*** in Should the Laws of Gravitation be Reconsidered? Héctor Múnera, Editor, Apeiron, Montreal 2011, p.285-315.**

Dayton C. Miller Revisited *

James DeMeo
Director, Orgone Biophysical Research Laboratory
Ashland, Oregon, USA
demeo@mind.net

1 Introduction

The history of science records the 1887 ether-drift experiment of Albert Michelson and Edward Morley as a pivotal turning point, where the energetic ether of space was discarded by mainstream physics. [1] Thereafter, the postulate of "empty space" was embraced, along with related concepts which demanded constancy in light-speed, such as Albert Einstein's relativity theory. The now famous Michelson-Morley experiment is widely cited, in nearly every physics textbook, for its claimed "null" or "negative" results. Less known, however, is the far more significant and detailed work of Dayton Miller. [2-11]

Dayton Miller's 1933 paper in *Reviews of Modern Physics* details the positive results from over 20 years of experimental research into the question of ether-drift, and remains the most definitive body of work on the subject of light-beam interferometry. [10] Other positive ether-detection experiments have been undertaken, such as the work of Sagnac, [12] and Michelson, Gale and Pearson, [13] documenting the existence in light-speed variations ($c+v > c-v$), but these were not adequately constructed for detection of a larger cosmological ether-drift, of the Earth and Solar System moving through the background of space. Miller's work on ether-drift was so constructed, however, and yielded consistently positive results.

Miller's work, which ran from 1906 through the mid-1930's, most strongly supports the idea of an ether-drift, of the Earth moving through a cosmological medium, with calculations made of the actual direction and magnitude of drift. By 1933, Miller concluded that the Earth was drifting at a speed of 208 km/sec towards an apex in the Southern Celestial Hemisphere, towards Dorado, the swordfish, right ascension 4 hrs 54 min., declination of −70° 33′, in the middle of the Great Magellanic Cloud and 7° from the southern pole of the ecliptic. [10, p. 234] This is based upon a measured displacement of around 10 km/sec at the interferometer, and assuming the Earth was pushing through a stationary, but Earth-entrained ether in that particular direction, which lowered the velocity of the ether from around 300 to 10 km/sec at the Earth's surface. Today, however, Miller's work is hardly known or mentioned, as is the case with nearly all the experiments which produced positive results for an ether in space. Modern physics today points instead to the much earlier and less significant 1887 work of Michelson-Morley, [1] as having "proved the ether did not exist."

While Miller had a rough time convincing some of his contemporaries about the reality of his ether-measurements, he clearly could not be ignored in this regard. As a graduate of physics from Princeton University, President of the American Physical Society and Acoustical Society of America, Chairman of the Division of Physical Sciences of the National Research Council, Chairman of the Physics Department of Case School of Applied Science (today Case Western Reserve University), and Member of the National Academy of Sciences well known for his work in acoustics, Miller was no "outsider." While he was alive, he produced a series of papers presenting solid data on the existence of a measurable ether-drift, and he successfully defended his findings to not a small number of critics, including Einstein. His work employed light-beam interferometers of the same type used by Michelson-Morley, but of a more sensitive construction, with a significantly longer light-beam path. He periodically took the device high atop Mt. Wilson (above 1,800 m elevation), where Earth-entrained ether-theory predicted the ether would move at a faster speed than close to sea-level. While he was alive, Miller's work could not be fundamentally undermined by the critics. However, towards the end of his life, he was subject to isolation as his ether-measurements were simply ignored by the larger world of physics, then captivated by Einstein's relativity theory.

After his death in 1941, Miller's work was finally "put to rest," in the publication of a critical 1955 paper in *Reviews of Modern Physics* by Robert S. Shankland, S. W. McCuskey, F. C. Leone and G. Kuerti (hereafter referred to as the "Shankland team" or "Shankland" paper), which purported to make a fair and comprehensive review of Miller's data, finding substantial flaws. [14] Lloyd Swenson's *Ethereal Aether* (1972) presents a cursory discussion of Miller and his "inexplicable" positive results, [15] giving a high degree of significance to the Shankland team's critique. Swenson wrote:

> ...Shankland, after extensive consultation with Einstein, decided to subject Miller's observations to a thoroughgoing review ... Einstein saw the final draft [of Shankland's prepublication manuscript] and wrote a personal letter of appreciation for having finally explained the small periodic residuals from [Miller's] Mount Wilson experiments. [15]

In August of 1954, Einstein replied to Shankland:

> I thank you very much for sending me your careful study about the Miller experiments. Those experiments, conducted with so much care, merit, of course, a very careful statistical investigation. This is more so as the existence of a not trivial positive effect would affect very deeply the fundament of theoretical physics as it is presently accepted. You have shown convincingly that the observed effect is outside the range of accidental deviations and must, therefore, have a systematic cause [having] nothing to do with 'ether wind', but with differences of temperature of the air traversed by the two light bundles which produce the bands of interference. [16, p. 2283]

From the above accounts, it certainly would appear that the case was finally closed on Miller, and that all the lose ends were finally cleaned up. With the strongest support for cosmological ether-drift swept aside as the alleged product of temperature errors, Einstein's theory of relativity continued to grow in popularity and dominance.

Here, I will compare the Shankland team's 1955 criticisms [14] to what is actually contained in Miller's published works, notably his 1933 paper which summarized his work on the subject. [10] It is my contention, the Shankland paper, published 14 years after Miller's death, attempted to resurrect speculative criticisms which had previously been raised and rebutted when Miller was alive, and not given serious credibility except among anti-ether fundamentalists. The Shankland paper also misrepresented Miller's data in several ways, and furthermore misrepresented it-

Figure 1. Miller's interferometer (left). Light paths of the Michelson-Morley and Miller Interferometers, as seen from above (right).

self as a definitive rebuttal, which it most certainly was not. In order to properly address this major issue of science history, I will also recount the central facts of Miller's work.

The basic principles of light-beam interferometry for detection of ether-drift are described in most textbooks, albeit with typical factual errors (*i.e.*, the slight positive result of the Michelson-Morley experiment is nearly always misrepresented as a "null" or "zero" result) and so will not be repeated here. However, there were novel methods introduced by Miller into the discussion of ether-drift, along with interferometer construction features and principles of operation which are not widely known — these will be detailed.

