"TOS 1-21"

SPHEX Club Presentation

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Introduction:

Now that the COVID-19 Pandemic has waned a little bit and life is returning somewhat to its typical pre-disaster rhythms, it is interesting to look back and see some of the bright spots in our altered patterns of life. I certainly don't want to underplay the tremendous challenges that we faced and the great hardships that were caused by both death and suffering, but many of us will most likely reflect on at least some of the routines that emerged with fond memories and nostalgia. COVID spawned hobbies. Some baked sour dough bread and finally learned how to keep a culture alive, many finished all of Netflix if not the entire internet, and a friend of mine even used the time to learn a new language. I took up watchmaking.

I can now say that many tools, some of which are decidedly not inexpensive, currently inhabit my pretty fully-stocked watch making bench. My interest in watchmaking was initially piqued by advertisements for watchmaking kits, and it seemed like a fun project to create a working mechanical watch that I could then actually use. I never bought the pre-populated kit, but exposure to that idea did prompt me to source the parts separately, purchase a beginner set of rudimentary tools, and assemble an automatic wristwatch. Things progressed. I took an online watchmaking course, and before I knew it, I was disassembling a modern watch movement and learning how all of its intricate parts worked. After just a few springs lost in the carpet, and a couple of screws mishandled, I was able to reassemble the watch and get it to run. Delving more deeply into both the course and the hobby, I then found myself purchasing antique pocket watches from eBay and completely rehabbing them. Pocket watches are great for beginners because the parts are not quite so tiny. I have now rebuilt a number of antiques by stripping them down to their individual parts, cleaning and repairing the workings, reassembling and lubricating the mechanism, and finally regulating the timing with my handy-dandy timegrapher machine.

One of the most challenging projects to date was to rebuild the watch that my mother-in-law gave to my father-in-law when they were engaged way back in the mid-1950s. That watch hadn't been serviced in years, but it now ticks in perfect time. My least challenging project, but no less enjoyable, was to replace the quartz movements in a couple of my father's watches that he loves to wear but which no longer worked properly. One fun, although repetitively frustrating project, was to work on a quartz replacement for an antique mechanical watch that my wife adores. The original movement was completely trashed, and the jeweler was ready to harvest the stones from their settings and melt the case down for its gold value. Perhaps a purist would balk, but replacing the worn-out mechanical movement with a modern quartz engine has kept that classic piece of jewelry out of the smelter's furnace. Unfortunately, or maybe the opposite, it seems to require regular intervals of maintenance.

I have now repaired and built a number of watches and continue to look for additional projects. After all of this fiddling with miniscule parts, I can honestly say that the modern automatic watch movement is an amazing feat of engineering. The conversion of the potential energy of a wound mainspring into the perfectly timed release of kinetic energy, by means of a precisely calibrated balance spring which engages in a reliable and repetitive dance with the pallet fork, is a marvel. The precision of the wheel train that converts the motion of the escapement into relevant increments per second is elegant. The translation of the action of the train of wheels to the motion works from which we can tell time is clever. And the ability to set, charge and recharge the entire apparatus with new energy by way of the keyless works creates a sense of stability and dependability that does not require batteries or modern computers. Indeed, the mechanical or automatic wristwatch has an allure and substantiveness that cannot be matched by its ubiquitous quartz counterpart.

One aspect of a wristwatch that always strikes my fancy is the bezel. Dress watches are adorned with fixed decorative bezels, and I own and have built several of those. Less formal watches, most commonly of the dive watch variety, will sport "count-up" bezels. I find these to be most useful when cooking, to keep track of how long the steaks should stay on the grill, or when hiking, when they are a tremendous aid to dead reckoning. I have also built a watch, however, that offers a second time zone bezel. Unsure of which type of bezel I preferred, I then created a watch with a rotatable undesignated bezel to allow for a variety of interpretations. Finally, I combined the best of both worlds by creating a true GMT watch that contains a second time zone complication with a 24-hour scale on the inner bezel (more properly called the "chapter ring"), and a standard dive-style count-up bezel in the typical location.

Many of us have seen other calculating features around the edges of watches. Tachometers are common, which allow the user to determine the speed of an object by timing it over a known distance. Slide rule bezels allow for complex mathematical computations. Even the simple rotating bezel has been modified to count down rather than counting up to aid in timing, to allow measurement of distance based on the timed interval between seeing a phenomenon and hearing it (a telemeter), or converting a short sampling of a patient's pulse into beats per minute (a pulsometer). So much can be done with these fascinating tools of time measurement. And the watches that I create can do it to within seconds per day.

But the more that I occupy myself with the watch, and every time that I place the balance wheel back into place and wait with baited breath to see, in an almost Frankensteinian way, if my creation will come to life, the more I wonder about exactly what is happening there. I use my timegrapher to make sure that the timepiece beats as close as possible to the prescribed beats per hour, and that it does so no matter the orientation of the watch – face up, face down, crown up, crown down, etc… I want my watches to keep time, and to do it consistently. But what, exactly, is the watch doing? What is time. Can a watch, or clock -- mechanical, quartz, or nuclear -- actually measure time? Are those measurements objectively valid – accurate or inaccurate – true or false? When I watch the secondhand sweep gracefully around the watch dial, am I watching the passage of time?

As a kid, I was a Star Trek fan, and although the types of events that I am about to outline occurred in a number of episodes in each of the various Star Trek franchises, one episode that clearly stands out in my memory is called "Tomorrow is Yesterday". The 21st episode of the first season of the original series told of how the United Starship Enterprise had unexpectedly been hurled back in time when it interacted with the gravitational forces of a "black star". Once back in time and in orbit around planet earth in the late 1960's, the Enterprise was seen by Airforce Captain John Christopher, who was beamed aboard the Enterprise before his fighter plane was inadvertently destroyed by the Enterprise's tractor beam. During the next 50 minutes or so of the episode, Captain Kirk and Mr. Spock are engaged in a high-stakes effort to retrieve any evidence of their presence, return Captain Christopher to his own timeline without any memory of having been aboard the Enterprise, and getting back to their own proper time without altering the flow of history. As you can imagine, through intelligence and ingenuity, the crew of the Enterprise is successful in all three goals. At the end of the episode, based on Spock's calculations and Scotty's engineering prowess, the Enterprise first goes back in time just far enough to somehow beam Captain Christopher back into his own body where he forgets all that had happened in the intervening three days, and then the ship goes forward in time to return successfully to the 23rd century and continue its true original destiny in its own proper time.

What is most amazing, however, is that when going backward in time, the crew members are all able to talk with one another, their heartbeats continue without agitation, and all of the ship's equipment appears to run properly.... except for the clocks!! At minute 50.5 of the episode Mr. Spock tells Captain Kirk to "notice the chronometers. They've started backwards." It's true! While everything else on the ship, both objects mechanical and biological, continue to operate in a forward way and at a standard rate, the clocks move backwards. Later, when the Enterprise moves forward in time, the clocks move forward at a highly accelerated rate until the ship arrives at the target time and everything settles back into the standard flow-rate, or passage of time. At first, as a child, this seemed to make sense. If clocks actually measure time, then when time goes backward so should they.

Not long after having that thought, and still being a child, I thought "wait a minute...." If time is moving backwards, and the clocks move backwards because time is moving backwards, then everything within that frame of reference should also be moving backwards. Why would our bodies move forward, along with all of the instruments that we are using, except for the clocks? The answer is obvious: Clocks do not measure time itself, they measure relative rates of change, and they don't even do that in a way that is analogous to other forms of measurement. If I want to measure the length of a piece of paper, I can compare it to a ruler. I am then able to take the very same ruler, unchanged, and use it to measure another piece of paper. After making these two measurements with one standard reference, the ruler, I am able to compare the length of paper-sheet one to the length of paper-sheet two with high confidence. Not so with clocks. When I measure the duration of an event with a stopwatch, I am counting the number of ticks that the watch makes during the measured event. If I then want to compare the duration of event one with the duration of event two, I can't use the same stream of clock ticks. I am forced to use a completely new succession of clock ticks to measure the second event, and I am left hoping that the beat rate of the stopwatch has not changed in between the first and second measurements. The clock isn't actually measuring anything. It just keeps beating away and we compare its beating to other changes on the assumption that the beat rate generates a reliable reference point.

So, if we can't measure time directly then we need to ask what is time, and how does it work? Is there an objective absolute time, and can that time ever be measured in an objective way? Does my watch even create a valid and reliable reference point if we want to understand "the passage of time"? Does time even pass? Furthermore, if time does exist in some objective way, and it does flow, could we actually travel through it? Is it possible to travel back in time, or forward, in anything like the typical science fiction conceptualization of time travel? From H.G. Wells to "Back to the Future", we have been intrigued by the notion of time travel, and while I will not claim to solve all of the heretofore unsolved mysteries of time itself, I will use the rest of my allotted time to examine the possibility of time travel as conceived in popular science fiction.

<u>Classical Time Travel</u>:

The prototypical notion of time travel involves an individual who experiences time indexed to her own perspective, who then leaves her "timeline" and joins another "timeline". The time traveler retains all of her own history, including memories and character traits, and is able to step off of her own "location in time" so as to step onto another "location in time". The second location could be either in the future or the past, but the concept is equivalent to movement through space. A person is at one location and is able to move to another location. If I were able to move physically from one location to another instantaneously, teleportation, my appearance at the new location would appear to those at that location to be arrival from an alternate reality.

