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Revisiting the 1887 Michelson-Morley Experiment

(Paper IV)

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This is the last instalment in a four part series, the aim of the work being to introduce absolute motion into Einstein's Special Theory *of* Relativity (STR). In Paper (I), we provided a new solution to the traditional twin paradox of Einstein & Langevin. This new solution suggests that hidden within the labyrinth of its seemingly coherent and consistent structure and fabric, Einstein's STR implies absolute motion. In Paper (II) we proposed the truly paradoxical case of the symmetric travelling twins. It is seen therein that this case unearths the deeply hidden inconsistency of Einstein's STR. This irretrievable contradiction seen in the case of the symmetric twins not only suggests, but points to the undeniable need and necessity for absolute motion. We thus set-forth in Paper (III) a relativistic aether model, which at best can be described as the Special Theory *of* Relativity in Absolute Space (STRAS). Having build the theory, we herein revisit several experiments carried out to detect absolute motion. The new theory *i.e.* the STRAS, requires that these experiments be recalibrated. So doing – *i.e.* recalibrating these experiments, we find that the Earth's speed through the hypothetical aether medium varies in the range $\sim 130 - 350\,\mathrm{kms}^{-1}$ *i.e.* $240 \pm 110\,\mathrm{kms}^{-1}$.

Keywords: gravitation and electricity – none Riemann geometry – Weyl unified theory – unified field theory.

"*At the heart of science is an essential balance between two seemingly contradictory attitudes – an openness to new ideas no matter how bizarre or counterintuitive they may be, and the most ruthless skeptical scrutiny of all ideas, old and new. This is how deep truths are winnowed from deep nonsense.*"

– Carl Sagan (1934 – 1996)

1. Introduction

In the pursuit of the foremost knowledge of the inner and outer workings of *Nature* in so far as the nature of the existence or leak thereof the hypothetical aether and or absolute motion is concerned, if one only read standard university textbooks, then – against the apex of their pursuit and the deepest of their desideratum, they – sadly and against their knowledge and will; come to believe that the Michelson-Morley Experiment (MME) is one of the greatest "*failed*" experiment ever carried out by humankind. Not only that, one will further learn (and most certainly come to believe) from these textbooks, that this experiment produced a "*null*" result that vindicated Einstein's philosophical position on the non-existence of absolute motion, space and time.

For the noble sake of eternity, if truth be told, then, the truth is that, this experiment (the MME) was the first (such) to detect the aether [6]. So what went wrong? If at all, who's fooling who here? Is everything OK? Behold! Herein we offer an explanation that might convince our reader that absolute space and motion may very well exist – there very well might be a sacrosanct and immutable grid of spacetime, a grid that acts on, but can never be acted upon – this is a position this reading seeks to bring before the esoteric *Grand Jury of Science*.

The foremost problem with our understanding of absolute motion and the hypothetical aether began with the maiden experiment *i.e.* the MME, in particular, how this result was interpreted and subsequently reported to an astound world. To begin with, from the "null" result of the MME as (wrongly) reported by the experimenters – Michelson and Morley [6], researchers and the general public have strongly come to believe that the original MME experiment ruled out the existence of the hypothetical immobile luminiferous aether. It should be said that this result is unexpected only in terms of *Galilean Physics* and as-well it should said that this very point needs to understood without fail. In Einstein's Special Theory of Relativity (STR), this null result is fully expected and as never mentioned in standard university textbooks, the STR does not however rule out the existence of any aether. Rather notoriously, standard university textbooks present the MME only in terms of Galilean Physics and because of this, the true meaning and understanding of the result of the MME is heavily distorted, and misleading. As will

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be demonstrated (argued) herein, the MME cannot, and does not rule out an immobile aether, or any aether for that matter.

In the readings [38, 39, 40, hereafter Paper I, II, and III respectively], we have not only argued that Einstein's Special Theory of Relativity (STR) points to the existence of absolute motion, but that it contains a clandestine logical flew that is not reconcilable without invoking the notion of absolute motion. In [40], we have build a special relativistic theory that takes postulates the of absolute motion – we have called this theory the Special Theory of Relativity in Absolute Space (STRAS). In the present reading, we are going to employ this theory – STRAS – to experimental attempts at detecting the possible absolute motion of the Earth though the supposed aether medium or absolute space. This will require us to recalibrate these experiments.

According to Michelson and Morley's forehand calibration which was *in-full-accordance* and *in-full-resonance* with the best of their understanding of physics of their day; they reasoned that, if, the aether did exist, then, they must expect a fringe shift of at least 0.4 *fringe*. Much to their surprise (and perhaps to their chagrin aswell) and that of the scientific establishment and wisdom of the day, they obtained a fringe shift that was a fortieth of this. According to their forehand calculation, a 0.4 *fringe* shift would imply that the Earth moves through the aether medium at a speed of at least $30\,\mathrm{kms}^{-1}$. A fortieth of this would mean the Earth moves through the aether at a speed of about $8\,\mathrm{kms}^{-1}$. Least we are accused of putting words into the mouth of our dear reader, let us quote directly from the great paper of Michelson and Morley:

> "Considering the motion of the Earth in its orbit only, this displacement [...*of the fringes*] should be $2Dv^2/V^2 = 2D \times 10^{-6}$. The distance D was about eleven meters, or 2×10^7 wavelengths of yellow light; hence the displacement to be expected was 0.4 *fringe*. The actual displacement was certainly less than the twentieth part of this, and probably less than the fortieth part. But since the displacement is proportional to the square of the velocity, the relative velocity of the Earth and the ether is probably less than one sixth of the Earth's velocity, and certainly less than one-forth."

