Time Dilation without Relativity

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Abstract

Time Dilation has been repeatedly confirmed via experiments to be a real, natural phenomenon which can be easily demonstrated and verified in any laboratory which can obtain two sufficiently accurate atomic clocks. Yet, many physicists insist on viewing Time Dilation as nothing more than an "illusion," a solution to a mathematical problem which has no meaning without the problem. Understanding that Time Dilation is a real, natural phenomenon is the "key" to understanding and resolving some of the greatest mysteries in science, and also to correcting some of the greatest misunderstandings in science.

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I. TIME DILATION EXPERIMENTS

In 1905 Albert Einstein discovered that Time Dilation (the slowing of time) was the solution to serious mathematical problems related to Relativity and simultaneity that had been plaguing other scientists for many years.[(1)] He realized that Time Dilation is a real, natural phenomenon in our real universe that can be mathematically measured and optically observed. Unfortunately, he failed to point out that Time Dilation is best understood as a natural phenomenon all by itself, without all the complexities of the Relativistic problems it solved.

In the past 100 years and more, experiments have repeatedly demonstrated and confirmed Time Dilation to be a real, natural phenomenon. Time actually does slow down for an object when the object is moving or when it gets closer to a gravitational mass. Perhaps the best known and most common demonstration we have today of how Gravitational and Velocity Time Dilation affect an object is what happens to clocks aboard GPS satellites. Each of the 30 or so GPS satellites orbits the Earth at a velocity of about 14,000 kilometers per hour.[(2)] At that velocity, time and the atomic clocks aboard the satellites run **slower** than atomic clocks on the ground by 7 microseconds (millionths of a second) per day, a fact predicted by Einstein's Theory of **Special** Relativity. Meanwhile, each of those satellites also orbits at an altitude of about

20,000 kilometers above the ground. At that altitude, the atomic clocks aboard the satellites run **faster** than atomic clocks on the ground by 45 microseconds per day, a fact predicted by Einstein's Theory of **General** Relativity.[3] As a result, the atomic clocks aboard each of the GPS satellites must be adjusted by 38 microseconds per day (45-7=38) or the whole GPS system would become worthless in a few days.

Perhaps the best and most important demonstration of the reality of Gravitational Time Dilation was performed by the National Institute for Standards and Technology (NIST) in Boulder, Colorado, in 2010.[4] They used two very accurate atomic clocks, they confirmed that the clocks were synchronous and ticking at exactly the same rate, and then they raised one of the clocks by just 33 centimeters (approximately 1 foot). As predicted by General Relativity, the raised clock ticked faster than when it was in the lower position. The difference was in picoseconds (trillionths of a second), but more clearly than any other such demonstration, it showed that Time Dilation is **not** just an illusion. It is real, even if many physicists refuse to accept it.

The most compelling and undeniable demonstration of Gravitational Time Dilation happened more or less by accident. "International Atomic Time" or TAI (from the French name Temps Atomique International) involves keeping track of time data produced by 391 atomic clocks distributed all over the world in 69 different institutes (as of October 2010).[2] Most of the clocks are located at National Metrology (weights and measures) Institutes. In the 1970s, it became clear that all the clocks participating in TAI were ticking at slightly different rates, mostly due to gravitational Time Dilation. The NIST's clock in Boulder, Colorado, for example, was at least 5,430 feet above sea level, while an atomic clock at the National Physical Laboratory in Teddington, England, was likely less than 100 feet above sea level. Today's adjusted TAI

scale, therefore, corresponds to an **average** time at mean sea level. Because the participating clocks had been mostly located well above sea level, that meant that the official TAI second slowed down by about one part in a trillion, i.e., the official second became about one picosecond longer.

There have been many other demonstrations of Velocity Time Dilation and Gravitational Time Dilation, the best known being the Hafele-Keating experiment in 1971[(5)] which involved carrying atomic clocks aboard jet aircraft circling the globe. Inexplicably, that seems to be all that the experimenters do: they confirm that Time Dilation is real. It seems the experimenters then step aside and let the mathematician-physicists argue details and minutia about how the experiments are all in error and mean nothing. Time dilation is not real, they argue in scientific papers. It's only an error in how distances and the speed of light are measured.[6][7][8] Or it's an error in linguistics.[9] Or it is only an illusion where each observer sees the other observer's time as being dilated.[10][11][12] Clocks are not time, [13] they argue, even though no one ever said or implied they were. Hourglasses or sand clocks stop working in outer space, they argue elsewhere, and sundials are equally worthless, therefore clocks cannot be used to measure time. But how do you measure time without clocks? They'll argue that Velocity Time Dilation might be real, but Gravitational Time Dilation is not. Or vice versa.[14] They'll argue that the delicate atomic clocks were probably jostled and made inaccurate when they were moved. They'll argue that "a year" is one orbit of the Earth around the Sun, and even if Time for an object slows down significantly, the length of a year always remains the same, so "official" Time remains the same. They'll argue anything and everything rather than accept that Time Dilation is real. Why? Probably because of the implications.