2 Miller's work with interferometry

Miller began his work on the question of ether-drift and light-beam interferometry with Edward Morley, from 1902 to 1906, using an apparatus three times as sensitive as the original interferometer used by Michelson-Morley in 1887. [2, 3, 4] In later years, from 1921 through 1928, Miller made additional refinements for sensitivity in his interferometer, obtaining increasingly significant positive results. [5-11]

His interferometer was the most massive and sensitive ever constructed, with iron cross-arms 4.3 m across, and standing 1.5 m in height (fig. 1). Four sets of mirrors were mounted on the end of each cross-arm to reflect light beams back and forth 16 times horizontally with a total round-trip light path of 64 m, starting from the same light-source, and finally recombined to form interference fringes whose movement relative to a pointer was read through a magnifying telescope. The large apparatus was floated

Figure 2. Left: the light-interference fringes as seen in the interferometer telescope, fringes shifted laterally as the instrument was rotated. Right: the original Michelson-Morley interferometer with an approximate 22-meter round-trip light-beam path, mounted on a concrete platform in the basement of the old Case School Physics building.

inside a circular tank of liquid mercury, providing a frictionless base for rotation. Fringe-shift movements (in tenths of a fringe, plus or minus in direction, see Figure 2, left) were observed by one person who walked around with the apparatus while it turned, speaking out the readings at the ring of bell which automatically sounded when electrodes made contact at 24° intervals (dividing the circle into 15 parts). An assistant then noted the readings on paper.

The readings, from consecutive turns of the apparatus were then organized into "sets," which were made at different times of day and at different seasons of year. Data sets were then averaged according to a sidereal time clock, which was correlated with external celestial coordinates. Miller became convinced of an ether Earth-entrainment effect, which necessitated using the apparatus at higher altitudes (to reduce the anticipated entrainment-effect of sea-level environments), and he additionally undertook the experiments in structures where the walls at the level of the light-path were open to the air, covered with canvas. Only glass, or glass and light paper covers were used along the light-beam paths, with all wood or metal shielding removed. By contrast, the original Michelson-Morley interferometer had a round-trip light-path of around 22 meters, [17] and the experiments were undertaken with an opaque wooden cover over the instrument, situated in the basement of one of the large stone buildings at Case School in Cleveland (today, Case-Western Reserve University), see Figure 2, right.

In his 1933 paper, Miller published the most comprehensive summary of his work, and the large quantity of data which supported his conclusions. A total of over 200,000 individual readings were made, from over 12,000 individual turns of the interferometer, undertaken at different months of the year, starting in 1902 with Edward Morley at Case School in Cleveland, and ending in 1926 with his Mt. Wilson experiments. These data do not include many rigorous control experiments undertaken at Case School Physics Department from 1922 to 1924. More than half of Miller's readings were made at Mt. Wilson using the most sophisticated and controlled procedures, with the most telling set of experiments in 1925 and 1926. [10, 11] By contrast, we can mention here, the original Michelson-Morley experiment of 1887 involved only six hours of data collection over four days (July 8, 9, 11 and 12 of 1887), with a grand total of only 36 turns of their interferometer. [1] Even so, as shown below, Michelson-Morley originally obtained a slight positive result which has been systematically ignored or misrepresented by modern physics. As stated by Michelson-Morley:

> …the relative velocity of the earth and the ether is probably less than one-sixth the earth's orbital velocity, and certainly less than one-fourth. ... The experiment will therefore be repeated at intervals of three months, and thus all uncertainty will be avoided. [1]

Unfortunately, and in spite of all claims to the contrary, Michelson-Morley never undertook those additional experiments at the different seasonal configurations, to "avoid all uncertainty." However, Miller did. Over many years, he developed increasingly sensitive apparatus, using them at higher altitudes and in open structures, making clear and positive detection of the ether. His experiments yielded systematic periodic effects which pointed to a similar identifiable axis of cosmic ether-drift, though of a variable magnitude, depending upon the season, time of day, density of materials shielding or surrounding the apparatus, and altitude at which the experiment was undertaken. He argued that basement locations, or interferometers shielded with opaque wood or metal housings, yielded the most tiny and insignificant effects, while those undertaken at higher altitudes and in less dense structures yielded more readily observable effects. The Michelson-Morley experiment, by comparison, was undertaken in the basement of a stone building closer to sea-level. Even so, it produced a slight positive result which was in agreement with Miller's results.

Miller's observations were also consistent through the long period of his measurements. He noted, when his data were plotted on sidereal time, they produced

> ...a very striking consistency of their principal characteristics...for azimuth and magnitude... as though they were related to a common cause... The observed effect is dependent upon sidereal time and is independent of diurnal and seasonal changes of temperature and other terrestrial causes, and...is a cosmical phenomenon. [10, p. 231]

3 Debates with Einstein

There are several newspaper accounts indicating a certain tension between Albert Einstein and Dayton Miller, since the early 1920s at least. In June of 1921, Einstein wrote to the physicist Robert Millikan:

> I believe that I have really found the relationship between gravitation and electricity, assuming that the Miller experiments are based on a fundamental error. Otherwise, the whole relativity theory collapses like a house of cards. [18]

Privately, in letters and in spoken words, there was a struggle going on for philosophical dominance, and occasionally this struggle surfaced into public view:

> *GOES TO DISPROVE EINSTEIN THEORY. Case Scientist Will Conduct Further Studies in Ether Drift.* Einstein discounts experiments speaking before scientists at the University of Berlin, Einstein said the ether drift experiments at Cleveland showed zero results, while on Mount Wilson they showed positive results. Therefore, altitude influences results. In addition, temperature differences have provided a source of error.
>
> "The trouble with Prof. Einstein is that he knows nothing about my results." Dr. Miller said.
>
> He has been saying for thirty years that the interferometer experiments in Cleveland showed negative results. We never said they gave negative results, and they did not in fact give negative results. He ought to give me credit for knowing that temperature differences would affect the results. He wrote to me in November suggesting this. I am

Figure 3. Left: upper part of Miller's data sheet for run No. 79. Temperature readings of four thermometers located at N, E, S, W in the room were read at the beginning of the run at 03:09 (left upper corner), and at 03:17 (right upper corner). Right: Miller's Control Experiments. A concrete platform supports the mirrors and optics of the interferometer, inside a small shelter on the grounds at Case School.