In the above quote, V is the speed of light, v the speed of the Earth in its orbit about the Sun and D the length of the arms of the Michelson and Morley Interferometer (MMI). It is clear from the above quote that Michelson and Morley suppressed their experimental result because it did not yield to the desideratum of their expectations. It is thus very correct to confidently say the first MME did detect absolute motion, its executioners (Michelson and Morley) simply did not believe the result was significant enough to announce they had detected the aether.

2. Michelson-Morley Experiment

The MME is a well conceived experiment – the aim of which is to verify experimentally whether or not the aether exists. Prior to their land-marking investigations, the two eminent scientists – Michelson and Morley, believed the aether must exist* and their obvious expectations (most certainly) was that, they would be the first to detect it. They hoped to detect the aether by comparing the time taken by light to travel a finite distance back and forth in a direction parallel to the velocity of a moving frame and that of a beam travelling the same distance in a perpendicular direction to velocity of a moving frame. Their (*tour de force*) experiment is based on the fundamental assumption that the speed of light is constant in an absolute frame considered to be in a state of absolute rest. This absolute frame in a state of absolute rest is the hypothetical aether.

The Michelson-Morley experimental setup is illustrated in figure **??**. For instructuve purposes, we are here going to go through a derivation of the formula for the fringe shift. Light is emitted by the light source where upon it travels to meet a central half-silvered mirror M. The half-silvered mirror splits the beam of light into two such that one-half of the beam passes un-deflected while the other is reflected at an angle of 45° relative to the line normal to the surface of the mirror at the point of contact between the light beam and the half-silvered mirror. The reflected beam travels in a direction perpendicular to the direction of the velocity of the moving frame where is will be reflected back to mirror M at point C by mirror M_1 upon contact with it. On its way back from point C, upon arrival at mirror M, it is transmitted un-deflected thus travels to the detector. On the other hand, the transmitted beam moving along AB, will upon contact with mirror M_2 be reflected back to mirror M. On arrival at point A, this beam will be reflected at an angle of 45° to the normal. The effect is that beams $A \longmapsto C \longmapsto A$ and $A \longmapsto B \longmapsto A$ will recombine at A. The distance L travelled between point A (on mirror M) and point B on mirror M_2 is equal to the distance L between the point A on mirror M and point C on mirror M_1.

In the original MME, the experiment was conducted in air. As we all know from optics, the speed of light is affected by the medium in which it travels, sadly or perhaps surprisingly, Michelson and Morley did not take this into account. Much more sadly, not until Cahill & Kitto's 2003 reanalysis of the MME [6], this experiment was conducted in air and other gas-mode mediums and none took into account the fact that the speed of light is affected by the medium in which it travel.

Let us make a brief analysis of the experiment before we go into the details of it. In this experiment, according to Galilean velocity addition law – which is obviously not

* Michelson and Morley [35] performed the Fizeau experiment where they confirmed Fresnel's dragging coefficient. From this experiment, Michelson was now of the opinion that Fresnel's stationary aether theory is correct, hence, he (and Morley) believed the aether must exist.

a correct description of *Nature*; in the moving frame, light moves along the path $A \longmapsto B \longmapsto A$ with speed c, but to the observer in the stationery aether, light will move with speed $c+v$ and $c-v$ along $A \longmapsto B$ and $B \longmapsto A$ respectively.

Now, in order to verify the hypothesis that the speed of light is c only with respect to an absolute frame of reference and not constant in moving frames as-well, Michelson and Morley reasoned that the time interval taken by light to travel in the longitudinal direction (between AB) compared with the time for light to travel in transverse direction between AC had to be different. Consequently, there must be a drift of interference fringes (or a significant shifting of fringes) at the detector when the apparatus is rotated. Therefore, they [Michelson and Morley] suggested building an interferometer to test this hypothesis.

Let us compute travel times $t_{\|}$ and $t_{\perp}$ which are the total travel times along the parallel and perpendicular arm respectively. If $t_{\|}^{+}$ and $ct_{\|}^{-}$ are the total travel time of the beam toward and away from the mirror M_2 before recombination, then, $t_{\|} = t_{\|}^{+} + t_{\|}^{-}$. From the set-up, if light travels at speed c as Michelson and Morley assumed, then, we will have $ct_{\|}^{+} = L + vt_{\|}^{+}$, $ct_{\|}^{-} = L - vt_{\|}^{-}$, which leads us to:

$$t_{\|} = \frac{L}{c+v} + \frac{L}{c-v} = \frac{2Lc}{c^2-v^2} = \frac{2L}{c}\left(1-\frac{v^2}{c^2}\right)^{-1}. \tag{1}$$

Now, as shown in Figure **??**, for the perpendicular arm, when the light paths between locations $A \longmapsto C \longmapsto A$ move transverse to the light whose speed is c, in the absolute frame, the light path is seen as an isoscele triangle in the absolute rest frame. For the geometry of this isoscele triangle, one finds that the time taken by light is given by:

$$t_{\perp} = \frac{2L}{\sqrt{c^2-v^2}} = \frac{2L}{c}\left(1-\frac{v^2}{c^2}\right)^{-\frac{1}{2}}. \tag{2}$$