Implication #1

The first implication resulting from viewing Time as it ticks at one rate at floor level and at a faster rate just a foot above floor level, is that Time is clearly not just a "concept" or "idea." Concepts and ideas do not slow down when they move or get close to a gravitational body. The experiments indicate that Time is an effect resulting from some property of matter. When an object moves, time slows down for that object and **only** for that object. When an object gets closer to a gravitational mass, time slows down for that object and **only** for that object.

That fact has also been repeatedly demonstrated with tiny atomic particles known as muons. In the muon experiments, it appears that the faster a muon moves, the longer that specific muon will exist, because Time slows down for that muon.[15]

The muon experiments also indicate that Time works at the subatomic level. The evidence clearly says that Time is caused by some property of the particles that comprise atoms and matter. Some of the more obvious effects caused by that property of matter are aging and decay. However, regular mechanical operations, cognitive functions and perception will also slow when time slows. And there seems to be only one possible property that can cause all the various effects of time: the mysterious property known as "particle spin."

"Starting in the 1920s, Otto Stern and Walther Gerlach of the University of Hamburg in Germany conducted a series of important atomic beam experiments. Knowing that all moving charges produce magnetic fields, they proposed to measure the magnetic fields produced by the electrons orbiting nuclei in atoms. Much to their surprise, however, the two physicists found that electrons themselves act as if they are spinning very rapidly, producing tiny magnetic fields

independent of those from their orbital motions. Soon the terminology 'spin' was used to describe this apparent rotation of subatomic particles."[16]

According to some experts,[17] "The spin of an electron never changes." But that appears to be much like the claim that the speed of light never changes. The experimental evidence seems to say that both change depending upon the object's speed and location.

When the NIST raised an atomic clock 1 foot and observed that it ran faster at that height than at the lower level, they were observing that the single aluminum ion (electrically charged atom) being used to measure time was vibrating faster between energy levels by a few quadrillionths of a second. A mechanical clock using gears and springs would also run faster at the higher altitude, but without the capability of showing such a precise time difference per second. A person would age faster, a calculator would calculate faster, and an apple would decay faster, but they, too, would not be able to show the tiny changes in the rate that Time passes for them. The evidence says they all experience Time moving faster because the particles from which their atoms are constructed "spin" at a faster rate when farther from a gravitational mass.

Of course, it can be argued that "spin" is not Time, that it is just another way of **measuring** Time. But, we can measure Time ***because*** it exists. If we could not measure Time, it would be just a "concept." The Time Dilation experiments clearly indicate that the **effect** of Time running at different rates is **caused** by some physical property of matter. And, it appears that the only known property of matter that could be the **cause** of Time Dilation in all the experiments is particle spin. The implication is that Time is an **effect** of particle spin, and particle spin is the **cause** of Time.

Of course, if aging, decay, perception, cognition and other physical processes used to measure the passing of Time are caused by "particle spin," that also means that Time does not and cannot exist in a vacuum or in any empty space between objects. And therefore, "Space-time" becomes merely a flawed mathematical construct, an obsolete mathematical model that needs to be replaced by a new mathematical model that better fits reality.

Implication #2

In his 1905 paper introducing Special Relativity, Einstein wrote this about variable time:

> "Thence we conclude that a balance-clock at the equator must go more slowly, by a very small amount, than a precisely similar clock situated at one of the poles under otherwise identical conditions."

The fact that a clock ticks slower at the equator than an identical clock at one of the poles also means that a clock in Spain ticks slower than a clock in England, and a clock in England ticks slower than a clock in Finland. Coupled with the fact that clocks at different altitudes tick at different rates, that means **the length of a second is different everywhere**.

The length of a second is officially defined as "the duration of 9,192,631,770 cycles of microwave light absorbed or emitted by the hyperfine transition of cesium-133 atoms in their ground state undisturbed by external fields."**(18)** In other words, a standard "second" is 9,192,631,770 "ticks" of a cesium based atomic clock. And, if you need to be more precise than that, you can measure fractions of a "tick."

But that length of a second was measured at the NIST laboratories in Boulder, Colorado, which is at least 5,430 feet above sea level. So, even though they established a "standard second," the specific atomic clock they used ticked at a **local** rate that was different from the **local** rate of virtually every other atomic clock in the world. Moreover, if that same clock could be moved to virtually any distant point on Earth, it too would tick at a different rate. So, if an atomic clock in an NIST lab ticks at the rate of 9,192,631,770 ticks per **local** second, and another clock elsewhere also ticks at 9,192,631,770 ticks per **local** second, any comparison of the two **local** tick rates will almost certainly show they tick at different rates because the lengths of the **local** seconds are different.

Implication #3

Implication #3 is that a key belief expressed by many mathematicians is undeniably false.

