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 experiments that demonstrate it. Possible explanations 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 and year and month of access.

Contrary to custom, quotations are in general not *de rigeur*, but may be abridged or combined with others from the same source[a]. Their meaning is however never consciously distorted.

The English language in its wisdom not having provided us with a non-gender-specific pronoun, for "he", etc. in general read "he/she" etc.

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 term "aether" is today a 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 any hopes of a successful career:

> "The concept of an aether was long ago discarded as a relic of 19th century voodoo science."[1]

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."[2].

The aether 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, where 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."[3]

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[a] Verbatim quotes are tagged "*sic*".

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

Homer[4] uses it in the sense of "fresh air" or "clear sky", the pure essence breathed by the gods[5]. Anaxagoras[a] speculated that atoms[b] are vortexes in the aether, an idea taken up in modern times by Lord Kelvin[c6].

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

Light

In the early scientific era of the 17th century there were two conflicting theories of the nature of light. The famous English scientist Sir Isaac Newton[d] said it was a *stream of particles* travelling in straight lines. The Dutch physicist Christian Huygens[e] held it to be *waves* propagating through a hypothetical medium, the 'luminiferous aether', conceived at the time as being 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[f] spoke of Huygens as "having dared to contest the mighty emission theory of Sir Isaac Newton"[7].

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[g], who wrote in his "*Book of Optics*":

> "Light rays are streams of minute particles, lacking all sensible qualities except energy."[8]

This is very close to the modern concept of a photon.

But then in 1803 the English physician Thomas Young[h] performed his famous *double-slit experiment*, demonstrating the *interference property* of light. This being explainable in wave, but not in particle terms, after that the corpuscular theory started to go out of fashion. By the 1850's it had been generally abandoned in favour of a wave model.

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

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

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

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

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

And when in 1865 James Maxwell[a] calculated from the electric and magnetic properties of a vacuum[b] that light, an electromagnetic wave, should travel through it at the known speed of 300k km/s, its ondulatory nature was generally accepted. And so therefore was by implication the existence of its medium, the luminiferous aether.

That light travels at a finite speed was first proposed by the Greek philosopher Empedocles[c], 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[d], based on the eclipses of Jupiter's moons. His value of 200k[e] km/s was however too low, due to his having taken the time light takes to cross the Earth's orbit as 22 min rather than the correct 16 min. Adjusting for this gives 275k km/s, close to the actual 300k km/s.

Further examples of the wave behaviour of light are *optical dispersion*, where a beam of white light is split up by a glass prism into a rainbow of colours. And *diffraction*, where light passing a small hole or narrow slit causes fringes on a screen. That light has a *characteristic speed c* and a *frequency f* are likewise wave properties.

Einstein

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

> "The introduction of [the concept of] a 'luminiferous aether' will prove to be superfluous."[9]

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. Newtonian action at a distance is only apparent. In truth is conveyed by a medium permeating space."[10]

This evidently contradicted his previous statement. But Albert was no stranger to contradiction.

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

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

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

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

[e] 'k' = thousand.

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

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[a] 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 *c* determined by the properties of the water medium. The same holds for *sea waves*, Fig. 1a[b], the disturbance here being caused by the wind.

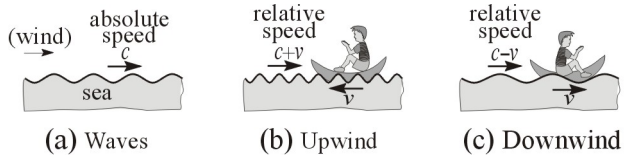

Fig. 1. Sea waves.

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 sailing downwind, Fig. 1c, the waves overtake the boat at the difference of the two speeds *c–v*.

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

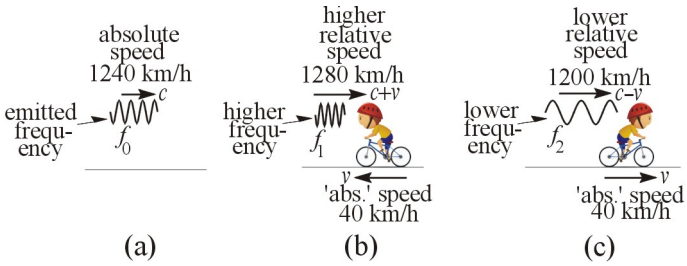

Fig. 2. Sound waves.

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[a] Here always *physical* waves, as opposed to the mathematical variety.

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

Consider a cyclist pedalling at speed v=40 km/h, Fig. 2b. Assuming for simplicity that there is no wind, this is also his speed through the air medium.

The characteristic speed c of a wave being its wavelength λ times its frequency f:

$$c = \lambda f \qquad \text{(eq.1)}$$

and the wavelength λ of the sound in the air being independent of the cyclist's motion, the frequency f he experiences is proportional to the wave speed relative to him:

$$\textit{experienced frequency} \propto^{a} \textit{relative wave speed}$$

When he is stationary, Fig. 2a, the cyclist experiences the emitted frequency f_0[b]. When pedalling at v=40 km in the opposite direction to the sound waves, Fig. 2b, 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 f_1 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 f_2 than when at rest[e].

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.

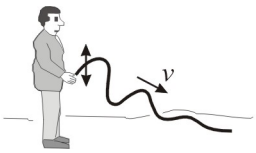

Fig. 3. Rope waves.

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 'aether'[f] – is nonsensical[g]. For there to be a disturbance, *something* (some physical

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[a] Varies as.

[b] Fig. 2a.

[c] Given by $f_1 = (c+v)/c.f_0 = (1280/1240)f_0$. Cf 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.

[e] Given by $f_2 = (c-v)/c.f_0 = (1200/1240)f_0$. Cf Fig. 1c.