> not so simple as to make no allowance for temperature. (*Cleveland Plain Dealer* newspaper, 27 Jan. 1926).

The above newspaper account is significant, as it demonstrates that Einstein was pushing the "thermal artefact" argument against Miller's results as early as 1926. There are other accounts of Einstein's discontent with Miller's results in *Conversations with Albert Einstein* written by Robert Shankland in the years after Miller's death. [19, 20]

4 Miller's control experiments

Miller was fully aware of the criticisms being made against his findings, that his interferometer was responding to one or another mechanical, magnetic or thermal influence. Given its large size and sensitivity, it required a careful set-up procedure prior to each use. Setting screws with extremely fine threads were used to adjust the mirrors, and the final adjustment could isolate 100 wavelengths of light by just a 16° turn of the screw. Even this was insufficient for the final adjustment, which was made by adding small weights of around 100 gram to the end of a cross-beam, which was sufficient to cause a micro-flexing of the iron supports by only a few wavelengths. Only then would the interference fringes come into view. And once in view, additional care had to be taken to prevent distortions from mechanical vibrations. Consequently, from the very beginning of the ether-drift experiments, Miller undertook extensive control experiments and procedures to guard against laboratory artifacts, and to objectively determine just how sensitive his apparatus was to external influences.

Figure 4. Left: Miller's fully-insulated interferometer as it was finally employed at Mt. Wilson, circa 1925, fitted with 2.5 cm insulating cork panels covering the metal support structure, and glass and light paper coverings along the light-beam path (paper removed for the photograph). These steps eliminated any significant influences of ambient temperature differences upon the apparatus and the air within the light-beam path, but still allowed the movement of ether-drift. Right: Miller's interferometer house on Mt. Wilson. With canvas-covered windows all around, insulating wood fibre walls, and fitted with a tent.

Especially between 1922-1924, Miller's control experiments were most rigorous, aimed at addressing the criticisms he had received following the earlier work, to make the apparatus as sensitive as possible only to ether-drift. A special interferometer of aluminum and brass was constructed, to guard against the possible effects of magneto-constriction (the measured periodic ether-drifting was the same as with the original iron interferometer). Procedures were made to judge the effects of mechanical vibration — such as using a loose or tight centring pin. Bases made of wood, metal or concrete were floated in the mercury tank, to judge and correct for the effects of strain and deformation. The apparatus was not touched when operating, but rather gently pulled in a circle by a thin string, slowly accelerated to the desired velocity of rotation while floating in the mercury tank. Different light sources were tried, mounted on different locations on the apparatus. Light sources outside the structure were also tried, including Sunlight, but finally an artificial light source located above the central axis of the instrument was used.

Possible temperature effects were evaluated by using radiant parabolic heaters to artificially heat the apparatus and the air through which the light-beam passed. These experiments showed the interferometer clearly was sensitive to artificial heating, and so steps were taken to eliminate the effect. Strong radiant heat sources, it was learned, would badly skew the apparatus if fo-

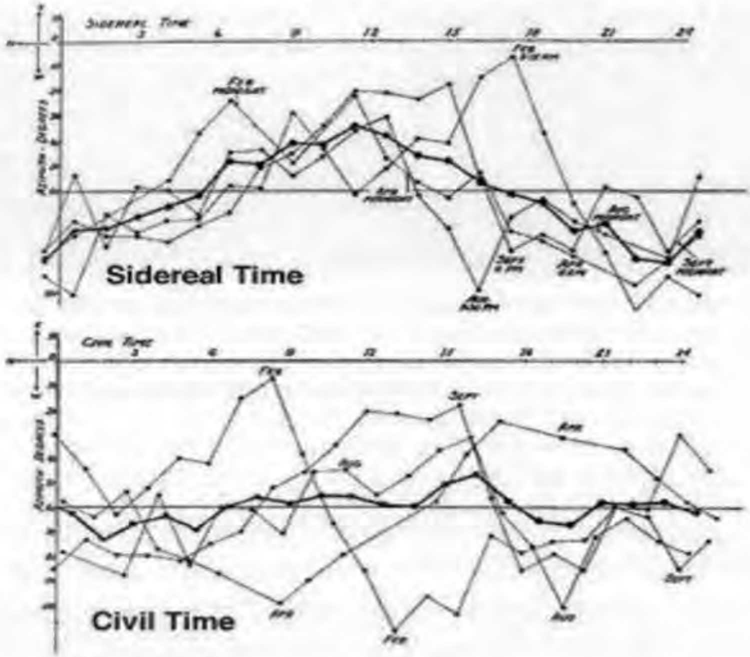

Figure 5. Periodicity of global ether-drift, Mount Wilson experiments, 1925-26. Top graph: data for four different months spread over a year versus sidereal time. The heavy line is the mean of all four epochs, showing a definite periodic curve. Bottom graph: the same data versus civil time; data spreads out, without apparent periodicity. [8, p. 362]

cused upon only one arm or pair of arms of the iron cross-beams. Equal heating of the apparatus had no such effect, but the metal arms were nevertheless covered with a one-inch cork insulation to guard against radiant thermal effects. The light-path was given a glass housing, which stabilized the temperature inside, and later, a light corrugated paper cover was added over the glass cover, which did not affect the ether-drift, but further protected against possible temperature variations. Low-level thermal effects were also evaluated, as from human body heat, by having the recording assistant stand in different locations while the apparatus was turned and operated.

Temperature effects from the larger environment were evaluated as well. Early ether-drift experiments, including those of Michelson-Morley and Morley-Miller, were undertaken inside basement locations with relatively stabilized temperatures, but shielded from the ether-drift as well due to heavy and dense

