THE AETHER

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Abstract

The existence of the electromagnetic aether is argued from two standpoints. Conceptual, based on the nature of physical waves. And practical: the various experimental measurements that demonstrate it. Possible reasons for the strange nullification of the 1887 Michelson-Morley aether-wind result are discussed.

CONTENTS

Preamble

To leave the main body of the text as uncluttered as possible, cross-references and 'asides' are placed in footnotes. The end-notes contain source references only. In the Internet case they comprise the main site name, with year and month of access in brackets.

Contrary to custom, quotations in general are not *de rigeur* with all the (...)s and [...]s in the right places. They may be abridged, or combined with others from the same source. But their meaning is never consciously distorted. Whenever possible, the original source reference is given.

Since the English language in its wisdom does not provide non-gender-specific pronouns, for "he", etc. in general read "he/she" etc.

Due to the common ground between this and the companion 'Einstein' article[1], there is some repetition.

Thanks are due principally to Barry Cavell and Stan Heshka, who read the original text and made many useful comments, most of which got incorporated. Also to Nick Landell-Mills and Arthur Mather who likewise gave valuable feedback.

INTRODUCTION

'Aether'

The "aether" today is effectively a scientific verbal obscenity, the "unspeakable ae-word" that no professional physicist shall be heard to utter on pain of being branded a deranged crackpot and saying goodbye to his hopes of a successful career:

> "The concept of an aether was long ago discarded as a relic of 19th century voodoo science."[a][2]

Robert Laughlin[b]:

> "The word 'aether' has extremely negative connotations in theoretical physics, due to its opposition to Relativity. This is ironic, because it nicely captures the way most physicists think about a vacuum[c]."[3].

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[a] This would include the likes of James Clerk Maxwell.

[b] Robert Laughlin (1950-) of Stanford University, physics Nobel Laureate.

[c] 'Vacuum' = "devoid of matter". But not necessarily devoid of non-material (non-matter-ial) things. For "vacuum" in general read "aether".

It nevertheless has a long and distinguished pedigree. The word derives from the Sanskrit *akasha*, which can also simply mean 'space'. References to it are common in Greek, Egyptian and Indian philosophy from the 5th century b.c. onwards. It was conceived as the material filling the 'aethereal' region above the terrestrial sphere, being described as:

> "The most subtle substance in creation, the mother of all other phenomena."[4]

Homer[5] uses it in the sense of "fresh air" or "clear sky", the pure essence breathed by the gods[6]. Anaxagoras[a] speculated that atoms[b] are vortexes in the aether; an idea that was taken up in modern times by Lord Kelvin[c7].

In the medieval cosmos the innermost terrestrial sphere was made up[d] of the four classical elements: fire, earth, air and water. And the outer celestial sphere containing the heavenly bodies was "quintessence" (the '5th essence'), effectively the aether.

Light

In the early scientific era of the 17th century there were two conflicting theories of light. Based on its properties of reflection and travelling in straight lines, Isaac Newton[e] held it to be a *stream of particles*. This did not, however, explain optical *dispersion*, where a beam of white light is split up by a glass prism into a rainbow of colours. Nor *diffraction*, where light passing a small hole or narrow slit causes fringes on a screen.

Both of these are consistent with the *wave model* proposed Christian Huygens[f]. That light has a *characteristic speed c* and a *frequency f* are further wave properties.

Waves in general require a *medium*. Huygens therefore propounded a corresponding l*uminiferous aether*, conceived at the time as essentially homogenous and stationary in space.

Mainly due to his greater prestige, Newton's corpuscular theory held sway for more than 100 years. Max Planck[g] spoke of Huygens as "having dared to contest the mighty emission theory of Sir Isaac Newton"[8]. In fact, however, the corpuscular theory wasn't even "Sir Isaac's". It was first formulated in the 10th century by the Arab polymath Ibn al-Haytham[h], who wrote in his "*Book of Optics*":

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[a] Anaxagoras (~500-428 b.c), pre-Socratic Greek philosopher.

[b] For the likewise pre-Socratic Greek philosopher Democritus (460-370 b.c.), atoms were the hypothetical invisible smallest components of all matter.

[c] Lord Kelvin (William Thompson) (1824-1907), Irish mathematician and physicist.

[d] Conceived as made.

[e] Isaac Newton (1642-1727), English physicist.

[f] Christian Huygens (1629-1695), Dutch physicist.

[g] Max Planck (1858–1947), German physicist.

[h] Ibn al-Haytham (965–1040), Arab mathematician and astronomer. .

> "Light rays are streams of minute particles, lacking all sensible qualities except energy."[9]

This is essentially the modern concept of a photon.

But then in 1803 the English physician Thomas Young[a] performed his famous *double-slit experiment* demonstrating the *interference property* of light. This being explicable in wave, but not in particle terms, after that the corpuscular theory started to go out of fashion. By the mid 1800's it had been generally abandoned in favour of a wave model.

And when in 1865 James Maxwell[b] calculated from the electric and magnetic properties of a vacuum[c] that electromagnetic waves should travel through it at the known speed of light, namely 300k km/s, its ondulatory nature was generally accepted. As was then likewise the existence of its medium the luminiferous aether.

It is interesting that Newton at one point cogitated an aether, writing in his 1704 *Opticks*:

> "Is not the heat of a warm room convey'd through a vacuum by the vibrations of a much subtiler medium than air, which remained after the air was drawn out? And is not this medium the same as that by which light is refracted and reflected?"[10]

He however then apparently had second thoughts, arguing that:

> "Such a medium would have to extend everywhere in space, and would disturb and retard the motions of the planets and comets. So there is no evidence for its existence, and it ought to be rejected."[11]

Newton seems to have conceived the aether in *mechanical* terms. Whereas in fact it is purely *electromagnetic*, with electric and magnetic but no mechanical properties[d].

That light travels at a *finite speed* was first proposed by the Greek philosopher Empedocles[e], who held that the Sun's rays take time to reach the Earth. The earliest quantitative measurement was made in 1676 by the Danish astronomer Ole Römer[f], based on the eclipses of Jupiter's moons. His value of 200k[g] km/s was too low, due his taking the time light takes to cross the Earth's orbit as 22 min rather than the true 16 min. Correcting for this gives 275k km/s, close to the actual 300k km/s.

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[a] Thomas Young (1773–1829), English physician and polymath.

[b] James Maxwell (1831–1879), Scottish physicist.

[c] p.2, note.

[d] Density, etc. Below.

[e] Empedocles (490-430 b.c.), pre-Socratic Greek philosopher.

[f] Ole Römer (1644–1710), Danish astronomer.

[g] 'k' = thousand.

Einstein

Contrary to what is often believed, Einstein[a] was a strong supporter of the aether. He somewhat half-heartedly rejected it in his 1905 Special Relativity paper, writing:

"The introduction of a 'luminiferous aether' will prove to be superfluous."[12]

But then in his 1920 Leiden address he resoundingly brought it back again:

"Recapitulating, we may say that according to the General Theory of Relativity space is endowed with physical qualities. In this sense there exists an aether. Space without an aether is unthinkable. Not only would there be no propagation of light, but also no standards of space and time."[13]

Evidently contradicting his previous statement. But Albert was no stranger to contradiction.

CONCEPTUAL

Waves

Experimentally, light behaves both as waves and as particles – the so-called *wave-particle duality*. For present purposes its wave behaviour is of most interest.

A wave[b] is not itself a material object. It is an *event*, a time-dependent *disturbance* propagating through a physical *medium* at a *characteristic speed c* determined by the properties of that medium:

wave = disturbance propagating through a medium

When one throws a pebble into a pond, the disturbance spreads out as ripples propagating over its surface at a characteristic speed determined by the properties of the water medium. The same holds for *sea waves*, Fig. 1a[c], the disturbance here being caused by the wind.
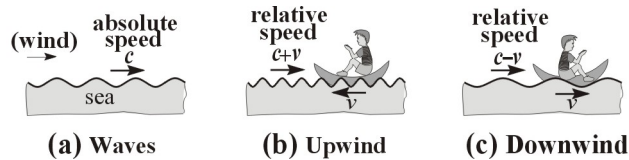

(a) Waves   **(b) Upwind**   **(c) Downwind**

Fig. 1. Sea waves.

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[a] Albert Einstein (1879–1955), German theoretical physicist.

[b] Here always *physical waves* – as opposed to the mathematical variety.

[c] 'Absolute' = with respect to the Earth's surface.

For a boat sailing upwind at speed v though the water, Fig. 1b, the velocity of the waves relative to it is the sum of the two velocities $c+v$. When the boat sails downwind, Fig. 1c, the waves overtake it at the difference of the two speeds $c–v$.

The same applies to *sound waves*, pressure disturbances travelling through the air medium at a characteristic speed c=1240 km/h determined by its properties[a], Fig. 2a.
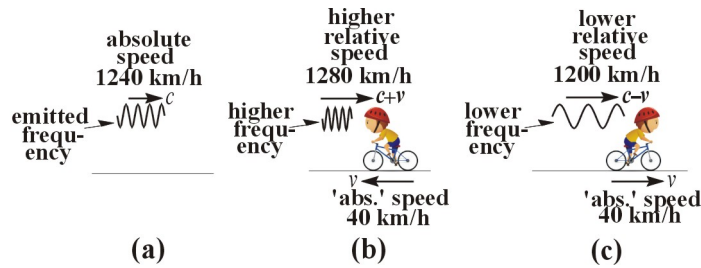

Fig. 2. Sound waves.

When a cyclist pedals at speed v=40 km/h in the opposite direction to the sound waves, Fig. 2b[b], their speed relative to him is the sum of the two speeds $c+v$=1280 km/h. He experiences them as 'bunched up', with a higher frequency than if he were at rest[c] – the so-called *Doeppler effect*[d].