[f] For present purposes defined the simply as "that which light is conceived as a disturbance propagating through".

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

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:

> "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".[11]

Albert Michelson[a]:

> "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."[12]

And According to Thomas See[b] Michelson:

> "Openly rejected Relativity on the grounds that it does not account for the transmission of light, but holds that the aether should be thrown overboard"[13]

The quantum physicist Paul Dirac[c]:

> "it is natural to regard light as the velocity of some real physical thing[d]. So we are forced to have an aether".[14]

The likewise quantum physicist John Bell[e]:

> "The aether was wrongly rejected on the purely philosophical grounds that what is unobservable does not exist"[f15].

Characteristic speed

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

$$c = \sqrt{\frac{1}{\rho\varepsilon}} = 1240 \text{ km/h} \qquad \text{(eq.2)}$$

where ρ, ε are the density and elasticity[g] respectively of the air medium. And the characteristic speed *c* of light through a vacuum is :

$$c = \sqrt{\frac{1}{\mu\varepsilon}} = 300\text{k km/s} \qquad \text{(eq.3)}$$

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

[b] Thomas See (1866-1962), American astronomer.

[c] Paul Dirac (1902-1984), English theoretical physicist. In 1951.

[d] Cf p.4, note.

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

[f] QM article.

[g] The inverse of its bulk modulus K_s.

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

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

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

And if – as Relativity stubbornly maintains – light is a "mediumless wonder", a disturbance of nothing propagating through nothing, the questions are:

– 1) *what* in this case *determines* light's characteristic speed *c*=300k km/s?
– 2) is it *simply a 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[d16]

Both of these are excellent questions, to which Relativity to date has provided no coherent answers.

EXPERIMENTAL (1)

Michelson

A good starting point for experimental evidence for the aether is the famous (some might say "infamous") 1887 aether-wind measurement carried out by Albert Michelson and Edward Morley[e] 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 United States, where he grew up firstly in small mining towns, where his father was a merchant. And then for his high school years in San Francisco, where he lived with an aunt.

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

[b] Applying a mechanical force to a spring, it at first cedes, but with time builds up an opposing force. Applying an electrical voltage (electrical force) to a capacitor, it at first cedes, but with time builds up an opposing voltage.

[c] Eqs.1,2.

[d] 'Vacuum' in general normally being another way of saying "aether" (p.4, note).

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

Fig. 4. Albert Michelson.

As an academically outstanding, but financially impoverished student, in 1869 the US president Ulysses Grant awarded Michelson a special appointment to the U.S. Naval Academy, where 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.

In 1880 he decided to pursue a career in physics. Obtaining leave of absence from the navy to study in Europe, he spent time at the universities of 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, Ohio[17].

Aether entrainment

That light is electromagnetic waves had been confirmed by Maxwell in 1864[a]. Waves implying a respective medium – a 'luminiferous aether' – experiments to determine its properties where a high priority in 19th century physics.

Measurements of stellar aberration had led to two main theories. The first, formulated by Augustin-Jean Fresnel[b] in 1818, held the aether to be *essentially stationary* within the solar system[c]. In which case there should be a detectable aether wind of some 30 km/s at the Earth's surface, its orbital speed around the Sun, Fig. 0-5.

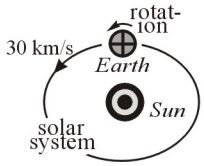

Fig. 0-5. Earth's orbit.

[a] Verified experimentally by Heinrich Hertz in 1887.

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

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

In 1844, however, George Stokes[a] put foreward an alternative theory: that the aether is *dragged* by Earth[18]. in which case there should be little or no measurable aether speed at the Earth's surface.

Michelson 1881

Michelson's interferometer were designed to test for Fresnel's 'stationary' (no aether dragging) hypothesis. And not for the existence of the aether itself, which was virtually universally accepted by the physicists of the time. Michelson wrote in the introduction to his 1887 report:

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

The instrument used was an *interferometer*. Its general principle is shown schematically in Fig. 6a. A beam of light is split into 'main' and 'orthogonal' paths. These 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 orthogonal axis. Resulting in a 'fringe shift', a displacement of the interference pattern, from which the speed of the aether wind can be calculated.

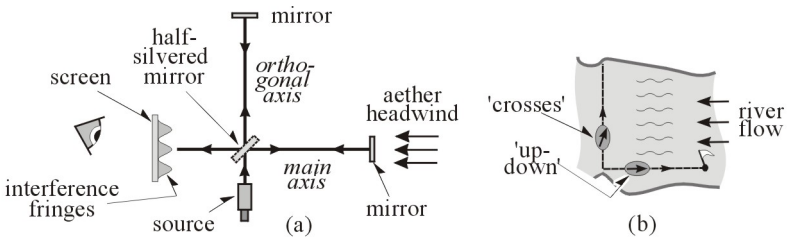

Fig. 6. Michelson-Morley (1).

An analogy is two twins in a river. One, the 'crosses' twin, swims across the river and back again. His 'up-down' brother swims the same distance, but first upstream and then back.

Since the 'crosses' twin has to head somewhat upstream, he takes longer than if there were no river flow. The 'up-down' twin gains time on his downstream leg. But because this is not compensated by what he loses on the upstream leg, he ends up taking *longer* than his brother. The respective mathematical relations are derived in the appendix[b].

In terms of the Michelson-Morley experiment, a different light travel time on the two axes would imply a positive aether wind.

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

[b] p.36.

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

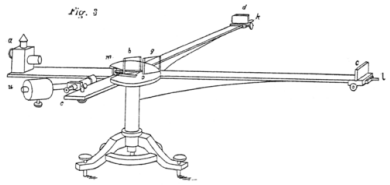

Fig. 7. Michelson's 1881 interferometer[19].

