Hello, my name is Stephen Lewis Grillo. And in this video I will be describing in simplest possible terms, the steps that lead us to an interesting alternate conclusion concerning a very famous conundrum in the history of physics. In essence, this is a precis to a group of papers and videos that I have produced which go into some detail in support of this particular conclusion, and I think this video brief will capture all the essential steps that lead us to a reformulated interpretation of something very well-known. Basically, it is my contention that Albert A. Michelson back in 1881, and again in 1887, designed a very interesting test to set the speed of Earth against the speed of light - both of which, at the time presumed to be entities that had a finite velocity through a very coordinate volume that we would call an aether-filled space – and in fitting analytical procedures to this design, he misapplied some well-known math to a physical schema that actually operated contrary to his reasoning.

Now, the issue of the aether comes into this particular discussion. Currently the state of the aether could be said to be in super-position; today, the aether is thought of as superfluous, though, as late as 1920 Albert Einstein accepted that the aether was required for his model of General Relativity.

Einstein declaration/free energy

I set this ambiguity aside, trying to not compel a final decision on the aether, but to just look again at the very simple time/rate problem that Michelson had to face; Michelson presuming an aether existed, where here we will deal with these moving entities as definable constants, regardless of the framework that is conjectured to support them.

Looking carefully at Michelson's original setup, and his reasoning, and the math he presented as the operators that should have controlled the outcome of his experiment – we will review, and please forgive the remedial steps that we shall take here, his thinking and his math-setting. I think a rudimentary approach will help us to see how he set up, and then attempted to operate a valid-seeming math argument on top of a rationale that he did not put into proper perspective.

In other words, we will look at Michelson's original experiment as if there is an applied error in his mathematics. And so this discussion could be somewhat properly described as: Michelson's Error.

Given that the steps that we take here present an argument that could have been presented in 1888, one wonders if Michelson would have taken pause to consider it. Moreover, the correction that we can point to is very simple. The reasoning is very clear. It is just a matter of setting things up as strictly as is possible, and presenting overtly implied details that go on to provide a clear and reasonable reassessment of the basics that are in play.

And so we begin: In 1881, Michelson produced, designed and built a very simple first device. This device {See Sketch A} should have allowed Michelson to measure the speed of Earth, using the constant speed of light as an index. Now, the speed of Earth's orbit was well-established by more basic trigonometric and analytic means. Indeed, Michelson's efforts were to establish a palpable example of how the aether influenced light, not simply extract the velocity of Earth through space. An elegant proof of the aether would come from the way light was forced to behave in its negotiating his device. His device would split a beam of light, and each beam would derive its continuing action based on the limitations of the aether. One beam would, then, take longer to get through his device than the other. The resulting gap could be used to calculate the speed of Earth as it moved through aether-filled space. The conclusion would be that light was interacting with the aether as expected in producing this gap. All said and done more would be known about the structure of space – and the things moving about in it.

Sketch A

Sketch A, clipped out of Wikipedia, illustrates the elements of his design. There's a light source, some reflecting mirrors, and a splitting mirror between them, and then a collection device that would harvest the final output. Again, the idea in purest terms breaks down like this: it is clear that light has a finite velocity through space; it is clear that Earth has a finite velocity through space - basic logic tells you that somehow you should be able to manipulate these two different entities as they interact with one another and get some differential outcome. So Sketch A shows you what Michelson thought should do that. It's a device that splits a beam of light, such that the two resulting pieces travel completely different paths, each having its own distinct mathematical expression to compute its journey.

Once split, the two rays of the beam travel at 90 degrees with respect to one another, until each reaches a mirror placed on its path at an equal distance from the splitter – that is to say, the contact point on the half-silvered mirror that is acting as a beam splitter. These mirrors then reflect the rays back towards the splitter – again we must be precise and say, split-point on the splitter. And when these rays make it back to the split-point, they reverse what happened when they first diverged at the splitter. The ray that passed straight through the splitter originally, now reflects at 90 degrees to the output path; the ray that was originally deflected 90 degrees, now passes straight through the splitter. Once these rays are on the output path, it should be, because of the way the light must move along the two separate paths through the aether at its one rate, that the rays find themselves separated by a gap owing to the motion of Earth.

