On Physical Time

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The multiple time conception of Einstein's relativity is discussed from historical and analytical perspectives. The advantages of a physical conception of time versus a philosophical conception of time are discussed with the objective of showing that relativity invokes a philosophical conception of time versus a physical one through the ad hoc hypothesis that time can be changed due to high velocity motion. The use of an absolute physical conception of time such as UTC removes the difficulties encountered by the introduction of the ad hoc relativistic theory of time that has its origin in a philosophical confusion regarding time. It is shown that the hypothesis of the existence of multiple times in special relativity is an unnecessary and ultimately contradictory conception of time, that cannot be a physically valid conception.

1. Introduction

The purpose of this paper is to examine the problem of physical time and to recommend a realistic conception of physical time. We will define physical time, as opposed to other kinds or types of ideas regarding time, as time in accordance with the conception of time, which regards time as an important concept which occurs in theories and problems of physics. So physical time is how time is regarded and conceived in the practice of physics and the technological arts, such as the various types of engineering. Now according to the practice of physics and engineering, time has a specific definition and meaning, it is defined by international agreement, and has specific procedures for its measurement. This physical time has a name. It is called Universal Coordinated Time which carries the standard abbreviation UTC. This UTC time has a specific definition, is standardized, and is sanctioned by national and international law. It is a physical time because it derives from a physical definition, and is regulated, maintained, and distributed by technological practice in accordance with concepts of physical theory.

The reader may wonder why such a conception as physical time deserves a special discussion to justify its usefulness. The answer is that physics needs a particularly clear and simple conception of time to replace the theories of time which have become the popular pastime of theoretical physics. Here we will not try to convince the reader that a new philosophically deep and beautiful theory of time is not necessary for the true understanding of the modern universe, but will suggest that the problem has been solved for quite a long time, and that all that is needed is an understanding of that simple conception of physical time, which has the attributes that it is simple, straightforward, and familiar to us as the everyday conception of time **that we use in our daily lives**.

2. Background on the Nature of Time

To begin we will briefly discuss the problem of what is time. There are two primary viewpoints that one can say are the most common ones. The first is that time is a human invention, which means that time is a concept invented by humans to understand or explain the primitives of motion and change. These are both things that require some explanation. Why does something change its place, motion, and why do things change, through the natural process of becoming, growing old and dying, through which a new cycle of rebirth produces a new generation which repeats the process. The process continues on without end and that implies the concept of eternity or the infinite continuity of the cycles of birth and death. This cyclic process is said to occur in time. The second idea about time is that it is a necessary condition for physical laws to exist. It existed before the beginning and has existed ever since and will exist forever into eternity. The main feature of this idea of time is that it exists without any human perception of it and that it is a preexisting condition of all materialistic process that define existence.

We can see that the first viewpoint is essentially humanistic, philosophical and artistic appealing to the emotional and artistic aspect of human experience and the second is materialistic, scientific and appeals to the logical minded, who prefer precision of thought. Here we will not digress into the philosophical problem of time but will confine ourselves to the problem of physical time. That is the problem of time measurement as it presents itself through a physical process taken to be a method of measurement and so representing a clock, a device for the measurement of physical time.

The purpose of this section is to give a brief history of the notion of time. The reader may initially skip this part and proceed to the main argument in section 3.0 upon a first reading. It is suggested that he refer back to this section in order to understand the references made in the main analysis to the ideas of the philosophers mentioned here.

Physical time, hereafter we will simply say time, as conceived by mankind has been the subject of scientific, religious, and philosophical enquiry since the dawn of history. It is clear that the modern science of astronomy arises from the measurement of time through the motions of the moon, sun, and stars. This recognition of time as a fundamental aspect of the physical world has its origins in the construction of a calendar to measure the cycles of days months and years, in order to guide the cycle of agriculture, planting and harvesting, and all civil human actions. Thus, ancient astronomy is the science of the measurement of time. Ancient religion viewed time as the the divine providence of the gods. All of these views of time conceive of it as eternal, fixed, and unchanging, in other words absolutely divine.

Certainly in ancient times the average person knew clearly what time was as a result of religious practice. Time was eternal, regulated the cycle of birth and death, presented mankind with the realization of his mortality, and inspired in him veneration for the creation of the world, and the Divine plan that governed all things. Time was universal and absolute being a creation of the divine being. But it is only with the modern philosophers that this conception of time becomes questioned.

2.1. Plato's "Time as the Moving Image of Eternity"

In the early Greek myths of creation we find that the notion of time was already present in the ancient consciousness. Pherecydes says before the creation of things, "Zas and Chronos existed..." Hence time existed before the miracle of creation and modern science has not improved much upon this conception that was created in the sixth century B.C.

Plato's famous definition of time as the moving image of Eternity, appears in the dialog of Timaeus, where Timaeus is describing the creation of the world, he says:"The nature of the Living Being was eternal, and it was not possible to bestow this attribute on the created universe, but he determined to make a moving image of Eternity, and so he ordered the heavens be made in that which we call time an eternal moving image of the eternity which remains forever at one. For before the heavens came into being there were no days or nights or months or years..." Later he repeats the metaphor following a long discussion of Being and Becoming, past and present and future, by saying: "...nor in general can any attributes which becoming attaches to sensible and changing things belong to it, for they are all forms of time which in its measurable cycles imitates eternity...as a result of this plan ...the sun and the moon and the five planets as they are called came into being to define and preserve the measures of time." From this we see the reason that, Plato said that the Divine celestial bodies were created as the "organs of time".