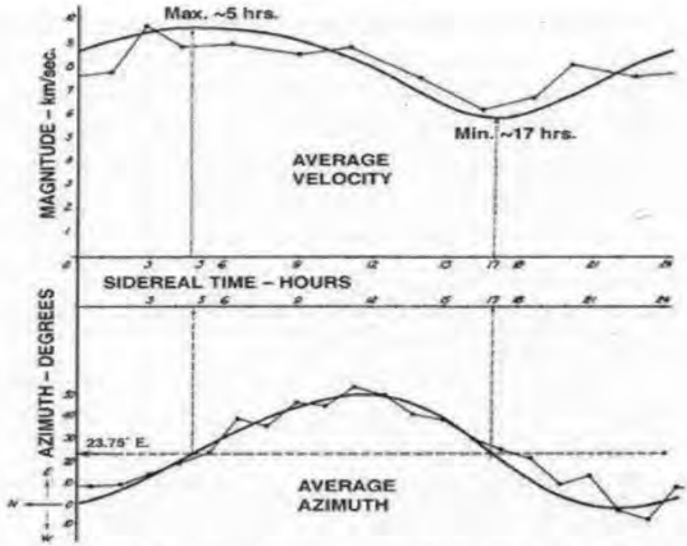

Figure 6. Average velocity and azimuth of global ether drift, from Mount Wilson experiments, 1925-26. Top graph: average variations in observed magnitude of ether-drift from all four epochs of measurement; maximum velocity occurs at around 5 hours, and minimum velocity at around 17 hours sidereal time. Bottom graph: average variations in observed azimuth readings according to sidereal time. The vertical axis shows the same average data from Figure 5 (top graph), [8, p. 362] but the horizontal axis uses Miller's revised seasonal averages. [10, p. 235] This graph helps define the axis of ether-drift. Amazingly, the independent averages for the four epochs provided by Miller (Feb.=-10° west of north, April=+40° east, Aug.=+10° east, Sept.=+55° east) together yield a mean displacement 23.75° east of north, which is very close to the Earth's axial tilt of 23.5°, and can hardly be coincidental. For more discussion see [21].

building materials. Miller's ether-drift experiments atop Mt. Wilson required a different approach, and a special house was constructed to shelter the interferometer. It had a floor, walls and roof, and canvas-covered windows all around at the level of the interferometer light-beam. During his last set of Mt. Wilson experiments in 1925-1926, a tent-like covering was erected over the roof and walls to provide additional shielding from direct Sunlight, to diminish thermal variations or radiant heating effects from the walls.

Miller noted that at no time during his entire work on the question did he ever observe any periodic effects expressing themselves according to civil time coordinates, as would be present if a thermal effect was radiating from a specific wall, related to solar heating. Since the measurements were made at different times of day, and at different seasons, their amplitude would vary, but the direction of the ether-drift would shift only to the same average points along a sidereal azimuth. This is graphically demonstrated in Figures 5 and 6. The measurements were latitude-dependent as well, and when analyzed with attention to the Earth's rotation, axial tilt, movement around the Sun, and Sun's movement through galactic space, finally revealed a common sidereal cosmological axis of ether-drift.

From reading his publications, one gets the impression of Dayton Miller as a very careful and exceptionally patient experimentalist, someone who took every possible precaution to insure his apparatus was detecting only the phenomenon of interest. He also appeared to be quite content with the possibility that, having undertaken all the various controls to shield the apparatus from thermal effects in the measurement room, he might finally get a true "null" or "zero" effect – he did not appear to be a "believer" in ether-drift who would succumb easily to bias. He was a genuine scientist, dedicated to finding the truth of the matter. A null result was not observed, however, and his efforts to control out mechanical and thermal artefacts never eliminated the observed periodic sidereal variations, which persisted throughout his experimental work. More will be said about Miller's control procedures below.

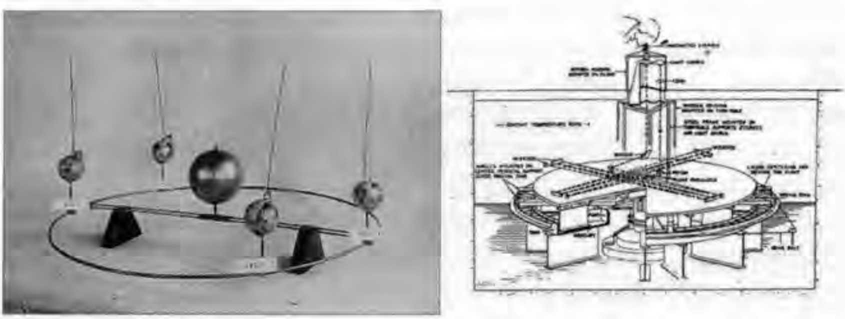

Figure 7. Left: a model constructed by Miller, displaying the axis of ether-drift for the four seasonal epochs of the Earth moving around the Sun. In Miller's model, the axis of drift appears to be roughly perpendicular to the plane of the ecliptic. Right: Apparatus used by Michelson-Pease-Pearson in their successful detection of an ether-drift of some unspecified quantity just under 20 km/sec at Mount Wilson. [22]

5 Michelson, and others, confirm an ether-drift

Miller's work did finally receive an indirect support from Albert Michelson in 1929, with the publication of "Repetition of the Michelson-Morley Experiment." [22] The paper reported on three attempts to produce ether-drift fringe shifts, using light-beam interferometry similar to that originally employed in the Michelson-Morley (M-M) experiments.

In the first experiment, undertaken in June of 1926, the interferometer was the same dimensions as the original M-M apparatus, with a round-trip light path of around 22 meters. A fringe shift displacement of 0.017 was predicted, but the conclusions stated "No displacement of this order was observed." The second experiment, undertaken on unspecified "autumn" dates in 1927, employed a slightly longer round-trip light path of around 32 meters. Again, "no displacement of the order anticipated was obtained," and the short report did not give details about the experimental surroundings or locations.

The third experiment was undertaken on an unspecified date (probably 1928) in "a well-sheltered basement room of the Mount Wilson Laboratory." The round-trip light path was further increased to approximately 52 meters. This time, having moved the apparatus to a higher altitude and using a longer light-path, a small quantity of ether-drift was detected which approximated the result observed by Miller, although the results were unjustifiably reported in negative terms:

> ...precautions taken to eliminate effects of temperature and flexure disturbances were effective. The results gave no displacement as great as one-fifteenth of that to be expected on the supposition of an effect due to a motion of the solar system of three hundred kilometres per second. These results are differences between the displacements observed at maximum and minimum at sidereal times, the directions corresponding to ... calculations of the supposed velocity of the solar system. A supplementary series of observations made in directions half-way between gave similar results. [22]

One fifteenth of 300 km/sec is 20 km/sec, a result the authors dismissed as they apparently had discarded the concept of an Earth-entrained ether, which would move more slowly closer to sea level. A similar result of 24 km/sec was achieved by the team of Kennedy-Thorndike in 1932, [23] however they also dismissed the concept of an entrained ether and, consequently, their own measured result:

> In view of relative velocities amounting to thousands of kilometres per second known to exist among the nebulae, this can scarcely be regarded as other than a clear null result.