So too with the conventional notion of time travel. If I want to go back in time, I leave my current location on the river of time and poof into existence at another point along the stream. In the tradition of great philosophers and scientists, let's consider whether this conception is even logically coherent.

The idea that time can be conceived of as a long objectively existing ribbon such that a person could jump off of one location on that ribbon and jump on at another point generates some very serious logical contradictions. The most famous of these is known as the grandfather paradox. The paradox begins when I leave my current time and go backward in time to meet my grandfather. For one reason or another, my grandfather and I don't get along and I end up killing him. Of course, I killed him in my past, long before he met my grandmother, made babies, one of which was my father, who then met my mother, who then gave birth to me. But if I killed my grandfather before my father was born, then I never would have been born. So far, we have the plot for "Back to the Future", in which Michael J. Fox desperately tries to rebuild the correct timeline so he does not go out of existence. But Michael J. Fox never should have been worried. If, because of his meddling in the past he never gets born, then he would never have existed and would not have been able to go back in time to mess up his own history. Thus, the paradox. If I go back in time and kill my grandfather, then I won't exist to go back in time to kill my grandfather, so I can't kill my grandfather. But if I don't kill my grandfather, then I will exist to go back to kill my grandfather, which means that I won't exist! Backward time travel is not possible if it leads to these types of paradoxes.

One possible solution to the grandfather paradox is known as the Novikov self-consistency principle. This response to the grandfather paradox posits that time travel is possible, but that anything that you do in the past is already part of history and thus cannot be changed. The possibility of a temporal causal loop seems to alleviate the described paradox by making a person's passage back in time part of what already happened, so no changes to history can take place. By going back in time, one simply fulfills the destiny that was already set in place in the past.

There are two fundamental problems with the self-consistency principle, even if one is willing to accept its radical implications for pre-destination and the loss of free will. The first is that by introducing a temporal loop, the future is eliminated. What most science fiction writers and a number of cosmologists seem to have missed is the idea that if the loop becomes a necessary part of the timeline, then it must repeat as part of the timeline ad-infinitum. If the loop exists as a necessary part of my history, then there would be no way to exit from the time path that loops back on itself and to continue on into some other future. On the self-consistency thesis, someone caught in a temporal loop could never escape it because the loop becomes part of an unchangeable past. In fact, the entire notion a future beyond the boundaries of the loop becomes impossible.

The second problem with utilization of the self-consistency thesis is that it generates a new logical contradiction known as the ontological paradox. In Star Trek IV The Voyage Home, the Enterprise is sent back to 20th century earth and, through various plot twists, must bring two humpback whales forward in time to save the planet. When looking for the necessary materials to convert the Klingon ship into a suitable aquarium, Scotty bargains with a local chemist by giving him the formula for transparent aluminum. Dr. McCoy worriedly asks Scotty whether disclosing this information from the future will disrupt the timeline. Scotty wryly answers by asking Dr. McCoy, "how do you know he didn't invent the thing?" And thus, the paradox. Scotty has the formula for something that hadn't yet been invented in the 1980s, and he offers it to a chemist in that time. That chemist then releases the formula and takes credit for inventing it. But he didn't invent it, it was given to him by Scotty. Scotty didn't invent it either. He assumes that by giving it to the 1980s chemist, he is fulfilling history by letting that man invent it. But if 1980s man didn't invent it, and Scotty didn't invent, then who did? Obviously, transparent aluminum just popped into existence un-invented – a logical impossibility.

The same paradox could be imagined if we went back in time to give Elvis all of his songs, to save him composing time and effort. Then he wouldn't write them. But if he didn't write them, then we can't go back in time to give them to him, but if we don't go back in time to give them to him, then he will write them…. on and on and on, a reverse grandfather paradox.

In addition to these logical difficulties with time travel, we must also face some practical ones. One such problem would be the Spatial-Motion Problem. If I imagine that I do have some means of jumping into the future, then the classical conception is that I will wink out of existence in my current time and wink into existence at a temporal point in the future. Don't ask me how life goes on during the time that I leave the current and arrive in the future without my continued presence in the interim. If I skip over the intervening time, then I won't be there to create my future, which I am now supposed to be visiting – another paradox. For now, let's just ask where I actually end up if I can make the trip. If I leave my current time at my current place, and then return to my current place at a future time, the earth won't be there under my feet when I arrive. The planet revolves around the sun, which revolves around the center of the galaxy, and I will be spatially displaced when I arrive in the future. I will need a time machine that keeps track of both time and space for my trip to be successful.

Some of you might already be preparing a counter-argument based on the configuration of H.G. Wells' time machine. In his story, the person in the time machine actually remains attached to a specific physical location relative to his surroundings, but hurtles himself into the future at an accelerated rate. We should worry about what that looks like to outside observers and why they don't interact with the time machine or why the time machine is not impacted by radiation and decay during its accelerated voyage, but Wells seems to solve those problems by positing that the time machine, during its travel, cannot be seen because it is "moving so fast through time", like a bullet that can't be seen even though it is there. In order for this solution to the practical problems of time travel to work, we need to think of time as an absolute structure that can be traversed. It forms a substrate of our experience that is ordered and through which we travel at a fixed rate, except when sitting in a temporally super-charged machine. Let's see if that is possible.

<u>Space-Time</u>:

The rate at which a wave propagates through a medium is dependent upon a number of factors including the nature of the medium itself. A jiggle to a mass of Jell-O will move through that refrigerated gelatinous goo differently than a splash in a pond of water will create emanating circular waves. Likewise, sound waves will behave differently in cold air, which is more dense, when compared to warm air that is more diffuse. But in 1865, as the culmination of many years of hard work performed by many talented physicists, James Maxwell was able to demonstrate that electromagnetic waves are able to propagate in a vacuum, without an underlying medium (no air, no water). We now know the speed at which electromagnetic radiation moves- 186,000 miles per second. What was important about Maxwell's work, however, was the idea that these waves could travel through a vacuum.

One possible explanation for how electromagnetic waves could move through empty space was that a medium did actually exist, although it was a previously undiscovered medium referred to as the luminiferous aether. It was called luminiferous, because once we realized that light was actually a form of electromagnetic radiation, there must be something through which light was transmitted – a medium by which the light waves could propagate.

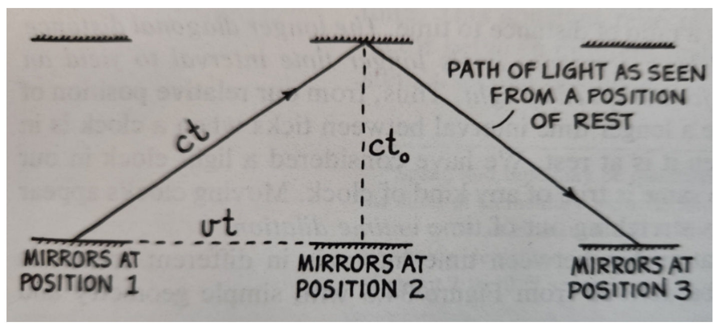
In now very famous experiments conducted in 1887, Albert Michelson and Edward Morley set out to test the way in which light waves interacted with their underlying medium, the luminiferous aether. They demonstrated that if a light source were to change trajectory over a period of time, it should be possible to measure the change in its relationship to the aether. Light waves traveling in the same direction relative to the aether should travel at a speed that is different than light traveling perpendicular to the aether. Although this sounds complex, it is based on intuitive principles. If I am traveling in a car at 100 miles per hour, and I shoot a gun in the same direction of my travel, supposing that the bullet leaves the barrel at 1,000 miles per hour, the total speed of the bullet would be 1,100 miles per hour. If I shoot the bullet from the car in a direction that is perpendicular to the motion of the vehicle and then measure its velocity in the direction that the car is traveling, it will only be moving at 100 miles per hour in that direction. Michelson and Morley devised a set of experiments to demonstrate a similar phenomenon with regard to light, with the intent to prove the existence of the underlying luminiferous aether substrate medium.

The experiment failed. In the most meaningful failed experiment in history, Michelson and Morley discovered that light travels at a fixed speed of 186,000 miles per second regardless of extraneous relationships. If I shine a flashlight from a moving vehicle or sitting still, in the same direction, the light will travel at the same speed. If a moving light source and a stationary light source are pointed in exactly the same direction and turned on at exactly the same time, the two light beams will travel in parallel with one another at exactly the same speed. The movement of one of the light sources will not in any way impact the speed of the light beam. Photons do not work like bullets. They move through space without an underlying medium and at a constant velocity. This fact has been tested and measured repeatedly with ever-increasing precision, and the evidence has remained absolutely consistent.

So, what does any of this have to do with time? Answer, Albert Einstein and the Theory of Special Relativity.

Speed can be calculated by determining the time it takes for an object to move over a known distance in a known period of time. If it takes me one minute to go one mile, then I know that I am traveling at 60 miles per hour. If it takes me two minutes to cover the same distance, then I am traveling at 30 miles per hour. Doubling the time it takes me to traverse a measured distance halves my speed. Simple. But now consider what happens if the thing whose speed is involved is light, when we know and can empirically demonstrate that the speed of light is constant. This is known as Einstein's light clock thought experiment.