2.2. Aristotle's Definition "Time as the Number of Motion"

When Aristotle began his considerations of the problem of time in his book on Physics, he stated it this way: "...time is present equally everywhere and with all things".

As Aristotle knew, it is pointless to discuss time without a clear statement of what it is, and is not. His statement makes it clear that time is a universal absolute, applicable to all physical processes equally the same everywhere or uniformly equivalent in all places and all epochs. This concept is at the very foundation of Natural Philosophy, which is the basis of physical science. Once we realize and accept that this is a necessary truth, we can appreciate why it is at the foundation of all of physical thought. The rejection of this necessary aspect of time as a physical conception is the hallmark of modern relativity physics that sets it apart from classical natural philosophy.

Aristotle also tells us that: "...change is always faster or slower, whereas time is not: for 'fast' and 'slow' are defined by time---'fast ' is what moves much in a shorter time, 'slow' is what moves little in a long time; but time is not defined by time, by being a certain amount or a certain kind of it." Here Aristotle is explaining that time is not movement, and he does this by making it clear that fast and slow are not attributes of time, but of the things which change in time. For Aristotle, time is not the physical process, but the definition of physical process. The important aspect of this argument is that to talk about motion in a physical way requires that we first have a notion of time, which is independent of the motions we are analyzing.

Aristotle does this because Aristotle tries to avoid the difficulty of the duality of time. It is clear that time is the measure of change and that change is the measure of time. There are two different ways of thinking about time and we must be careful not to mix them up, because as it is clear, all measurement of time involves a physical process which measures a motion. Hence, if the clock measures more motion for a given number of time, then we say the motion is fast and contrary wise, we say that the motion is slow if the clock measures less motion for the same number of time. But what if we are trying to measure time itself, how do we measure it? The process whose motion which we measure as the number of time, is itself subject to the difficulty of being fast or slow, in comparison, so what is it that is different, the motion or the passage of time? In the context of physics, the answer must always be that it is the motion which changed and not time. Otherwise we are faced with a logical contradiction and hence the truth that time is an absolute, is a necessary precondition of physical thought. Einstein violates this necessary rule, and that is a major reason for the continuing controversy over relativity.

2.3. Descartes' Time as a Mode of Thought Serving to Explain Duration

Renee Descartes defines time in section LVII of his **Principles of Philosophy** as follows:

> "LVII. That some attributes exist in the things to which they are attributed, and others only in our thought; and what duration and time are. Of these attributes or modes there are some which exist in the things themselves, and others that have only an existence in our thought; thus, for example, time, which we distinguish from duration taken in its generality, and call the measure of motion, is only a certain mode under which we think duration itself, for we do not indeed conceive the duration of things that are moved to be different from the duration of things that are not moved: as is evident from this, that if two bodies are in motion for an hour, the one moving quickly and the other slowly, we do not reckon more time in the one than in the other, although there may be much more motion in the one of the bodies than in the other. But that we may comprehend the duration of all things under a common measure, we compare their duration with that of the greatest and most regular motions that give rise to years and days, and which we call time; hence what is so designated is nothing superadded to duration, taken in its generality, but a mode of thinking."

This passage does not clearly state the idea that for Descartes time is a mode of thought derived from the idea of duration which serves to explain it. If we read carefully we can see the notion in the above passage but not clearly. But by consulting Spinoza's interpretation of Descartes' notion of time we encounter a more definitive statement of what Descartes means by time. Spinoza in His book, The Principles of Descartes Philosophy, defines eternity and duration separately. Eternity is defined as: "an attribute under which we conceive the infinite existence of God." Eternity for Spinoza is an absolute existence. Duration is a possible existence defined as:"Duration is an attribute under which we conceive the existence of created objects so far as they preserver in their own actuality." Time is now defined relative to duration, as follows:"In order to determine or measure this (duration) we compare this with the duration of objects which have a fixed and certain motion, and this comparison is called time. Therefore time is not an affect of things but only a mode of thought or, as we have said, a being of reason: it is a mode of thought serving to explain duration."

The reader should notice that the Cartesian idea of time is very close to our modern idea of physical time. The main difference is that the modern conception of time has been stripped of the supposed metaphysics, which entails the concepts of eternity and duration, leaving only the bare notion of physical time as a relation of measurement. An essential element in this idea is the independent nature of time as we humans conceive it. Its absolute existence is taken as a precondition to understanding time's meaning. Note Descartes stress upon the idea of time as a necessary mode of thinking, which does not assert that time is real in a physical sense.

2.4. John Locke's Time as Personal Perception of Duration

According to Locke, "This consideration of duration, as set out by certain periods, and marked by certain measures or epochs, is that, I think, which we most properly call time." Locke said we arrive at this idea of duration through a train of succession of ideas following each other in our mind and upon which we reflect to construct the idea of duration in time. Locke's duration is therefore a relational one, because we define the duration in the same way as we define a distance, as the interval between points. For time the duration is the interval between successive nows or moments in time. However, for Locke duration was not an objective time, but a personal individual time because "We have no perception of duration but by considering the train of ideas that take their turns in our understandings." So for Locke, time as duration is entirely relative to the individual and is not our concept of physical objective mathematical time which is embodied as the UTC time.

2.5. Van Helmut's Time

Van Helmut's time is a duration defined from the everlasting eternity of time by dividing up of the divine eternal duration into segments, which correspond to the durations of experience of living beings. It is defined as a dual concept to Locke's time in this way. Whereas Locke defined rational time from the succession or sequence of nows, as the interval between them, Van Helmut did the opposite. He took the eternal duration and broke it up into pieces using the nows as the dividing or divisional markers. But for Van Helmut there was an infinity of possibilities in making up this division into durations of experienced being, which he identified with the lifetimes of living creatures. Topologically, Van Helmut's time resembles the definition of a compact space as defined by a series of closed coverings.