Conversely, when pedalling in the same direction as the sound waves, Fig. 2c, they overtake him at the difference of the two speeds $c–v$=1200 km/h. He here experiences them as 'spread out', with a lower frequency than if he was at rest[e].

And if one takes a length of rope and shakes one end up and down, Fig. 3, *rope waves* travel down it at a speed determined by the mechanical properties of the rope medium; and so on.
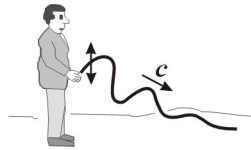

Fig. 3. Rope waves.

The idea of waves without a medium – pond or sea waves without water, sound waves without air, rope waves without a rope, light waves without a corresponding

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[a] Its density and compressibility (below).

[b] Assuming no wind.

[c] Fig. 1b.

[d] When standing beside a motorway, the sound frequency of approaching cars is higher than that of receding ones, and falls abruptly as they pass one.

[e] Fig. 1c.

luminiferous aether[a] – is nonsensical[b]. A wave is a *disturbance*, and for there to be a disturbance *something* (some physical thing) has to be disturbed. In the humdrum everyday world we live in, there can be no smile on the face of a Cheshire cat without a Cheshire cat.

Maxwell noted that:

> "Whenever energy is transmitted from one body to another, there must be a medium, or substance, in which the energy exists after it leaves one body and before it reaches the other".[14]

Albert Michelson[c]:

> "The undulatory theory of light assumes the existence of a medium, the aether, whose vibrations produce heat and light, and which is supposed to fill all space."[15]

Paul Dirac[d]:

> "It is natural to regard light as the velocity of some real physical thing[e]. So we are forced to have an aether".[16]

John Bell[f]:

> "The aether was wrongly rejected on the purely philosophical grounds that what is unobservable does not exist"[g][17].

Michelson also openly rejected Einstein's Relativity[h] on the grounds that:

> "It does not account for the transmission of light, but holds that the aether should be thrown overboard"[18]

Characteristic speeds

The characteristic speed *c* of sound waves through the air is given by:

$$c = \sqrt{\tfrac{1}{\rho \varepsilon}} = 1240 \text{ km/h}$$

(eq.1)

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[a] Defined for present purposes as "that which light is conceived as a disturbance propagating through".

[b] 'Non-' + 'sensical' = doesn't make sense.

[c] Albert Michelson (1852-1931), American physicist of 'Michelson-Morley' fame (below).

[d] Paul Dirac (1902-1984), English theoretical physicist.

[e] Cf p.2, note.

[f] John Bell (1928–1990), Irish quantum physicist, in a 1951 interview.

[g] QM article.

[h] According to Thomas See (1866-1962), American astronomer.

where ρ, ε are the density and elasticity[a] respectively of the air medium.

Similarly, the characteristic speed *c* of light through a vacuum is:

$$c = \sqrt{\tfrac{1}{\rho\varepsilon}} = 1240 \text{ km/h}$$

(eq.2)

where μ, ε are its magnetic permeability and electrical permittivity.

Magnetic permeability μ being associated with electrical inductance, it is effectively 'electric inertia'[b]. Electrical permittivity ε being associated with electrical capacitance, it is effectively 'electric elasticity'[c].

The mathematical expressions for the characteristic speeds of light and sound[d] are thus *exactly analogous*. Again strongly suggesting that they both refer to essentially the same phenomenon, namely the propagation of a physical disturbance through a physical medium.

And if – as Relativity maintains – light is a "mediumless wonder", a disturbance of nothing propagating through nothing, then the questions it has to answer are:

– 1) *what determines* light's characteristic speed *c*=300k km/s?
– 2) is it *a mere coincidence* that this is exactly the speed one would expect of an electromagnetic disturbance propagating though a medium with the electric and magnetic properties of a vacuum[e][19]

These are both excellent questions, to which Relativity to date has provided no coherent answers.

EXPERIMENTAL (1)

Michelson

A good starting point for the experimental evidence for the aether is the famous (some might say "infamous") *1887 aether-wind measurement* carried out by Albert Michelson and Edward Morley[f] at the Case School of Physics in Cleveland, USA.

Albert Michelson was born in Strelno, Prussia. When he was two his family emigrated to the USA where he grew up, firstly in small mining towns where his father was a

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[a] Or 'compressibility', the inverse of its bulk modulus K_s.

[b] Applying a force to a mass, the motion takes time to build up. Applying a voltage (electrical force) to an inductor, the current (electrical motion) takes time to build up.

[c] Applying a force to a spring, it at first cedes, but then builds up an opposing force. Applying a voltage (electrical force) to a capacitor, it at first cedes, but then builds up an opposing voltage.

[d] Eqs.1,2.

[e] Aether (p.2, note).

[f] Edward Morley (1838–1923), American physicist.

merchant. And then for his high school years in San Francisco where he lived with an aunt.

Fig. 4. Albert Michelson.

As an academically outstanding, but financially impoverished student, in 1869 Michelson was awarded a special appointment to the U.S. Naval Academy by the US president Ulysses Grant. He excelled excelled in optics, heat, climatology and drawing. After graduation and a further two years at sea, in 1875 he returned to the Naval Academy to become an instructor in physics and chemistry.

Having decided to pursue a career in physics, in 1880 he obtained leave of absence from the Navy to study in Europe, spending time at universities in Berlin, Heidelberg and Paris. In 1881 he resigned from the Navy, and in the following year returned to the USA to take up an appointment as Professor of Physics at the Case Western Reserve University in Cleveland[20].

Michelson 1881

That light is essentially electromagnetic waves had been finally confirmed by Maxwell in 1864. Their existence was demonstrated experimentally by Heinrich Hertz in 1887.. Since waves require a medium, a hypothetical luminiferous aether, experiments to determine its properties had a high priority in 19th century physics.

Measurements of stellar aberration had led to two main theories. The first, formulated in 1818 by Augustin-Jean Fresnel[a], held that the aether is *essentially stationary in space*[b] – for practical purposes, within the solar system. In this case there should be a measurable *aether wind* of some 30 km/s, the Earth's orbital speed around the Sun, Fig. 0-5.

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[a] Augustin-Jean Fresnel (1788-1827), French civil engineer and physicist.

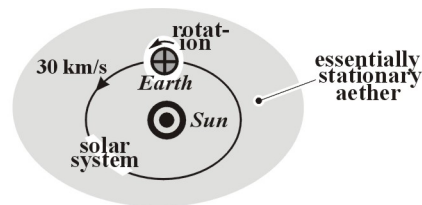[b] Or at the most, only partially dragged along by the Earth.

Fig. 0-5. Earth's orbit.

In 1844, however, George Stokes[a] put foreward the alternative theory of *aether entrainment*: that the aether is "dragged along" by Earth[21]. In which case there should be little or no detectable aether wind at the Earth's surface.

Michelson's experiments were designed to test for these two hypotheses. And not for the existence of the aether itself, which was virtually universally accepted by the physicists of his time. He wrote in the introduction to his 1887 report:

> "The experimental trial of the first [Fresnel] hypothesis forms the subject of the present paper".

The interferometer he used is shown schematically in Fig. 6a. A beam of light is split into 'main' and 'perpendicular paths, which are then recombined to form an interference pattern on a screen. An aether headwind on the main axis would make the average speed of light along it *slower* than on the perpendicular axis, resulting in a 'fringe shift', a displacement of the interference pattern, from which the aether speed can be calculated.
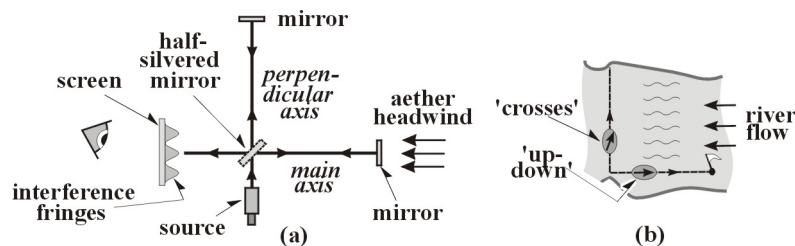

Fig. 6. Michelson-Morley (1).

An analogy is two twins swimming in a river, Fig. 6b. One, the 'crosses' twin, swims across the river and back again. Due to the river's flow he has to head upstream somewhat, and so takes longer than if the river were stationary.

His 'up-down' brother swims the same distance, but first upstream and then back down again. Because the time he loses on his upstream leg is not compensated by what he gains on his downstream leg, he ends up taking longer than his brother.

In interferometer terms, a slower light travel time on the main axis would then imply an aether wind.

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[a] George Stokes (1819-1903), Irish mathematician and physicist.

Michelson's first interferometer was designed and built in 1881, during his stay in Hermann von Helmholtz's[a] laboratory in Berlin. It is shown in Fig. 7.
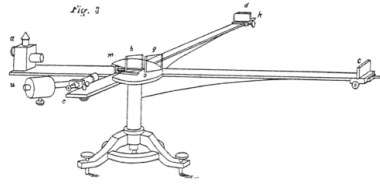

Fig. 7. Michelson's 1881 interferometer[22].

In spite of its being mounted on a solid stone pier, however, due to the instrument's extreme sensitivity to vibrations, it soon became apparent that it could not be used in a city like Berlin. It was therefore moved to the quieter grounds of the *Astrophysicalisches Observatorium* in Potsdam.

But even there, although under ordinary circumstances the fringe shifts were measurable, Michelson noted that:

"Stamping on the pavement 100 meters from the observatory could make the fringes disappear entirely!"[23]

Apart from which that was a series of other practical problems due to temperature variations, mechanical distortion of the arms during rotation, etc.