The difference in the time of travel for the beams in the two arms $\Delta\tau(0) = t_{\|} - t_{\perp}$ is given by:

$$\Delta\tau(0) = \frac{2L}{c}\left[\left(1-\frac{v^2}{c^2}\right)^{-1} - \left(1-\frac{v^2}{c^2}\right)^{-\frac{1}{2}}\right]. \tag{3}$$

For $v \lll c$, one can use a series expansion*, so that (3) is given by:

$$\Delta\tau(0) = \frac{L}{c}\left(\frac{v^2}{c^2}\right). \tag{4}$$

This time difference, $\Delta\tau(0)$, in the two beams will lead to a path difference, δl, in the two beams. That is, δl is equal to the speed of light c times $\Delta\tau(0)$ *i.e.*:

$$\delta l = \left(\frac{v^2}{c^2}\right)L. \tag{5}$$

What this all means is that the two beams start out in phase and on their return trip, there are out of phase. Because these beams are now out phase, we are going to have constructive and destructive interference at the detector. If we are to focus on just one fringe, a rotation of the interferometer should lead a shift in the fringes. As Michelson and Morley did and, as is done in all descendants of the MME, let the interferometer be rotated through $90°$ such that the arm-AC is now parallel to the velocity of the moving frame and the arm-AB is traverse to the velocity of the moving frame.

$$\Delta t(90°) = -\frac{L}{c}\left(\frac{v^2}{c^2}\right). \tag{6}$$

The time difference, $\Delta\tau$, in the two configurations, *i.e.* $\Delta\tau = \Delta t(0°) - \Delta t(90°)$, is twice that given in (4), *i.e.*:

$$\Delta\tau = \frac{2L}{c}\left(\frac{v^2}{c^2}\right). \tag{7}$$

The corresponding path difference δd, is equal to the speed of light c, times $\Delta\tau$, *i.e.*:

$$\delta d = 2\left(\frac{v^2}{c^2}\right)L. \tag{8}$$

The fringe shift δA_m to be expected from this is given by $\delta A_m = 2c\Delta\tau/\lambda$, where λ, is the wavelength of light used in the experiment, *i.e.*:

$$\delta A_{\rm m} = \frac{2L}{\lambda}\left(\frac{v^2}{c^2}\right). \tag{9}$$

In anticipation, Michelson and latter Michelson & Morley [34, 37] (wrongly) reasoned that because the Earth is moving at a speed of $\sim 30\,{\rm kms^{-1}}$ in its orbit about the Sun, they could calculate a minimum expected fringe shift. Alas! not only is the Earth moving about the Sun but the Solar system as a whole is orbiting the centre of the Milkyway Galaxy at about $220\,{\rm kms^{-1}}$, thus a minimum value to be considered for the motion of the Earth through the aether is $\sim 250\,{\rm kms^{-1}}$, or more correctly $\sim 220 \pm 30\,{\rm kms^{-1}}$. Clearly, Michelson and Morley appear to have been completely ignorant of the motion of the Solar system about the galactic centre. In this first experiment, Michelson used yellow light with $\lambda = 5.75 \times 10^{-7}\,{\rm m}$ and the arms of the interferometer were $2.4\,{\rm m}$, thus the expected fringe shift calculated by him was $\delta A_{\rm m}^{exp} = 0.04\, fringe$. His instrument was sensitive enough to detect a 0.01 *fringe* shift.

In 1881 when Michelson [34] undertook the maiden experiment, he found no indications of the anticipated shift of interference fringe *i.e.*, from with the experimental margins, he obtained a δA_m which was compatible with zero. He repeated the experiment, with his colleague, Professor Edward E. Morley. This time, they used interferometric arms that where almost 10 times the previous, *i.e.* $L = 22\,{\rm m}$. Their expected fringe shift this time

* $(1+x)^a \simeq 1 + ax + \ldots$ for $|x| < 1$ where in the present case $x = v^2/c^2$.

was $\delta A_{\rm m}^{exp} = 0.40\,fringe$, and they obtained $\delta A_{\rm m}^{exp} = 0.03\,fringe$ and from there, they announced their now World famous result that the aether does not exist.

The reason for rejecting this result was that it lead to speed of $\sim 8\,\rm kms^{-1}$ for the Earth in the aether medium. This falls far short of the expected $\sim 30\,\rm kms^{-1}$ of the Earth's orbital speed about the Sun. One wonders what could have happened had they got a fringe shift corresponding to the expected $\sim 30\,\rm kms^{-1}$? Would they have endorsed the existence of the aether? If they did, with the advent of the knowledge that the Solar system as a whole is orbiting the centre of the Milkyway Galaxy at about $220\,\rm kms^{-1}$, this result would certainly need to be revised and the fringe shift would once again, fall far short of the $220\,\rm kms^{-1}$.

It is our submission here that in the MMEs, the thrust must be put in establishing whether or not there is a fringe shift and if so, the next *port-of-call* is to establish whether or not this fringe shift is statistically significant. If it is found that the shift is statistically significant, then, the issue of calculating the implied speed of the Earth in the aether is an issue to do with calibration. Only after ~ 120 years was it noticed by Professor Cahill *&* Kitto [6] that there is need to correctly recalibrate the MME. Their recalibration efforts led to a speed of the Earth in the aether medium of $\sim 369 \pm 123\,\rm kms^{-1}$.