2.6. Isaac Newton's Absolute Time

It is believed that two important Cambridge Platonists exerted a strong formational influence on Isaac Newton's notion of time. Hence they are viewed historically as precursors to Isaac Newton. The significance of the new approach to time as a mathematical and physical conception as opposed to a philosophical conception arises from the scientific revolution in the work of Galileo and his followers that culminates in the mechanical theory of Isaac Newton. Galileo is generally credited as the initiator of this approach as he is supposed to have been the first to measure motion by experiment using a physical measurement of time to formulate the laws of motion.

It is important to notice that this revolution in thought, which is termed the scientific revolution is really in a sense a mathematical revolution in the application of mathematics to the problem of motion and this in turn transformed the calculus because of the need to represent motion mathematically. Hence the concepts of time and space became mathematical and through this transformation time and space became physical through the application of the mathematical ideas of the calculus. More properly we should use the terminology of Newton's method of fluxions as this is the mathematical embodiment of change in time. It is this conception of Newton that is the revolution in thought. Here we will try to see how this physical idea of time evolved form the philosophical ideas. Later we will be more specific in pinpointing the way the physical notion of time is differentiated from the philosophical conception of time.

Absolute time is the name given by Isaac Newton to his conception of time as duration described in his Mathematical Principles of Natural Philosophy. It is a conception of time particularly suited to the mathematical problem of motion, where time is the measure of motion. Of course, for this to be the case, we have to have a measure of time that is uniform and independent of the motion to be measured. Hence Newton stressed the idea of an absolute time, which was a kind of ideal time free of the imperfections of time measurement, which Newton discussed, such as the inequality of the day. Newton says: "The natural days, which commonly, for the purpose of the measurement of time are held as equal, are in reality unequal...It may be that there is no equable motion, by which time can be accurately measured...But the flow of absolute time cannot be changed. Duration, or the persistent existence of things, is always the same, whether motions be swift or slow or null." This discussion seems carefully crafted and clear in its meaning. However, that is because the basic concept of absolute time is an underlying conception of our modern physical time, that is, fundamental in the construction of our modern clocks. It was an underlying assumption in the development of atomic time that this time must be a uniform and equable time, and that was one of the goals which modern time keeping has achieved. However, in Newton's time, time measurement was problematical. A typical clock was accurate to only within 15 minutes a day.

Newton's absolute time was an ideal perfection of time concept, which was uniform in its flow and hence produced a uniformly consistent measure of motion, as compared to the actual clocks of the time which were inaccurate. But there is more in Newton's absolute time conception that became a serious source of trouble as a result of philosophical objections to this conception of time. It appears that the name absolute time was one cause of the problem, while the other was that the idea of duration as time was not generally acceptable to the philosophers, although it was indispensable and necessary to the establishment of the concept of physical time.

The main philosophical objection to the idea of duration, was that it is independent of the senses of the observer, and hence was an objective concept, while, for the philosophers, the concept of time was an abstraction developed from the perception of a sequence of events occurring in the mind. The conflict between these two conceptions of time became the subject of heated debate in the 18th century.

2.7. Berkley's Personal Time in the Mind

Newton's idea of absolute time was severely criticized by George Berkley as part of his untiring and thoroughgoing critique of Newton's philosophy. Simply put, in Berkley's view, time was a personal subjective experience, intimate and unique to each existing individual being. In his view absolute time as a duration was simply unacceptable.

Berkley explains his views this way in A Treatise Concerning The Principles of Human Knowledge, 1710: "Time, place, and motion, taken in particular or concrete, are what everybody knows, but, having passed through the hands of a metaphysician, they become too abstract and fine to be apprehended by men of ordinary sense... But if time be taken exclusive of all those particular actions and ideas that diversify the day, merely for the continuation of existence or duration in abstract, then it will perhaps gravel even a philosopher to comprehend it. For my own part, whenever I attempt to frame a simple idea of time, abstracted from the succession of ideas in my mind, which flows uniformly and is participated by all beings, I am lost and embrangled in inextricable difficulties. I have no notion of it at all, only I hear others say it is infinitely divisible, and speak of it in such a manner as leads me to entertain odd thoughts of my existence; since that doctrine lays one under an absolute necessity of thinking, either that he passes away innumerable ages without a thought, or else that he is annihilated every moment of his life, both which seem equally absurd. Time therefore being nothing, abstracted from the succession of ideas in our minds, it follows that the duration of any finite spirit must be estimated by the number of ideas or actions succeeding each other in that same spirit or mind. Hence, it is a plain consequence that the soul always thinks; and in truth whoever shall go about to divide in his thoughts, or abstract the existence of a spirit from its cogitation, will, I believe, find it no easy task."

2.8. The Leibniz-Clarke Controversy

The start of the 18th century marked a period of our story which erupted into philosophical controversy regarding the nature of time. In the previous sections the different and contradictory opinions regarding the nature of time were summarized. This divergence of strongly held opinions was bound to result in controversy.