In spite of being mounted on a stone pier, however, due to its extreme sensitivity to vibrations it soon became apparent that it could not be used in a city such as Berlin, and was accordingly moved to the quieter grounds of the *Astrophysicalisches Observatorium* in Potsdam.

But even there, although under ordinary circumstances the fringe shifts could be measured, Michelson noted that:

> "Stamping on the pavement 100 meters from the observatory could make the fringes disappear entirely!"[20]

Not to the mention many further problems due to temperature variations, distortion of the arms during rotation, etc.

The aether speeds Michelson obtained with this instrument were low, far less than the 30 km/s predicted by Fresnel's stationary-aether[b] hypothesis. In view of this and the considerable experimental uncertainties, he concluded that the Fresnel option could be substantiated:

> "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."[21]

thereby implicitly confirming Stokes' complete-aether-dragging theory.

Michelson-Morley 1887

In 1885 Lord Rayleigh[d] wrote to Michelson urging him to repeat his 1881 experiment with greater accuracy[22]. 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] No aether dragging.

[c] With respect to the solar system. Not at the Earth's surface.

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

The improved version of the 1881 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 the instrument on a large sandstone block[a] floating in a circular trough of mercury. And the sensitivity was improved by increasing the light path to ten times its previous value via repeated reflection.

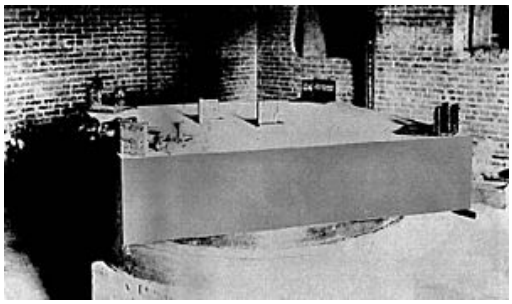

Fig. 8. The 1887 interferometer[23].

The mercury trough allowed the device to turn with close to zero friction. Given an initial push, it would continue rotating slowly for many minutes while the fringes were observed through a telescope. But even so, they could at times disappear completely due to passing horse traffic, distant thunderstorms, etc. And the observer could easily "get lost" when they returned[24].

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[25]. In 1998 Héctor Múnera reanalyzed the results using modern statistical methods. He found that they gave, at a 95% confidence level[b], aether speeds of:

– midday readings: $v_{\in}$ [c]=6.22+/-1.86 km/s
– evening readings: $v_{\in}$= 6.8+/-4.98 km/s[26]

with an average of some 6.5 km/s. The results are plotted in Fig. 0-9. The somewhat higher value and greater experimental error of the evening results is explicable (below).

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[a] ~30 cm thick and 1.5 m square.

[b] A 95% probability of the effect not being due to chance.

[c] Using the subscript '∈' for 'aether'.

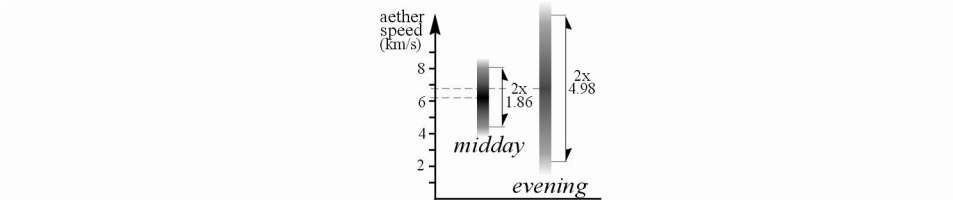

Fig. 0-9. Michelson-Morley results.

Since these were again considerably less than the 30 km/s expected on Fresnel's 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."[27]

He wrote in a letter to Lord Rayleigh in August 1887:

> " The result is decidedly negative [for the Fresnel theory]. The deviation of the interference fringes from zero was not the expected [30 km/s]. It follows that if the aether does slip past, the relative velocity is less than one sixth of the Earth's[b]."[28]

Michelson never questioned the *existence* of the aether, but only the extent to which it is entrained by the Earth's motion. As is evident from the title of his two papers:

> "The Relative Motion of the Earth and the *Luminiferous Aether*" (italics ours)

In spite of being a religious agnostic[29], Michelson firmly believed in the aether to his dying day. Obviously, since his own experiment had demonstrated its existence.

Nullification (1)

In spite of Michelson-Morley's clearly positive aether-wind result of ~6.5 km/s[c], well outside his 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."[30]

The famous "null result" quoted in most physics textbooks. It made Michelson's "the most famous failed experiment in history"[31]. And gained for him a physics Nobel prize, the first American ever to receive one[32]. After this the idea of the aether went out of fashion.

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[a] Of 30 km/s.

[b] Ditto.

[c] Fig. 0-9

But again, 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."[33]

Anyway, since when have the experimenters' expectations been a valid criterion for judging an experimental result? To the contrary: Science purports to be open-minded and objective, and to proceed from experimental measurements to explanatory theories, and not vice-versa. Simply because something is smaller than expected doesn't mean that it doesn't exist. And since when has "coming to be said" been accepted 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. "[34]

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

Even if Michelson-Morley *had* obtained a null result, as they recognized that wouldn't have established the aether's non-existence. But simply a zero aether speed 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 improved the interferometer's sensitivity by increasing the lengths of its arms[c] to three times the original values, and made a number of other improvements.

Fig. 10. Dayton Miller in 1921[35].

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[a] Dayton Miller (1866–1941), American physicist and astronomer.

[b] Above.

[c] The parallel and orthogonal paths, Fig. 6a

Measurements in 1905-6 in Cleveland again gave positive results, although with a lower value of ~3.5 km/s[36]. But since very small '2nd order' differences[a37] of around one part in a million[b] were being measured, a certain variability 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 as far as possible the effect of aether entrainment, the aether being dragged along by the Earth.