Professor Cahill *&* Kitto [6] made rwo corrections to the MME calibration: (1) they assumed that the arm along the direction of motion undergoes a Lorentz-Fitzgerald contraction $L' = L\sqrt{1-v^2/c^2}$ and (2) that the speed of light in medium of refractive index n is c/n. These two corrections, led them to:

$$\delta A_{\rm m} = \frac{(n^2-1)L}{\lambda}\left(\frac{v^2}{c^2}\right). \tag{10}$$

From this formula, the smallness of the fringe shift is now explained by the factor n^2-1 since for air we have $n_{\rm air} \sim 1.00290$ hence $n^2-1 \sim 0.00580$. If one does not assume Lorentz-Fitzgerald contraction and only corrects for the speed of light in a medium of refractive index n, then [6]:

$$\delta A_{\rm m} = \frac{2n^3L}{\lambda}\left(\frac{v^2}{c^2}\right). \tag{11}$$

Since $n_{\rm air}$ is close to unity – for the speed of the Earth, it leads to the same result as the MME calibration.

3. Reinterpretation of the MM-Experiment

As already stated: with James Clerk Maxwell having shown (theoretical) in 1864 that light was a wave and that this light wave should travel at a constant speed and coupled with the knowledge that typical waves (or all known waves at the time) needed a medium in which to travel in, it was reasoned that there must exist a medium through which these light waves travel and this medium – coined the aether, had to fill all of space so that light can travel in the cosmos as it typical does. The MME was designed to measure the Earth's putative motion in this aether medium and the underlying calibrations they used was the Galilean calibration *i.e.*, their interpretation was based:

> *On the* (*clearly wrong*) *assumption that spacetime and the Laws of Nature obeyed Galilean invariance and also* (*if it the aether exists, on the correct assumption*) *that the aether was immovable* (*at absolute rest*)*, permeable, all-pervading and nonponderable; its was the carrier of light waves, a medium which light assumed its universal speed c.*

What we are going to do here is essentially what Professor Cahill *&* Kitto [6] have done *i.e.* recalibrate the MME – *albeit*, with a significant difference. We will do so on the basis of the proposed STRAS. Three things we are going to take into account are:

1. The speed of light c' in a medium of refractive index n is $c' = c/n$.
2. As outlined in the STRAS (Paper III), length contraction is real (and not relative) physical phenomenon and occurs along the direction of motion of the body in question in exactly the manner proposed by Lorentz and Fitzgerald [20, 19, 13].
3. In a vacuum where $n \equiv 1$, the motion of light is independent of the motion of the body from which the photon is ejected, this means, in vacuum, a photon does not acquire a component of the velocity of the body from which it is ejected. In a medium where $n > 1$, the motion of light is independent of the motion of the body from which the photon is ejected, this means that in this medium, a photon does not acquire a component of the velocity of the body from which it is ejected.

The third recalibration assumption (above) sets the present recalibration effort apart from that of Professor Cahill *&* Kitto [6] and as will be seen, this leads to clearly testable predictions on the vacuum-mode MMEs.

3.1. Gas-mode MME

Now, we consider the case where the interferometer is immersed in a medium of refractive index $n > 1$. In this medium, light no longer has its usual speed c but $\tilde{c} = c/n$. According to the Extended Second Postulate of Relativity, only light in a vacuum is not going to be dragged by a moving frame, this means that – for light in a gas-mode, it will be dragged by the medium in the same manner as we have argued that a neutron will be dragged by a moving frame if released from it because it acquires a component of the motion of the body from which it was released. In-passing, it appears, in this case, the photon must somehow possess inertial properties for it to be dragged by this medium. For us to quantify the motion of light in this gas, we must must now use the Relativistic velocity addition law:

Notable Experimental Attempts at Detecting the Absolute Motion of the Earth through the Luminiferous Aether Using the Michelson Interferometer.
$(1881-1930)$

Table (1): Column (1), lists the index of the experiment as it appears in the present table; Column (2), lists the names of the experimenter(s); column (3), the year in which the experimenter(s) performed the experiment; column (4), the type of experiment they conducted; column (5), the length of the arm of the Michelson interferometer; column (6 & 7), give the expected fringe shift from the Galilean calibration (gc) and the and the Absolute Relativistic Calibration (arc) assuming the Earth moves through the aether at $30\,\mathrm{kms}^{-1}$, respectively; column (8), gives the experimentally measured fringe shift, and lastly; column (9 & 10), gives the measured speed of the Earth in the luminiferous aether from the Galilean calibration and the Absolute Relativistic Calibration method respectively. This table is reworked from the table of Stankland *et al.* (1955). We assume $\lambda_{yellow} = 5.75\times10^{-7}\,\mathrm{m}$, and that at Standard Temperature and Pressure (STP) $n_{\mathrm{air}} = 1.000290$ and $n_{\mathrm{helium}} = 1.000036$.