In his Mathematical Principles of Natural Philosophy, Isaac Newton defined the concepts of absolute space and absolute time. These have come down to us through the physics textbooks, which present them as false conceptions that have been corrected through the acceptance of Einstein's theory of relativity. However, Einstein was not the first to object to the ideas of absolute space and time, that honor is attributed to George William Leibniz who attacked the Newtonian philosophy and precipitated a famous dispute with Clarke, a Newtonian advocate. It is clear from reading the previous sections that Leibniz was not the first, or only, philosopher to dispute the Newtonian idea of an absolute time, but his disagreement is certainly the most famous of the objections which were voiced in opposition to the ideas of the Newtonian natural philosophy. The dispute began as a theological discussion, and then evolved into a discussion of absolute time and its rejection by Leibniz. The essence of the debate is primarily a philosophical one and the main objection seems to be the absolute character of time conceived in the context of realism. That is, the debate is about the nature of time itself and not about how time should be viewed as a practical aspect of human understanding.

2.9. Mach's Objection to Newtonian Absolute Time

In his famous book The Science of Mechanics, Ernst Mach severely criticized the Newtonian notion of absolute time, which was at that time the accepted physical theory. If we apply the Hegelian conception of the progress of history as modern physics textbooks appear to do, we can interpret Newton's absolute time as the thesis, and Mach's objection as antithesis to Newton's theory, a sea change in the philosophy of physical time, which culminated in Einstein's theory of relativity as the new synthesis. However, even though Einstein based his scientific philosophy upon Mach's objections, and because of this it is claimed that Einstein's ideas were derived from Mach, this fact greatly disturbed Mach, who found no reasonable justification for this claim and did not accept Einstein's theory of relativity, even after being told he was the father of it. Hence we must be careful in claiming Mach as the father of our modern physical ideas regarding time and space and inertia. (The reader should note that modern textbooks do make this claim and that it should be judged with caution.)

Mach's objection to Newton's absolute time concept, which he called monstrous, can be stated this way. Mach did not conceive of time as a real, but merely as an abstraction in terms of a relation by which "...all things in the world are connected with one another and depend on one another and that we ourselves and all our thoughts are also a part of nature. It is utterly beyond our power to measure the changes of things by time. Quite the contrary, time is an abstraction, at which we arrive by means of the changes of things; made because we are not restricted to any one definite measure, all being interconnected." Hence for Mach, time was simply an abstraction derived from our perception of the things happening in the world. He concluded by damning Newton's absolute time as "an idle metaphysical conception."

The alert reader should notice that Mach's objection is merely a repeat of what Aristotle had said many centuries before. It is clear that Mach's objection would have slipped into oblivion, since it is not part of our modern conception of physical time, if not for the advent of Einstein's theory of relativity. The basic reason is that our modern conception of physical time asserts that it is possible to measure the changes of things by time and employ them in a socially useful way, contrary to what Mach asserts. But in order to do this, one has to adopt a conception of time that makes it absolute in the sense that it is independent of our measurements and so absolute time is a practical conception, even if it is purely a human invention with no actual metaphysical reality. It seems to be this metaphysical conception of the reality of time that is the source for Mach's objections against the idea of absolute time, and not its practical usefulness in human understanding.

2.10. Heinrich Hertz Defines Physical Time Rigorously

In The Principles of Mechanics, Presented in a New Form, first edition published in 1900, Heinrich Hertz gives the first rigorous definition of physical time, which is almost the same as the one we use today. Hertz gives the following definition on page 140 of the Dover edition. "We determine the duration of time by means of a chronometer, from the number of beats of its pendulum. The unit of duration is settled by arbitrary convention.

To specify any given instant, we use the time that has elapsed between it and a certain instant determined by a further arbitrary convention. This rule contains nothing empirical which can prevent us from considering time as an always independent and never dependent quantity which varies continuously from one value to another..." Hertz' time is absolute in the sense of Newtonian absolute time, in which time is taken to be "flowing equably, without relation to anything external".

In the modern definition, the chronometer counts oscillations of a Cesium atomic transition, which defines atomic time. The unit of duration is the SI second, which for clarity we call the atomic second, to make it clear it is defined in terms of the frequency of the Cesium atomic transition. For physical experimentation and not calendar or navigational use, the duration is the number of atomic seconds. We cannot in general use the difference in UTC calendar time, unless we know that the interval considered has not been altered by leap seconds.

2.11. Einstein's View Of Time As "... only an illusion, although a convincing one."

In the introduction, it was pointed out that there are two views of time. The first that it is a human invention, designed to interpret and explain human experience and the second is that time is a physical concept defined through its measurement by the physical process of a clock. It should be clear to the reader at this point that the main philosophical differences in conceptions of time relate to the question of the ontological status, or reality of time. The question, is time real, is answered differently by what today we call the substantivalist and relational views of time. We will try to avoid these fancy philosophical terms and simply state that a believer in the reality of time stresses the durational nature of time as absolute and eternal, a kind of real existing entity, while the opposite view holds that there is nothing real about time since it is simply a relation of physical events to the sequence of sensations that produce images in our minds that constructs the idea of time.

The main point of this paper is to demonstrate that both conceptions of time are essential and that one cannot be suppressed in favor of the other without contradiction. However, it is clear that for physical purposes the conventional acceptance of the notion of physical time defined as UTC has proven superior in being a physically more fruitful conception.

Einstein's concept of time is a peculiar combination of these two ideas. It tries to combine the solipsistic idea of time as human experience into a physical theory of time so that physical time can be somehow, both a philosophical and personal time, and at the same time be a useful physical concept of time measurement. That this idea is satisfying to both viewpoints regarding time explains its satisfying appeal to the philosopher and to the physical scientist.