If I am in a room that has a mirror fixed to the wall directly across from me and I shine a light into that mirror, I will be able to record the length of time that it takes for that light to travel across the room and back again. If the room were 186,000 miles wide, the total round-trip travel time would be two seconds. Easy Peasy. But what if my room, with me, my light source, and my mirror, are all moving at a uniform velocity past a fixed observer who is outside of the room. Now, from that observer's point of view, which is perpendicular to the direction of my room's movement, the light actually passes not only forward and backward, but also to the side. The light travels a further distance as seen from the outside observer's "frame of reference" than it does as seen from the frame of reference within the room. So far so good. The person in the room clocks the passage of the light as taking two seconds round trip, as does the person outside of the room. For both observers, the light bounce takes two seconds to complete. However, from the external frame of reference, the light traveled further than it did in the internal frame of reference. Intuitively, if the light traveled further in the same amount of time, then it must have traveled faster. But light ALWAYS travels at the same speed, so it could not have traveled any faster than 186,000 miles per second. If the speed is the same, and the distance is longer, then the only solution to the problem is that the time that it takes for the light to traverse the longer distance must increase. Both watches, within their own frame of reference, registered a two second duration. This must mean that time moved more slowly in the moving room as compared to the passage of time in the outside frame of reference. Time itself dilated and did not flow at the same rate in the two distinct frames of reference. This realization is at the heart of the Theory of Special Relativity.



What is truly amazing, however, is that just about everyone in this room is able to do the actual calculations for time dilation. It requires only rudimentary geometry and basic algebra, no calculus necessary. We all know the Pythagorean Theorem and how to calculate the hypotenuse of a right triangle when the two other sides are known. We know that $a^2+b^2=c^2$. On that basis, looking at this figure, we can calculate the distance that light traveled as measured from the outside, stationary, frame of reference as compared to the internal, moving, frame of reference. From the internal point of view, the light traveled up to the mirror and straight back down totaling distance ct_0*2. From the external frame of reference, the light traveled on two diagonal paths totaling distance $ct*2$. If I know distance ct_0 and distance vt, then by the Pythagorean Theorem, I can calculate distance ct. If it takes one second on both clocks to traverse distance ct_0 from the moving frame of reference, and distance ct from the stationary frame of reference, then with just a little algebra, I can calculate the difference between the rates at which each of the two clocks are ticking relative to one another. In other words, the time dilation between these two frames of reference will be the ratio between ct and ct_0. For those of you

$$c^2t^2 = c^2t_0^2 + v^2t^2$$

$$c^2t^2 - v^2t^2 = c^2t_0^2$$

$$t^2[1 - (v^2/c^2)] = t_0^2$$

$$t^2 = \frac{t_0^2}{1 - (v^2/c^2)}$$

$$t = \frac{t_0}{\sqrt{1 - (v^2/c^2)}}$$

who like to solve for variables, you can do the algebra on your own time as shown here. (It looks more daunting than it actually is.)

The point of this entire discussion of Special Relativity is something that has now been experimentally verified. Time moves more slowly in a moving frame of reference relative to a stationary frame of reference. If I were to hop in a super-fast spaceship and travel at half the speed of light, when I returned to earth, I would have aged much less than any of you who remained behind in a stationary frame of reference. From within my frame of reference, my clock would tick at a standard rate, as would yours when considered from within your frame of reference, but when I decelerate and return to your stationary frame of reference to compare our clocks, we will find that time passed much more quickly for you than for me. I will be younger than you at that point even if we were both born at exactly the same time. I cannot stress enough that these calculations have been verified numerous times. For example, were it not for corrections that we make to synchronize moving clocks and stationary clocks, our GPS array would not work.

Based on the foregoing, I would argue that one specific type of "time travel" is possible, although I don't really think that it counts as time travel. It is possible to age more slowly relative to another person based on Special Relativity if one frame of reference is moving and the other is stationary. But notice how this would work. If I were able to jump into a quickly moving spaceship, then from my frame of reference your clock would be running more slowly than mine, and from your frame of reference mine would be running more slowly than yours. Since our motion is relative to each other, if we were the only two things in the universe, it would be impossible to determine whether you were moving past me or I were moving past you. Each is aging more slowly in comparison to the other. However, if one of us is acted upon by an outside force and decelerated, then the objective truth regarding which of us ages more slowly becomes reality. The one of us who is decelerated effectively rejoins the frame of reference of the other, and will have aged less. But in this sense, I haven't traveled through time into your future, my time simply passed more slowly than yours. I did not leave my time and join another alternate time. I can't go back and re-live my timeline or change it. My frame of reference collapses into yours, and now that we have a shared frame of reference, we can recognize time dilation. I could certainly depart on another fast moving ship, and if I do I will long outlive you, but time for me will continue to pass as it always has. There is no objective external time of which I am jumping in and out. I am not traveling to another point in time. Time is just passing differently for me than for you, so I would not say that this constitutes time travel in anything like the conventional conceptualization.

As an aside, a careful analysis of Special Relativity demonstrates not only that time dilates across different frames for reference, but that the concept of simultaneity and the order in which events occur are also impacted. Two events that take place simultaneously in one frame of reference do not necessarily occur simultaneously in another, and events that happen in one order in one frame of reference might happen in a different order in another frame of reference. There is no sense in which we can ask which perception is correct, because there is no absolute third frame of reference to which we are able to refer.

<u>The Myth of Passage</u>:

What does it mean to ask how quickly time passes? I can calculate how quickly something moves through space by measuring the time it takes to traverse a known distance. But to determine how quickly time is passing, or how quickly something moves through time, I would have to measure its passage against some other type of time, a "hypertime". Of course to know how quickly hypertime flows, I would have to compare it to a higher order hypertime-prime, and onward into and infinite regress. We now know that no hypertime exists. There is no temporal substrate. Time is relative, as is the measurement of time, and without change time cannot be measured. If clocks don't tick, time does not pass, because it isn't really there as an independent entity. Without absolute time, there simply isn't anything through which we can pass. Perhaps, as Kant argued, time is a mode of perception but not a property of things in themselves. Whether that is true or not, time is not a substrate that we traverse.

One last thought experiment: Suppose we lived in a universe where things disappeared for periods of time and reappeared again after an interval of time. Imagine that scientists are able to recognize the patterns by which objects of various masses wink out of existence, and then how long it takes before they wink back into existence. Don't worry about the mechanics of it; just imagine living in that universe. We would become accustomed to watching a pen disappear, for example, and we might even be able to predict that it will be gone long enough that I better bring a spare writing instrument to my important meeting. We wouldn't even feel distress when a loved one disappeared, because we would know that they'd be back right on schedule. Now imagine that the time directorate has calculated a once in a billion years event, when, for a short period of time, the wink-out time for everything in the universe would coincide. Scientists are able to describe how things will disappear one-by-one, until nothing is left. However, after the predicted interval, things would begin to reappear.

Now imagine that you can watch this all happen. On the predicted date, things start to disappear- each on schedule and each for a predicted duration. What is predicted is that the second-to-last object would wink out for 30 minutes, and ten minutes later the last object would wink out for 60 minutes. Right on cue, this happens. The second-to-last object disappears, and ten minutes later, the universe is empty. But then the second-to-last object reappears. Question- how long was the universe empty? Did an empty universe exist for 20 minutes? Was the interval between the last disappearance and the first reappearance infinitely long? My guess is that there was no duration between the last disappearance and the first reappearance, because no time existed in an empty universe. The reappearance of the first object occurred simultaneously with the disappearance of the last object.

<u>Final Argument</u>:

To summarize, motion only exists relativistically. If there were only one object in the universe, there could be no motion because there is no objectively existing coordinate system of absolute space to which the location of the singular object could be compared. For motion to exist, it is necessary to compare two objects to determine whether they are remaining stationary relative to one another, moving toward one another, or moving away from one another. Given a third frame of reference, it could be determined that two objects that are stationary relative to one another are actually moving at a constant velocity away or toward the third frame of reference, but from within the combined frame of reference of the first two objects, they would be stationary because there would be no change in the relationship between them.

The same is true of time. From within a single frame of reference, objects appear to be temporally stationary relative to one another, meaning that time is perceived to pass at the same rate for all objects within that frame of reference. The light clock thought experiment, and subsequent empirical verification, demonstrates that the actual “flow of time” will dilate when two objects are in motion relative to one another, but will appear “normal” when perceived from within each frame of reference. However, the dilation is bi-lateral. From each frame of reference, the clock on the alternate frame of reference will appear to run slower since there is no objective way in a universe containing only those two frames of reference to determine which is moving and which is stationary. In fact, to even ask which one is moving is a non-sensical question if only those two frames exist. At some point, however, one frame of reference will be conflated into the other by being acted upon by a decelerating force. If A is conflated into B, then A will have aged more slowly. If B is conflated into A, then B will have aged more slowly. What I call the conflation of one frame of reference into another is known more formally as the Lorentz Transformation. It is my thesis that the existence of the Lorentz Transformation makes time travel impossible because it actually combines two separate frames of reference into a singular frame.