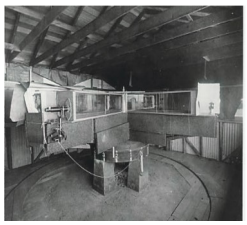

Fig. 0-11. Miller's Mt Wilson interferometer[38].

Miller made some 12'000 sets of observations, as opposed to M&M's 36. He made them over the course of a year, something M&M had recognized needed doing but never did. He concluded that the solar system[c] moves through the aether at a speed:

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

in an astronomical direction[e] (α =5.2, δ=–67°), towards the *Dorad*o (Swordfish) constellation in the Great Magellanic Cloud[39].

Fig. 12a shows specimen measurements plotted against sidereal time. Fig. 12b shows his overall averaged results[f40]. Solar and sidereal times are discussed in the appendix[g].

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[a] Due to the $(v/c)^2$ term in the Lorentz factor (eq.4, p.**Erro! Indicador não definido.**). The Earth's speed through the aether being around 0.1% of that of light.

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

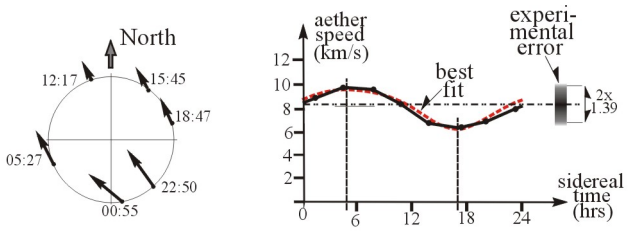
[c] Having taken readings over the course of a year, he could eliminate the effects of the Earth's orbit. At a 95% confidence level.

[d] Solar system with respect to the aether.

[e] p.34.

[f] Somewhat higher than M&M's (Fig. 0-9) due to Cleveland being at a higher latitude (41°) than Mt Wilson (34°).

[g] p.37.



(a) April 1921 (b) Overall averages

Fig. 12. Miller's results[41].

Miller had however by now realized that the aether speeds he was obtaining were far too low. Still assuming this to be due to aether entrainment, and using the Earth's orbital speed as a reference, he calculated that his measured value of 8.22 km/s corresponded to a true aether speed of ~208 km/s[42]. 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[a] whose sensitivity approached that of Miller's. He reported:

> "An aether-drift of some unspecified quantity, just under 20 km/sec."[43].

In spite of this being *more than three times* his original 1887 speed, and with a more accurate instrument, it was again attributed to experimental error. And when in 1932 Kennedy and Thorndike obtained the even higher value of 24 km/sec[44], 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"[45]

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 light-weight."

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

> "Miller's findings remained uncomfortably in the scientific background, impossible to refute and equally impossible to accept."[46]

---

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

[b] Below.

Miller was however 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[47].

Apart from all of this he was an exceptionally careful and rigorous experimenter[a], who during his lifetime successfully defended his results against all skeptics. In 1925 he was awarded $1000[b] by the prestigious *American Association for the Advancement of Science* for his detection of the aether[48] – 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"[49].

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"[50], in 1955 Shankland et al. pronounced Miller's results to be worthless, attributing them to seasonal temperature effects[51].

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

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

Thirdly, temperature variations being Sun-dependent, they should depend on *solar time.* But Miller's results were functions of *sidereal time*[d]*.* 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.[52]

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

---

[a] Cf the exerpt from his1925 report in the appendix (p.35).

[b] Worth a lot more then.

[c] p.35.

[d] Based on a direction in space with respect to the fixed stars rather than the Sun (Fig. 12, appendix p.37.).

> "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."[53]

There by now being no-one 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[54].

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 (!)[55]. Reginald Cahill[a]:

> "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 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."[56]

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:

$$\gamma = \frac{1}{\sqrt{1-\left(\frac{v}{c}\right)^2}} \qquad \text{(eq.4)}$$

so-named in honour of the Dutch physicist Hendrik Lorentz[d].

In the same year the Irish physicist 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:

---

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

[b] "Absolute motion" is one of his ways of avoiding the unspeakable ae-word.

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

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

> "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]."[57]

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."[58]

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

In 1897 the Irish physicist Joseph Larmor[c], likewise independently, derived the same relation[59].

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*[d]
– 2) the *refractive index* of the medium, in this case air

The Michelson-Morley interferometer is repeated in Fig. 13[e]. For an aether head-wind v, the speed of light is c-v on the outward leg and c+v on the return leg. Were there no length contraction, this would give an average speed of c/γ^2[f]. With length contraction the apparent speed is γ times this, i.e. c/γ. And on the orthogonal axis where the photon moves perpendicularly to the aether wind, the average speed is also c/γ[g].

---

[a] George FitzGerald (1851–1901), Irish physicist.
[b] Why this is not exactly the case is shown in the next section.
[c] Joseph Larmor (1857-1942), Irish physicist.
[d] Known to Miller, but not to M&M at the time of their experiments.
[e] Fig. 6
[f] eq8, p.36.
[g] eq.6 (p.36),

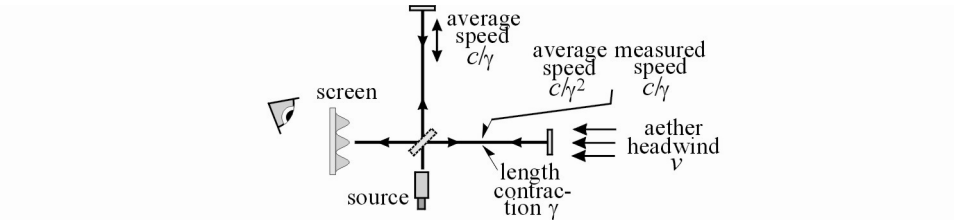


Fig. 13. Michelson-Morley (2).

