What is Time?

(It is Particle Spin.)

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***Abstract**: Albert Einstein's explanation of Time Dilation [1], along with "The Twin Paradox" explained by Paul Langevin [2], pose two scientific questions: (1) "What IS Time if it can be dilated?" and (2) "HOW is Time dilated by velocity and gravity?" The answers in this paper may be only a revisualization of what has been known for over a century, but it appears the topic has never before been explained by a layman in layman's terms. This paper is an expansion of an observation about Time Dilation described in my previous paper: "Time Dilation Re-Visualized.[3]"*

We note the passage of time by observing objects around us as they move, grow, age and decay. We measure the rate at which time passes by counting physical cycles of movement in the world and universe around us – the cycles of the sun, the cycles of the moon, and the cycles of the seasons.

What we commonly measure and call "Time" is just an agreed-upon standard. Two centuries ago, "noon" occurred at a different time in nearly every town and city. Clocks all around the globe were commonly set to 12:00 "noon" when the sun was at its highest point during the day. Then the need for railroad schedules gradually created a requirement that everyone must use an agreed-upon standard for when "noon" occurred in a specific "time zone."

In his 1905 paper[1], Albert Einstein noted a very different aspect of Time. He explained that Time will run slower for an object whenever the object *moves*. For convenience, he used clocks to describe how movement (velocity) dilates (slows down) Time:

> If at the points A and B of K there are stationary clocks which, viewed in the stationary system, are synchronous; and if the clock at A is moved with the velocity *v* along the line AB to B, then on its arrival at B the two clocks no longer synchronize, but the clock moved from A to B lags behind the

> other which has remained at B by $\frac{1}{2}tv^2/c^2$ (up to magnitudes of fourth and higher order), *t* being the time occupied in the journey from A to B.
>
> It is at once apparent that this result still holds good if the clock moves from A to B in any polygonal line, and also when the points A and B coincide.
>
> If we assume that the result proved for a polygonal line is also valid for a continuously curved line, we arrive at this result: If one of two synchronous clocks at A is moved in a closed curve with constant velocity until it returns to A, the journey lasting *t* seconds, then by the clock which has remained at rest the travelled clock on its arrival at A will be $\frac{1}{2}tv^2/c^2$ second slow. 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 last sentence above explains that a clock at the equator will run slower than a clock at the North Pole simply because the clock at the equator is moving at about 1,000 miles per hour around the Earth's axis, while a clock at the North Pole just rotates in place once per 24 hours, scarcely moving at all. *Everything* at the equator that measures Time will run more slowly than an identical object at the North Pole. A human being standing on the equator will *age* more slowly (by a very small amount) than a human being standing at the North Pole.

A decade later, Einstein produced his "General Theory of Relativity" which explained that Time will also slow down the closer an object is to the center of a massive gravitational body. Time will pass more slowly for a person standing on the street than it will for a person on the upper floors of a building next to the street. And because the Earth is not a perfect sphere, but is slightly flattened at the poles, a clock at the North Pole is also 13 miles closer to the center of the Earth than a clock at the equator. That means a clock at the North Pole will run slower than a clock at the equator by a very slight amount that will partially offset the differences in the passing of Time caused by the differences in <u>velocity</u> at the North Pole and equator.

These are not just theoretical differences in the passage of time. Clocks used in the Global Positioning System (GPS) satellites must routinely be adjusted to compensate for the difference in the passage of time on the satellites versus the passage of time for clocks on earth. Special Relativity predicts that an on-board atomic clock on a GPS satellite moving at 8,700 miles per hour will fall behind clocks on the ground by about 7 microseconds per day because of the slower ticking rate due to the time dilation effect of their relative motion. General Relativity predicts that the same clock on the same GPS satellite 12,550 miles above the surface of the Earth will get ahead of ground-based clocks by 45 microseconds per day due to their different distances from the center of the Earth.[4]

The combination of these two relativistic effects means that the clock aboard the satellite will tick faster than an identical clock on the ground by about 38 microseconds per day (45-7=38). The difference might seem insignificant, but the high-precision required of the GPS system requires nanosecond accuracy, and 38 microseconds is 38,000 nanoseconds. If the effects upon Time were not properly taken into account, a navigational fix based on GPS satellite locations would be false after only 2 minutes, and errors in global positions would continue to accumulate at a rate of about 10 kilometers each day. The system would be utterly worthless for navigation and location in a very short time.