The aether speeds Michelson obtained with this instrument were considerably less than the 30 km/s expected on the Fresnel hypothesis. In view of this, and the considerable experimental uncertainties, he concluded that stationary-aether theory[b] could not be substantiated, reporting that :

"The interpretation of the results is that there is no displacement of the interference bands. The hypothesis of a stationary[c] aether is thus shown to be incorrect."[24]

The Stokes theory of complete aether dragging was thus implicitly confirmed.

Michelson-Morley 1887

In 1885 Lord Rayleigh[d] wrote to Michelson urging him to repeat his 1881 experiment with greater accuracy[25]. By now Professor of Physics at the Case School, Michelson accordingly began a collaboration with Edward Morley, Professor of Chemistry at the Western Reserve University situated on the same campus.

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[a] Hermann von Helmholtz (1821–1894), German physician and physicist.

[b] With no dragging.

[c] Within the solar system.

[d] Lord Rayleigh (John William Strutt) (1842-1919), English scientist.

The improved interferometer they created together is shown in Fig. 8. To minimize thermal and vibrational effects, it was assembled in the closed heavy stone basement of a Case school dormitory. Vibration was further reduced by mounting it on a large sand-stone block floating in a circular trough containing 275 kg of mercury. The sensitivity was improved by increasing the light path to ten times its previous value by repeated reflection.
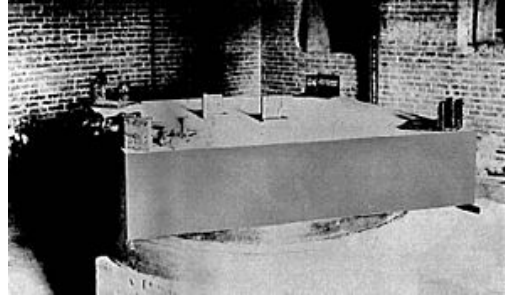

Fig. 8. Michelson's 1887 interferometer[26].

The mercury trough allowed the instrument to turn with close to zero friction. Given an initial push, it would rotate slowly for many minutes while the fringes were observed through a telescope. But even so, they could at times disappear completely due to distant thunderstorms, passing horse traffic, etc. And the observer could easily "get lost" when they returned[27].

A total of 36 sets observations were made over four days in July 1887, during an hour at noon and an hour at six o'clock in the evening[28]. In 1998 Héctor Múnera reanal-yzed the results using modern statistical methods. He found that they gave aether speeds of, at a 95% confidence level:

$$\text{– midday readings: } v_{e\in}{}^{a} = 6.22 +/- 1.86 \text{ km/s}$$
$$\text{– evening readings: } v_{e\in} = 6.8 +/- 4.98 \text{ km/s}[29]$$

They are plotted in Fig. 0-9. The somewhat higher value and the greater spread of the evening readings are explicable[b].

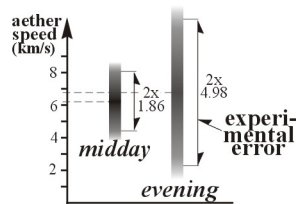[a] Using the subscripts 'e' for 'Earth' and '$\in$' for 'aether'.

[b] Below.

Fig. 0-9. Michelson-Morley results.

Compared to the 1881 experiment, the results were this time definitely positive. But since they were still well below the 30 km/s expected on the Fresnel stationary aether hypothesis, Michelson reported that:

> "The relative velocity of the Earth and the aether is probably less than one sixth of the Earth's orbital velocity[a], and certainly less than one fourth."[30]

In August 1887 he wrote to Lord Rayleigh saying:

> "The result is decidedly negative [for the Fresnel theory]. The deviation of the interference fringes from zero was not the expected. It follows that if the aether does slip past, the relative velocity is less than one sixth of the Earth's[b]."[31]

Michelson himself never questioned the aether's *existence*. But only the extent to which it is entrained by the Earth's motion. This is evident from the title of his two papers: "*The Relative Motion of the Earth and the Luminiferous Aether*". In spite of being a religious agnostic, he firmly believed in the aether to his dying day[32]. Obviously, since his own experiment had confirmed it.

Nullification (1)

In spite of Michelson-Morley's clearly positive aether-wind result[c], however, well outside the experimental error, it later:

> "Came to be said to be within the range of an experimental error that would allow it to be actually zero."[33]

This is the famous "null" result that is quoted in most physics textbooks. It made Michelson's "the most famous failed experiment in history"[34]. And gained for him a physics Nobel prize[d], the first American ever to receive one[35]. After this the aether went out of fashion.

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[a] Of 30 km/s.

[b] Ditto.

[c] Averaging the noon and evening readings: ~6.5 km/s (Fig. 0-9), .

[d] In 1907. "For his optical precision instruments".

As just seen, however, the Michelson-Morley result was *very definitely not zero*. And they themselves did not report it as such. So how could it have "come to be said" to be null within experimental error? Dayton Miller[a] commented in 1933:

> "The indicated effect was *not* zero. The conclusions published in 1887 stated that the observed relative motion of the Earth and aether did not exceed one fourth of the earth's orbital velocity. This is quite different from the null effect now so frequently imputed to this experiment."[36]

Anyway, just because something is less than expected, that doesn't make it "null". And since when have the experimenters' expectations been a valid criterion for judging a scientific experiment? To the contrary, Science purports to be open-minded and objective, and to proceed from experimental results to explanatory theories, and not vice-versa. And since when has "coming to be said" been an accepted part of scientific methodology?

In their final report M &M made the further important qualification that:

> "In what precedes the motion of the solar system is not considered[b]. The experiment will therefore be repeated at intervals of three months, and all uncertainty will be avoided. "[37]

This they unfortunately never did. Had they done so, the course of modern physics could well have been very different.

And even if Michelson-Morley *had* obtained a null result, as they themselves recognized, that wouldn't have established the aether's non-existence. But simply that its speed is zero at that particular point in the Earth's orbit.

Dayton Miller

In 1900 Morley was joined at the Case School by Dayton Miller. Together they increased the interferometer's sensitivity by extending the lengths of its arms[c] to three times the original values, and made various other improvements.

Fig. 10. Dayton Miller in 1921[38].

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[a] Dayton Miller (1866–1941), American physicist and astronomer.
[b] Above.
[c] The parallel and perpendicular paths, Fig. 6a

Measurements in 1905-6 in Cleveland gave the lower value of ~3.5 km/s[a][39]. Remembering, however, that very small '2nd order' differences[b][40] of around one part in a million[c] were being measured, and a certain variation was to be expected.

From 1906 onwards Miller continued experimenting alone. His most important work was done during 1925-6 on top of Mt Wilson in California at 1750 m above sea level. The idea was again to reduce the effect of any possible aether entrainment[d], the aether being dragged along by the Earth .

Fig. 0-11. Miller's Mt Wilson interferometer[41].

Miller made ~12'000 sets of observations[e], as opposed to Michelson-Morley's 36. And since he made them over the course of a year[f], he was able to eliminate the effects of the Earth's orbit and calculate the overall velocity[g] of the *solar system* through the aether. He obtained an aether velocity of[h]:

$$v_{s\in}{}^{i} = 8.22 \pm 1.39 \text{ km/s}$$

in an astronomical direction[j] (α =5.2, δ=−67°), towards the *Dorad*o (Swordfish) constellation in the Great Magellanic Cloud[42].

Because Michelson-Morley[a] had only measured the *projection* of the aether wind onto their interferometer plane at the respective point in the Earth's orbit, their speed was somewhat lower.

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[a] Although still definitely positive in terms of the range of experimental error.

[b] Due to the $(v/c)^2$ term in the Lorentz factor (eq.3, p.8). The Earth's true aether speed is around 0.1% of that of light (below).

[c] A difference of 10 cm in a journey of 100 km.

[d] p.10.

[e] Rotations of the interferometer.

[f] What M&M had recognized needed doing, but never did.

[g] Magnitude and direction.

[h] At a 95% confidence level.

[i] Solar system ('s') with respect to the aether ('$\in$').

[j] p.36.

Fig. 12a shows specimen Miller readings plotted against sidereal time[b]. And Fig. 12b,c his averaged overall results[43].
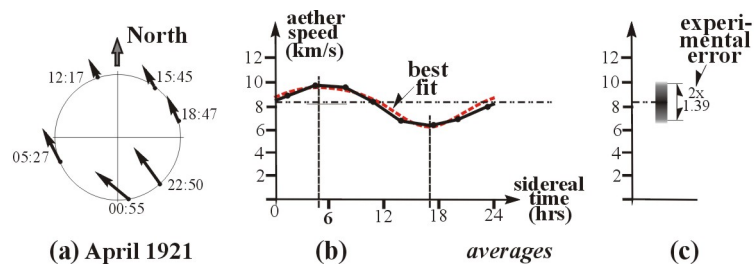

Fig. 12. Miller's results[44].

Miller had however by now realized that the aether speeds he was obtaining were far too low. Still assuming that this was due to aether entrainment, and using the Earth's orbital speed as a reference, he calculated that his measured aether speed of 8.22 km/s corresponded to a true speed of ~208 km/s[45]. We discuss this value later.

In 1929 Michelson, now together with Pease and Pearson, repeated his original 1887 experiment. Also on top of Mt Wilson, and with a larger interferometer[c] whose sensitivity approached that of Miller's. He reported:

"An aether-drift of some unspecified quantity, just under 20 km/sec."[d][46].