This incredible statement serves to illustrate how deeply ingrained was the concept of a static ether.

Michelson, Pease and Pearson went on to make speed-of-light measurements in a one mile long partially-evacuated steel tube lying flat on the ground, oriented roughly southwest to northeast. While the purpose of these experiments was not to measure any ether-drift or variation in the speed of light, such variations in fact were observed and reported in their paper. [24] A newspaper account of these experiments, published after Michelson's death in 1931 but prior to their final publication of results reported:

> Dr. Pease and Mr. Pearson say the entire series of measures, made mostly between the hours of 7 and 9 PM, show fluctuations which suggest a [variation] of about 20 kilometres per second. [25]

Miller commented on these results, suggesting they would have measured a stronger ether-drift variation if they had taken their interferometers outside of the basement structures and steel pipes:

> If the question of an entrained ether is involved in the investigation, it would seem that such massive and opaque shielding is not justifiable. The experiment is designed to detect a very minute effect on the velocity of light, to be impressed upon the light through the ether itself, and it would seem to be essential that there should be the least possible obstruction between the free ether and the light path in the interferometer. [10, p. 240]

Miller had, by this time, acquired a lot of experience working on Mt. Wilson, using his large interferometer in the specially-constructed interferometer house. With a light path of 64 m, Miller's apparatus was still significantly more sensitive than the best apparatus of Michelson-Pease-Pearson. Given that Michelson-Pease-Pearson did make some small detection of an ether-drift from their efforts at Mt. Wilson, in spite of the fact that it was located in a basement location, their report of detectable sidereal fringe displacements supports Miller's findings. It is also notable that this was the second time Michelson's work had significantly detected an ether, though in the first instance of Michelson and Gale (1925) the apparatus could only measure light-speed variations along the rotational axis of the Earth. [13] These papers by Michelson and also by Kennedy-Thorndike have conveniently been forgotten by modern physics, or misinterpreted as being totally negative in result, even though all were undertaken with far more precision, with a more tangible positive result, than the celebrated Michelson-Morley experiment of 1887. Michelson went to his grave convinced that light speed was inconstant in different directions, and also convinced of the existence of the ether. The modern versions of science history have rarely discussed these facts.

6 Shankland team's 1955 critique of Miller

As previously pointed out by Swenson, [15] Shankland's 1955 critique of Miller's work was undertaken with "extensive consultations" with Einstein, who like Newton and others before him had assumed only a static or stagnant ether, through which the Earth passed without material affect and, hence, without entrainment close to the Earth's surface. Shankland in fact was Miller's student for many years, and only emerged to become a professional advocate of Einstein's relativity after the death of Miller in 1941. Shankland became Chairman of the Physics Department at Case following Miller's retirement and death, building his professional career upon publications misrepresenting the Michelson-Morley experiments as the most solid evidence on the question, and publishing widely-read interviews with Einstein. [16, 19, 20, 26]

Shankland later took up administrative positions within government agencies developing nuclear energy – he rarely discussed Miller's positive ether-drift measurements in any of these papers except in the 1955 paper under discussion here. [14] In this sense, it is legitimate to view Shankland, and other members of his team (all Einstein advocates from Case) as very biased reviewers of Miller's work.

The very first sentence in the Shankland team's 1955 paper began with the falsehood, now widely parroted in nearly every physics textbook, that the Michelson-Morley experiments had a "null" result. The third sentence in the Shankland paper was similarly false, claiming that "All trials of this experiment except those carried out at Mount Wilson by Dayton C. Miller yielded a null result within the accuracy of the observations." This kind of chronic misrepresentation of the slight positive results of many interferometer experimenters, including Michelson and Morley, Morley and Miller, Sagnac, Michelson and Gale, and Michelson, Pease and Pearson, suggests an extreme bias and deliberate misrepresentation. The fact that this is a very popular bias does not excuse it. By redefining all the positive results observed by what may in fact have been the majority of ether-drift researchers, as mere expressions of "observational inaccuracy," Shankland narrowed his task considerably.

These and other sentences in the Shankland paper revealed its bias from the get-go, and gave it the spirit of an autopsy, where Miller was dissected without careful concern, and certainly where no advocate of ether theory appeared to be involved in the process. It is possible, by the 1950s, there was nobody left who could fill Miller's shoes to make an adequate defense. Ether-theory was then being compared to "the search for perpetual-motion machines," [15] and such ridicule surely must have had a silencing effect upon the entire fields of physics and astronomy. Swenson also suggests that, during his later years, Miller was largely ignored and isolated. This appears to be correct, as according to an interview with Shankland made in 1981, shortly before Miller died he gave all of his interferometer data sheets — hundreds of pages of measurements — to his one-time student Shankland, with the somewhat bitter statement that he should "either analyze the data, or burn it." [27] In that same interview, Shankland also blamed Miller for having blocked the awarding of a Nobel Prize to Einstein for his relativity theory — clearly, Miller's work was a major obstacle to the Einstein theory of relativity, and for that reason may have given Einstein and his followers sleepless nights.

The title of the Shankland paper, and its overall representation suggests the authors had made a serious review of "*the* interferometer observations" of Miller, to include some kind of comprehensive and inclusive evaluation — but this was not the case. There were two basic approaches to the Shankland team's analysis: 1) a search for random errors or statistical fluctuations in Miller's data, and 2) a review of selected data sets which they claimed demonstrated significant thermal artefacts in the data. We can review these claims.

7 Shankland team's evaluation for random-statistical variations

The Shankland paper did present a statistical analysis of a portion of Miller's published 1925-1926 Mt. Wilson data, concluding that his observations

> ...cannot be attributed entirely to random effects, but that systematic effects are present to an appreciable degree" and that "the periodic effects observed by Miller cannot be accounted for entirely by random statistical fluctuations in the basic data. [14, p. 170]

Also, the Shankland team admitted they

> ...did not embark on a statistically sound recomputation of the cosmic solution, but rather [looked for]...local disturbances such as may be caused by mechanical effects or by nonuniform temperature distributions in the observational hut. [14, p. 172]

In short, they admitted the harmonic patterns in Miller's data could not be due to any systematic measurement error, nor result from any mechanical flaws in the interferometer apparatus itself — while simultaneously admitting a disinterest in computation of any potentially validating ether-drift axis ("cosmic solution") from his data. These were important admissions, as the suggestion is, unless they could find some other fatal flaw in his data, Miller had really got it right, and measured a real Earth-entrained ether drift.