	Experimenter(s)		**Year(s)**	**Medium**	L (m)	$\delta A_m^{gc}(30)$ $(1f)$	$\delta A_m^{arc}(30)$ $(1f)$	δA_m^{obs} $(1f)$	V_{gc} (kms^{-1})	V_{arc} (kms^{-1})
(1)	Michelson & Morley	[37]	1887	AM	11.00	0.40	0.000232	0.010000	4.83	201
(2)	Morley & Miller	[32, 33]	1902 – 4	AM	32.20	1.13	0.000655	0.015000	3.47	144
(3)	Miller	[24]	1921	AM	32.00	1.12	0.000649	0.080000	8.04	333
(4)	Miller	[24]	1923 – 4	AM	32.00	1.12	0.000649	0.080000	8.04	333
(5)	Miller	[24, 25]	1925 – 6	AM	32.00	1.12	0.000649	0.088000	8.43	349
(6)	Kennedy	[23]	1926	AM	2.00	0.07	0.000041	0.002000	5.08	211
(7)	Illingworth	[15]	1927	HM	2.00	0.07	0.000005	0.000400	2.27	267
(8)	Piccard & Stahel	[42]	1927	AM	2.80	0.13	0.000075	0.006000	7.44	308
(9)	Michelson *et al*	[36]	1929	AM	25.90	0.90	0.000522	0.010000	3.16	131
(10)	Joos	[16]	1930	HM	21.00	0.75	0.000054	0.002000	1.57	184

$$V = \frac{v'+v}{1+v'v/c^2}. \qquad (12)$$

From this formula, what we seek is the Fresnel-drag formula. With the advent of Einstein's STR, Fresnel's equation which explains very well the motion of light in a moving medium of refractive index greater than one, it was shown from (37) by Max Theodor Felix *von* Laue $(1879-1960)$ in 1907 to be just an approximation, valid for v much smaller than c, for the relativistic formula to add the co-linear velocities v (medium) and $v' = c/n$ (rest frame) and for the speed of light $c \longmapsto c' = c/n$ from this we have:

$$\tilde{c}_a = \frac{\tilde{c}+v}{1+\tilde{c}v/\tilde{c}^2} \simeq \frac{c}{n} + \underbrace{\left(1-\frac{1}{n^2}\right)v}_{\textbf{Fresnel Drag}}. \qquad (13)$$

$$\tilde{c}_{a\parallel} = \frac{c}{n} \quad \text{and} \quad \tilde{c}_{a\perp} = \frac{c}{n} + \left(1-\frac{1}{n^2}\right)v. \qquad (14)$$

In our calculation, we shall neglect Fresnel dragging on the assumption that for the scenario under consideration, its effect is negligibly small, so we will have $\tilde{c}_a = c/n$. Now, for the transverse arm, we have:

$$\left(\frac{(\tilde{c}_{a\perp}\cos\theta)\Delta t_\perp}{2}\right)^2 = L_\perp^2 + \left(\frac{v\Delta t_\perp}{2}\right)^2. \qquad (15)$$

For non-relativistic speeds $\cos\theta \sim 1$, thus, taking this approximation into account and re-arranging the resultant expression so as to make $\Delta t_\perp$ the subject to the formula, one obtains:

$$\Delta t_\perp = \frac{2L_\perp}{\tilde{c}_{a\perp}}\left(1-\frac{v^2}{\tilde{c}_{a\perp}^2}\right)^{-\frac{1}{2}} = \frac{2nL_\perp}{c}\left(1-\frac{n^2v^2}{c^2}\right)^{-\frac{1}{2}}. \qquad (16)$$

Notice something here; the above derivation assumes that the interferometer carries with it the light beam *i.e.*, it drags is along with. According to the extended second postulate, or the second postulate if the STR-AS, this is correct, because it is only in the vacuum mode that the interferometer will not drag the light beam. This is something that differentiates Cahill's re-calibration from ours and this can and must be used as a tool to find out if Cahill's *Process Physic*s and the STR-AS are perhaps one and the same thing. If they make the same predication, then, it would be interesting phenomenon, they may just be different ways of looking at the same thing like Schrödinger's wave mechanics and Heisenberg's matrix mechanics.

Now, for the parallel arm, we will have for the first part of the trip of the light beam to the mirror:

$$\tilde{c}_{a\parallel}^{+}t_\parallel^{+} = L_\parallel\sqrt{1-\frac{v^2}{c^2}} + vt_\parallel^{+}, \qquad (17)$$

and for the return trip, we will have:

$$\tilde{c}_{a\|}^{-}t_{\|}^{-}=L_{\|}\sqrt{1-\frac{v^2}{c^2}}-vt_{\|}^{-}, \tag{18}$$

and the total time $\Delta t_{\|}$ in the arm #1 is $\Delta t_{\|}=t_{\|}^{+}+t_{\|}^{-}$, *i.e.*:

$$\Delta t_{\|}=\frac{L_{\|}}{c}\left(\frac{1}{\tilde{c}_{a\|}^{+}/c}\frac{1}{1-v/\tilde{c}_{a\|}^{+}}+\frac{1}{\tilde{c}_{a\|}^{-}/c}\frac{1}{1+v/\tilde{c}_{a\|}^{-}}\right)\sqrt{1-\frac{v^2}{c^2}}. \tag{19}$$

Fringe Shift for Low Refractive Index Medium

Now, to first order approximation and for low refractive index medium *i.e.* $n\longmapsto 1$, equation (19) reduces to:

$$\Delta t_{\|}=\frac{2nL_{\|}}{c}\left(1-\frac{v^2}{c^2}\right)^{\frac{1}{2}}\left(1-\frac{n^2v^2}{c^2}\right)^{-1}, \tag{20}$$