The same apparent speed of light is thus obtained on *both axes* – as was predicted by FitzGerald and Lorentz[a]. Meaning that an interferometer will 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 already 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 and Miller's experiments now give true aether speeds of:

$$v_{\in}=359 \pm 54 \text{ km/s}; \quad v_{S\in}=433\pm40 \text{ km/s}^{60}$$

respectively, Miller's being in the astronomical direction (α =5.2 hrs, δ= –67^{o}).

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 a direction (α=5.5 hr, δ =–70^{o}) [61], close to Miller's value. Michelson-Morley's direction in principle also agrees with this, although comparison is hampered by measurements only having been taken at a single point in the Earth's orbit[c].

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[62]) and a soft vacuum (Joos in 1930[63]).

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

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[a] p.18.

[b] p.16.

[c] Cf p.14.

the even lower 1.5 km/s[64]. Ironically, these were taken as confirming the Michelson-Morley "null" result. In fact they confirm the FitzGerald-Lorentz length contraction[a].

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 specimen transit times plotted over three sidereal days. 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.

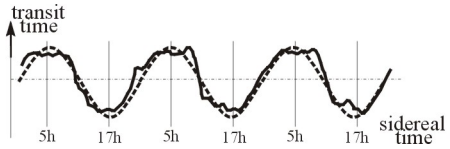

Fig. 0-14. deWitte's signal transit times.

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[65].

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 orientation for their cable, almost perpendicular to the approximately southerly aether wind direction determined by Miller. They make no reference to Miller's work, and so like deWitte they were presumably unaware of it. Otherwise they would surely not have used this orientation.

---

[a] p.18.

[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.

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)[66], again close to Miller's values.

Wallace

In 1961 *Bryan Wallace*[a] 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[67].

> "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."[68]

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

Marinov

The colourful *Stefan Marinov*[b] 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 – Soviet communism's standard way of dealing with such cases. 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[69].

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^o)[70]. We discuss these values 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."[71]

---

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

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

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[72]. 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."[73]

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')."[74]

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

Spacecraft flyby

Further measurements 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, Fig. 0-15, and is lower when it recedes.

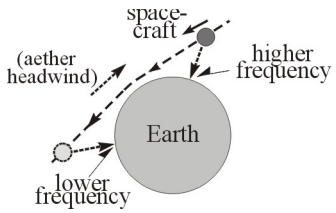

Fig. 0-15. Spacecraft flyby.

In the presence of an aether headwind, both these frequencies will be higher than expected[b]. And vice versa for an aether tailwind[c]. In mainstream physics this is known as the "flyby nomaly"[d],

---

[a] p.6.
[b] Fig. 2b.
[c] Fig. 2c.
[d] An 'anomaly' only for aether skeptics.

Analyzing the Doeppler shifts for various spacecraft flybys at various points in the Earth's orbit, an average aether-wind speed for the solar system of ~420± 20 km/s is obtained[75], close to the Miller and Cahill values[a].

The Doeppler effect for electromagnetic waves is effectively further evidence for the aether. As seen in the cyclist example[b], the effect depends on differing observer speeds *relative to the medium* – the air for sound and the aether for electromagnetic waves. No medium: no Doeppler effect. That electromagnetic waves *do in practice* show a Doeppler effect implies a corresponding medium, an aether.

Other

In a further experiment, electromagnetic signals were found to travel faster from Washington to Los Angeles than vice versa, with a small, but consistent and replicable, difference of 37 nanoseconds[76].

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 that confirmed the invariance of the speed of light in the east-to-west and west-to-east directions to within 50 meters per second. Although published in *Science* magazine in November 1990[77], to date there have been no takers[78]. Silence sometimes speaks louder than words!

General

Resuming the above aether wind measurements:

	year	*type*	*speed*	*direction*
M&M	1887	interferometer	359±54	??
Miller	1933	- " -	433±40	(5.2h, –67^{o})
Torr&Kohlen	1981	coaxial cable	417±40	(5.2h, –65^{o})
deWitte	1991	- " -	??	(5h, ??)
Cahill	2006	- " -	400±20	(5.5±2h, –70±10^{o})
NASA	2008	Doeppler	420±30	??

[a] p.20.

[b] Fig. 2.

[c] Physics professor at the University of Connecticut.

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

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[79]. 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

GENERAL

CMB

When the cosmic microwave background (CMB) was discovered in 1965, it was quickly realized that it could provide an 'at rest' reference for speeds[b].

Consider a spaceship out in deep space, shown in 2-d terms in Fig. 16. When moving at a non-zero speed with respect to the CMB, due to the Doeppler effect[c] the pilot to experiences a higher CMB frequency in front of him and a lower frequency behind. When he observes the same frequency all around him, he knows he is at rest with respect to the CMB.

Fig. 16. Microwave background (2).

The absolute velocity[d] v_S of the solar system has been calculated on this basis to be 370 km/s in an astronomical direction (α =11.2 hrs, δ=–7.2^o), towards the constellation Leo[80], Fig. 17a.

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

[b] Contradicting Einstein"s first postulate that there is none.

[c] p.6.

[d] Taking Cahill"s aether-wind value.

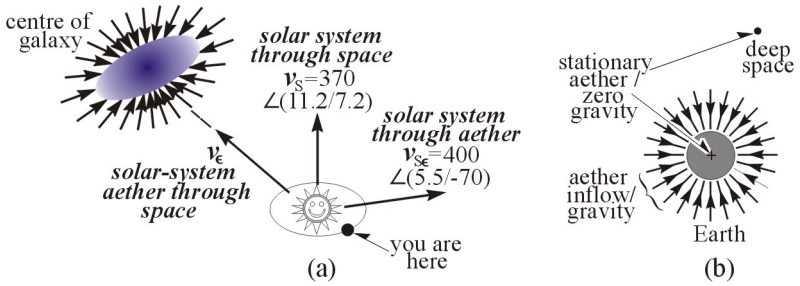

Fig. 17. Aether, absolute speeds; gravity[a].