In an imaginary mathematical universe described by many mathematicians, Time Dilation is reciprocal. Since everyone is moving and there is no stationary frame of reference, those mathematicians argue that each observer can claim that his time is "normal" and time being experienced by another observer is running slow.

In our real universe, Time Dilation is definitely **not** reciprocal. A scientist measuring time at the bottom of a mountain will see that his time is running **slower** than the time being measured by another scientist at the top of the mountain. The scientist at the top of the mountain will **agree**, since he can see that his time is running **faster** than the time being measured by the scientist at the bottom of the mountain.

And since Time Dilation is an effect of particle spin, a spin which can be caused to slow down by both gravity and movement, velocity Time Dilation will undoubtedly work the same way. The astronaut twin traveling at 95% of the speed of light will look back at the Earth and see that the Earth is orbiting the Sun much **faster** than once per year. According to his time, the Earth is orbiting the Sun **ten times** per year. And if he is sending a radio signal back to Earth once every 24 hours of his time, the twin back on Earth will receive those signals at an average rate of **ten times** every 24 hours. (It won't be exact, of course, since the signals will be traveling different distances at a specific speed of light. The frequency of the signals would get slower and slower as the astronaut twin's ship moves away from the Earth, and faster and faster when the astronaut is on his way back to Earth.)

Implication #4

Implication #4 may be the one that mathematician-physicists most want to ignore: the speed of light is not a constant. It also appears to be very easy to demonstrate via experiment, even though, inexplicably, it seems no one has done so.

It appears that speed of light will be 299,792,458 meters per second when emitted and measured at the level of the lab in Teddington, England; it will be 299,792,458 meters per second when emitted and measured at the NIST labs in more than "mile high" Boulder, Colorado; it will be 299,792,458 meters per second when emitted and measured aboard the International Space Station; and it will be 299,792,458 meters per second when emitted and measured virtually anywhere on Earth or in space. So, all observers at all those points will view the speed of locally emitted light as traveling at 299,792,458 meters per second. But, since the

length of a second is different virtually everywhere, in reality the speed of light is different virtually everywhere.

If the length of a second is different everywhere, which location and which clock provides the length of a second that is used to measure the so-called "fixed" speed of light?

In reality, the speed of light is only guaranteed to have a value of 299,792,458 meters per second in a vacuum when measured by someone situated next to the measuring equipment.[(19)] While astronomers in the distant past used various methods to get approximations of the speed of light coming from celestial objects, we have no tools to measure such incoming light with the same precision we measure the speed of light we create in a laboratory ourselves. In a lab, we can create/emit a photon, bounce the photon off a mirror and detect the photon when it hits a detector situated next to the emitter. We can thus measure the time between emission and detection over a fixed distance. We cannot detect a photon that was emitted by a distant star as it enters a measuring device without destroying the photon. Therefore we have no way to measure how fast it travels within the measuring device.

But, if the NIST can measure the difference in time between a clock at floor level and another clock one foot higher, someone can surely measure and compare the difference in time atop a building versus on a lower floor of the same building. And they can also measure the speed of light **per second** as measured at those two locations. We know from past experiments what the results must be.

Any mathematical model which assumes a fixed speed of light is not representative of our existing universe and will almost certainly produce incorrect answers.

II. CONCLUSION

It appears there is only one point in our universe where time and light move at their maximum rates: the hypothetical stationary point where the Big Bang occurred. All matter moved outward from that point, and, in theory, all matter is evenly distributed in all directions from that point, thus providing not only a stationary point, but the only point where the pull of gravity is the same from all directions.

In the rest of the universe, virtually all objects are moving, and thus Time for all objects will be dilated, i.e., slower than the maximum. Until we can find that Big Bang point in our universe that is stationary and where all effects of gravity are in equal balance, we may have no way to precisely determine the actual difference between Earth Time and the maximum Time. We can only compare the dilated Time being experienced by one specific object to the dilated Time being experienced by another specific object.

The idea that the current mathematical model of the universe is no longer valid is not new.[20] Comparisons are made to Ptolemy's geocentric mathematical model of the universe, which was accepted as inviolate for over a thousand years. But as better instruments were developed and better measurements made, it eventually became clear that Ptolemy's model of an Earth centered universe was invalid and that a Sun-centered mathematical model more correctly fitted observations. So it is with the current mathematical model for space-time. The model cannot handle time running at different rates for a single observer, as occurred in the NIST experiment, nor can it handle the idea that the speed of light is variable, as measurements of time and the speed of light at different altitudes indicate to be true.

The key points being made in this paper are

1) Science needs a new mathematical model based upon variable time and variable speed of light that fits better with reality than the current space-time model.

2) Time is a real, natural phenomenon that appears to be caused by a mysterious property of matter known as “particle spin.”

3) Since it appears that “Unifying quantum mechanics and general relativity requires reconciling their absolute and relative notions of time,”[21] it is difficult to imagine anything more important to science than figuring out exactly how Time works.

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