Because motion through time, just like motion through space, can only be perceived when comparing two different frames of reference, the passage of time would not take place if only a unitary entity existed in the universe. Perceived differences in the rate of the “passage of time” depend upon comparison of two distinct frames of reference, and the determination as to which time flow is the actual time flow will only become fixed when one or the other frame of reference is eliminated by action of an outside force (deceleration, or if we shift from Special Relativity to General Relativity, gravity as well) so that the two frames of reference converge. On this basis, time is as relative as space and it is impossible to compare time from within a single frame of reference to anything else, let alone a different “timeline”. There is no absolute time and there is no independently existing set of time coordinates against which the temporal movement of an object through time could be measured. Time, or more precisely the rate of the passage of time, can only be measured when one frame of reference is compared another, but not to time itself. There is no absolute “time itself”.

The foregoing analysis proves that time travel, as commonly conceived and portrayed in science fiction, is not only susceptible to logical contradictions, but it is empirically impossible. Since we cannot travel through time within a single frame of reference, the only way to travel "back in time" would be to retain one's solitary frame of reference when one joins an alternate frame of reference. But the very act of joining another frame of reference by means of the Lorentz Transformation by definition obliterates the potential measurement of time from the vantage point of your own separate frame of reference. You cannot carry two frames of reference simultaneously, so you cannot compare your prior frame of reference to a what is perceived in your ultimate frame of reference. Any experiences outside of that frame of reference simply won't exist and never will have existed, which means you will be unable to compare your current state of affairs with any alternative timeline reality.

In short, you cannot measure a difference in temporal location from within your own frame of reference. Temporal location can only be measured across frames of reference. But if you join an alternative frame of reference, which is what classical time travel asks us to imagine, then you lose your initial frame of reference and no comparison can be made to it. You will become part of the historical timeline that your current frame of reference contains, and there will be no way to contrast it to an alternate historical timeline, because from within your current frame of reference, that alternate timeline simply won't exist.

One possible solution to the time travel problem exists as part of Einstein's General Theory of Relativity. Kip Thorne, Michael Morris, and Ulvi Yurtsever have done some interesting research into time travel as an implication of General Relativity. Their hypothesis is that the singularities within black holes actually create regions of space-time that are so tightly curved upon themselves that it is possible to jump from one region of space-time to another. However, this solution to time travel requires an arbitrarily advanced society that has access to almost limitless amounts of energy to create stable black holes that produce no more than 1g of force at the event horizon, and still bend space-time sufficiently to allow time travel. Mathematically, that would require a form of negative energy for which, even these authors admit, we have no evidence to believe exists.

Conclusion: I am unable to suspend disbelief long enough to enjoy “Back to the Future”, although I still gain pleasure from Star Trek, even TOS 1-21.

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TOS 1-21

Michael A. Gillette, Ph.D.

SPHEX Club

March 9, 2023


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BEAT ERROR
PARAMETERS
value
start/stop
menu/speaker
MULTIFUNCTION TIMEGRAPHER
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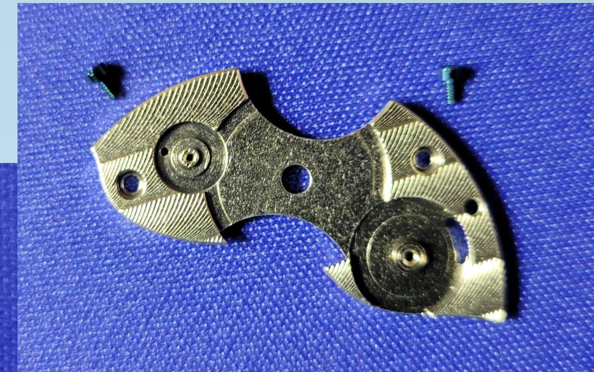



HAMILTON


BURLINGTON


SWISS ARMY
PULSAR
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HAMILTON WATCH CO.
LANCASTER, PA.
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Plain Bezel, Non-Rotating

Dive watch
Count-Up
Bezel

Second Time Zone Bezel

Rotating Un-numbered Bezel

Count-Up Bezel With GMT Complication

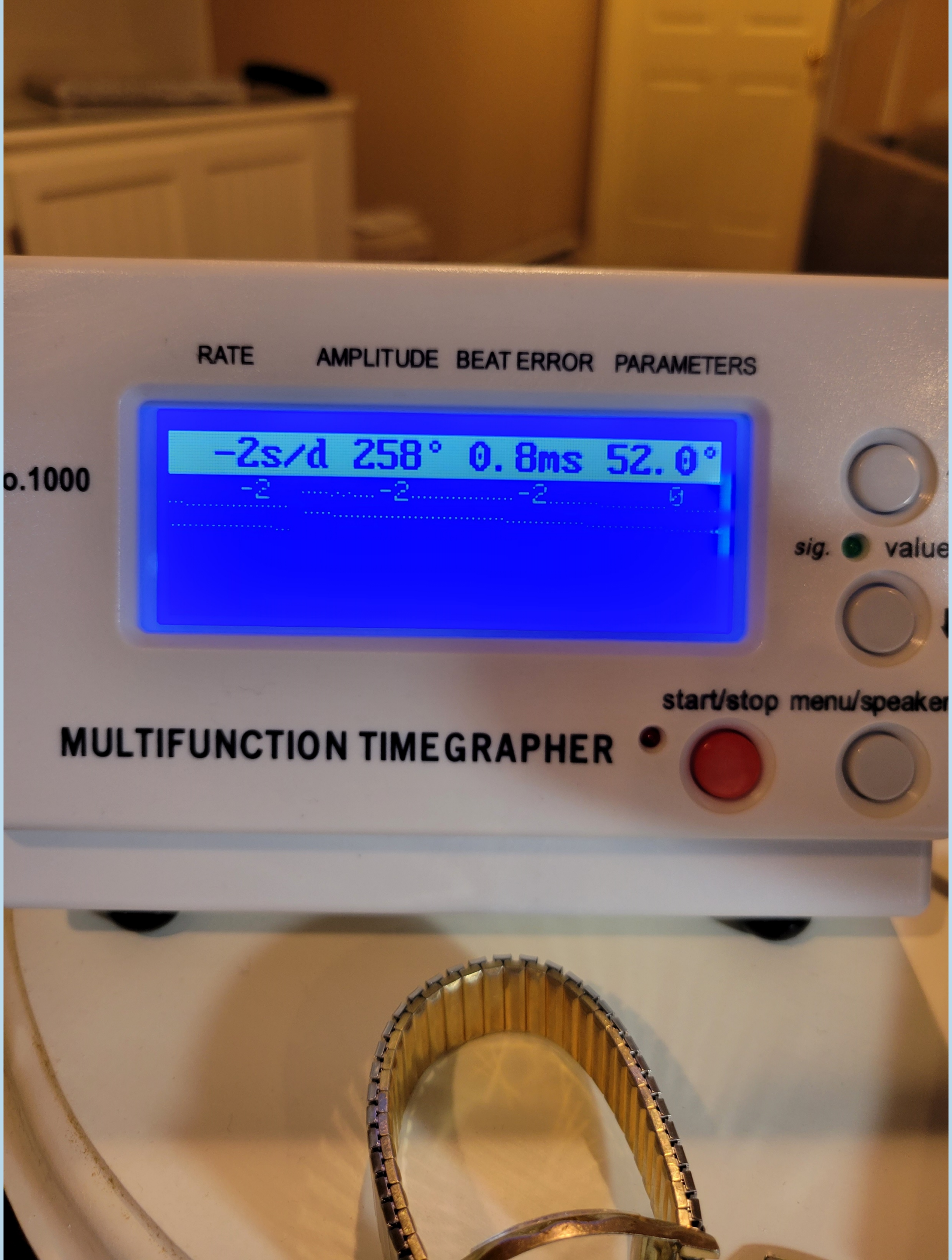
Tachometer Chapter Ring

Slide Rule Bezel

Countdown Bezel

Telemeter Bezel

Pulsometer Bezel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MULTIFUNCTION TIMEGRAPHER