But in spite of this being *more than three times* his 1887 result, it was again attributed to experimental error. And when in 1932 Kennedy and Thorndike obtained the even higher 24 km/sec[47], they too dismissed it:

"In view of relative velocities amounting to thousands of kilometers per second existing among the nebulae, this can scarcely be regarded as other than a clear null result"[48]

This amazing statement is as if to say:

"I may weigh 180 kg. But in view of weights amounting to seven tons existing among elephants, this can scarcely be regarded as other than clearly lightweight."

So when Miller published his final results in 1933, they got little attention, since they fatally undermined Einsteinian Relativity, by then almost universally adopted by the mainstream physics establishment[a]:

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[a] Fig. 0-9.

[b] For solar and sidereal times, see the appendix p.40.

[c] With a 52-meter round-trip light path.

[d] Michelson seems to have been adverse to reporting exact numerical values! (Cf p.13.)

"Miller's findings remained uncomfortably in the scientific background, impossible to refute and equally impossible to accept."[49]

Miller, however, was no scientific lightweight. A Princeton physics graduate with a doctorate in astronomy, he headed the Case School physics department from 1893 until his retirement in 1936. He served as secretary, vice president and president of the *American Physical Society*. He was elected to the *National Academy of Science*. And was a member of the *US National Research Council*, becoming chairman of its Physical Sciences Division[50].

Apart from all of this, he was an exceptionally careful and rigorous experimenter[b] who during his lifetime successfully defended his results against all skeptics. In 1925 he was awarded $1000[c] by the prestigious *American Association for the Advancement of Science* for his detection of the aether[51] – something the scientific establishment subsequently declared not to exist!

If anyone deserved a fair hearing it was Miller. He didn't get it. Largely ignored and isolated in his later years, shortly before his death he gave all his data, more than 300 pages of interferometer readings, to his research associate Robert Shankland, with the somewhat bitter comment to "Analyze them or burn them"[52].

Shankland

After Miller died in 1941, Shankland became chairman of the Case School Physics Department. He did indeed "analyze" Miller's data. But the department having in the meantime "converted" to fundamentalist Einsteinism, his "analysis" had the express intention of discrediting his former boss's work.

After extensive consultation with Einstein, and in what has been called "One of the most perverse scientific papers ever published"[53], in 1955 Shankland et al. pronounced Miller's results to be worthless, attributing them to seasonal temperature effects[54].

The allegation was fatuous. Firstly because Miller had already exhaustively investigated and discarded this same possibility in a long series of control experiments[d] – something that Shankland as Miller's assistant at the time obviously knew well.

Secondly: if temperature was the cause, *daily variations* should produce analogous effects, which they didn't.

Thirdly, temperature variations being Sun-dependent, they vary with *solar time.* But Miller's results were functions of *sidereal time*[e]. And so on.

The so-called "analysis" wasn't even done by the paper's authors. But by a Case School graduate student, Robert Stearns, who got only a footnote credit.[55]

---

[a] Below.

[b] Cf the exerpt from his1925 report, appendix p.39.

[c] Worth a lot more then.

[d] p.39.

[e] Based on a direction in space with respect to the fixed stars, rather than the Sun (Fig. 12, appendix p.40.).

Shankland sent a pre-publication draft of his paper to Einstein, who wrote him a personal letter of appreciation:

> "I thank you very much for sending me your careful study of the Miller experiments, showing convincingly that the observed effect has nothing to do with an 'aether wind', but is due to differences of temperature."[56]

There by now being no-one left alive prepared to defend Miller, his pioneering work was interred along with his body. While fundamentalist Einsteinism grew in popularity and dominance.

Having thus betrayed his master, Shankland received his thirty pieces of silver in the form of a series of widely published interviews with Einstein. After which his academic career soared. He ended his days as a bureaucrat within the emerging governmental atomic energy infrastructure[57].

At Mt. Wilson today there is no record of the exhaustive ground-breaking work done there by Miller, but only a memorial plaque to Michelson and Einstein (!)[58]. Reginald Cahill[a] wrote:

> "It was an injustice and a tragedy that Miller's contributions to physics were not recognised in his lifetime. Not everyone is as careful and fastidious as he. He was ignored simply because it was believed then, as it is now, that 'absolute motion' (the aether)[b] is incompatible with Special Relativity (it is!). It was accepted without evidence that his experiments must be wrong. This shows once again how little physics is evidence based – as Galileo discovered to his cost. Even today Miller's experiments attract a hostile reaction from the physics community."[59]

EXPERIMENTAL (2)

Length contraction

In 1889 Oliver Heaviside[c] showed from Maxwell's equations that movement though the aether at speed v alters electric fields by the *Lorentz factor* γ, named after the Dutch physicist Hendrik Lorentz[d]:

$$\gamma = \frac{1}{\sqrt{1-\left(\frac{v}{c}\right)^2}}$$

(eq.3)

---

[a] Reginald Cahill (1948-) Australian theoretical physicist.

[b] Another of Cahill's creative ways of avoiding the unspeakable ae-word.

[c] Oliver Heaviside (1850–1925), English engineer and mathematician.

[d] Hendrik Lorentz (1853-1928), Dutch physicist.

In the same year George FitzGerald[a] used this, and the *ad hoc* hypothesis that intermolecular forces are electrostatic, to derive the *length contraction* relation, thereby explaining the alleged null result of the Michelson-Morley experiment:

> "The forces binding the molecules of a solid might be modified by motion through the aether such that the base of the interferometer is shortened, neutralizing the optical effect[b]."[60]

In 1892 Lorentz, independently and more rigorously, arrived at the same conclusion:

> "There will be a contraction in the direction of motion proportional to the square of the ratio of the velocities of translation and of light, such as to annul the effect of aether drift in the Michelson-Morley interferometer."[61]

Whence its name: the "FitzGerald-Lorentz length contraction".

Cahill

In 2002 Reginald Cahill re-examined the Michelson-Morley and Miller interferometer results. He found that both experimenters had failed to take into account:

– 1) the FitzGerald-Lorentz *length contraction*[c]
– 2) the *refractive index* of the medium, in this case air

The Michelson-Morley interferometer set up is repeated in Fig. 13[d]. For an aether headwind v, the light speed is $c-v$ on the outward leg and $c+v$ on the return leg. Without length contraction, this would give an average speed of c/γ^2[e]. Taking the contraction into account, the apparent average speed is γ times greater, namely c/γ.

On the perpendicular axis where the photon moves at 90° to the aether wind, the average light speed is likewise c/γ[f].

---

[a] George FitzGerald (1851–1901), Irish physicist.

[b] Why this is not exactly so is shown in the next section.

[c] Known to Miller, but not to M&M, at the time of their experiments.

[d] Fig. 6

[e] Appendix eq.5 (p.37).
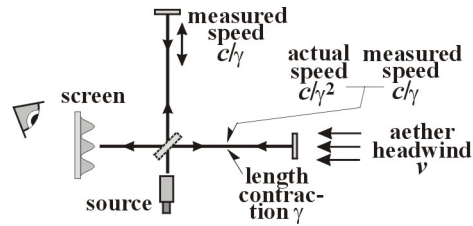
[f] Appendix eq.6 (p.37).

Fig. 13. Michelson-Morley (2).

The *same apparent speed* of light is thus obtained on *both axes* – as was predicted by FitzGerald and Lorentz[a]. An interferometer will thus in principle *always give a null result*, independently of any aether wind.

The FitzGerald-Lorentz contraction, however – and this was Cahill's other crucial insight – refers to conditions *in vacuo*. But the Michelson-Morley and Miller experiments were performed *in air* where the speed of light is somewhat lower. In this case the two effects *don't* exactly cancel out. But leave a *small residual*, which is what Michelson-Morley, Miller and others were measuring. We noted[b] that Miller had realized that his results were too low, but had attributed this to aether entrainment.

Making the necessary corrections, the Michelson-Morley[c] and Miller's experiments now give average aether speeds of:

$$v_{e\in} = 258\pm77 \text{ km/s}; \quad v_{s\in} = 374\pm63 \text{ km/s}^{[62]}$$

respectively. The detailed calculations are shown in the appendix[d].

In 2006 Cahill made his own aether-wind measurement using a coaxial cable and two atomic clocks linked by an optic fibre. He obtained a solar-system aether speed of:

$$v_{s\in} = 400\pm20 \text{ km/s}$$

in an astronomical direction (α=5.5 hr, δ =-70°) [63], compatible with Miller's values.

In the heat of the Relativity debate of the late 1920s, attempts were made to "purify" the Michelson-Morley experiment by carrying it out in helium (Illingworth in 1927[64]) and a soft vacuum (Joos in 1930[65]). Because helium has a considerably lower refractive index than air, both experiments gave smaller values for the aether wind. Illingworth obtained 3.13+/-1.04 km/s. And Joos the even lower 1.5 km/s[66].

Ironically, these were taken as confirming the Michelson-Morley "null" result. In fact all they confirm is the FitzGerald-Lorentz length contraction[a].

---

[a] p.19.

[b] p.16.

[c] Midday readings.

[d] p.37.

The dependency of interferometer results on the refractive index of air was further demonstrated by an experiment carried out by Demjanov[67]. As the air was gradually evacuated from his instrument, the fringe shifts steadily decreased and finally vanished.

deWitte

Further experimental evidence for the aether was obtained by *Roland deWitte*[b]. A technician with the Belgium Telephone Company, in 1991 he was given the task of synchronizing two caesium atomic clocks, separated by 1.5 kilometers of coaxial cable in a north-south orientation, using radio frequency signals.

The tests ran for 178 days. Fig. 0-14 shows three days' specimen transit times. The maximum is in the sidereal direction ($\alpha \approx 5$ hr)[c], the same as that obtained by Miller half a century previously[d]. Like most others, however, deWitte seems to have been unaware of Miller's work.
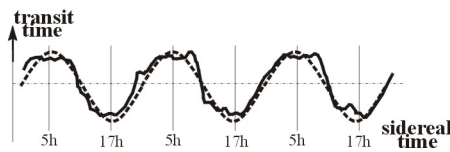
Fig. 0-14. deWitte's results.