Unfortunately it is impossible that this attempt to unify the two viewpoints about time, the scientifically physical and the philosophically metaphysical, can actually be accomplished. The problem is that the two viewpoints must inevitably be contradictory, since it is not possible to establish both an objective physical time of measurement and a subjective metaphysical personal time of individual perception. This problem of contradictory results is the hallmark of special relativity and its failure to resolve the difficulties is due to the inherent philosophical difficulty at the heart of Einstein's conception of time. Simply put, Einstein's time is not physical time but a metaphysical time, solipsistic in nature and physically impossible of non-contradictory measurement.

Stated differently, it is simply impossible that any clocks known to human physical science can operate in the way envisioned by Einstein, since the essential character of his philosophical method produces a conclusion that violates the underlying mathematical method of measurement by assigning a number value to a measurement of physical time.

3. Physical Time and Problems of its Interpretation

Einstein's theory of relativity has become the accepted theoretical interpretation of physical time, but as we will discover, Einstein's theory of time is not really a theory of physical time, as it purports to be, but a metaphysical interpretation of time submerged within a physical-mathematical theory that pretends to be a theory of physical time.

Einstein's time is not true physical time, and its attempt to pose as physical time is the source of all the problems of time in modern physics. Effectively Einstein's time is a philosophical time, and we should not be surprised that it produces contradictory and peculiar concepts. Much of the difficulty in Einstein's theory derives from the suppression of the notions of time as eternity and duration, and the replacement of these ideas with a bare notion of time as merely a relation of measurement correlated with the perception of events by different observers in relative motion. The basic flaw was that in the process of stripping time of its supposed metaphysical notions of eternity and duration, a different metaphysics took its place which stressed a solipsistic conception of time.

3.1. Physical Time is an Absolute

The very first thing we must understand about physical time is that it is an absolute concept. This follows from the definition, and the practice of measurement. Time as a human invention can only be made real through the method of physical measurement, and it is through this process that time acquires its physical reality. Although in actuality we are measuring motion, the real purpose of a clock is to measure time as we imagine it to be in our theories of time. Because time is a physical measurement, physical time must be an absolute measure of time and all measurements of time are related to it as the absolute standard of measure. To make this abundantly clear, it is a legal requirement that time measure must be in terms of UTC time, which is the accepted definition of physical time used by international agreement. That is why it is called universal time. For all practical purposes UTC is time, and it is absolute in the sense that it is the standard measure of time everywhere for everyone.

One might ask why this should be so. There are two factors to consider. The first is the problem of measurement and the second is the problem of human understanding of time. In the first case, we require a uniform physical process to measure time. It turns out that there are not many such physical processes. This fact means that no two clocks ever read the same time. The process of clock making, the physical measurement of time, began as an attempt to mimic the time of rotation of the earth. So the earth is the first clock to be used to define time physically. Clocks therefore all are built to record time that does not contradict the time of the earth clock. So the first requirement of a measurement of physical time is that it must conform to some ideal standard of time. Now this requirement seems to imply, as a result of centuries of clock making, that the clock builder strive to achieve a clock which measures time uniformly, or equably as Newton says. This is done by making the harmonic or repeating cyclic process that is counted as uniformly identical as possible. In other words, each cycle of time is required to have the same length as all the other cycles of time. Such a requirement is found to provide the basis of clock measurement such that time can now be measured with a greater accuracy than any other physical measurement. This accuracy is achieved by the selection of physical processes that are identically repetitive with a high level of exactness. In other words, all of the repetitive cycles are identical to a high level of precision. This satisfies both the human desire for a high level of physical order and uniformly but also gives a very accurate way to measure physical time.

The acronym UTC is actually French and in English translates into coordinated universal time. Here the key word is coordinated. This is where the human aspect of the definition comes in. This requires that the definition be agreed to and accepted by all countries. In other words its physical definition in terms of measurement is coordinated so that it is universally maintained for all countries. This universal coordination requires that time be uniformly measured. A requirement that flows from the human perception of time as uniform and equable as Newton says. Another aspect of coordinated time is that it has no contradictions or discrepancies in its definition. Thus we do not have time in the United States of America different in any meaningful way, from the time in Germany, or France or Britain or Russia. (There are obviously going to be very, very small differences, but these are less than the requirements defined for the coordination.)

3.2. First Thought Problem

Here we discuss the first thought problem in physical time. The purpose is to demonstrate the reason for a uniformity and uniqueness in the concept of a physical time. This problem arises in discussions of the theory of relativity which is supposed to be a physical theory whose subject is physical time. The problem is posed this way. Given two inertial frames equipped with rods and clocks in accordance with Einstein's specifications, what is the rate of the clocks in the two inertial frames? Now this problem is never posed in terms of physical time, although it should be. The problem is posed this way to illustrate a particular problem in the special theory of relativity. It is this. It is impossible to define physical time as applicable to this problem without demonstrating a contradiction with the special relativity theory. The reason is that special relativity never gives a specific definition of time. But merely suggests that the time in the inertial frames is somehow related to physical time. Once we give a specific definition of time, we discover that that is the only possible time.

The first question we need to answer is this: What determines the rate of the clocks in the first reference frame, called frame A? We don't know unless we specify that it is UTC. Since UTC is time, we must specify that that is what is measured if we seek to measure time.

Now we ask: What determines the rate of the clocks in the second reference frame, called frame B? We don't know unless we specify it is UTC. We do this since we have in the theory the assertion that we have in all inertial frames the same time (UTC). We now have the rather curious situation that we have defined physical time in the two inertial frames and they are identical and absolute. One can see right away that this leads to the contradiction of the usual understanding of the theory which asserts that clocks in relative motion read different times. What has gone wrong? Not my reasoning!