The very common illustration given for what should be happening in Michelson's device is the scenario where a boat on a moving stream has traveled downstream a given distance from the dock and then returned to the dock. Now compare that journey to the journey where the boat travels the same measured distance across the stream as the former and then returns. All other elements taken as equal, it will take longer time for the boat to go downstream and then back than to go cross stream and then back. In more technical terms the boat vectors in relation to the stream, but each case produces a different vector outcome So if we had two boats in a race, starting from the same corner of the dock, each traveling the same measured distance from the starting point, the boat crossing the stream would always win. Michelson expected the same outcome to happen in his device. In the proper parlance Michelson expected a phase mismatch at the collector, given that the winning ray would win by only a tiny fraction.

Math Expressions

Of course the classic analytical procedures that will compute these two different cycle times were at Michelson's disposal. So Michelson applied these procedures to the overt operation he was certain to find happening in his device. And so one can see how Michelson should be confident that he could in fact capture evidence of Earth's velocity integrating differentially with light's velocity.

As it turns out, this particular test produced very unsatisfactory results. Michelson could not find the presumed gap in these rays as they completed their cycles. There should have been a gap. He did not find it. It was a bracing failure. In 1881 Michelson wrote it off to the fact that, well, the device, as you can see, isn't very stable; it's not as rigorously built as one could imagine. So in the years that followed he found himself at Case Western. And there, he set up a much more rigorous and solidly built device.

Sketch B

Sketch B, again from Wikipedia, is a photograph of that particular device. We see a very heavy and massive table, floating in mercury. All of this presumed to remove any errant and/or extraneous vibrations that could affect the system. The key reason being that even minute vibrations needed to be removed from the system - because this overtly simple device is hiding a very, very complex technical problem.

You see, the distance between this splitting mirror and these reflecting mirrors has to be exactly equal for this system to reliably produce a gap. This fact can't be over emphasized. If you were to think of this system as using a very high frequency, very short wavelength beam of light, you might accurately perceive that the lengths between the splitter and reflecting mirrors would have to be within a few hundred- thousandths of an inch. Now you think about that having to happen in 1887. Trying to get that kind of precision in a solid, heavily built device was their true technical obstacle.

Indeed, that particular technical problem required that these reflecting mirrors be mounted on adjusters that could micro-tune, as it were, the essential distance between these elements.

Each of these mirrors had to be exactly equidistant between here and here. Again, a very, very large technical problem. It would not be possible without tunable mirrors that were able to move forward and back - and, effectively rotate right and left on their vertical axes. However, and again, with all of this rigor; with all of this fine tuning and precision, Michelson gathered nothing of the expected gap, save a bit of interference he could write off as imperfections of his technical pieces. Clearly, something was wrong.

Remember, with this experiment Michelson was trying to assess the validity of the aether, as it was, at this time in history, still a little bit under debate – certainly not overtly proven to be real. Michelson was trying to come down on the side that holds light to travel at its finite velocity through said aether. It is a very elusive thing, this aether - its only interaction with the physical world is to hold light to its constant velocity; that is to say, constrain light to its one velocity. It seems history has found Michelson to be a proponent of this aether as he continued, long after this failure, to design a test that would reveal it.

But, by the close of 1887, he had tried twice and failed twice. Even though one could say it should have easily produced the predicted result, Michelson had to report that his device, his experiment, was a failure, especially in terms of describing a contextual aether upon which you could meld light's constant velocity. And when Michelson reported out that his test had failed, the null result was roundly interpreted as a very big puzzle.

As we know, empirical thinking took a number of radical steps to come to some coherent understanding of puzzle. The first of which landed just a couple of years later – circa, 1889. A logician, one G. W. Fitzgerald brought forward the idea that, well, maybe things shrink in the direction of the motion. And if that shrinkage just so happens to be a certain value, it would cancel the expected gap. Odd idea, but it turns out that it held a bit of sway for a while, until soon after, step two occurred, when H. Lorenz worked out a more unifying global interpretation of how this shrinkage could be held to a higher mathematical standard, and so, create a bonefides for this idea of shrinkage. And of course, step three in the resolution of this puzzle came when Einstein coalesced his global interpretation of things – which revealed that if you actually look closely at what this shrinkage means you find that time is altered by motion.

Of course by the time we get to Einstein's work we have hurtled past the 1887 survey we are making. We are here to look very closely at what Michelson's math was attempting to do. Indeed, we're going entertain the idea he very likely produced an error in logic, which then forced his application of math to be faulty. And with this fault in place he could not divine the proper outcome. He was expecting a gap. His math predicted it; yes, but there's a bit of logic here - an option, as it were, that indicates how a fugue appeared in his process. And I think we can make this bit of logic, though subtle in some ways, very clear.