The time difference $\Delta t=t_{\|}-t_{\perp}$ in the two times of travel is such that:

$$\Delta t=\frac{2nL_{\|}}{c}\left(1-\frac{v^2}{c^2}\right)^{\frac{1}{2}}\left(1-\frac{n^2v^2}{c^2}\right)^{-1}-\frac{2nL_{\perp}}{c}\left(1-\frac{n^2v^2}{c^2}\right)^{-\frac{1}{2}}. \tag{21}$$

and if $L_{\|}=L_{\perp}=L$ as is the case with the design of interferometers, then:

$$\Delta t=\frac{2nL}{c}\left(1-\frac{n^2v^2}{c^2}\right)^{-\frac{1}{2}}\left[\left(1-\frac{v^2}{c^2}\right)^{\frac{1}{2}}\left(1-\frac{n^2v^2}{c^2}\right)^{-\frac{1}{2}}-1\right]. \tag{22}$$

Now, taking only terms up to first order approximation in terms of v^2/c^2, one will arrive at:

$$\Delta t=n(n^2-1)\left(\frac{v^2}{c^2}\right)\frac{L}{c}. \tag{23}$$

As in the original MME, a 90° rotation will result in the fringe shift:

$$\delta A_{\mathrm{m}}=\frac{2\left(n^2-1\right)L}{\lambda}\left(\frac{v^2}{c^2}\right)\quad\text{for }\ n>1. \tag{24}$$

Equation (24) is the first major result of our entire work as this formula submits our ideas to the test of experience for low refractive index medium. At this point we should hasten to say that one hundred and twenty one years after the MME was performed, from a *Process Physics* vantage point, it is Cahill [5] in 2002 who was the first to arrive at the above result (24). Using this result, Cahill has interpreted the famous 1979 Brillet-Hall Experiment [1] which was performed in vacuum and is said to have detected no absolute motion, to mean the supposed null result is because for the vacuum $n=1$. From (24), clearly, if $n=1$, it follows that $\delta A_{\mathrm{m}}=0$, *i.e.* no fringe shift should register, hence absolute motion is not expected to be detected as is the case in the famous 1979 Brillet-Hall Experiment [1].

Actually, for the vacuum mode MME as in the case of the 1979 Brillet-Hall Experiment, the two beams do not recombine but are spatially separated and the fringe pattern is as a result of this separation of the two beams and the best way to deduce absolute motion is by measuring the fringe separation and using the Young's slit technique to deduce the speed of the Earth *via* the luminiferous aether.

Table ((1)) is a demonstration of equation (24) at work. On average, the Galilean calibration detects absolute motion of magnitude $5.00\pm 3.00\,\mathrm{kms}^{-1}$ which falls far short of either the $30\,\mathrm{kms}^{-1}$ and $250\,\mathrm{kms}^{-1}$ speed of the Earth around the Sun and the galactic center respectively, while the calibration done using (24) (lets call this calibration the absolute relativistic calibration), give an average absolute motion of $240\pm 80\,\mathrm{kms}^{-1}$. It is clear from this table that the expected fringe shift from the absolute relativistic calibration considering the motion of the Earth about the Sun and the Sun about the galactic centre are comparable to the detected fringe shift. It is seen again from this table that the Helium-mode MMEs produce absolute motion that us comparable to that obtained from Air-mode MMEs.

From all what has been presented in this section, it is therefore clear that using the Galilean calibration as done by Michelson and Morley, *prima facie*, one arrives at the conclusion that absolute motion does not exist because the from resulting fringe shift, what one expects is far too large in comparison to what one actually measures but with the correct calibration, the conclusion is clear, absolute motion is detectable.

Fringe Shift for High Refractive Index Medium

Now, to first order approximation and for high refractive index medium *i.e.* $n\gg 1$, equation (19) reduces to:

$$\Delta t_{\|}=\frac{2nL_{\|}}{c}\left(1-\frac{(3n^2-1)}{n^2}\frac{v^2}{c^2}\right), \tag{25}$$

The time difference $\Delta t=t_{\|}-t_{\perp}$ in the two times of travel for $L_{\|}=L_{\perp}=L$, is such that:

$$\Delta t=\frac{2nL}{c}\left(\frac{n^4-6n^2-6}{2n^2}\right)\frac{v^2}{c^2}\sim\frac{n^2L}{c}\frac{v^2}{c^2} \tag{26}$$

$$\delta A_{\mathrm{m}}=\frac{2nL}{\lambda}\left(\frac{v^2}{c^2}\right)\quad\text{for }\ n\gg 1. \tag{27}$$

Again as is the case with equation (24), equation (27) is the second major result of our entire work as this formula submits our ideas to the test of experience for high refractive index medium.

3.2. Vacuum-mode MME

We are now going to consider the MME under vacuum conditions. As proposed in Paper III, in a vacuum, light (photon) does not acquire a component of the motion of the body from which it detaches from. If this assertion about the behaviour of light in vacuum is correct, then, what this means is that, in vacuum-mode MMEs that have been performed to-date, what has be sent to the detector *via* the one slit of the detector's telescope is one of the two beams (*i.e.*, the returning beam reflected at M_2) as the other beam would be blocked by the walls of the telescope since there is only one opening. The two beams are distance $d = v\Delta t_{\parallel}$ apart.