Little of deWitte's original data has survived. But Cahill has shown that his aether speed is also compatible with Miller's.

DeWitte realized that the effect he was observing was of cosmic origin. But not being an accredited physicist, he was unable to get his results published in any physics journal. And he was subsequently dismissed from his research post. With his findings censured or ignored, and without a job, deWitte became deeply depressed and suffered an early death[68].

Torr and Kolen

In another version of the deWitte set up, in 1981 Torr and Kolen[e] compared two rubidium vapor clocks separated by 500m of coaxial cable. Unfortunately they chose an east-west direction, almost perpendicular to that obtained by Miller[f]. Since they make no reference to Miller's work, like deWitte were presumably unaware of it. Otherwise they would surely not have used this orientation.

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[a] p.19.

[b] Roland deWitte (??), Belgian telephone technician,

[c] When the component of the aether wind projected onto the cable is greatest.

[d] p.15.

[e] At the University of Utah.

[f] p.15.

The small projection of the aether wind onto their cable nevertheless enabled them to estimate its velocity at 417±40 km/s in a direction (5.5h, −65^0)[69], close to Miller's and Cahill's values[a].

Wallace

In 1961 *Bryan Wallace*[b] was making radar distance measurements to the planet Venus when he noted discrepancies in the speed of light *c*. He submitted his findings to *Physical Review Letters*, but was refused and had to publish elsewhere[70].

> "How could NASA not have noticed this?"

he asked. He claimed that NASA *had* in fact noticed, but that:

> "Due to the unfortunate things that tend to happen to physicists rash enough to challenge Einstein's second postulate, they were reluctant to acknowledge it. Getting a physicist to say that the speed of light is not constant is like trying to exsanguinate a turnip."[71]

Wallace died in 1997 with his findings, like Miller's, neither confirmed nor refuted by the physics establishment, but simply ignored.

Marinov

The colourful *Stefan Marinov*[c] comes close to many people's idea of a scientific crackpot. A native of Bulgaria and former Assistant Professor of Physics at Sofia University, he was four times forcibly subjected to psychiatric treatment for his political views[d]. Emigrating later to the West, he became involved in the scheme of an esoteric Swiss religious sect to extract energy from the vacuum of space[72].

In 1979, now in Brussels, he made a series of measurements of the speed of light using synchronously rotating mirrors. He concluded that the solar system moves though the aether at an average speed of 350 km/s in an astronomical direction (α=12 hr, δ=−20^0)[73]. We discuss this value later.

Marinov's various submissions to *Nature* were consistently refused. As were also his letters to the editor and his paid advertisments. The editor wrote to him:

> " I am sorry to have to tell you that I am not willing to publish your papers, because in my judgement they will not persuade our readers of the validity of your claims. We also do not sell advertising space to people with unorthodox views who have failed our usual tests of acceptability, which would be quite unacceptable. (sgd) Dr. Philip Campbell, Editor."[74]

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[a] p.20.

[b] Bryan Wallace (d.1997), American radio astronomer.

[c] Stefan Marinov (1931–1997), Bulgarian physicist.

[d] Soviet communism's standard way of dealing with such cases.

In other words "Your submissions are quite unacceptable, because I have deemed them quite unacceptable".

Marinov was so incensed with this that he threatened to immolate himself in front of the British Embassy in Vienna[75]. He later commented:

> "It is clear that to recognize the failure of Relativity in the third quarter of the twentieth century is a hard nut for the scientific community to crack. But it must be done, and the sooner the better."[76]

He ended his life by jumping off the top floor of the Graz University library, writing in his suicide note:

> "Having walked so many years on the thorny way of truth, I became tired. My books and papers are my scientific testament. I hope that soon the absolute space-time concepts which I restored by numerous experiments and simple mathematical theory will be accepted by the scientific community. On leaving this world I can only repeat the eternal words: *Feci quod potui* ('I did what I could')."[77]

And if, as it now seems, there is in fact an aether wind, the idea of extracting energy from it is maybe not quite so crackpot after all.

Spacecraft flyby

Further estimations of the aether speed are obtained from the radio-frequency signals emitted by spacecraft as they fly by the Earth. Due to the Doeppler effect[a], when a spacecraft approaches the Earth the received signal frequency is greater than the emitted. And is conversely lower when the spacecraft recedes, Fig. 0-15.
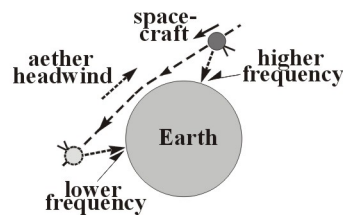

Fig. 0-15. Spacecraft flyby.

In the presence of an aether headwind, both frequencies are higher than expected. In mainstream physics this is known as the *flyby anomaly*:

> "*Unexplained* signal Doeppler shifts that are *not predicted* by accepted Science, and *not understood* by present-day scientists."[78] (italics ours)

---

[a] p.6.

The shifts are however only an "anomaly" for those who don't recognize the aether's existence. For those who do, they are not only explainable, but provide a further and independent means of estimating the speed of the aether wind.

Cahill analyzed a number spacecraft flybys at various points in the Earth's orbit, obtaining an average aether-wind speed for the solar system of:

$$v_{s\in} = 420 \pm 30 \text{ km/s}$$

coming in from an astronomical direction (α =5±2 hr, δ=−70± 10°)[79]. This is compatible with Miller's and his own previous results[a].

The existence of a Doeppler effect for electromagnetic waves in general is further evidence for the aether. As seen in the cyclist example[b], the effect depends on the *observer's speed relative to the medium*. No medium: no observer speed relative to it; no Doeppler effect.

Other

In 1990 the American university professors Howard Hayden[c] and Petr Beckmann[d] offered a $2,000 reward to anyone citing from the literature an experiment showing the invariance of the speed of light in the east-to-west and west-to-east directions to within 50 m/s. The offer was published in *Science* magazine in November 1990[80]. But to date[e] there have been no takers[81]. Silence sometimes speaks louder than words.

In a further reported experiment, electromagnetic signals were found to travel faster from Washington to Los Angeles than vice versa, with a small but consistently replicable difference of 37 nanoseconds[82].

General

Resuming the above aether wind measurements:

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[a] p.20.

[b] Fig. 2.

[c] Howard Hayden (??), physics professor at the University of Connecticut.

[d] Petr Beckmann (1924-1993), Czechoslovakian professor of electrical engineering at Colorado University.

[e] May 1919.

	year	type	speed	direction
M&M	1887	interferometer	258±77	??
Miller	1933	- " -	374±63	(5.2h, −67°)
Torr&Kohlen	1981	coaxial cable	417±40	(5.2h, −65°)
deWitte	1991	- " -	??	(5h, ??)
Cahill	2006	- " -	400±20	(5.5±2h, −70±10°)
NASA	2008	flyby	420±30	(5±2h, −70±10°)

Cahill takes the flyby and Torr & Kohlen results as representative of the others, giving a solar-system velocity though the aether:

$$v_{S\in} = 420\pm30 \text{ km/s}$$

in an astronomical direction (5 h,−70°).

Múnera noted that of the six experiments that he analyzed carried out between 1887 and 1932[a], all without exception *obtained* non-null aether speeds. But with the notable exception of Dayton Miller, all *reported* null results[83]. An Italian proverb runs:

"*Tra il dire e il fare, c'è di mezzo il mare.*"

("Between the saying and the doing, in the middle is the sea.")

In mainstream physics, it would seem, there can be similar discrepancies between the '*fare*' (results) and the '*dire*' (reporting of them).

Cahill wrote:

"It is now belatedly understood that numerous experiments, beginning with Michelson-Morley's, have always shown that the Einstein postulates are false; that there is a detectable space[b]; and that motion through it has been repeatedly observed since 1887. In denying such obvious empirical facts Special Relativity is just silly. Michelson died not realising that he had obser-ved absolute motion[c]. Ironically, he received a Nobel prize for reporting that he had not observed what he in fact had[d]."[84]

---

[a] M&M (1887), Miller (1926), Piccard and Stahel (1926), Illingworth (1927), Joos (1930), Kennedy and Thorndike (1932).

[b] Another of his creative ways of avoiding the unspeakable ae-word.

[c] Ditto.

[d] Not quite exact. Michelson reported a positive aether wind (p.13). *Others* nullified it for him – and then accused *him* of being the nullifier! (Cf the Einstein and *wikipedia* quotes).

GENERAL

CMB, gravity

When the cosmic microwave background (CMB) was discovered in 1965, it was quickly realized that it could provide an 'at rest' reference for speeds[a]. Consider a spaceship out in deep space, shown in 2-d terms[b][85] in Fig. 16. When moving with respect to the CMB, due to the Doeppler effect[c], the pilot experiences a higher CMB frequency in front of him and a lower frequency behind. When he observes the same CMB frequency all around him, he then knows he is at rest with respect to it.
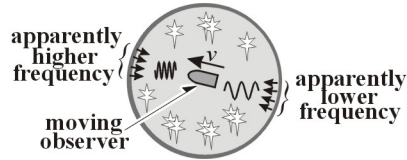
Fig. 16. Microwave background.