It all starts with the basic idea of this aether and how it maps onto the Cartesian model of space. In the first place space was thought to be too esoteric to have any interaction with something as mundane as light; hence, the aether was invented to deal with light. Now one could at least map a Cartesian volume onto space, and then map the aether onto the Cartesian volume and, viola, light can leave point A and travel to point B at one constant velocity. Now to capture Earth's motion through such an entanglement, is no easy task. Proper procedure demands that one starts with Earth at rest to make baseline assessments of one's proposition, equipment et al. And then increase the speed, taking measurements along the way until one has arrived at the full orbital speed. But since Earth is unconditionally moving - it can't be stopped, started or varied, Michelson had to make the assessment that his general analytic problem would need to be seen in a reciprocated manner. He would have to see the putatively fixed aether instead blowing past his device as a wind, for which he uses the term apparent aether wind.

Panel 10 cdr

Considering this adapted perspective, one can see this single presentation in physics {this test} as having two inherent interpretations. One can see the device as moving through the fixed aether - as the aether, itself, is mapped onto Cartesian space; and one can see the aether as moving, with the device mapped onto, that is to say fixed in Cartesian space. Taken purely in terms of mathematics, each case can be seen as presenting the same analytical problem.

Let’s review the key steps. Here, again, is the abstract that Michaelson was working with: he's got an apparent aether wind coming into his device. He is standing behind this device, again, as if it were fixed. And as the aether wind passes, the light beams interact with the aether. As he understood it, the interaction with the flow would create two different outcomes for the rays of the split beam. Let’s look at an animation that isolates the cross-current ray.

State 1 animation

As we know, of the two occurring in his device, this is the cycle that requires the least time. But we also know this cycle is longer than the cycle which finds the aether not moving at all. The inscribed V in the animation illustrates the reason why. The beam - let’s switch to the idea of a single photon – the photon must interact with more aether in the moving aether scenario than in the one where the aether is not moving. Since the photon can only travel at c, it travels each leg of the V at c. The act of this photon inscribing this V into the flowing aether creates two legs, each of which is longer than L. This extra distance the photon travels, at c, takes extra time. This extra time causes the photon to cycle more slowly along L to the mirror and back. Yes, the shortest possible time for the cycle would be if the device were fixed, ie not moving. Michelson’s math is meant to reveal that the slowing of the photon along L is correlated to the speed of the frame. The higher the speed, the wider the V and the slower the cycle along L. Now Michelson wasn’t too worried with this essential slowing of the cross-current cycle along L, he was only concerned with idea that the cross-current photon cycled faster than the on-axis photon.

And all told, when we share Michelson’s interpretation and stand with him behind his device, we all witness a vector scenario. The speed of the photon must interact with the speed of the aether. Michelson’s math fits this scenario perfectly.

POV

When we see the V forming as the photon cycles along L, we see how Michelson came to expect the gap and thereby prove the validity of the aether – and the velocity of Earth as indexed against light.

To complete the analysis, we perceive that once the photons have negotiated their respective returns to the splitter, we should find them one behind the other on their way to the collector. For this survey we should brand the line from the splitter to the collector as the y-axis. So we find the photons on the y-axis. Michelson expected them to follow this output path and enter the collector out of phase.

Animation frieze 41

Michelson expected them to be out of phase, but they weren't. Something was wrong.

So to see this something, we'll have to look, again at the more remedial steps and see what Fitzgerald had to say about the goings-on in Michelson's interferometer.

Panel 11 cdr

This particular frame is illustrating the exactness of the L that has to be involved here. We're looking very carefully at the distances between these two mirrors and this split-point on the splitting mirror. These distances, indicted in red, have to be almost perfectly equal, if not, the very tiny gap Michelson was expecting could not manifest properly.

Panel 12 cdr

As we look at the math expressions that apply here, we clearly see a slight difference in them. This radicand shows up as the only difference in these expressions and the expression with the radicand applies to the cross-axis component. Breaking then down we see L as representing the frame length to be negotiated by the cycling photon. The photon travels L from the splitter to the reflecting mirror and then back so 2L is the working distance. The capital V beneath it represents the speed of the cycling photon, which we see in Einstein's equations becomes c. And below 2L/V we see the denominator in each expression contains a lower case v. This lower case v represents the actual velocity of the frame or apparent aether wind, as you would have it. In any case the expression without the radicand describes the cycle time of the on-axis photon. And to hi-light their general utility we notice that they compute the cycle time of each photon as it negotiates its respective L. And again they compute ever so clearly that there should be a gap between the photons as they exit the mirror-maze and find themselves on the output path. And even though Michelson had to use these expressions on the reciprocated case he still should have gathered the gap he expected.