Of interest from the perspective of the politics of science, is the fact that *this statistical analysis was not undertaken by any of the four members of the Shankland team listed as authors of the paper!* The analysis was in fact undertaken by Case physics student Robert L. Stearns, for his Master's Thesis, [28] — Stearns was given only a footnote credit in the Shankland paper.

Stearns, who performed the analysis, informs us about the large amount of data gathered by Miller. He mentions the existence of "316 sets of data...by Miller in 1925-26" for the centrally-important Mt. Wilson experiments. [28, p. 15-17] Each data set was composed of 20 turns of the interferometer, with sixteen data points per turn (a total of 320 data points per data set). Miller noted his work at Mt. Wilson was undertaken at four different seasonal "epochs," each of which encompassed a period of around ten days, centred on the following dates: April 1st, August 1st, and September 15th, 1925 and February 8th 1926. [7, 10] It must be kept in mind, that these Mt. Wilson data from 1925 and 1926 provided the most conclusive and foundational observations for Miller's ether-drift calculations and conclusions, as presented most clearly in his 1933 paper. As detailed below, the Shankland team mentions these Mt. Wilson data, but in a manner which confuses them with his earlier and less significant efforts, including various control experiments conducted at Case School. The significance of this confusion of dates will be highlighted momentarily.

8 Shankland team's assertion of temperature artefacts

Regarding possible temperature artifacts in Miller's data, this objection was raised early on in the history of ether-drift interferometry, and specifically rebutted by Miller when he was still alive. A letter exchange between Miller and Georg Joos from a 1934 issue of Physical Review records part of this debate, and appears to be one of the few *published* criticisms on the temperature issue Miller ever received while still alive. Miller had this to say about the problem:

> When Morley and Miller designed their interferometer in 1904 they were fully cognizant of this...and it has never since been neglected. Elaborate tests have been made under natural conditions and especially with artificial heating, for the development of methods which would be free from this [thermal] effect. [29]

The Shankland critique never made any systematic evaluation of possible thermal artefacts using a larger set of Miller's data, as was done with the statistical evaluation. Instead, they appear to have "gone fishing" in Miller's data for something by which they could simply dismiss him. For example, Miller's own 1923 temperature-control experiments were brought into discussion, where radiant parabolic heaters were used to artificially create a general doubling of the size of interference fringes. Miller describes these experiments:

> 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 displacements. Even when two of the heaters, placed at a distance of three feet from the interferometer as it rotated, were adjusted to throw the heat directly on the uncovered steel frame, there was no periodic effect that was measurable. When the heaters were directed to the air in the light-path which had a covering of glass, a periodic effect could be obtained only when the glass was partly covered with opaque material in a very nonsymmetrical 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 displacements could not possibly be produced by temperature effects. [10, p. 220]

Perhaps without intending to do so, after examining Miller's laboratory notes for the Cleveland temperature control experiments, the Shankland team confirmed Miller on this point:

> In the experiments where the air in the optical paths was directly exposed to heat, large second harmonics (0.35 fringe for one heater, and about twice this value for two heaters) were always observed in the fringe displacements, and with the expected phase. Shifting the heaters to a different azimuth produced a corresponding change in the phase of the second harmonics. *When the optical paths and mirror supports were thermally insulated, the second harmonics were greatly reduced to about 0.07 fringe.* [14, p. 174] (emphasis added, J.D.)

This statement confirmed the wisdom of Miller's approach. The added insulation reduced the thermal effects from a nearby radiant heater to only 20% of the un-insulated readings. I have an ordinary commercially-available electric radiant parabolic heater at my home, and it gets so hot you cannot stand closer than 30 cm without burning yourself, or possibly catching your clothing on fire. If Miller had used a parabolic heater even half as strong as this, it would certainly have been a source of heat much stronger than anything present in his Mt. Wilson experiments, particularly at night, during foggy or overcast conditions, and when the entire interferometer house was covered over with a tent, with the apparatus and light-beam path covered with cork, glass and paper insulation. Consider a radiant heater at several hundred degrees C, creating a steep thermal gradient but only a 0.07 fringe shift in the insulated interferometer. How much *less* of an effect would be produced by a human body, or even from the inside of a solar-heated wall? Assuming an environmental thermal effect only one-tenth that seen with the parabolic heater (a wood composite wall radiating inside the structure at perhaps 50°C?), fringe shifts of *only 0.007* would have been produced, *well below observational detection*. Miller's data sheets, for example, recorded observations "in units of a tenth of a fringe width," though readings down to hundredths of a fringe were possible with care. Overall accuracy of the ether-drift measurements approached a hundredth of a fringe after mathematical averages of many readings were extracted.

The Shankland paper nevertheless used these control experiments as a weapon against Miller, claiming without evidence that heater-type effects *might* have occurred in his Mt. Wilson experiments, even where no such heater or remotely similar heat source was present. But why would the Shankland team shy from undertaking a more systematic evaluation for temperature artefacts? They could have, for example, evaluated only Miller's daytime interferometer experiments, and looked for a thermal effect from the southerly wall of the structure during the various epochs — if they could have shown an effect present in daytime data which was not present at night, it would have devastated Miller's claim, and proved their case. However, this obvious analytic procedure was not done, or if it was done, not reported.

The Shankland paper also resurrected the temperature criticisms by Joos (1934), but without reference to Miller's rebuttal in the same published exchange. [29] If the periodic effects observed by Miller were the product of temperature variations, as was claimed by Shankland and Joos, then why would that variation systematically point to the same set of azimuth coordinates along the celestial *sidereal clock*, but *not* to any single terrestrial coordinate linked to civil time? Miller repeatedly asked this question of his critics, who had no answer for it. The Shankland team likewise evaded the question.

It is clear Miller had been deeply engaged on the problem of temperature effects, and worked hard to know exactly how they might be produced, and how to eliminate them. The Shankland paper, however, seized upon Miller's open acknowledgment of fringe-shifts from air heating by powerful radiant heaters during control experiments, and a few other sentences written in his laboratory book, and tried to claim thermal anomalies were probably the source of whatever periodic effects were subsequently measured by Miller at Mt. Wilson, when no radiant heaters were used, and when the empirically-developed control procedures were put in place. Without some kind of independent experimental evidence to support such a claim of a thermal influence, their dismissal was illogical.