What is wrong is that the problem is not clearly stated in special relativity. Suppose we have multiple inertial reference frames in relative motion with respect to each other, and we ask, what is the rate of the clocks in each of them? The only two conclusions which we can arrive at are that they are either all different or all the same. But in the first case we have actually a meaningless situation, because nothing reasonable can be concluded from it. (This is where the difficulty that time is a human conception comes into the problem.) It asserts that physical time is relative, that all clocks run at different rates, and that the rates of the clocks will be different when compared with each other. In fact, this kind of a measurement is meaningless, because we knew the rates were different before we compared them and the result that they are different after we compare them tells us nothing we didn't know before the comparison. It results in no increase in information about the system of clocks. Now in the second case, we have to assume all the clocks run at the same rate, and then when we compare them we find that they all run at the same rate, and the theory of special relativity is falsified. So we have two alternatives, either time is entirely relative, in which case it can never be proved as true, and the second case where time is absolute, and that can never be disproved.

Before we proceed to the next section, the reader should notice that in his papers Einstein assumes that all clocks run at the same rate, and this is his fundamental premise. This is basically the same as saying that all clocks run according to UTC time. Hence they all run at the same rate. The contradiction is produced in that Einstein produces a clumsy mathematical argument that shows that the clocks produce different clock readings, i.e. numbers, when they are compared. Hence it must be concluded that they record different times. This result contradicts the hypothesis and so the Lorentz transformation method used to produce the result must be false. That is the normal way mathematics is used.

Hence the argument proves that the Lorentz transformation method used by Einstein is a false method since it leads to a contradiction. Despite this, physicists maintain the absurd conclusion that the clocks do correctly record time and that it is different for the different clocks in relative motion. This result cannot be due to a difference in time as claimed by Einstein as his fundamental insight. The proof, which is outlined above, shows that if we are to have universally true physical laws, then time must be the same in all inertial frames, and this can not the case if time is different in different inertial frames.

To summarize. In order to construct a meaningful rational physics, that is to conceive of universal physical laws, time has to be defined as an absolutely universal concept, otherwise no meaningful laws of physics can be derived and no rational interpretation of nature will be possible. Nature would remain unintelligible without the idea of absolute time. Hence, in order to say anything meaningful about time, the first thing we must do is to assume, as by a definition, that time is uniform and thus the same everywhere and always as Aristotle told us many years ago. Hence it must be UTC or conform to the idea of time as measured in accordance with the specifications of UTC. If we don't do this, we can't perform any kind of a time measurement and conclude anything logically correct about that time measurement. By definition a measurement of time is a comparison of a interval of time to be measured against a standard interval of time. This standard interval has to be absolute time or else the measurement is meaningless. Now, it is obviously absurd to say that a measured difference in physical time means that there is a difference in time, or that time changed. The reason is simple, one cannot ever say that the difference is due to a change in time instead of a change in the measurement of physical time. In order to answer this paradox, one has to define time in a way that is not physical so that its measurement is not changed by a physical change. This kind of definition is impossible, so all that can be done is to say that physical time is different and attribute that change to a change in the physical process involved in the measurement.

3.3. Second Thought Problem

To resolve the difficulties discussed above, consider the following problem. We have a clock calibrated in accordance with physical time or UTC, and suppose it is at rest in some inertial frame A. We have a second clock also calibrated in accordance with physical time or UTC in a relatively moving reference frame B. We now seek to compare the rate of clock B with clock A, and ask the question: Is there a difference in the rates of the two clocks? The answer is we have no way to know in advance unless we have some theory that asserts there is a physical difference in the clocks caused or related to the motion of the B clock relative to the A clock. Oddly enough the principle of relativity of Poincare asserts that there is no physical difference as a result of the motion of B relative to A that could cause the B clock to run at a rate different from the A clock. So they read the same. But this contradicts what Einstein says in his theory of relativity which asserts there is no absolute rest frame. The main point here is that if the principle of relativity of Poincare is true, then the clocks behave as if an absolute universal physical time exists for all states of relative motion. Hence physical time is absolute according to the principle of relativity.

This paradox is really the result of difficulties of defining the conditions of the problem. There is within it a refutation of relativity that is perfectly valid. The usual interpretation is that absolute time is disproved by relativity, so the paradox is that this is disproved. It is certainly a surprise to discover that the principle of relativity implies that time is absolute.

3.4. First Discussion Digression

Let us examine what the results are at this point. We assumed as little as possible and discovered in the first thought problem that without an absolute definition of time, we can't say anything at all regarding the results of time measurement. This is pretty much the same as if two clock makers built different clocks and then tried to determine which clock kept the correct time by comparing them. There is no way this can be done, as is obvious. Clock makers use a physical definition of time to set their clocks and assess their accuracy. Huygens may have been the first physicist to define a physical time when he specified that a clock should be regulated to keep sidereal time, using the assumption that the earth's rotation is a universal uniform and absolute time.

Now once we define this physical time it becomes an absolute, in the sense that if all clocks adhere to it, and they all must do so to be called a clock, then physical time is absolute in the sense of Aristotle. In the second thought problem we discovered this result was also true for all clocks in relative motion in which the principle of relativity held good. Hence, although motion may be purely relative, the measure of time remained absolute. So if we ask whether time is absolute or not. The answer is perfectly clear, physical time is absolute. This is obviously true by a definition, but it is a necessary truth.