Bringing these expressions into focus helps us see what Fitzgerald did when the test produced no gap.

Panel 13 cdr

It would be appropriate to notice that the functional operation of Michelson's interferometer included the ability to rotate such that the component legs could change positions with respect to the apparent aether wind. It was Michelson's intention to capture short lapse data to investigate the Earth's rotational dynamics on his device and long lapse data that would investigate Earth's orbital mechanics on the device. Keeping this in mind makes Fitzgerald's idea all the more interesting.

Fitzgerald saw that he could play hard ball with analytics and produce an empirical overlay that create a solution to the puzzle. His solution was this: if the component leg of the device that found itself on the axis of motion were to shrink by $\sqrt{1-v^2/V^2}$, that would adjust the on-axis cycle time to equal the cross axis cycle time. This would produce no gap - all other things remaining as same – which was what Michelson captured. This was Fitzgerald applying empirical thinking on a grand scale; he created a law whereby a physical dimension was altered by motion.

Panel 17 cdr

And Fitzgerald's case became all the stronger when Lorentz came along and expanded the mathematical case for Fitzgerald's empirical idea. And Lorentz makes this odd new physical law palatable for Einstein.

Though Einstein makes it clear that he is aware of Michelson's work, we must note this extract from Wikipedia:

There has been some historical controversy over whether Albert Einstein was aware of the Michelson–Morley results when he developed his theory of special relativity, which pronounced the aether to be "superfluous." In a later interview, Einstein said of the Michelson–Morley experiment, "I was not conscious it had influenced me directly... I guess I just took it for granted that it was true."

Wikipedia attribute: Swenson, Loyd S. Jr., *The Ethereal Aether: A History of the Michelson–Morley–Miller Aether-Drift Experiments, 1880–1930,* University of Texas Press, 1972

One understands the extract when one notices that Einstein uses Fitzgerald Contraction in its exact form in his length contraction expression: $L' = L \sqrt{1-u^2/c^2}$. Moreover, Einstein is distilling Michelson's perspective when he notes that the un-shrunken component leg gives rise to the time extension, that is to say, time dilation: $T' = T / \sqrt{1-v^2/V^2}$; where lower case v is identical to u, and upper case V is identical to c.

POV

When Michelson expects his cross-axis photon to slow as it crosses the flow of aether, and with his math telling him it would slow even more if the flow speed were higher, we can say Michelson was first to experience Einstein's concept of Relative Rest. Michelson expecting a resultant vector for the photon on the cross-axis of his device is the root of Relative Rest.

This is what history delivered to us. But now, we turn to the critical question concerning Michelson's vector assay. Just for the sake of unwinding, let's look at the original premise that would obtain if one could move the device and consider the aether fixed. Well, the same mathematics compute the spatialized paths of the photons and it becomes very clear to us from where the extended cycles come. As actual spatial paths, the photons on each component leg make round trips that are longer than 2L.

Panel 15 cdr

Notice this light purple line, it lies on-axis and begins at P1 where we see the splitter begin its movement through the aether. It ends at a point in space where the photon overtakes the receding mirror. Now we take note the dark purple line as it represents the path of the reflected photon as it leaves that space-point. We need only take note of its return to P1 at the splitter. The sum of these two lines is longer than 2L. The cycle time, therefore, is extended because light has traveled through space at c along the paths represented by these lines. This cycle is a very uncomplicated time/rate case; no accelerations- no vectoring.

Now we take note of the light green line as it lies on the cross-axis and also begins at P1 as the splitter begins its movement through the aether. We watch as the photon it represents follows the path Michelson expected to follow. It ends at the reflecting mirror and the photon now follows the dark green line back to P1. This dark green line is the same length as the light green line but taken together they sum longer than 2L. But it is also true that the latter sum is shorter than the former sum; hence we see them compared on the left side of this graphic.

So we have looked at the scenario where the apparatus encounters an apparent aether wind, and the scenario where the apparatus moves through a fixed aether, and seen in both cases to expect a gap. But no gap appears so we are left with Fitzgerald's Contraction to resolve the puzzle. But still yet one wonders if Michelson got something wrong? I beg your indulgence and ask you to look again at the green lines. Let's bring back Michelson's expectations as we earlier animated them.