The question then becomes: Exactly what are we measuring if Time will move at a different rate for someone on the equator versus someone at the North Pole, and for someone atop the Empire State Building versus someone at ground level?

It isn't *just* velocity and gravity. A stationary person sitting motionless in "absolute space" away from any large gravitational mass will still age, and his wristwatch will still tick off the seconds.

But, as soon as he starts to move, Time for him and his clocks will start to slow down in comparison to what was occurring when he was sitting motionless. And if a large gravitational mass passes nearby, it will also cause Time to slow down for him.

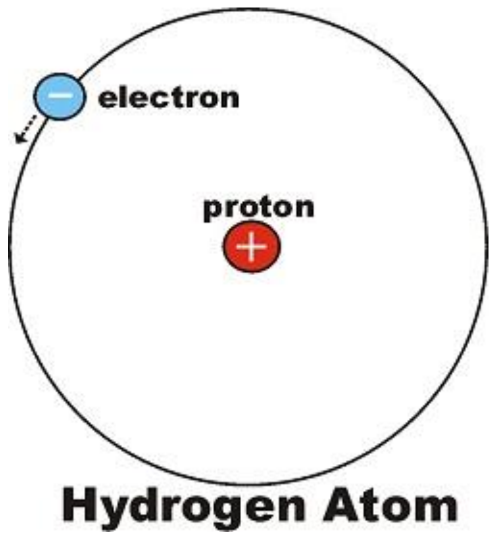
Since we are all moving in a universe filled with stars, and planets and other objects, being "stationary" in empty "absolute space" is basically just a hypothetical concept. But the speed of light is NOT hypothetical, and velocity-based Time Dilation is computed by measuring an object's velocity relative to the speed of light which is, in turn, measured relative to a purely hypothetical stationary object in empty space.

The speed of light is not only fixed, we know of nothing that can move faster than the speed of light. That suggests that Time Dilation *must* be caused by some kind of "conflict" with the speed of light. Time, or something that controls or causes Time, is forced to slow down because it cannot exceed the speed of light.

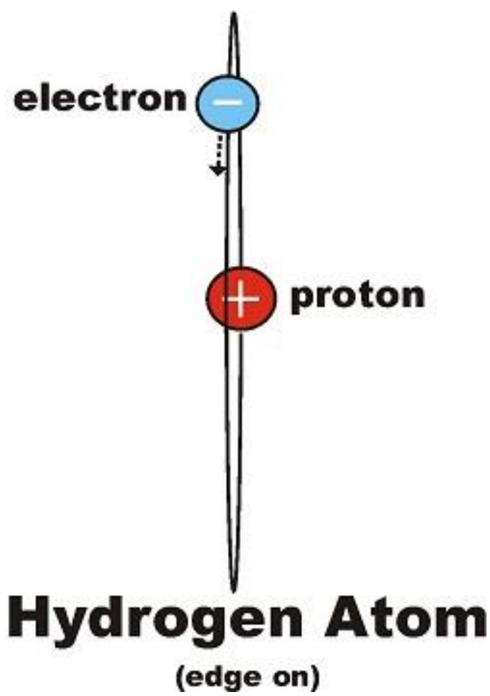
It appears there is only one "thing" that can cause Time to slow down when it conflicts with the speed of light, and that is "particle spin." That observation seems to indicate that particle spin IS Time, and Time IS particle spin.

Since no one knows exactly what an electron looks like, nor exactly how “particle spin” works, it is easier to illustrate and explain how particle spin appears to cause or control Time and Time Dilation if we use a more familiar model of an atom.

Below is a visualization of a simple hydrogen atom showing how the single electron orbits around the single proton that is the atom’s nucleus. The electron orbits around the proton at a "fixed" speed. And, evidently, the electron itself is spinning (as is the proton). Since protons and electrons are particles, “electron spin” is just one form of “particle spin.”