This is approximately perpendicular to the solar system's velocity though the aether as determined by interferometer experiments, namely $v_{S\epsilon}$≈400 km/s in an approximately southerly direction[b].

The difference between the two is the absolute velocity v_ϵ[c] of the aether in the vicinity of the solar system. Cahill's re-analysis of Miller's data[d] showed this at the Earth's surface to comprise:

– 1) 30 km/s due to its orbital rotation
– 2) 42 km/s inflow towards the Sun
– 3) 420±30 km/s inflow towards the centre of the galaxy[e]

With a further:

– 4) 11.2 km/s inflow towards the Earth's centre[81]

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

All of this suggests that *gravity* is associated with an *aether inflow*:

gravity ⇔ *aether inflow*

In outer space both gravity and the aether speed are zero. But there is also a zero gravity point near[h] the Earth's centre, Fig. 17b. Meaning that the aether is stationary

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[a] "Through space" = "with respect to the CMB".
[b] p.20.
[c] With respect to the CMB.
[d] Ditto.
[e] The gravitational pull towards the centre of the galaxy being ten times greater than that towards the Sun.
[f] Were it not for its fluctuations (below).
[g] Although variations in its direction do (below).
[h] Strictly: 'close to it', due to the minor gravitational effects of the Sun, Moon, etc.

there too. This ties in with the Hafele-Keating observation that their results could be referred either to the Earth's centre, or to the distant stars (outer space)[82].

It is interesting to note that in one of his first published theories of gravity[a], Newton speculated that it could be due to a medium flowing continually downward toward the Earth's surface, where it is partially diffused and partially absorbed[b83].

We can also note that the Marinov rotating-mirror experiment[c] gave a result closer to the CMB velocity than to interferometer aether-wind speeds, for as yet unexplained reasons.

So the solar system moves through the aether at ~400 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, a far cry from the essentially static medium envisaged by Maxwell and Lorentz[d].

That the aether's nature should be basically 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, which is rationally senseless[e84]. The essential nature of the aether could well inherently elude us.

Turbulence

Cahill observed something that deWitte had noted, and is also in fact present in the Michelson-Morley and Miller results. Namely that the aether wind is not smooth but *gusty*, varying from hour to hour and from day to day in both magnitude and direction at a level of around ±20km/s[85].

The same fluctuations are seen in spacecraft flyby data[f86]. 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.

Specimen Michelson-Morley and Dayton Miller[g] readings are shown in Fig. 0-18[87].

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

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

[c] p.22.

[d] p.3.

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

[f] p.23.

[g] Fig. 12a.

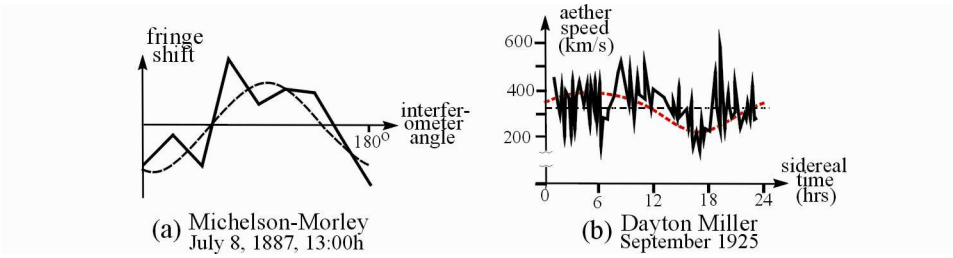

Fig. 0-18. Aether gustiness (1).

Fig. 0-19 shows the fluctuations abstracted from the deWitte experiment[a][88].

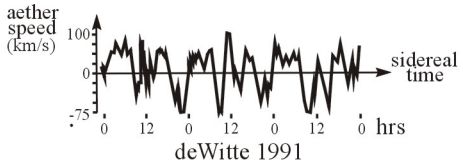

Fig. 0-19. Aether gustiness (2).

Múnera noted that in the Michelson-Morley readings:

> "There were strong variations during a single session. 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."[89]

At midday the aether inflow to the Sun[b] is perpendicular to the plane of the interferometer and has no effect[c], Fig. 0-20a. Whereas in the evenings it contributes to the results, Fig. 0-20b. And while at midday the Earth's rotation opposes its orbital motion, in the evenings it is perpendicular to it.

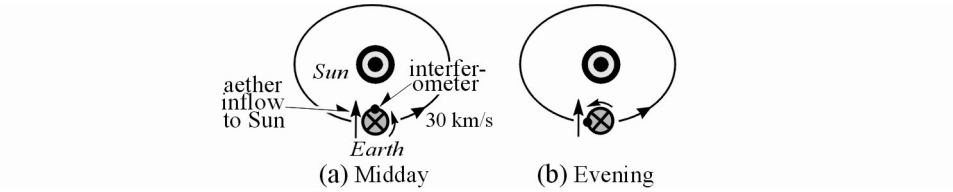

Fig. 0-20. Michelson-Morley (3).

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[a] Fig. 0-14.

[b] p.26.

[c] Apart from its directional variations.

These two considerations could explain the greater variability in the M&M evening measurements[a]. And also why they are somewhat higher than the midday readings.

Returning to the Torr-Kolen experiment[b], since their coaxial cable was at almost 90° to the approximately southerly sense of the aether wind, variations in the aether wind *direction* should produce significant effects. In fact they reported considerable day-to-day fluctuations[90].