On this basis, the absolute velocity[d] v_S of the solar system has been calculated to be:

$$v_S = 370 \text{ km/s}$$

in an astronomical direction (α =11.2 hrs, δ=−7.2^o), towards the constellation Leo[86], Fig. 17a.
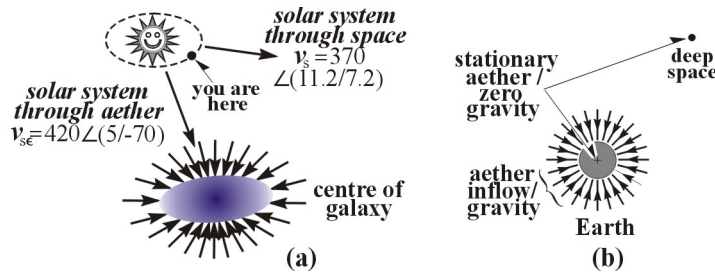
Fig. 17. Aether: absolute speeds; gravity[e].

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[a] Contradicting Einstein's first postulate that there is none.

[b] SpaceTime article.

[c] p.6.

[d] Taking Cahill's aether wind value.

[e] 'Through space' = with respect to the CMB.

This is nearly perpendicular to the solar system's velocity though the *aether*[a] of ~420 km/s in an approximately southerly direction[b]. The difference between the two is the absolute velocity[c] of the aether in the region of the solar system.

Cahill's re-analysis of Miller's data[d] showed the aether speed at the Earth's surface to comprise:

– 1) 30 km/s due to the Earth's orbital rotation
– 2) 42 km/s inflow towards the Sun
– 3) 420±30 km/s inflow towards the centre of the galaxy

With a further:

– 4) 11.2 km/s inflow towards the Earth's centre[87]

but that in principle[e] doesn't show up in horizontal interferometer experiments[f].

All of these suggest that *gravity* is associated with an *aether inflow*:

$$gravity \Leftrightarrow aether\ inflow$$

In outer space both gravity and the aether speed are presumed to be zero, Fig. 17b. But there is also a zero gravity point close to[g] the Earth's centre. Meaning that the aether is stationary there too. This ties in with the Hafele-Keating observation that their results could be made sense of referred either to the Earth's centre, or to the distant stars (outer space)[88].

A further indication of the aether–gravity association is that both motion through the aether and a gravitational field cause clock slowing[h][89].

It is interesting that in one of his first published theories[i], Newton speculated that gravity could be due to a medium flowing continually downward toward the Earth's surface, where it is partially diffused and partially absorbed[j][90].

---

[a] Determined by interferometer experiments.

[b] p.20.

[c] With respect to the CMB.

[d] Ditto.

[e] Were it not for its fluctuations (below).

[f] Although variations in its direction do (below).

[g] Strictly: 'close to it', due to the minor gravitational effects of the Sun and Moon, etc.

[h] Relativity article.

[i] In his "*Philosophiæ Naturalis Principia Mathematica*"

[j] He later abandoned it in favour of his inverse-square law.

We can also note that the Marinov rotating-mirror result[a] is closer to the Earth's velocity with respect to the *CMB*[b], rather than through the aether[c], for as yet unexplained reasons.

So the solar system moves through the aether at ~420 km/s. The Earth orbits the Sun at 30 km/s. And the aether at the Earth's centre is stationary! This "aether stuff" is evidently somewhat complex and obtuse, a far cry from the essentially static medium originally envisaged by Maxwell and Lorentz[d].

That the aether's nature should be essentially incomprehensible to us, is however hardly surprising. If everything in the universe, including we ourselves, is made of aether, in trying to understand it we are a part trying to comprehend the whole of which it is part. This being rationally senseless[e][91], the true nature of the aether could well inherently elude us.

Aether turbulence

Cahill observed something that deWitte had noted, and is also present in the Michelson-Morley and Miller results: namely that the aether wind is not smooth but *gusty*, varying from hour to hour and day to day in both magnitude and direction, at a level of around ±20km/s[92].

The same variations are seen in spacecraft flyby data[f][93]. Shankland also noticed them in Miller's readings, but used them as evidence of his inaccuracy without considering that they could be a real effect.

Fig. 0-18 shows the fluctuations in specimen Michelson-Morley and Miller[g] measurements[94].

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[a] p.22.

[b] p.26.

[c] As measured by interferometer (p.24) .

[d] p.3.

[e] The 'self-incomprehension' principle (QM article).

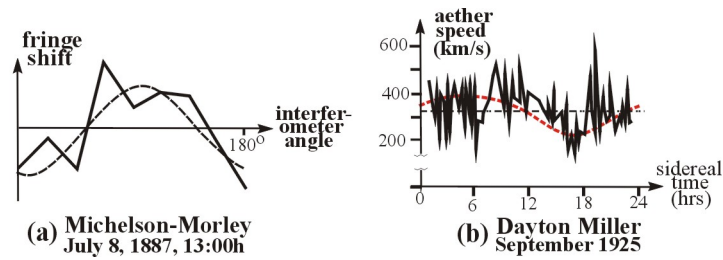[f] p.23.

[g] Fig. 12a.

Fig. 0-18. Aether gustiness (1).

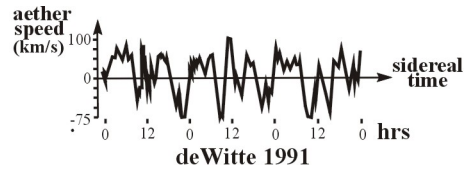And Fig. 0-19 those abstracted from the deWitte experiment[a][95].

Fig. 0-19. Aether gustiness (2).

Múnera similarly noted that in the Michelson-Morley results:

> "There were strong variations. Over the hour of the midday session of July 9, the aether speed changed from 18.1 to 16.8 km/s, and its direction from – 151.5º to –176.4º. In the evening session the speed changed from 28.4 to 29.6 km/s, and the direction from +96.0º to +86.0º."[96]

Fluctuations in the aether inflow to the Sun[b] could explain the greater variability of the M&M evening readings[c], where they contribute to the result[d]. Whereas at midday[e] they are perpendicular to the interferometer plane and have no effect[f].

---

[a] Fig. 0-14.

[b] p.27.

[c] Fig. 0-9.

[d] Fig. 0-20b.

[e] Fig. 0-20a.

[f] Apart from any directional variations.
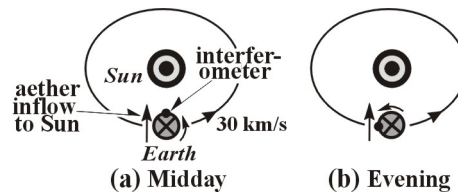
Fig. 0-20. Michelson-Morley (3).

Similarly, whereas in the evenings the Earth's rotation is perpendicular to its orbital motion[a], at midday it opposes it[b]. This could explain the somewhat lower midday values.

Aether-wind fluctuations also mean that the considerable variability in the M&M results[c] is not all due to experimental error – giving even less grounds for a 'null' interpretation.

Returning to the Torr-Kolen experiment[d], since their coaxial cable was almost perpendicular to the approximately southerly direction of the aether wind, variations in its *direction* should produce significant effects. They in fact reported considerable day-to-day fluctuations[97].

On a 'gravity ⇔ aether inflow' hypothesis[e], variations in the aether speed should show up in the *gravitational constant* G. This seems to be the case. Cahill notes:

> "As the precision of gravitational constant G measurements improved over the years, the disparity between the values obtained has increased. Results now differ by nearly 40 times the estimated error."[98]

The final question is: what does aether turbulence actually *mean* in physical terms? At present there seems to be no answer. However, the universe is littered with cataclysmic events – supernova explosions, neutron star and black hole mergers, collisions been galaxies, etc. And since physical reality overall seems to be essentially "aethereal"[f], the turbulence could simply be "cosmic weather".

LIGO

The Laser Interferometer Gravitational-wave Observatory (LIGO) comprises two large stationary vacuum laser interferometers with 4 km arms, situated 3000 km apart in Livingston-LA and Richland-WA in the USA[g].

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[a] Fig. 0-20b.

[b] Fig. 0-20a.

[c] Fig. 0-9.

[d] p.21.

[e] p.27.

[f] 'Electromagnetic'.

[g] Cf Fig. 6a.

Designed to detect gravitational waves, they are exceptionally sensitive, capable of detecting changes in mirror spacing of one part in 10^{21} – equivalent to the width of a human hair in the distance between the Earth and Proxima Centauri![a].

But since they operate in the *vacuum mode*, they are *insensitive* to the everyday aether wind and its fluctuations[b99]. Initial operations between 2002 and 2010 correspondingly gave null results.

But then on September 14, 2015 a "chirp" was registered by both detectors, Fig. 0-21a. The time interval between its detection by the two devices was consistent with an effect travelling at the speed of light.
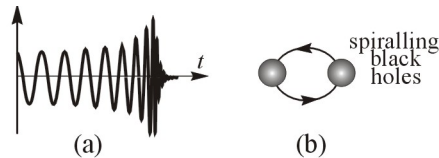
Fig. 0-21. LIGO wave.

This was interpreted as deriving from the final moments of the merger of two black holes more than a billion light years away, Fig. 0-21b. The estimated radiated power was more than ten times that of the total light emission of the observable universe.

That the disturbance travelled at the speed of light suggests strongly that the aether was involved. But since vacuum interferometers in general are insensitive to aether disturbances, the question is: what does the result *mean* in physical terms? For the moment this remains a good question.

It would be interesting to run the LIGO in the *gas mode*, with air rather than a vacuum in its tubes. This would resolve once and for all the Michelson-Morley dispute. But it would also risk confirming the Cahill interferometer calibration[c], demonstrating the aether's existence and falsifying Special Relativity. One wonders whether it will ever be done.

NULLIFICATION (2)

General

In spite of the overwhelming conceptual arguments for the aether, and the indisputable experimental evidence for it, mainstream physics persistently persists in denying its existence. Already back in 1873 Maxwell wrote:

---

[a] 4×10^{13} km away.