POV

Remember this is Michelson's expectation and the root of Relative Rest. When we first looked at it we saw the apparent aether wind create a vector scenario and that has come down through history as the model that obtains. But when we set the apparatus into motion we created a very flat time/rate scenario – which leaves us to ask, what put the photon on the light green path? - other than Michelson would want such. You see, for every velocity of the apparatus there is an angle at firing that could put the photon on just such a perfect path as to always be receding from the split-point along L. The analytical expression for which Michelson is in fact using. It's just that nothing on his apparatus should put the photon on such a path. In fact, it is clearly a violation of inertia rules. A source can't imbue a massless entity with lateral inertia, otherwise every point of light in the night sky would mark the exact position of its representative the star. And if the inertia violation isn't enough corruption, there is something very noteworthy that has been lying unrecognized in Michelson' maze. Assuming the device is in motion and under the contraction Fitzgerald materialized, the on-axis math expression Michelson uses is still valid; meaning, it is the correct math to use under these conditions for any length L. So Fitzgerald's contracted length is like any given L that might appear in this time/rate scenario. The math does not see anything special about the contracted leg. The math is saying give me any L and I will calculate the cycle time correctly. When we look at this graphic we see the orange mirror depicting Fitzgerald's Contraction for this component leg. The net effect of which is the shortening of this sum.

Which takes us to here. Nice – we have removed the gap. But look, when I shortened this sum, it shrank keeping it behavioral roots intact. This is because the underlying analytic behaviors are not altered by the contraction. This leaves us to harvest the difference in these two legs as an exact ratio relatable to the motion - that is, constant velocity of the frame. Needless to say I designed an untried test in 1990/91 that would extract this ratio. And needless to say this ratio has been manifesting in the original design since day one.; it is understanding the problem correctly that allows you to release it.

Which leaves us to correct the expectations that we should have when the proper inertial laws are obeyed. I find the point is most clearly illustrated when we the direction of the frame to move from south to north of the page instead of the west to east – as we have depicted thus far.

Panel 18 cdr

We take note of the blue reference line that denotes the position of all elements when the photon strikes the splitter. From that point on, the cross-axis photon continues along that reference line because it possesses no lateral inertia, and the device drifts northward due its motion. The photon reflects at the mirror and returns along the reference line to a new point on the splitter ie not the point it originally passed through. The photon that reflected at the splitter to find itself coursing the on-axis component leg, has traveled due north to overtake a receding mirror. Whereupon it reflected and returned along its reference line. And here's a bit of magic which occurs when we set things right: when the on-axis photon returns to that point in space where the photons originally split ie the intersection of the two reference lines, the cross-axis photon is at that instant landing on its new contact point on the splitter. Note red markers. As the cross-axis photon reflects to exit the maze, the on-axis photon carries on due south. This leaves to note two very telling details; they are time aligned, meaning they have both traveled exactly the same distance, ie taken the same time, to exit the mirror maze. And there is a gap between them owing exclusively to the velocity of Earth through space. This is the gap Michelson was expecting, however we notice the gap is not on the y-axis as he expected but on the x-axis. And the fact they are time-aligned allows us to see how this gap has remained hidden all these years – because tuning the mirrors to have the images exiting the mirror maze to coalesce to a single point on a screen literally erases it. While simultaneously the natural time-aligned-ness produces no gap in the y-axis- leaving Michelson nothing to witness for his pains. A more complete description of this time-aligned-ness can be found at www.2cspacetime.info

And there is yet another feature that is worth noting: when we rotate the source to lie on the axis of motion we see an element that has an historic provenance.

Panel 22 cdr

Namely, a very small gap does appear on the y-axis, and Michelson did collect this gap, but so small was it compared to his expectations, it seemed more errata than data. The math shows to expect a 3.38 fraction of the total gap that appears in the x-axis. Remember Michelson's expected gap is in all regards base on the same mathematical approach as the one that resolves the inertially correct scenario. And so, the fractional gap that Michelson collected, searching as he did exclusively on the y-axis, is virtually the same as the one illustrated here.

Which leaves us finally to comment on technical refinements to the original Michelson design, we find we need correct but two elements. But they are very, very important to get right. The first has to do with Michelson's original technical problem, namely – aligning two mirrors at equal distances from a single point in space, while certifying they remain at a perfect 90 degrees to one another.

Panel 24 cdr

This compound requirement can be handled by a CNC machine. By cutting a 90-degree angle into, say, a one-inch thick ingot, and then scribing a 45-degree reference line at the intersection of the two faces, you remove the angular noise introduced by tunable mirrors. The second is a bit simpler: we replace the normally large light source, with a micro–fine laser; perhaps one that produces clouds of photons in bursts. Given that the L of the device is meaningful in producing a meaningful gap, some thought would have to go into the min/max L for any final test device.