The remaining question is: what does this aether-wind turbulence *mean* in physical terms? At present there seems to be no answer. However, our universe is littered with cataclysmic events: supernova explosions, neutron star and black hole mergers, galaxy collisions, etc. And since overall physical reality seems to be essentially electromagnetic – i.e. 'aethereal'– aether turbulence could be simply '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. Designed to detect gravitational waves, they are exceptionally sensitive, capable of detecting changes in mirror spacing of one part in 10^{21}. This is equivalent to the width of a human hair in the distance between the Earth and Proxima Centauri[c].

Operating in the vacuum mode, the instruments are insensitive to the everyday aether wind and its fluctuations[d91]. 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 instruments was consistent with an effect propagating at the speed of light.

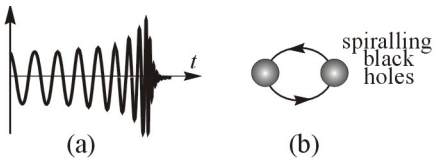

Fig. 0-21. LIGO wave.

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

---

[a] Fig. 0-9.
[b] p.21.
[c] 4×10^{13} km away.
[d] p.21.

That the disturbance travelled at the speed of light suggests strongly that the aether was involved. However, since vacuum-mode interferometers are in general insensitive to aether disturbances[a], the question is: what do the traces *mean* in physical terms? (Good question!)

It would be interesting to operate LIGO in the gas mode, with air rather than a vacuum in its tubes. But since that would risk confirming Cahill's interferometer calibration[b], demonstrating the aether's existence and falsifying Special Relativity, one wonders whether it will ever be done.

NULLIFICATION (2)

General

In spite of all the above, mainstream physics persistently disparages the conceptual arguments for the aether's existence, and nullifies experimental evidence confirming it. Maxwell in 1873:

> "There appears to be, in the minds of some eminent men, some prejudice, or *a priori* objection, against the hypothesis of a medium in which the radiation of light and heat and electric actions at a distance take place." [92]

Thomas See[c] in 1920:

> "A strange tendency has arisen in recent years for abandoning the aether as an unecessary hypothesis."[93]

A recent Google search by the author[94] for "Michelson-Morley result" gave, in order of appearance:

"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* "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

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[a] p.20.
[b] p.19.
[c] In 1920.

> Morley found no significant difference between the speed of light in the two directions." [95]

And so on almost *ad inf*. In the same vein, Einstein wrote 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*."[96] (italics ours)

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

> "Conscious departure from rectitude." [97]

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

> "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 observed absolute motion. Ironically, he received a Nobel prize for reporting that he had not observed what he in fact had."[98]

Come to think of it, why doesn't the Physics Establishment cut all the "explicative" bla-bla and simply declare that 2+2=5, calling anyone refusing to accept it a crackpot? That's the level we're at.

Absolutism

What we have to try to explain is an effective *aether-agnosia*[c] ('not wanting to know of the aether') that seems to have been around well before Einstein's time, and maybe before Michelson's too. We noted Maxwell's 1873:

> "There appears to be, in the minds of some eminent men, some prejudice or à *priori* objection, against the hypothesis of a medium … "[d.]

Europe in the 18th and early 19th centuries was "absolutist", in the sense that political power was firmly in the hands of an established landed aristocracy. Newton's

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

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

[c] From the Greek *a* (not) + *gnosis* (knowing

[d] p.30.

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[a99].

The *droits du seigneur* ("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 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 placed a *pressure for change* onto the social structure.

In such times, *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 Newtonian space and time. And also the aether, which is effectively an absolute.

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

> "There are no eternal facts, just as there are no absolute truths".[100]

Later 20th C post-modernism:

> "has at its heart a general distrust of grand theories and ideologies; a general skepticism toward the assumptions of Enlightenment rationality."[101].

In art, an article on Cubism notes that:

> "In the four decades from 1870-1910, western society witnessed more technological progress than in the previous four centuries. Inventions like photography, cinematography, sound recording, the telephone, the motor car and the airplane heralded the dawn of a new age. Correspondingly, artists developed Cubism where a painting often looks like an image seen in a broken mirror."[102]

The 'broken mirror' being the old way of looking at things, in the process of being replaced by a new one.

So when in 1905 Einstein came along "proving scientifically" that there are no absolutes and that everything is relative, this was exactly what people wanted to hear. And they turned a blind eye to its 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 in the 1920s quantum physics came along declaring that reality is not only inherently *relative*, but also inherently *indeterminate*, and can be any way one wants depending only on one's consciousness[a]: well "Wow!".

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[a] In England the "Four Pillars of the Establishment" were Monarchy, Church, Empire and Newton.

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

Francis Bacon[a] 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 either 'open/liberal' or 'closed/conservative':

agenda: 'open/liberal or closed/conservative

In times of change the agenda is open/liberal. Flexibility and adaptability are valued. In stable settled times the opposite holds. The 'closed/conservative' principle dominates, and respect for tradition and the maintainance of the *status quo* become key values. Since social mobility is here low, the road to individual advancement lies in allying oneself with the existing power structure,

With its emphasis on opportunity and innovation, a liberal agenda tends to *undermine* the existing power structure. Thereby opening it up and creating further opportunities for innovation. Conversely, allying oneself with that structure tends to strengthen it and the prevalent *status quo*. Each agenda is thus effectively *self-reinforcing*, leading to abrupt swings between them when they switch.

Getting back to the aether, by the mid 1800s, thanks principally to Maxwell, its existence was conventional wisdom. It was therefore perceived as pertaining to the reigning 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 1980s Thatcher/Reaganism, the agenda is once again authoritarian and absolutist. And no-aetherism and Relativity having in the meantime become the conventional wisdom, *they* now comprise the mainstream line that all professional physicists are required to "Toe or else!".