[b] p.20.

[c] p.19.

"There appears to be in the minds of some eminent men a prejudice, or *priori* objection, against the hypothesis of a medium in which the radiation of heat and light take place." [100]

Thomas See in 1920:

"A strange tendency has arisen in recent years for abandoning the aether as an unecessary hypothesis." [101]

Einstein in his 1916 Relativity paper:

"Michelson and Morley performed an interference experiment in which [an aether wind speed] should have been clearly detectable. But it gave a *negative result*. The most careful observations *have never revealed* anisotropic properties. This is very powerful argument in favour of the principle of relativity, contradictory to which *no empirical data has ever been found*." [102] (italics all ours)

A recent Internet search by the author for "Michelson-Morley result" similarly gave, in order of appearance[103]:

"The result was negative."
"There is no aether."
"The Michelson-Morley is a perfect example of a null experiment."
"There was no fringe shift."
"Michelson found no evidence of the aether."

…

The *en.wikipedia* likewise "informs":

"The Michelson–Morley experiment compared the speed of light in perpendicular directions in an attempt to detect the relative motion of the stationary luminiferous aether ('aether wind'). *The result was negative*. Michelson and Morley found *no significant difference* between the speed of light in the two directions." [104]

And so on, almost *ad inf*.

In the face of the overwhelming contrary experimental evidence, all of this evidently constitutes a pretty massive – as Herbert Dingle[a] would have delicately put it:

"Conscious departure from rectitude." [105]

But which in the vernacular could well be called "blatant lies".

The basic problem with the aether is of course that it *refutes Einsteinian Relativity*, today a "scientific fundamentalism" that professional physicists are required to "Subscribe to or else!".

---

[a] Herbert Dingle (1890–1978), English physicist.

But since professional physicists are in general far from stupid, and able to detect a blatant lie when they see one, mainstream physics finds itself obliged to endlessly hammer home its contrary version, in an essentially vain attempt to maintain its "credibility"[a] and thereby its members' jobs, reputations and research funding. Presumably based on the hallowed Joseph Goebbels'[b] principle that:

"A lie repeated often enough becomes a truth."

William S[c]. could have commented[d]:

"The Establishment doth protest too much, methinks."

Absolutism

What we have to explain is an effective *anti-aetherism*[e] that seems to have been around well before Einstein. And judging by Maxwell's 1873 comment[f], probably before Michelson too.

Europe in the 18th and early 19th centuries was 'absolutist' in that political power was firmly in the hands of an established landed aristocracy. Newton's rationally ordered universe, with its Master Creator who kept Himself to Himself and didn't stick His nose into things that weren't His business, validated that structure and suited the times admirably[g][106].

The *droits du seigneur* – the "rights of the lord" (the little lord down here on Planet Earth, not the Big Lord up in the sky) – were graciously delegated by the Big Lord up in the sky to little lords down on Earth without too many awkward questions about how they were being exercised.

By the second half of the 19th century, however, things were changing radically. Increasing industrialization was causing extensive migration from the countryside into the towns. And more crucially: was putting money and hence political power into the hands of a *nouveau riche* class of non-land-owning industrialists, businessmen, bankers and the like. All of which put a *pressure for change* onto the socio-political structure.

In times change *flexibility* and *adaptability* are the order of the day. The old absolutism had to go, and together with it, anything that symbolized it. In Science this included Newton's absolute space and time. And also the aether, which is effectively an absolute.

---

[a] Don't laugh!

[b] Joseph Goebbels (1897–1945), Nazi propaganda minister.

[c] William Shakespeare (1564-1616), English poet, playwright and actor.

[d] Cf the famous *Hamlet* line: "The lady doth protest too much, methinks". (She wasn't in fact protesting her chasteness, but could have been.)

[e] Or maybe *aether-agnosia*: "not wanting to know of the aether" (from the Greek *a* (not) + *gnosis* (knowing)).

[f] p.31.

[g] The "Four Pillars of the English Establishment" were Monarchy, Church, Empire and Newton.

We see this in philosophy. In 1878 Nietzsche[a] declared that:

> "There are no eternal facts, just as there are no absolute truths".[107]

And later post-modernism:

> "Has at its heart a general distrust of grand theories and ideologies; a general skepticism toward the assumptions of Enlightenment rationality."[108].

Likewise in art. An article on Cubism notes that:

> "In the four decades from 1870-1910 western society witnessed more techno-logical progress than in the previous four centuries. Artists correspondingly developed Cubism where a painting often looks like an image seen in a broken mirror."[109]

The "broken mirror" here being the old way of seeing things.

So when in 1905 Einstein came along with "proving scientifically" that everything is relative, and that there are no absolutes, this was exactly what people wanted to hear. And they turned a blind eye to his theory's manifest ambiguities and inconsistencies. Just as 18 years previously they had turned a blind eye to Michelson-Morley's indisputably positive aether-wind result.

And when somewhat later in the 1920s quantum physics declared that reality is not only inherently *relative*, but is also inherently *indeterminate*, and can be any way one wants depending only on one's consciousness[a]: well "Wow!".

Francis Bacon[b] noted:

> "People prefer to believe what they prefer to be true".

Agenda

At each period of its history a society seems to have an explicit or implicit *agenda*, that can be basically 'open/liberal' or 'closed/absolutist':

agenda: 'open/liberal' or 'closed/absolutist'

In times of change where flexibility and adaptability are valued, the agenda is open/-liberal. In stable settled times the opposite holds: the closed/conservative principle dominates, with respect for tradition and the maintainance of the *status quo* as key values. Social mobility here being low, the road to individual advancement lies in allying oneself with the existing power structure,

A liberal agenda, with its emphasis on opportunity and innovation, tends to *undermine* the existing power structure, opening it up to further change. Conversely, allying oneself with the power structure in conservative times tends to strengthen the reigning *status*

---

[a] Friedrich Nietzsche (1844-1900), German philosopher.

[b] Francis Bacon (1561–1626), English statesman and polymath.

quo. Each agenda is thus effectively *self-reinforcing*, leading to abrupt swings when they switch.

Returning to the aether, by the mid 1800s – thanks principally to Maxwell – its existence was conventional wisdom and hence part of the prevailing absolutist agenda. So when towards the end of the century this was rejected, the aether had to go too.

Today the opposite is the case. In the throes of the massive swing to the political right that started with Thatcher/Reaganism in the early 1980s, the agenda is once again authoritarian and absolutist. And Einsteinian Relativity and anti-aetherism having in the meantime become the conventional wisdom, it is *they* that now comprise the mainstream line that professional physicists are required to "Toe or else!".

More than a century after Michelson-Morley, anti-aetherism is therefore alive and kicking. But now for exactly the opposite reason. Its original rejection derived from a *liberal agenda* and the need to *break* with the conventional wisdom. Today's rejection stems from a *conservative agenda* and a pressure to *conform* to that "wisdom".

That an acceptance of essentially anti-authoritarian Relativity should have become a touchstone for *compliance* with authority, is evidently ironic. But history is littered with such contradictions. As Einstein said of himself, with his inimitable humour:

"To punish me for my contempt of authority, Fate made me one."[110]

Science doesn't tell us the way things are. It tells us *the way we want to be told* they are:

Science tells us the way we want to be told things are

Or maybe better: we only listen to those scientists who tell us what we want to hear, ignoring those who don't. As Francis Bacon so truly noted[a]; and Dayton Miller discovered to his cost[b].

That would seem to be it. In open/liberal times no-one wants to know of anything smelling of absolutism. And vice versa in closed/absolutist times. No matter how well founded a scientific thesis, its acceptance or rejection depends little on its objective merits, and principally on whether or not it supports the current political agenda. Adam Becker[c]:

"The course of scientific progress is dictated as much by the vagaries of the *Zeitgeist* and the forcefulness of personalities, as by the strength of ideas themselves. When trying to understand why certain ideas are accepted as gospel, and others are forgotten, dismissed or even actively suppressed, the political context is essential."[111]

Maxwell wrote in 1877:

---

[a] p.34.

[b] p.17.

[c] Adam Becker (??), Science writer.

"Those 'eminent men', who take upon themselves the task of ignoring anything that contradicts their cherished beliefs, follow 'Scientism', a corruption of Science that is really a pseudo religion. With so many following it, and pretending it to be Science, it is little wonder the scientific world is in such a sorry state of affairs."[112]

Maxwell's 'eminent men' were presumably the previous generation of toe-the-line mainstream physicists who clung to the established Newtonian corpuscular model for light, and refused to have anything to do with the nutty new-fangled wave theory with its attendant luminiferous aether.

Max Planck noted:

"A new scientific truth doesn't triumph by convincing its opponents. But rather: they eventually die out and a new generation familiar with it grows up."[113]

"*Plus ça change ...*"[a].

APPENDIX

Celestial coordinates

The *celestial coordinates* of a heavenly body are its celestial longitude and latitude, the projection of earthly longitude and latitude into outer space, Fig. 0-22.
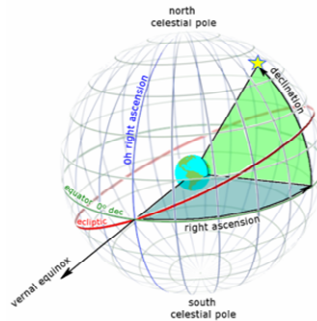
Fig. 0-22. Celestial coordinates[114].

If one stood on the equator at 0° longitude[b] at midday on the March equinox (21/03), the Sun would be immediately overhead at a *Right Ascension*[c] α =0 hrs and a *declination* δ=0°. A star 30° above the northern horizon at that point would have

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[a] French proverb: "The more things change, the more they remain the same".