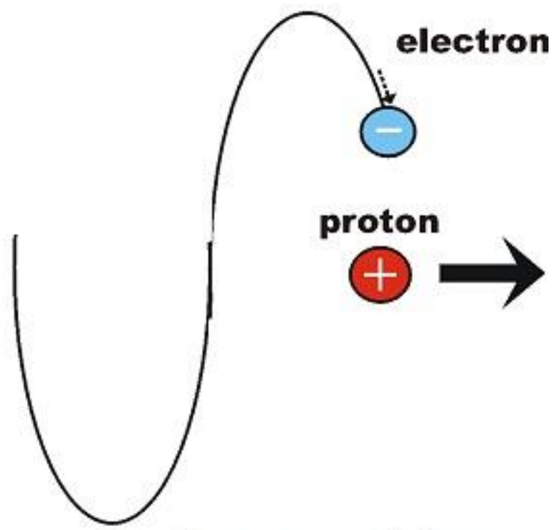


When viewed edge-on, the hydrogen atom would theoretically look like this:



Next we need to understand that although the speed (or velocity) at which the electron orbits the proton appears fixed, the time it takes the electron to complete one orbit of the proton is evidently NOT fixed. And therein lies the key to understanding the apparent cause of Time Dilation.

When the hydrogen atom is forced to move laterally through space, the circular orbit of the electron becomes a cork-screw path, and the distance the electron needs to move at its fixed velocity in order to complete one orbit increases proportional to the lateral speed.



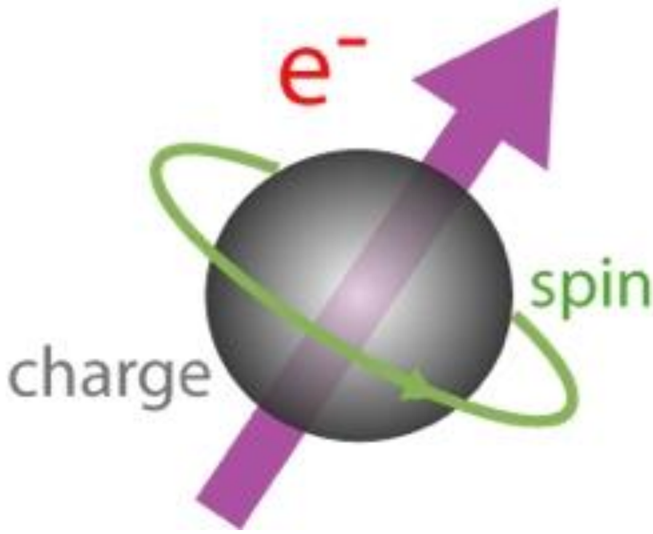
If we were to assume that one orbit by the electron around the proton ***while the atom is stationary*** equals "one fundamental unit of time," we can then easily see how Time will slow down (i.e., dilate) if the object containing the hydrogen atom is forced to move.

However, one "fundamental unit of time" is NOT one orbit of an electron around the proton of a stationary atom. Since any periodic process can be viewed as a "clock," we must use the smallest or shortest *known* periodic process as the "fundamental unit of time." And that is one "orbit" or "rotation" or "spin" of a stationary particle itself. We know this is necessary because we know Time Dilation also affects individual particles – muons being the best known example.

(Muons are unstable subatomic particles with a mean lifetime of 2.2 microseconds. They are created locally when cosmic rays collide with particles in Earth's upper atmosphere. Their short mean lifetime does not provide enough time for the particle to reach the surface of the Earth, yet they *do* reach the surface in great numbers. That happens because their high speed (about 99 percent of the speed of light) slows down the Time they experience (i.e., they experience Time Dilation), allowing them to travel further before decaying.) [5]