So a century after Michelson-Morley, the "will not to believe" in the aether persists. But now for the contrary reason. Its original rejection derived from a *liberal* agenda and need to *break* with reigning authoritarianism. Today's rejection stems from a *conservative* agenda and a desire to *conform* with reigning authoritarianism.

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

"To punish me for my contempt of authority, Fate made me one."[103]

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

---

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

Or maybe better: we only listen to those scientists who tell us what we want to hear, ignoring those who don't – as Dayton Miller discovered to his cost[a].

That would seem to be it. In open/liberal periods 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 mainly on the current political agenda, little on its objective merits. If a theory supports the agenda it is accepted. And if not then not. Science writer Adam Becker says:

> "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."[104]

Maxwell again:

> "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."[105]

Bertrand Russell[b]:

> "It has been said that man is a rational animal. All my life I have been searching for evidence for this."[106]

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.

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[a] p.17.

[b] Bertrand Russell (1872–1970), English philosopher.

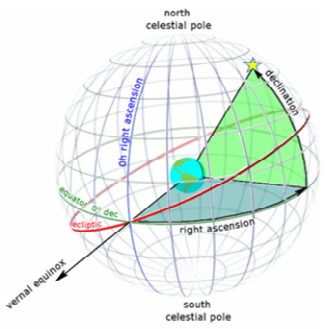

Fig. 0-22. Celestial coordinates[107].

If one stood on the equator at 0° longitude[a] at midday on the March equinox (21/03), the Sun would be immediately overhead at a *Right Ascension* (RA) α =0 hrs and a *declination* δ=0°.

A star 30° above the northern horizon at this instant would have declination δ=+60° and coordinates (α =0 hr, δ=60°). A star 30° above the southern horizon would have coordinates (α =0 hr, δ=–60°).

Longitude and hence Right Ascension being measured eastwards, a star immediately overhead 5 hrs previously to this[b] would then have coordinates (α =5 hrs, δ=0°); and so on.

Miller's control experiments

An exerpt from his1925 report[c]:

> "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

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[a] The Greenwich meridian.

[b] At 07:00 hrs.

[c] Miller 1925.

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 produced by temperature effects." [108]

Can anyone reading this doubt he was a serious experimenter?.

River twins[a]

The 'crosses' twin swims across the river and back again. The 'up-down' twin swims the same distance, but first upstream and then back, Fig. 0-23a.

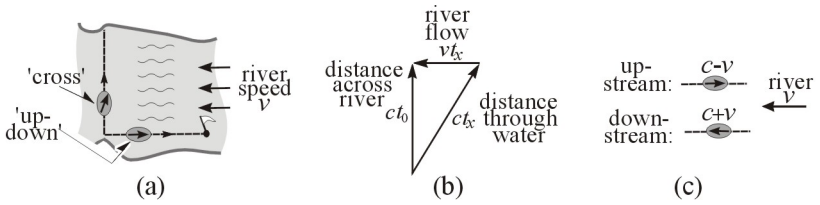

Fig. 0-23. River twins (2).

Taking first the 'crosses' twin, Fig. 0-23b, let c be his swimming speed, t_0 the time he would take to cross a stationary river, and t_x the time he actually takes. The width of the river is then ct_0; the distance he swims through the water is ct_x, and the distance the river carries him down in this time is vt_x. Using Pythagoras theorem and the Lorentz factor γ[b]:

$$(ct_x)^2 = (ct_0)^2 + (vt_x)^2 \qquad \text{(eq.5)}$$

Whence his actual crossing time t_x:

$$t_x = \gamma t_0 \qquad \text{(eq.6)}$$

For the 'up-down' twin, his absolute upstream speed is c-v and his downstream speed c+v, Fig. 0-23c, giving a total journey time $2t_1$[c]:

$$2t_1 = \frac{ct_0}{c-v} + \frac{ct_0}{c+v} \qquad \text{(eq.7)}$$

Whence his average leg time t_1:

$$t_1 = \gamma^2 t_0 \qquad \text{(eq.8)}$$

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[a] Fig. 0-5.

[b] eq.4 (p.18).

[c] 't_1' to match the 'crosses' twin's single leg time t_x. The distance he travels on each leg is the 'cross' twin's ct_0.

The 'up-down' twin's average leg time is then[a] longer than the 'crosses' twin's by the factor γ:

$$t_1 = \gamma t_x \qquad \text{(eq.9)}$$

As a check, for a stationary river, setting v=0, the Lorentz factor γ is unity and the leg times for the two twins are equal.

Sidereal, solar times

Imagine[b] for simplicity that '12:00 midday' in both solar and sidereal times are defined as the instant on the March equinox (21/03) that the Sun and some fixed star are immediately overhead[c], Fig. 24a.

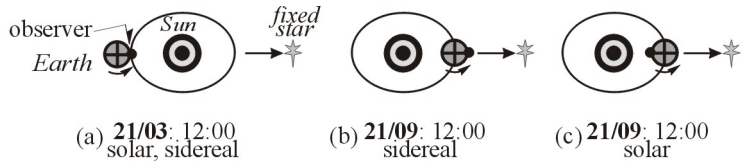

Fig. 24. Solar, sidereal times.

Six months later, 12:00 sidereal time is as in Fig. 24b, and 12:00 solar time is 12 hrs later, Fig. 24c. A year then has 365 solar and 366 sidereal days, making a sidereal day 4 mins[d] shorter than a solar day.

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[a] Using eq.6.

[b] For illustration.

[c] Being daytime, the fixed star is obviously behind the Sun and not visible.

[d] 24 hrs/365 days = 4 mins.

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