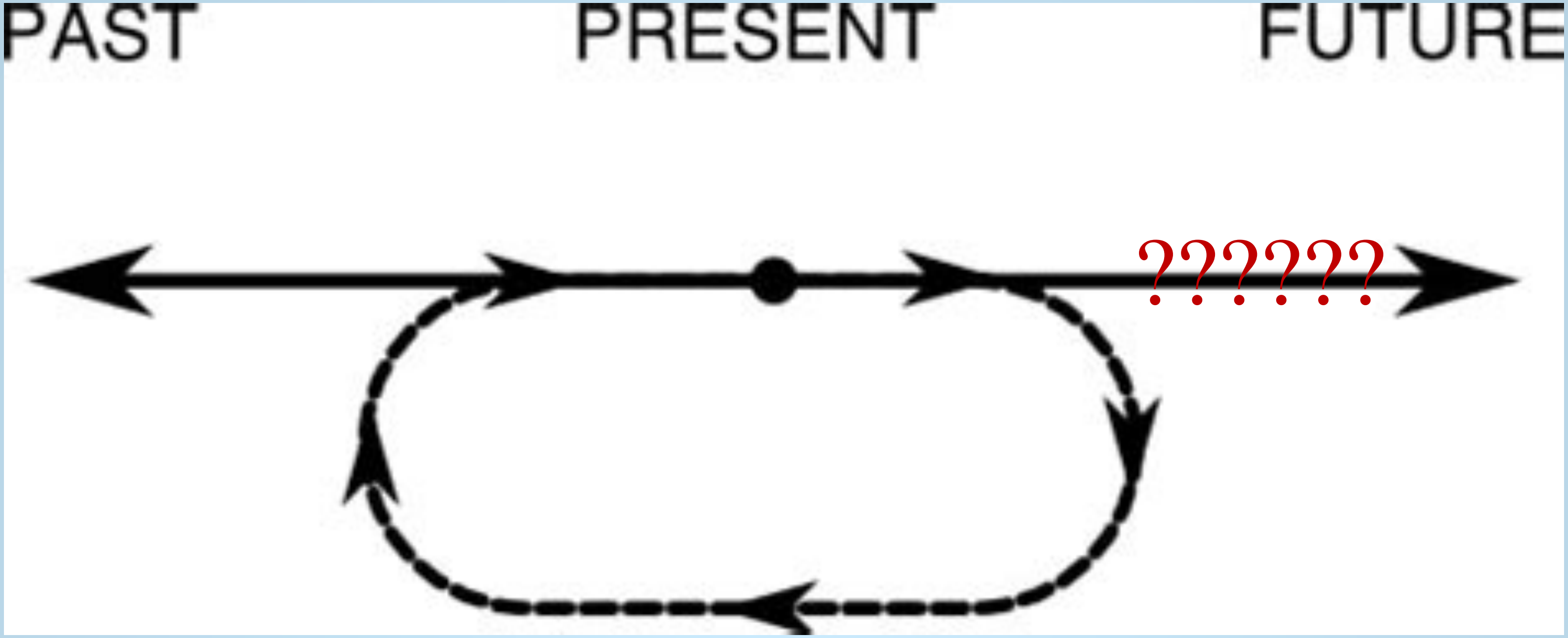
A 23rd Century Starship in the Late 1960's

Airforce Capt. Christopher and Starship Capt. Kirk

The Ship's Chronometers Running Backwards

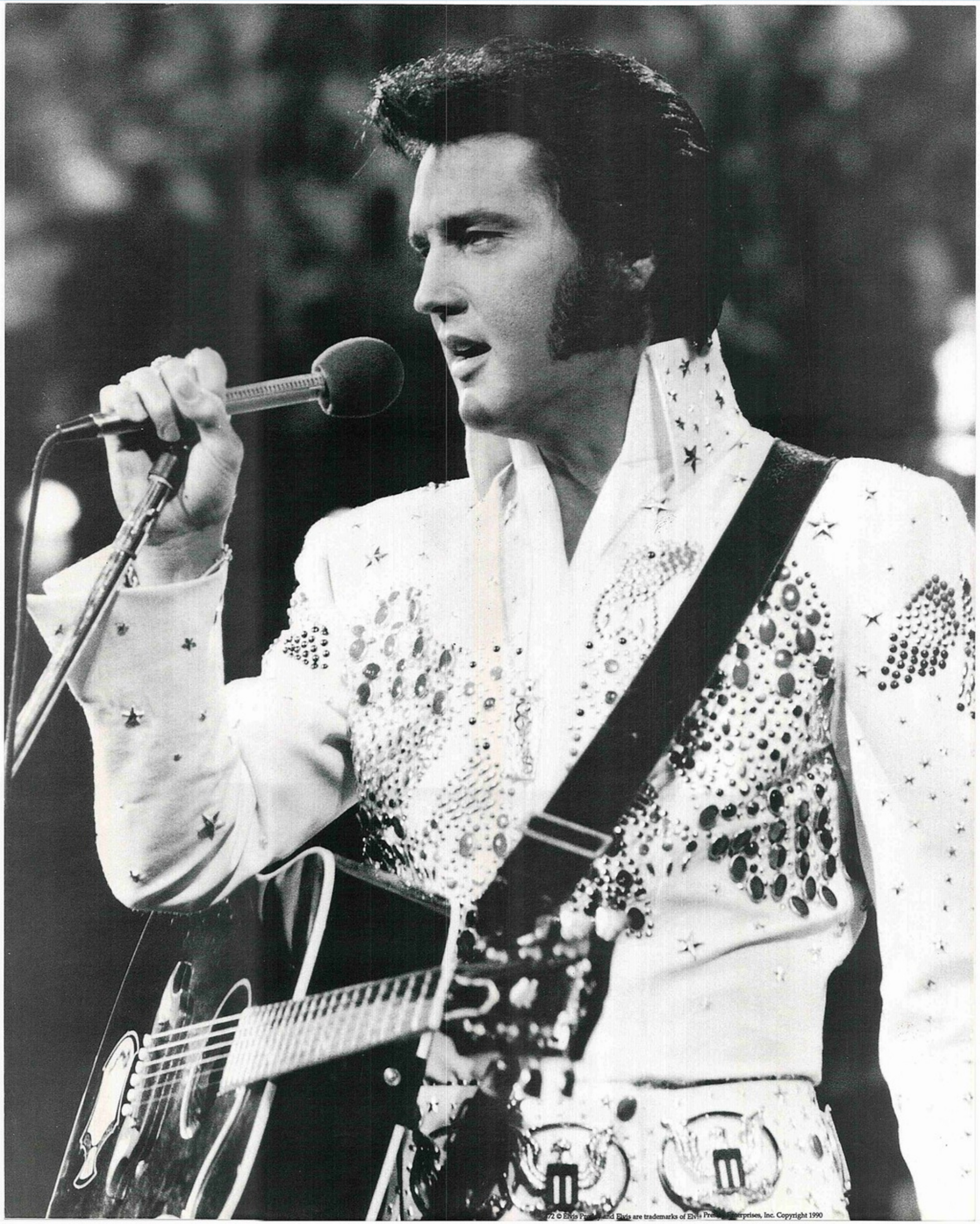
Do we stand on a ribbon of time?


STEVEN SPIELBERG PRESENTS
BACK TO THE FUTURE
A ROBERT ZEMECKIS FILM



How is continued travel into the future possible if the loop will invariably repeat?