We are forced to this conclusion by the problem of measurement. All measurement must be by comparison to an absolute standard of definition. Without this absolute, measurement is irrelevant or meaningless. We can see that Aristotle appreciated this problem and stated his physics in terms designed to avoid the difficulties. Newton did the same in his formulation of the foundation of the science of mechanics.

It should be clear that we are not discussing time, but a specific definition of time, that is physical time. Thus it is not a philosopher's time, and it is not subject to philosophical confusions. Physical time is a necessary truth of empirical measurement, which is a conventional product of empirical physical and technological practice. Hence statements about it are true by conventional agreement. Once it is recognized that such statements imply a necessary truth in order to make comparisons of clocks, it becomes clear that one can only make statements regarding physical time which assumes it is absolute.

3.5. Third Thought Problem

Consider the empirical fact that clocks in motion do run slow when compared with rest clocks. This experiment has been done, but not often repeated. We take a clock calibrated in UTC and call it A. A second identical B clock calibrated in UTC is placed in motion relative to the first clock. When the B clock is returned to the rest clock and compared, it is observed that the B clock dial time is behind or reads less elapsed time (duration) than the A clock. All the evidence seems to indicate that this is a physical fact beyond dispute. The problem is to explain why this result occurs. In other words, what causes clock B to read behind clock A? A second question is does this mean that physical time is not absolute?

The answer, that suggests itself, is that something different existed in the physical conditions of the two clocks, that caused the B clock to run slow compared to the A clock. This must be the motion of clock B since that is the only difference. This motion implies an absolute rest frame, since otherwise by the principle of relativity, there is no physical difference due to the motion of clock B. Hence motion caused the B clock to run slow. But does this imply that time is not absolute? No, since in this case, the moving clock no longer measures physical time by definition and there is no reason to suppose that there is any other time, which is physical time of motion, which the clock actually measures. All we can conclude is that the B clock in motion does not keep true physical time.

3.6. Second Discussion Digression

The Leibniz-Clark controversy is the model for the modern debate regarding the nature of space and time which is framed in terms of substantival and relational time and space. The modern terminology is confusing and the reader can readily understand the two modern positions as basically modern interpretations of the absolute versus relative versions of time and space debated by Clarke and Leibniz respectively. A good modern definition of absolute time and what it means is the following. By absolute time, what is meant is that time is free or independent of any being capable of perceiving it. By relative time is meant that the time is dependent upon the state of mind of the one perceiving it.

In the theory of relativity it is claimed that physical time is dependent upon the motion of the observer, hence it is a relational time theory. But that is not the origin of the name. The name derives from the principle of relativity of Poincare, which asserts that it is impossible to perceive absolute motion by any physical means. It is clear that absolute means something that is free or independent, a sense of usage which is quite different from the usual meaning given to it. We will see later how this causes difficulties for the debate over relational versus substantival time. Because absolute time is not exactly the same as substantival time as its critics have assumed and proclaim it to be.

All that absolute time requires is that it is free or independent of external influence, is the same in all places, and that it is uniform in its rate, Newton says equable, and that this rate is maintained without change or variation from one epoch to another. In other words, the observer or measurement conductor places no conditions upon the measurement that can change time. Hence the measurement is a reflection of the difference in time interval being measured and not reflection of an influence due to a difference in the conditions of the measurement. It is clear that such a time is the time envisioned by physicists as modern physical time that we call UTC. The actual facts of UTC are a bit different from the previous statement. UTC is in fact nearly perfectly uniform, but it is not everywhere the same, because no two clocks keep exactly the same time, and it is not exactly uniform from epoch to epoch, and this requires an explanation.

The objective of UTC is to be as good a realization of the ideal of absolute time as technology can produce. Basically UTC is atomic time as defined by atomic transitions of Cesium, which have a uniform and defined frequency relative to UTC, combined with the time defined by the earth's rotation. The combination works this way. The atomic time is uniform and equable, it is the same for all epochs, but the UTC time needed to match the rotation of the earth is not uniform. Hence the device of adding or subtracting leap seconds is used to keep the UTC time synchronous with the earth's rotation. Hence, time defined by UTC can be used in navigation, as in the GPS. The effective result of this is as follows. When used to compare clocks or define frequency in the short term, UTC time is always the same, even from epoch to epoch. However, when a comparison of long term trends is made, UTC time will reflect the slowing of the earth's rotation as is necessary to keep it synchronized with the diurnal rotation. So we see that although UTC is not exactly absolute time, it is pretty close to being absolute for almost all practical purposes, even navigation. (Notice that when used in navigation, UTC time is basically time as defined by the rotation of the earth. Inasmuch as this is defined in the way specified, it is absolute since in UTC time the earth's rotation always occurs in the defined number of seconds which constitutes the length of a sidereal day.)

3.7. Absolute Physical Time is a Measurement Necessity

The problem of measurement in physics is exactly this. Measurement is a comparison of that which is to be measured against some absolute standard of measurement. This absolute standard is a necessity and is true by the necessity of a definition. The problem which arises with respect to the measurement of physical time is that philosophically speaking time is not a physical concept, it is a metaphysical idea of the human mind.

Immediately we have the problem that arises from the fundamental fact that time is a human invention. This leads into the difficulty that one can conceive of time as being anything one wants it to be. In particular the idea of absolute time as formulated by Newton is too physical and begs questions about its existence. So to claim a physical time exists is to claim something beyond both physics and philosophy.

The problem really arises from a misunderstanding that time, a human invention, requires a human convention to be interpreted. This has almost been almost accomplished with the introduction of UTC, but in the theory of special relativity the conception of absolute physical time has not been accepted and the argument that it does not exist is the source of much difficulty.

