of time dilation), since of course $x' < x$.

A lot has been discovered and became known about electronic communications since 1905. In the modern electronic age, we now understand that the "event" described in Einstein's scenario has to be communicated to the observer in the stationary frame by some electronic means (i.e., a wireless signal, optical signal, etc). That signal must be transmitted from the moving fame to the stationary frame and will contain a message such as "the photon was detected here in the moving frame - stop your clock!", and this *does take* additional time. We may ask: why

[3] In Section 3 of the 1905 paper (where the Lorentz transformations were derived), the reader will find what Einstein's assumption was concerning the "event" of the arrival of the photon at point x':

QUOTE The ray moves relatively to the origin of S, when measured in the stationary system, with the velocity $c - v$, so that $x'/(c - v) = t$. UNQUOTE

This is clear and unequivocal evidence that Einstein assumed that the arrival of the photon at point x' in the moving frame is an event that is known instantly in the stationary frame.

the occurrence of the event cannot be communicated instantly to the stationary observer as Einstein had imagined? Because we now understand that the process of "observing" a photon necessarily means its destruction, and hence the "observation" of the event will be carried out in the moving frame S' *only*. In 1905, Einstein of course could not have foreseen the technical difficulties associated with the observation of a quantum of electromagnetic energy.

As we must now realize, if the moving frame is traveling with a velocity that is not negligible by comparison with c, then there will be some time "slippage", or latency, between the time t', observed in the frame S', and the time t, which is the actual time at which the message is received by the stationary observer. Hence, the difference between t and t' can be regarded as a *synchronization error*, as opposed to the more dramatic view that "time has lost its absolute meaning" due to motion. Accordingly, "time latency" will be a much more appropriate term than "time dilation". Here, of course, we must stress that the Lorentz transformations are still valid, since those transformations are a direct mathematical consequence of the law of the constancy of the velocity of light.

Why we must accept the concept of time latency instead of the concept of time dilation? For one important reason: it eliminates an illogic paradox that resulted from the concept of time dilation (as well as the thousands of papers that were written in an attempt to solve it), namely: the Twin Paradox. If we accept the concept of time latency, there is no "twin paradox"; there is only latency in the timing of observed events. If the relative motion stops, all the clocks will display the same reading! (Note that there has been some remarkable papers [1], [2] that placed the validity of the Hafele and Keating experiment in very serious doubt). Speaking about such things as the twin paradox is in reality within the realm of metaphysics! As far as physics is concerned, we simply must acknowledge the fact that there will be engineering limitations on the process of synchronizing very fast moving clocks.

One important experiment that was conducted in the past and that seemed to support the principle of time dilation was the experiment with cosmic ray muons, first conducted by Rossi and Hall in 1941 [3] and repeated recently in accelerator rings. In that experiment, muons traveling with a velocity $v \approx c$ are observed to survive longer than muons that travel with velocities that are much less than c. That experiment, however, can be understood on the basis of the principle of time latency, in the following manner: when a muon decays, its wave function undergoes the transformation $\psi_\mu \to \psi_e$, that is, it becomes the wave function of an electron. How do we determine whether a wavefunction represents a "muon" or an "electron"? We try to interact with it by electromagnetic means. If the particle representing that wavefunction is traveling with a very high velocity, there will be some latency in the timing at which we obtain "information" as to what the traveling wavefunction represents. The event $\psi_\mu \to \psi_e$ simply cannot be observed instantly. Since we obtain information about the occurrence of that event through some electromagnetic or electronic means, then the Lorentz gamma factor will indeed control the time at which the event $\psi_\mu \to \psi_e$ is *actually* observed. In all aspects, it would appear that the original particle had "lived" longer. But one must recognize that this type of problem is inherently a synchronization problem that is related to the fact that the particle is moving with a velocity that approaches that of our means of communication. Under these conditions, time-synchronized "observability" of different states of matter is simply impossible. Some latency should be expected. It is indeed amazing and regrettable that the physics community at large has not recognized this problem and opted instead to accept dangerous and metaphysical concepts such as the suggestion that "time loses its rate of flow" when motion occurs.

Conclusions

The flawed concept of time dilation emerged as a result of Einstein's failure to recognize the synchronization problem in electronic communications. This is not surprising given that the special theory of relativity was published in 1905 (only the telegraph was known at that time). Remarkably, the mathematics of Einstein's theory is correct, since the theory is totally based on the cornerstone experimental fact of the constancy of the velocity of light in all inertial frames. Recognizing the synchronization problem, while it doesn't alter the mathematical results of Einstein's theory, it leads however to the replacement of the concept of "time dilation" with the concept of "time latency", which is the simple recognition of the fact that there are engineering limitations on the process of synchronizing very fast moving clocks. Hence, no radical departure from classical mechanics is necessary in understanding the physical effects observed at very high velocities.

"Time dilation", with all of its inexplicable paradoxes, was a metaphysical assumption; and it is certainly beneficial for physics going forward that this assumption be abandoned.

References

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