STAR TREK IV
THE VOYAGE HOME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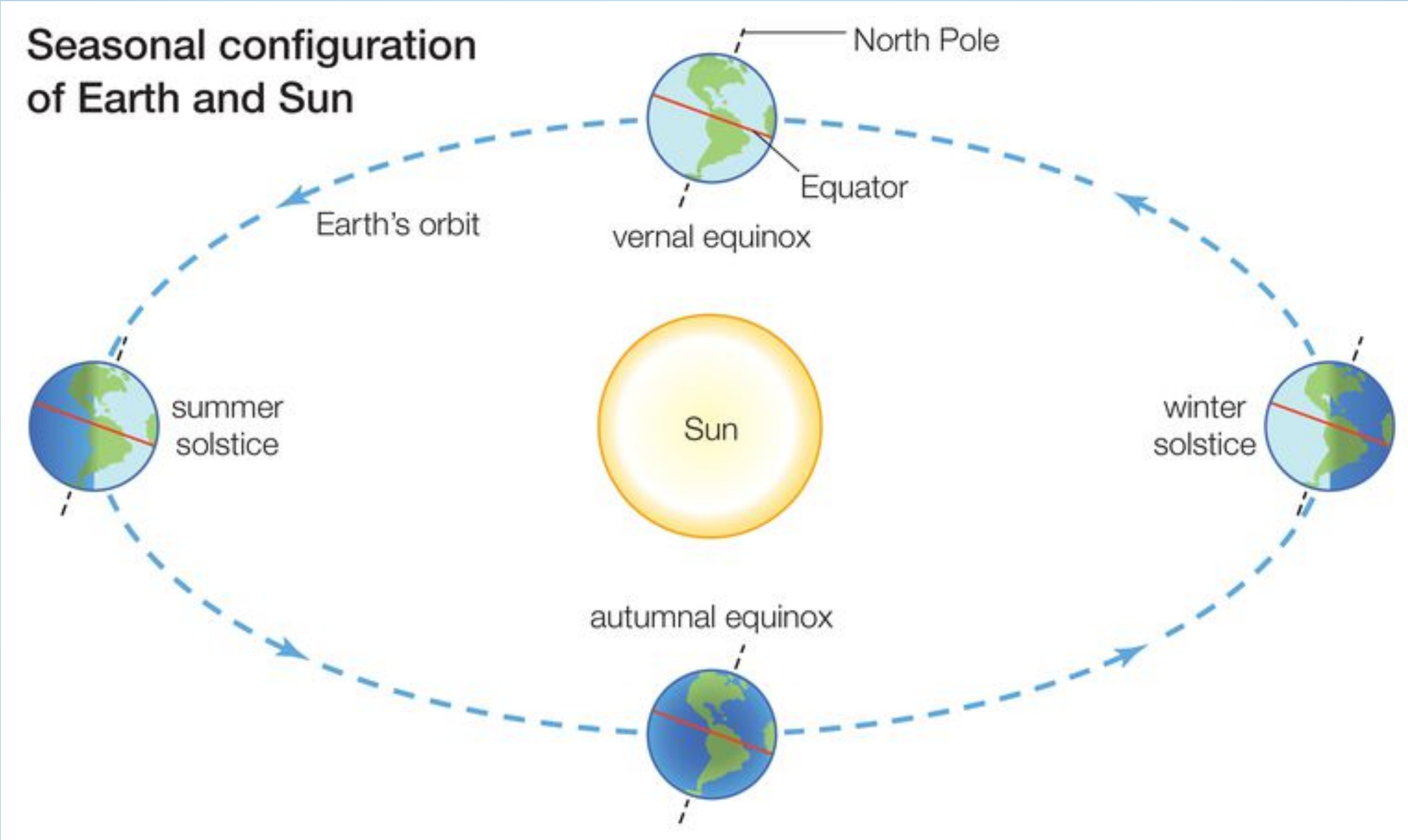
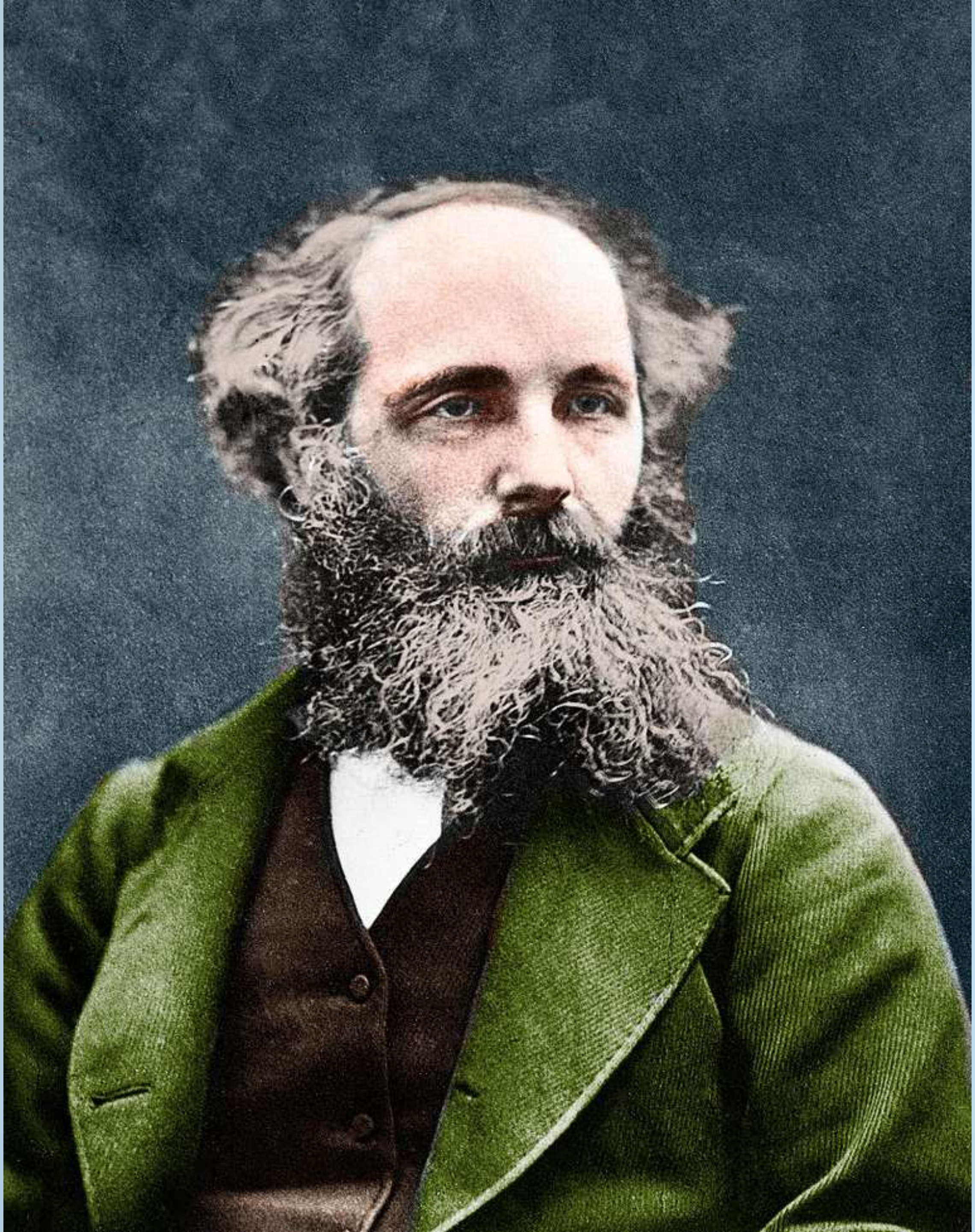
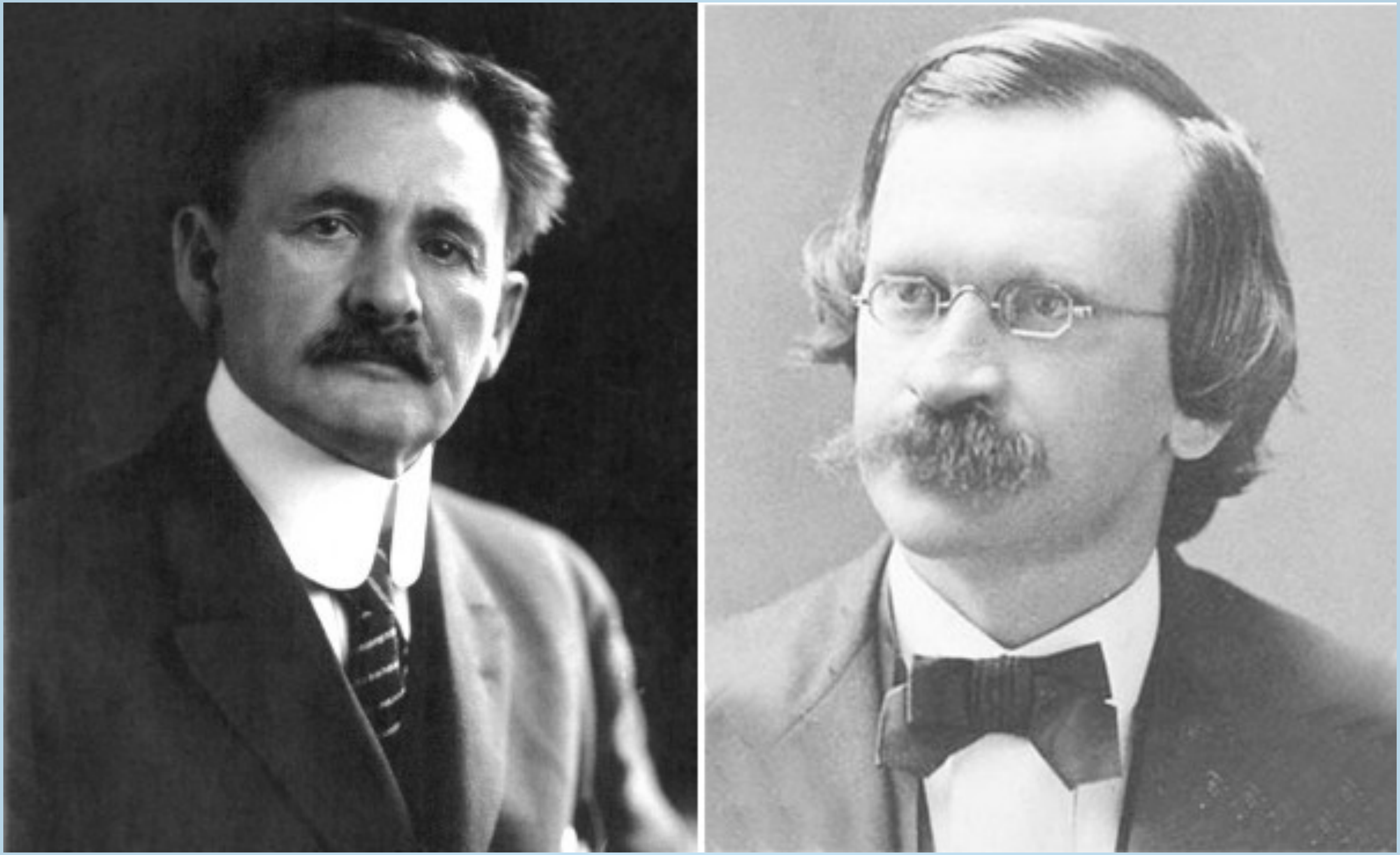

Seasonal configuration
of Earth and Sun
North Pole
Equator
Earth's orbit
vernal equinox
summer
solstice
Sun
winter
solstice
autumnal equinox