The Shankland paper also went through a series of arguments about the interferometer house, how the wall materials, roof angles, interferometer glass housing, *etc.*, might result in a definable effect upon the air temperature in the light beam path, concluding only they could not rule out such an influence — that it "...is not in quantitative contradiction with the physical conditions of the experiment." [14, p. 175] Given their ignoring the sidereal nature of the periodicities, this statement could hardly be taken seriously, and certainly did not constitute a rebuttal of Miller's data.

The Shankland paper finally attempted to correlate several selected daytime interferometer runs with temperature measurements made at the same time. They acknowledged difficulty in correlating low fringe-shift values with low temperature differentials, but found one set of high fringe-shift values correlated with slightly higher temperatures, even while noting another set where high values correlated with lower temperatures. Finally, they complain that

> ...no temperature data are available to reveal thermal conditions at the roof, which may be responsible for the large fringe displacements at the times of highest altitudes of the Sun. [14, p. 176]

If this sounds confusing, a reading of the full original text provided little clarification.

Failing to show anything damning from daytime data sets, when temperature gradients inside the interferometer house might be expected to be at a maximum, they turned their focus to night-time data sets. Once again, only a few of Miller's data sheets were selected out to prove their case. Data from two nights (30 Aug. 1927 and 23 Sept. 1925) with stable air temperatures were reviewed — these nights showed very clear and systematic fringe variations (fig. 4, p. 176, ref. [14]), but because the azimuth of the fringes changed minimally over the approximate 5 hours of observation, the critics complained "it would be extremely unlikely if the fringe shifts were due to any cosmic effect." [14, p. 177] Apparently, the Shankland team was so locked into the older "static ether" assumptions of the original Michelson-Morley experiment, they were unclear about what they should have seen in Miller's data. In 1927, at a *Conference on the Michelson-Morley Experiment* held at Mt. Wilson Observatory, where Michelson, Lorentz, Miller and others made presentations and engaged in open debate, Miller addressed this question:

> Observations were made for verifying these [static ether] predictions ...but it did not point successively to all points of the compass, that is, it did not point in directions 90° apart at intervals of six hours. Instead of this, the direction merely oscillated back and forth through an angle of about 60°... [8, p. 356-357]

The reason for this is that Miller's detected axis of ether-drift is oriented reasonably close (within 60°) to both the Earth's axis of rotation and the axis of the plane of the ecliptic.

Another important fact which nearly escapes detection in the Shankland paper is that the 30 August data were made in Cleveland, while the 23 Sept. data were from Mt. Wilson, and *neither were a part of the published Mt. Wilson data Miller used for calculations of the ether-drift* — both dates are well outside of the 10-day epochal periods identified by Miller. Furthermore, not all of the interferometer data sheets for a given date — which presumably would have had similar weather and temperature conditions — were included by the Shankland team for critical review. They selected only those data sets which appeared to support their argument of a claimed thermal anomaly. For example, they selected

> ...ten sets of observations, Nos. 31 to 40 inclusive, made in the hut on the Case campus between midnight and 5:00 AM on August 30, 1927.

and

> ...runs 75 to 83 inclusive taken from 12:18 AM to 6:00 AM on September 23. [14, p. 176-177]

Other than making the *claim* these selected data gave them the *impression* of being the result of temperature errors, they had no other stated criterion for bringing them into discussion. This biased data-selection, or rather *data-exclusion* procedure forces one to ask: *What about data sets No. 1 to 30, and runs 1 to 74?* Similar unexplained data selections or data exclusions occur throughout the Shankland paper, leaving one to wonder if the *unselected and excluded* data, which constituted the overwhelming majority of it, simply could not provide support for their criticisms. One can imagine the howl of protest which would have occurred if Miller had taken this approach, arbitrarily excluding data from his calculations which superficially suggested something other than a real ether-drift.

A third data set from 30 July 1925 was highlighted by the Shankland team as it contained one extremely large peak where Miller noted "Sun shines on interferometer." This data does appear to have been a part of Miller's published Mt. Wilson analysis. However, the Shankland team extracted only "observations Nos. 21 to 28 inclusive, made between 1:43 AM and 6:04 AM on July 30, 1925." Obviously, at around 6:00 AM the sun rose and caught Miller and his assistant off-guard. What about observations Nos. 1 to 21, or other early-morning data, where the sun *didn't* shine on the interferometer? These other data were not brought into discussion, except they did note that the runs prior to the sunshine incident demonstrated "...an extremely erratic behavior...we have no ready explanation for this apparent departure..." Here, the Shankland team basically confesses their grab-bag of "ready" explanations was empty, and the idea that those data were expressing a real ether-drift was simply too "impossible" for them to consider. The fact that Miller included the note about the Sunlight on this data sheet speaks to his honesty.

The Shankland team also identified data sets Nos. 56-58 from 8 July 1924, which was part of Miller's control experiments made in a basement location at Case physics laboratory — the temperatures were very stable, and the fringe oscillations were quite small, and they argued these data were a proof for thermal effects on the apparatus. However, it was this very problem of basement and dense surrounding materials which led Miller on the path to use the apparatus in locations not subject to significant ether-shielding or Earth entrainment. After 1921, Miller only used the Case School laboratory to undertake control experiments, and that is why those particular data were never published.

The Shankland paper concluded its temperature criticisms by discussing a few additional data sets: Nos. 113-118 from April

2nd, Nos. 88-93 from August 8th, 1925, and Nos. 84-91 from February 11th, 1926 (p. 177). Here, the amplitudes and phases were claimed to have been "nearly alike," but insufficient detail was given to allow a review of the critic's claims, and it did appear they were once again incorrectly misinterpreting Miller's data along the lines of static ether assumptions.

As in almost all the cases given above, *none of these data were analyzed systematically*, nor were they presented in such a manner that the author's criticisms could be factually reviewed. I got the impression, they simply scanned through a pile of Miller's data sheets, and with a wave of the hand, picking and pointing to only selected parts, dismissed it all as the product of thermal artefacts. Miller's detailed control experiments were basically ignored, as was the fact that, for all these experiments, the interferometer was enclosed in a small house covered over with a tent, while apparatus was shielded with cork insulation, and the light-beam path covered with glass and paper panels — with a full rotation occurring in less than a minute, one is left to wonder how any observable thermal variations could develop within Miller's data, especially variations with a sidereal-cosmic component.