Absolute time is really just a human invention to facilitate the measurement of time and make the laws of physics universally true and rational. Once accepted, this concept must be absolute and applied consistently throughout all sciences and technologies. This is unfortunately not the case.

4. Einstein's Theory of Relativity

Stripped of its metaphysical obscurities, Einstein's theory of relativity is an attempt to explain away a problem in physics. The problem is the failure to apply the Galilean principle of relativity to electromagnetism. Einstein's solution to this problem involved the invention of two definitions, which he called postulates, such that these definitions made true the idea that the contradictions could be avoided by adoption of these new definitions, taken to be physically real concepts. This needs to be repeated so as to make clear the actual process involved. To solve a problem in physics, Einstein changed the definitions of time and space in physics, so as to avoid the posed difficulty by a change in definitions that took the form of physical postulates now thought of as laws of physics, so as to avoid the difficulty that electromagnetism violated the Galilean relativity principle.

In his own words Einstein tells us how he redefined the concept of time:

> "It is well known that this contradiction between theory and experiment was formally removed by the postulate of H. A. Lorentz and FitzGerald, according to which bodies experience a certain contraction in the direction of motion. However this ad hoc postulate seemed to be only an artificial means of saving the theory. Surprisingly it turned out that a sufficiently sharpened conception of time was all that was needed to overcome the difficulty discussed. One had only to realise that an auxiliary quantity introduced by H.A. Lorentz and named by him 'local time' could be defined as 'time' in general."

That is all that is involved in Einstein's theory of relativity. The theory invokes new definitions so that the physical concepts of time and space are modified into new concepts and thereby they become true by definition and not through the truth of existence as demonstrated empirically. The nice part about this particular maneuver is that it is time and space that are redefined, and since these are not really physical entities to begin with, the redefinition of what they mean is easily imposed. Unfortunately there were unforeseen problems. This is the essence of the problem with relativity. If the new definitions had been imposed successfully without difficulties, then the imposed definitions would be acceptable. However they immediately led into new difficulties. These are known as the paradoxes of relativity.

The problem posed by Einstein's relativity is exactly this. To resolve the paradox of Galilean relativity applied to electromagnetism, a new definition of time was introduced. This definition resolved that contradiction but produced a contradiction in the conception of time. This contradiction was introduced into physics and is not actually a measurement problem but a theoretical problem in the philosophy of physics. It asserts that there is a difference in time, and that time is not universal or uniform. Hence this conception of time contradicts the notion of UTC.

Karl Popper in his book, **The Logic of Scientific Discovery**, discusses an interesting difficulty that arises in science. Dr. Popper gives the example of the definition of lead as a metal that melts at a certain temperature. By this definition, if lead melts at a different temperature, then it is not lead. To a reader, the discussion by Dr. Popper seems to be a bit of a meaningless argument. However, when we get to the problem of time it is an acute problem. The reason is that time is not an actual physically existing material thing with well defined properties that can be used to define it.

The problem that occurs with time was first pointed out by Plotinus many years ago. He pointed out that if we define time as the motion of a celestial sphere, say the daily diurnal rotation of the celestial vault, then we can't define time as the motion of a different celestial sphere, say the moon. But aren't both of these movements really defined by time? Yes, we think so. But, now which one is the definition of time, and if we decide to define time that way does that mean time is not defined by the motion of a different sphere? Hence, the difficulty arises this way. If motion is time, then which motion is it that is time, given the many different motions and times that can be defined as time. Hence there can be one and only one motion that is defined as time. According to this criterion, the assertion that relative motion invokes a difference in time encounters the difficulty that only one standard motion can be conceived as time. Hence the purported claim that there are two different times involved in the rest and moving frames simply doesn't fit the definition of time, and so the assertion that time is different in the two frames must be false. One and only one time can describe the two motions.

This is exactly the problem that Einstein introduced into physical thought with his conjecture that the velocity of light can be explained as being a universal constant in all inertial frames by the supposition that time changed. This re-introduced the contradiction that Aristotle and Plotinus noted many years ago. That is that time can not be defined by motion unless it is defined by one and only one particular motion which is taken as the absolute measure of time conceived as universal and absolute as defined above.

5. Conclusion

In this paper we briefly looked at the problem of: What is time? This is an old philosophical problem that has its origins in Greek philosophy. The different conflicting philosophical opinions regarding the nature of time are today reflected in the modern physical theory of relativity. That theory asserts that time is a physical concept that depends upon the observer's reality. It does nothing to resolve the difficulties in the definition of the conception of time but compounds them.

The main point of this paper is to point out that there is a scientific approach to the definition of a physical conception of time. This physical conception avoids the difficulty that viewed philosophically, time is an unreal conception incapable of a satisfactory philosophical analysis. However, viewed physically, time as a purely human invention can be made into a meaningful physical conception despite its inherent unreality as a philosophical conception, through the process of measurement, and that process defines it irrevocably. Hence the physical meaning of time is to be sought in its manner of measurement as a practical procedure. This provides us with the definition of time as an absolute physical conception through the international definition of UTC. That is, physical time becomes the practical definition as specified in the universal coordinated time (UTC).

The reader should see that given the physical definition of time, it becomes a definite physical conception and that constrains it from the metaphysical meddling of relativity. Relativity has effectively introduced a philosophical conception of time into physics and as we have see here, a philosophical conception time is insufficient as physical a concept. Hence the relativistic conception that time can be different for different states of motion must be rejected and removed from natural philosophy.