[b] The Greenwich meridian.

[c] 'RA'.

declination $\delta=+60^o$ and coordinates ($\alpha = 0$ hr, $\delta=60^o$). A star 30° above the southern horizon would have coordinates ($\alpha = 0$ hr, $\delta=-60^o$); and so on.

Longitude and Right Ascension being measured eastwards, a star immediately overhead 5 hrs previously to this[a] would have coordinates ($\alpha = 5$ hrs, $\delta=0^o$); and so on.

Interferometer calibrations

M&M, Miller

Michelson-Morley and Miller used for their interferometers an essentially Newtonian calibration that didn't take length contraction into account.

Referring to Fig. 13, repeated here for convenience, for a light path length d and an aether headwind v, the light speeds on the main axis are $c-v$ on the upwind leg and $c+v$ on the downwind leg, giving an out-and-return time t_1:

$$t_1 = \frac{d}{c-v} + \frac{d}{c+v} = \frac{2cd}{c^2-v^2}$$

(eq.4)

and an average light speed c_1 on this axis:

$$c_1 = \frac{2d}{t_1} = \frac{c}{\gamma^2}$$

(eq.5)

where γ is the Lorentz factor[b].
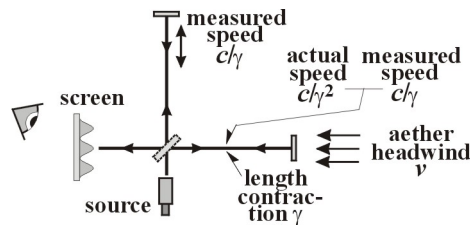
Fig. 23. Michelson-Morley (2).

On the perpendicular axis, let the photon take time t_2 to reach the opposite mirror. During this time it travels a distance ct_2 through the aether. And gets blown back a distance vt_2 by the aether headwind, Fig. 0-24. Giving an apparent light speed c_2 on this axis[c]:

$$c_2 = \frac{d}{t_2} = \frac{c}{\gamma}$$

(eq.6)

---

[a] At 07:00 hrs.
[b] eq.3, p.18.
[c] Pythagoras.
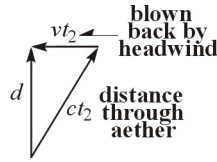
Fig. 0-24. Interferometer, p-axis{{interfer}.

The aether speed v on Earth being very much smaller than that of light c[a], the Lorentz factor γ here reduces to:

$$\gamma = \frac{1}{\sqrt{1-(v/c)^2}} \approx 1 + \tfrac{1}{2}(v/c)^2$$

(eq.7)

In terms of the 'MMM'[b] calculated aether speed v_m, the difference Δv between the apparent light speeds on the two axes is then[c]:

$$\Delta v = c_2 - c_1 = \frac{c}{\gamma}(1-\tfrac{1}{\gamma}) \approx \frac{c}{2}(\tfrac{v_m}{c})^2$$

(eq.8)

Whence:

$$v_m \approx \sqrt{2c\Delta v}$$

(eq.9)

This is the relation 'MMM' used to calculate their aether speed v_m, the axis speed difference Δv being obtained from the fringe shifts.

Cahill

On the Cahill calibration, the speed of light is its air value c_a:

$$c_a = c/n$$

(eq.10)

where n is the refractive index of air.

With no length contraction, the speed difference Δv between the two axes would be[d]:

$$\Delta v = \frac{c_a}{\gamma_a}(1-\tfrac{1}{\gamma_a}) \quad \text{where} \quad \gamma_a \approx 1 + \tfrac{1}{2}(nv/c)^2$$

(eq.11)

Length contraction, however, foreshortens the main axis by γ, increasing the apparent speed of light on it correspondingly and giving an axis speed difference Δv[e]:

$$\Delta v = \frac{c_a}{\gamma_a}(1-\tfrac{\gamma}{\gamma_a}) \approx \frac{c(n^2-1)}{2}(\tfrac{v}{c})^2$$

(eq.12)

---

[a] $(v/c)^2$ << 1.

[b] According to the Michelson-Morley/Miller calculation.

[c] Substituting c_1, c_2 from eqs 5,6 and γ from eq.7.

[d] Using eqs.7,8.

[e] Approximating n≈1.

Equating the two expressions for Δv[a], the corrected aether speeds v in terms of their 'MMM' values v_m are:

$$v = \frac{v_m}{\sqrt{n^2-1}}$$

(eq.13)

The refractive index of air depends on its pressure. Cleveland and Mt Wilson being at 200 m and 1740 m above sea level respectively, their relative pressures[b] are $p=0.989$ and $p=0.821$[115]. The refractive index of air at sea-level being n=1.000293[116]; and taking its 'n–1' component to be proportional to pressure[c]; the corresponding refractive indexes for air at the two locations are n=1.00029 and n=1.000241 respectively.

Substituting into eq.13 gives correction factors of 41.5 and 45.5 respectively. Applied these to the 'MMM' speeds v_m[d] gives true aether speeds v:

M&M: $v_{e\in}$ = ~258±77 km/s[e];   Miller: $v_{s\in}$ = 374±63 km/s[f]

Miller

An exerpt from Dayton Miller's report on his 1925 Mt Wilson control experiments[g]:

"An extended series of experiments was made to determine the influence of inequality of temperature in the interferometer room, and of radiant heat falling on the interferometer. Several electric heaters were used, of the type having a heated coil near the focus of a concave reflector. Inequalities in the temperature of the room caused a slow but steady drifting of the fringe system to one side, but caused no periodic displacement. Even when two of the heaters were placed at a distance of three feet from the interferometer as it rotated, and were turned to throw the heat directly on the uncovered steel frame, there was no measurable periodic effect. When the heaters were turned on to the light-path which had a covering of glass, a periodic effect could be obtained only when the glass was covered with opaque material in a very non-symmetrical manner, as when one arm of the interferometer was completely protected by a covering of corrugated paper-board while the other arms were unprotected. These experiments proved that under the conditions of actual observation, the periodic displacement could not possibly be produc-$$ed by temperature effects."[117]

---

[a] 'MMM's and Cahill's (eqs 8,12).

[b] To that at sea level.

[c] n $\Rightarrow$ 1 + 0.000293p.

[d] pp 12, 15

[e] Midday readings. Substituting v_m=6.22, n=1.00029 into eq.13.

[f] Substituting v_m=8.22, n=1.000241 into eq.13.

[g] Miller 1925.

Reading this, can anyone doubt he was a serious experimenter?.

Sidereal, solar times

For the sake of illustration, imagine standing on the equator at 0° longitude on the March equinox (21/03), Fig. 25a. The Sun and some fixed star are immediately overhead. Define this instant as '12:00 hrs' in both solar and sidereal times.
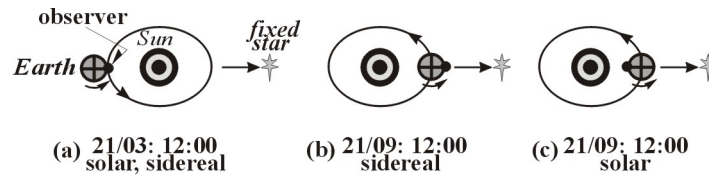

Fig. 25. Solar, sidereal times.

Six months later, 12:00 sidereal time is when the same fixed star is overhead, Fig. 25b. And 12:00 solar time is 12 hrs later, when the Sun is overhead, Fig. 25c.

A year thus has 365 solar and 366 sidereal days, making a sidereal day ~4 mins[a] shorter than a solar day.

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[a] (24 hrs)/(365 days) $\approx$ 4 mins.

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INDEX

, So how come the aether's non-existence needs to be so incessantly reasserted? The fundamental problem is of course that it with a basic *credo*[a]:

> *Art.1*) Relativity is correct
> *Art.2*) Relativity is always correct
> *Art.3*) Should, exceptionally, Relativity
> be proved wrong,
> arts 1) and 2) take immediate effect

be incapable of grasping it could well be that behind the scenes there is in fact *massive doubt* about Relativity's rightness.

Meaning that the mainstream Physics Establishment,.

as not to realize that the 1887 Michelson-Morley result *wasn't* in fact 'null',

---

[a] Paraphrasing a sign about the boss that people sometimes stick up on their office walls.

Wrong. They weren't attempting to detect the atr

[1] Fiennes 2019a.

[2] cellularuniverse (1811).

[3] en.wikipedia/aether (1901).

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[12] Einstein 1905, p.1.

[13] Einstein 1920.

[14] Maxwell 1873, p.438.

[15] Michelson 1881.

[16] Marjanovic 2018.

[17] en.wikipedia (1904).

[18] See 1920.

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[20] en.wikipedia (1901).

[21] en.wikipedia (1901).

[22] en.wikipedia (1901).

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[24] Michelson 1881.

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[29] Múnera 1998, p.13; Cahill 2002.

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[56] orgonelab (1012).

[57] cellularuniverse (1012).

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[62] Cahil 2002.

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[67] academia.edu/38362757; Demjanov 2010.

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[75] salon (1012).

[76] bourabai.narod (1012).

[77] padrak (1012).

[78] Hughes 2014, p.xviii.

[79] Cahill 2008.

[80] On 30/11/1990.

[81] Beckmann 1987.

[82] Beckmann 1987.

[83] Munera 1998.

[84] arxiv (1008); cartesio-episteme (1008);

cellularuniverse (1012); mountainman (1012).

[85] Fiennes 2019c. Fig.019.

[86] Cahill 2003.

[87] Cahill 2003, 2008.

[88] firstthings (0008).

[89] Fiennes 2019b, Figs.20,29.

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[91] Fiennes 2018d, p.48.

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[96] Múnera 1998.

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