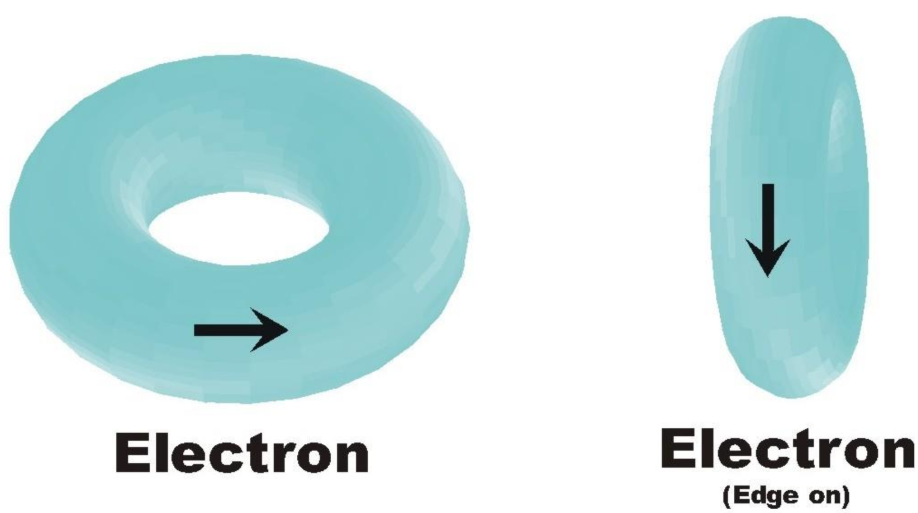
So, “a fundamental unit of time" is one complete spin of a hypothetical *stationary* particle. However, the Time we all experience is **NOT** fixed because particles do not remain stationary, and thus the time it takes for a particle to complete one spin is not fixed. One complete spin of a *moving* particle is one *dilated* unit of time.

Unfortunately, we do not know with any precision what a particle looks like or how it spins. Some theoretical models show an electron spinning just as the Earth spins on its axis:



With such a model, in order to visualize how the moving electron tracks a parabolic path through space, you have to fix an imaginary point to the “surface” of the electron and follow the path that the point tracks.

A different and perhaps more accurate “model” turns the electron into a rotating “string,” possibly looking very much like a donut.



Some also envision an electron as looking more like a dog chasing its tail, with a clear point to mark one complete rotation. However, it doesn't really matter what the electron looks like, just as long as it is understood that one orbit or rotation while stationary in space equals one "fundamental unit of time."

How does this work with gravitational Time Dilation? It's more difficult to illustrate, but particle orbital spin is distorted depending upon whether the spin is toward or away from the gravitational mass.

This way of viewing time also appears to explain how Time can STOP. When an object (such as an electron or a human) reaches the speed of light, the particles can no longer rotate or vibrate or do anything that would require changes in velocity. The object ceases to exist as a coherent object and will become waves of energy moving across the universe forever. Time will stop for that object. Likewise, when an object enters a black hole, the electron spin will be ground to a halt by gravitational forces, and Time will stop.

This means that dilated Time is the ***normal*** form of Time, since everything in the universe is moving ***and*** is being affected by gravity. If there was some way to measure extremely small differences in the passage of Time, we would see that a person's head ages faster than his feet when he's standing upright, and his arm will age slower than the rest of his body if he waves his arm around.[6]

For every 1 second ticked off by a watch on the wrist of the man standing on the North Pole, approximately 1.000014242225 seconds will tick by for the man standing on the equator. That is hardly a noticeable difference.[7] The difference is even less for a man in San Francisco versus a man in Los Angeles.

Time Dilation does not really become noticeable for a human until he reaches velocities nearing the speed of light. If the man on the equator boards a space ship there and travels toward some distant star at a relative velocity of 298,290 kilometers per second (which is 99.4988% of the speed of light), he will experience only 1 second while a stationary person at the North Pole experiences 10 seconds. The space traveler will age "1 year" while a stationary person ages 10 years. The space traveler's wrist watch will tick off 1 year while an identical watch on the wrist of the man at the North Pole will tick off 10 years.

What is Time? Time is the spin of sub-atomic particles. Each particle is a clock ticking off its own Time. Groups of particles, which we call objects, experience Time as movement, growth aging and decay. And we measure Time by noting events that regularly repeat. However, since the slowing of particle spin results in the slowing of Time for that particle and that particle alone, Time and particle spin must be the same thing.

References

[1] Einstein, Albert (1905) – *On the Electrodynamics of Moving Bodies*.
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[6] http://www.dailymail.co.uk/sciencetech/article-1314656/Scientists-prove-time-really-does-pass-quicker-higher-altitude.html

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