Since in a vacuum – according to the STRAS, light will travel at a speed c, it follows that $c\Delta t_{\parallel}^{+} = L\sqrt{1 - v^2/c^2} + v\Delta t_{\parallel}^{+}$ and $c\Delta t_{\parallel}^{-} = L\sqrt{1 - v^2/c^2} - v\Delta t_{\parallel}^{-}$, and hence $\Delta t_{\parallel} = \Delta t_{\parallel}^{+} + \Delta t_{\parallel}^{-} = 2L(1 - v^2/c^2)^{-\frac{1}{2}}/c$ and given that $d = v\Delta t_{\parallel}$, it follows that to second approximation in terms of v/c, that:

$$d = 2\left(\frac{v}{c}\right) L. \tag{28}$$

What this means is that if the slits are a distance d-apart as given by (28), then, the two beams will undergo a double-slit-type interference as happens in the famous Young's Double Slit Experiment (YDSE). We know from the YDSE, that the fringe separation δy is related to, d, the wavelength λ and the distance D of the slits and the screen, by the relationship $\delta y = \lambda D/d$. From this simple relationship, it follows that the fringe separation will be a direct measure of the speed v of the MME apparatus in the aether medium. That is to say:

$$v = \frac{1}{2}\left(\frac{D}{L}\right)\left(\frac{\lambda}{\delta y}\right) c \tag{29}$$

This is a clear and testable prediction of the validity of the STRAS thus forms the frosty nursery for its possible falsification. In a normal MME in gas-mode, one obtains as shown in figure **??**, annular shaped rings in the fringe pattern whereas in the YDSE, one obtains parallel fringes for as long as the two parallel beams make it past the two slits. What this means is that in the vacuum-mode MME, we have to pass the light coming from the mirrors through a grating of with the appropriating grating-space. One must know forehand the required grating-space.

The question or "trouble" is that, since v is unknown, one can not know forehand the appropriate grating-space. This requirement might appear like a hindrance, but what we can do it to for the grating's resolution. For example, from (28), the resolving power R of the grating is such that $R = d/L/v$ that is, for a grating-space d for every unit arm of the interferometer, this grating will be able to detect a speed change of v. If we know a detector that can resolve $1\,\mathrm{kms}^{-1}$ for every unit length of arm of the interferometer, then, our grating space should be $\sim 6.66\mu\mathrm{m}$. We do not know about the practicability and feasibility of making such a diffraction grating, but if it can be made, then, we can with a great degree of confidence say that it will be able to measure speed changes and as-well the speed of the MME apparatus to within an accuracy of $1\,\mathrm{kms}^{-1}$.

4. Contrast and Comparison with *Process Physics*

The MME results to be expected from the STRAS for low refractive index medium as predicted by (24) are congruent to those of *Process Physics* being championed by Professor Reginald T. Cahill (of the Flinders University in Australia) and his collaborators [3] . This may lead one to the conclusion that the present endeavour may be a subset of *Process Physics* or *vise-versa* or that the present discovery of (24) is not original and independent. As we shall argue below, we strongly believe not only are our endeavours original, but that they are wholly independent of Professor Cahill & Kitto's 2002[5] discovery of (24) *via* a *Process Physics* approach.

5. General Discussion

One hundred and sixteen years latter ($i.e.$, $1887 - 2003$), it strongly appears that the 1887 result of Michelson and Michelson which appeared to have found a safe, unshakable, and permanent place in physics textbooks is under serious scrutiny, the jury is all out [*cf.* 18, 5, 6, 4, 8, 9, 10, 26], this time with greater determination to overturn the tables and thereafter delivering what appears to be an "*everlasting and eternal judgement*". The aether may "*not be dead after all*".

At this point, we must hasten to say – that, it strongly appears that Maxwell [21], Lorentz [20, 19] and other early proponents of the luminiferous aether stand to be vindicated, while Einstein and the legion of anti-aether advocates may find themselves under the pile and weight of the sands of Einstein's Philosophy of Relativity. A new understanding has dawned and experience is pointing in the direction of an overhaul of the more than century old dogma that absolute space and absolute motion are superfluous. It is interesting to see how physics will develop in the 21^{st} century.

With the new re-calibration methods of Professor Cahill & Kitto [6] and as-well the one proposed in the present work, one can safely say that the first ten to fifteen years of the 21^{st} century are witnessing a clandestine resurgence of the aether which for most of the past century, have been kept tightly under the lid. A popular resurgence of the aether strongly appears eminent. Professor Cahill & Kitto [5]'s re-calibration of the Michelson interferometer appears to be the key to finally fathom the fringe shift of the MMEs. With this re-calibration of the MME, the stirring agreement of the results thereof with the COBE measurements is most certainly reassuring. The results of Smooth *et al.* [45] are not interferometric in nature, hence it is completely independent in nature, just as Torr & Kolen [46]'s results of the detection of absolute motion are independent confirmation of absolute motion.

As how to look at the STR in the advent of the aether, after a ponderous introspection of the supposedly resolved twin paradox, we have provided – in our modest view; a way to do so *via* the new Lorentz transformations in Paper III. These transformations are built on the idea that, relative to the absolute frame of reference – *i.e.*, the luminiferous aether frame; the velocity of light (*i.e.* its speed plus its direction) is the same for all inertial observers. Because of this, all observers can determine their state of motion relative to the absolute space. Phenomenologically and empirically, the resultant theory is the same as Einstein's STR – less the philosophy that absolute space and motion are superfluous; it is the STR in absolute space where absolute motion is real and measurable.