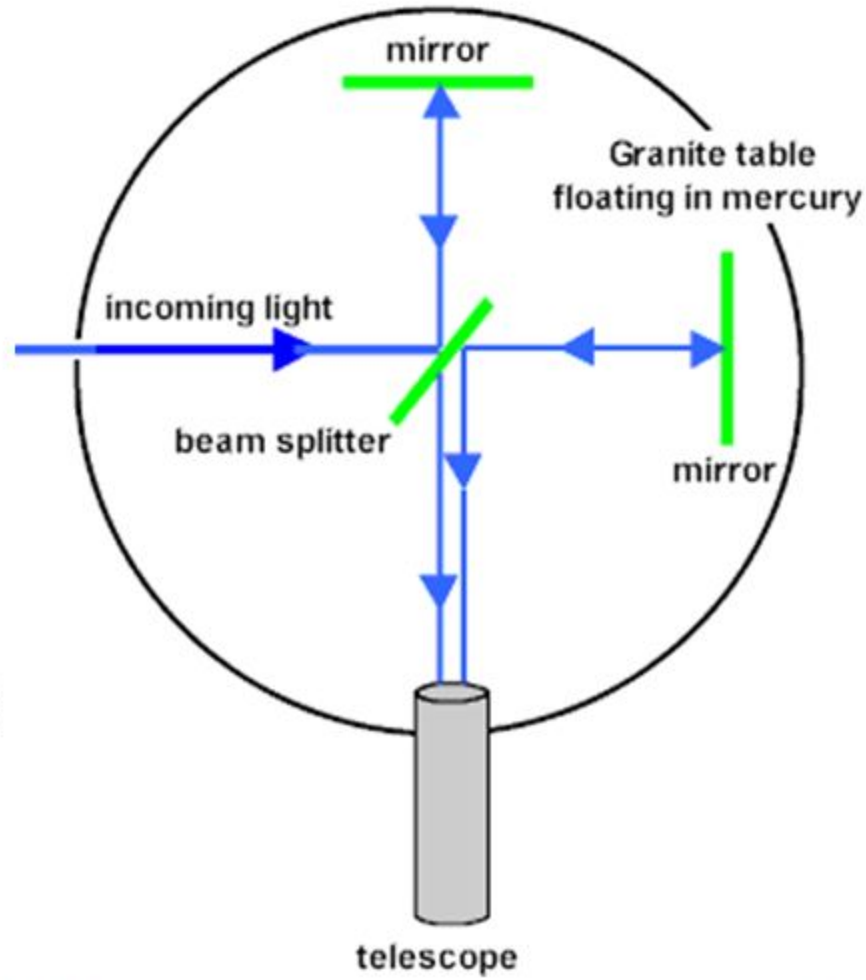
James Maxwell, 1831-1879

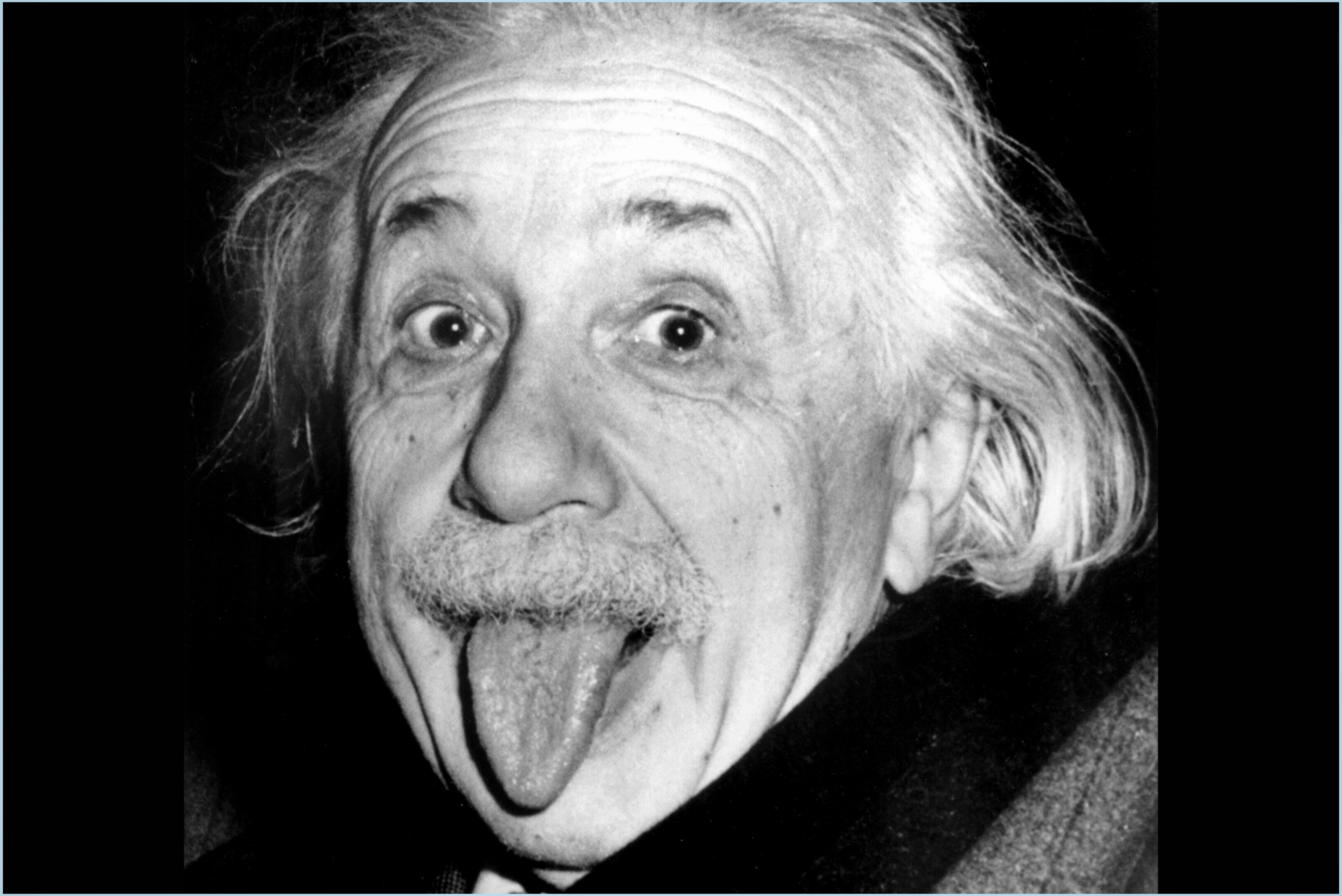


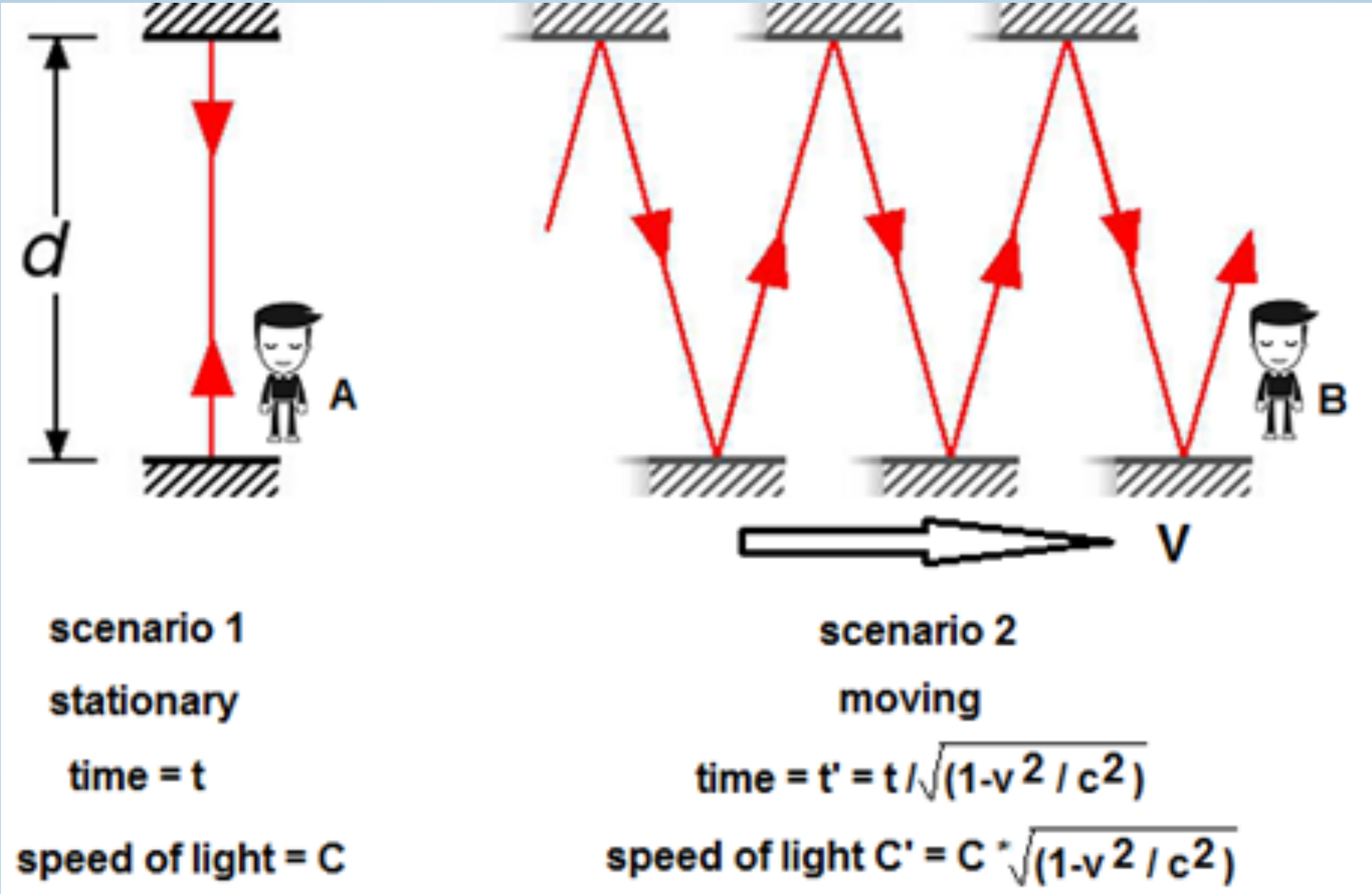
Michelson and Morley
Circa 1887

Michelson-Morley, 2

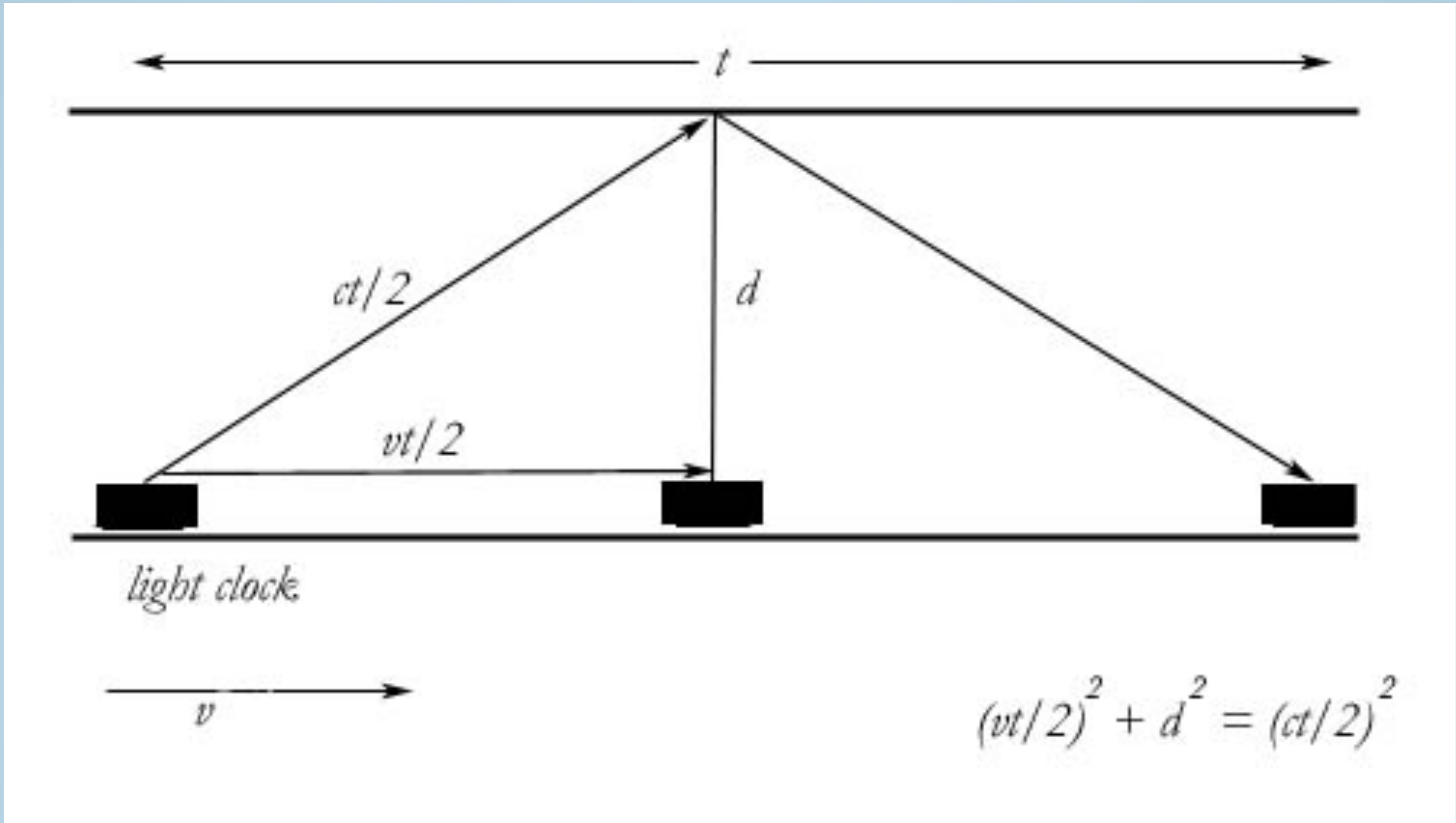
- Michelson and Morley devised an apparatus to shoot light off in a particular direction, then using a half-silvered mirror, deflect some of that light off at a 90 degree angle.





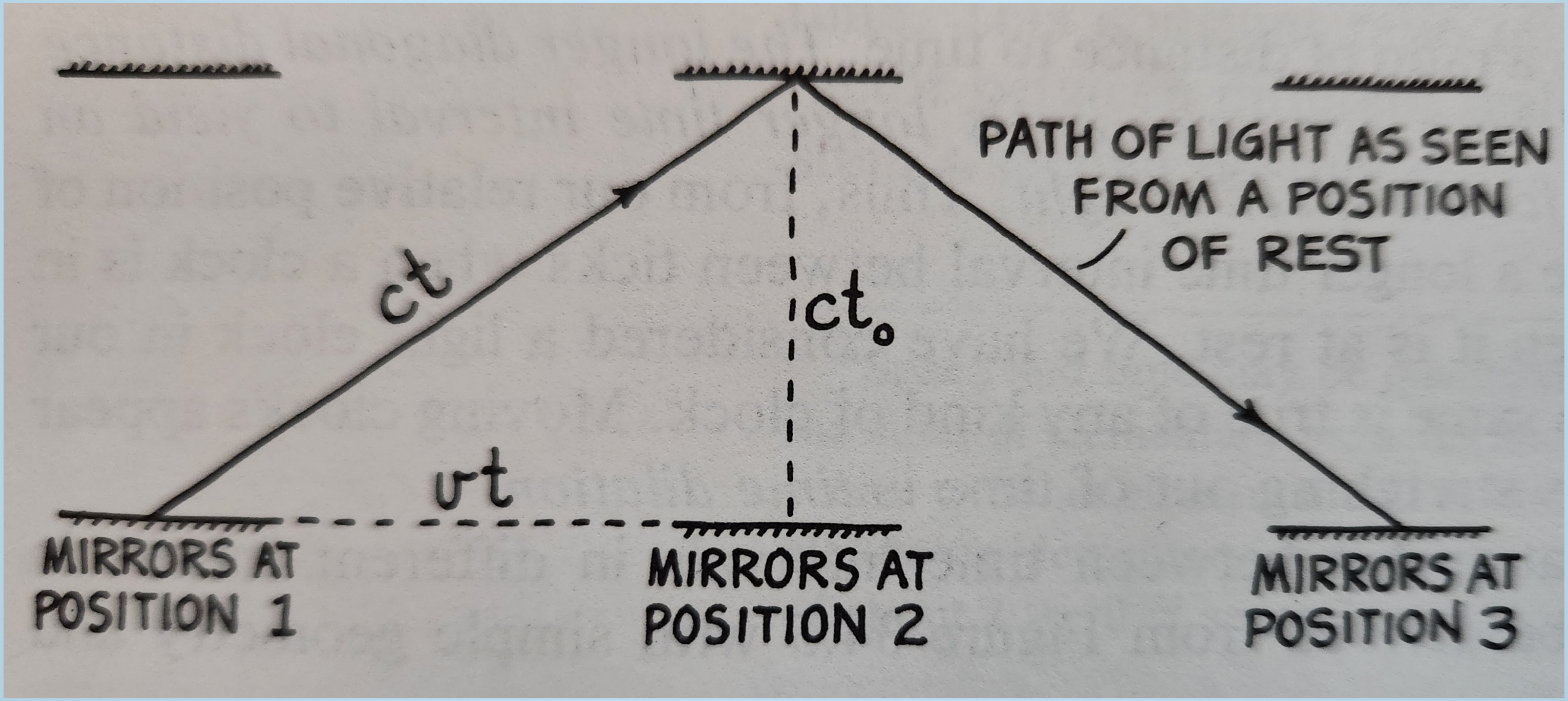


Light must travel further in a moving frame of reference when compared to a stationary frame.



We can calculate the difference with the Pythagorean Theorum

The amount of time dilation will be the ratio of ct to ct_0



$$c^2t^2 = c^2t_0^2 + v^2t^2$$

$$c^2t^2 - v^2t^2 = c^2t_0^2$$

$$t^2[1 - (v^2/c^2)] = t_0^2$$

$$t^2 = \frac{t_0^2}{1 - (v^2/c^2)}$$

$$t = \frac{t_0}{\sqrt{1 - (v^2/c^2)}}$$

It looks a little daunting, but solving for these variables is basic algebra

Does General Relativity do better than Special Relativity?

The Original Series, Season 1, Episode 21

Discussion….

… if we have time.