With the proposed STR with absolute space and motion, the null result of the vacuum mode MMEs is understandable. Cahil understands this null result as being due to the fact that the refractive index of the vacuum is unity, and from his recalibration, the null result follows. We hold a different view here. The null result is due the reuniting light beams in the MME being spatially separated. This spatial separation leads to a new calibration, that absolute motions for vacuum mode MMEs can be deduced by using the Young's double split technique to measure the speed of the Earth in the luminiferous aether. This provides an independent test since the calibrations form the vacuum mode and the gas mode MME will here be very different. Obtaining compatible results from different calibrations will be the clearest indication yet, that sure, the aether is real, it is here to stay. Also, we have provided the idea of the aether speedometer. This is yet another method for an independent verification. Thus we have three methods (with independent calibrations) to measure absolute motion and all these must be employed.

Professor Cahill *&* Kitto [6] derive their re-calibration from the new quantum physics of *Process Physics**. We should admit our ignorance here. We have not any clue what this *Process Physics* is all about, besides that it does give a plausible re-calibration of the MME. On that footing, we should also state that Professor Cahill *&* Kitto [6]'s re-calibration emerges as natural consequence of the proposed STR-AS. If Professor Cahill *&* Kitto [6]'s physics is different from the physics that is to emerge in our proposed STRAS, then, the prediction from the STR-AS that the fringe separation of the vacuum mode MME – *via* the Young Double's Slit Technique; are a measure of absolute motion, is a prediction that may separate *Process Physics* and the STRAS. It is interesting question to ask: "With respect to the measurement of absolute motion, what meaning does *Process Physics* give to the fringe separation for the vacuum mode MME?"

To different researchers, the aether has different meanings and names. The quantum field theorists calls it the fixed Minkowski background of spacetime. Some cosmologists *e.g.* Niayesh [27] trying to fathom the supposed acceleration expansion of the Universe call it the gravitational aether (*e.g.* Xiao-Mei *&* Yi [48]; Zlosnik *et al.* [49]) or darkenergy. Some quantum theorists prefare the term the invisible Dirac sea. The aether is called by the many different names. Perhaps it is time for physicists to converge – as they did at the legendary Slovary conference of 1927; and give serious thought to the seemingly undeniable hard experimental results that the aether exists in the true sence of the word exist, it is measurable.

On the same footing but different trajectory, we note that together with its accompanying philosophy, Einstein's STR has received the greatest accolades in the popular media; and in most if not all modern textbooks of physics, these theories are presented as a *touch-and-go* works, as being so sacrosanct; behind the scenes as demonstrated herein, there is an ever growing chorus that Einstein's Philosophy of Relativity has caused a more than 100-year stagnation in physics [2] because any attempt in the mainstream journals to suggest ideas that go contrary to Einstein receives not just a stonewall but a double if not triple rock-wall defense so much that many physicists feel frustrated and it appears physics may well have landed into a crisis (see *e.g.* Hu [14]; Castro *et al.* [7]; Rabounski [29]; Smolin [31]; Woit [47] amongst many others).

One would understand the rejection of ideas that challenge central tenets of physics, especially if they have no experimental basis, but, to reject and conceal experimental results simple because they go against a physics dogma is not science but something else other than science. Science concerns itself with measurable results and thus; no matter our feelings, no matter our influence in this World, experimental results are verdicative and final, experimental results have the last word. Faced with the ruthless wrath of experimental evidence, we but have just two choices, to accept the results or to accept the results – for nothing can go against results that have been measured âĂŞ the experiment has spoken.

In the year of the centenary of Einstein's STR and on the occasion of the centenary celebrations of Einstein's miracle year of 1905, Professor Cahill [2] had this to say:

> *"The Einstein postulates were first formulated in* 1905 *and have played a fundamental role in limiting the form of subsequent physical theories, and in also defining our comprehension of reality. They lead to the concept of spacetime, and that a curved spacetime explained gravity. They also lead physicists to reject any evidence that was revealing that the postulates were in disagreement with experimental data. In physics they have become a vigorously defended belief system, and any discussion of the numerous experiments that indicate their failure is banned."*

6. Conclusion

In closing, allows us to say this: that, in the present moments in humankind's quest for understanding of *Nature*, real progress in fundamental physics appears to be stalled. We believe the

* See *e.g.* http://www.mountainman.com.au/process_physics/

twin pillars of this stagnation are due to Einstein's all-sweeping dismissal of absolute space and hence absolute motion as mere superfluous, and again the great Danish physicist Niels Bohr's all-sweeping dismissal of the existence of an objective reality. Undoubtedly, the philosophies of Einstein and Bohr have had enormous influence in physics over the past 90 years or so. We believe that once the physicist has overcome these twin pillars of stagnation, real progress in fundamental physics will begin to take place. The unification of quantum mechanics with Einstein's GTR, the apparent acceleration of the Universe, the rotation curves of galaxies – but to mention a few; are all calling for Lazarus to raise from the dead. Shall the coming-back to life of the dead destroy the present? We believe not. We believe our philosophical interpretation of facts is what is set to change. For example, having something like: Special Theory of Relativity in Absolute Space and a Probabilistic Quantum Mechanics with an Objective Reality.

7. Recommendations

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