For the casual reader, who had not undertaken a careful review of Miller's original experiments, the Shankland paper might appear to make a reasoned argument. However, the Shankland paper basically obfuscated and concealed from the reader most of the central facts about what Miller actually did, and in any case was so unsystematic and biased in its approach, excluding from discussion perhaps 90% or more of Miller's extensive Mt. Wilson data, as to render its conclusions meaningless.

As a final note, after I completed research into the archives of both Miller and Shankland at Case University, and urged the faculty of the CWRU Physics Department on the importance of the original Miller data sheets, they were finally located and placed into the CWRU Archive.

9 Conclusions

My review of this important but sad chapter in the history of science left me both astonished and frustrated. Miller's work on ether drift was clearly undertaken with more precision, care and diligence than any other researcher who took up the question, including Michelson, and yet, his work has basically been written out of the history of science. When alive, Miller responded concisely to his critics, and demonstrated the ether-drift phenomenon with increasing precision over the years. He constantly pointed out to his critics, the specific reasons why he was getting larger positive results, while others got only small results, or no results. Michelson and a few others of the period took Miller's work seriously, but Einstein and his followers appeared to view Miller only as a threat, something to be "explained away" as expeditiously as possible. Einstein in fact was catapulted into the public eye following the end of World War II. Nuclear physics was then viewed as heroic, and Einstein fast became a cultural icon whose work could not be criticized. Into this situation came the Shankland team, with the apparent mission to nail the lid down on Miller's coffin. In this effort, they nearly succeeded.

The Shankland conclusions against Miller were clearly negative, but the one systematic statistical analysis of his Mt. Wilson data merely confirmed what Miller said all along, that there was a clear and systematic periodic effect in the interferometer data. The Shankland paper also confirmed Miller's contention that this periodic effect was *not the product of random errors or mechanical effects*. The Shankland team subsequently searched for temperature artefacts in Miller's data, but failed to undertake any systematic analysis of his centrally-important Mt. Wilson data in this regard. Instead, they made a biased selections of a few published and unpublished data sets obtained from different periods in Miller's research, from different experimental locations, including from his control experiments at Case School.

Miller's most conclusive 1925-26 Mt. Wilson experiments encompassed a total of 6,402 turns of the interferometer, recorded on over 300 individual data sheets. [10] That was the data the Shankland team should have been focused upon and evaluated systematically. Instead, only a few of Miller's data sheets from these most centrally-important experiments were selected — certainly less than 10% of the data available to them was brought into discussion — and then only after being firstly dissected to extract only those data which could most easily be misconstrued as evidence for presumed temperature artefacts. For certain, some of the data held up for public critique came from Miller's control experiments at Case, or possibly from trial runs when technical "bugs" were being worked out in the apparatus and building. Miller is no longer alive to inform us about his data, but the Shankland team willy-nilly lumped together both published and unpublished data, without comment.

The Shankland group undertook no new experiments of their own, neither on the question of ether-drift, nor on the subject of thermal perturbations of light-beam interferometry — they made essentially an "armchair analysis" of Miller's data. Only some of Miller's original data was carefully selected to make a rather unbelievable claim that small natural ambient temperature gradients in Miller's Mt. Wilson observation hut might produce fringe shifts in the insulated interferometer similar to what Miller himself previously observed in his control experiments using strong radiant heaters. The Shankland paper argued there must have been "thermal effects" in Miller's Mt. Wilson measurements, but provides no direct evidence of this.

At no time did the Shankland group present evidence that temperature was a factor in creating the periodic sidereal fringe shifts observed by Miller in his published data, even though this was their stated conclusion. In fact, they presented evidence from Miller's own laboratory notebooks which implied thermal gradients in the Mt. Wilson interferometer house would have been *below the observational limits* of the insulated apparatus.

The larger issue of periodic or harmonic effects in the data, expressed in nearly identical cosmic sidereal coordinates at different seasons and at all hours of the day, was never addressed or evaluated by the Shankland group. Neither was any attempt made to show *exactly how* an external temperature phenomenon could affect the interferometer readings to yield such a systematic sidereal effect. This issue was almost totally avoided by the Shankland team.

A reading of Miller's 1933 paper shows the picayune and biased nature of the Shankland team procedure, as the systematic sidereal periodicities observed by Miller expressed themselves nearly uniformly across the board, though at differing magnitudes. From 1906 to 1926, Miller undertook over 200,000 separate readings, over 12,000 turns of the interferometer demonstrating harmonic periodicities constantly pointing to the same general axis of ether-drift in the cosmos — a factor which was completely independent of the time of day, or season of year in which the experiments were undertaken. At best, the critics provided only an *ad-hoc argument*, a claim or suggestion without substance, that some small part of Miller's data *might* contain an undefined temperature effect.

From all the above, it appears the Shankland group, with some degree of consultation with Einstein, decided that "Miller must be wrong" and then set about to see what they could cherry-pick in his archive to support their *a priori* conclusion — which is not a scientific method.

As I have discussed previously, Miller found the ether-drift effect to be stronger at higher altitudes and also to be small when the experiment was undertaken in heavy stone buildings or when the interferometer light-path was encased in wood or metal shielding. In my studies over the last 30 years, I've found many examples from the fields of biology, meteorology and physics that independently support the assertion of a subtle energetic force with similar altitude-dependent and metal-reflective properties — notably in the works of Wilhelm Reich, Giorgio Piccardi, and Frank Brown. [21, 30-34, 47] Likewise, there are many new findings in astrophysics, where anisotropy of cosmological factors have been discovered which are congruent with Miller's identified axis of ether-drifting, [8, p. 241] and the reanalysis by Allais of Miller's results. [35, 36]

Notable in this respect are the experiments of Cahill, of the Chemistry, Physics and Earth Science Department at Flinders University in Australia; [37, 38] De Witte working with the Belgian telecommunications company Belgacom, in Brussels; [39] Galaev at the Institute for Radiophysics and Electronics, National Academy of Sciences of Ukraine; [40, 41] and, Múnera [42, 43] and Múnera and his collaborators of the Physics Department, Universidad Nacional de Colombia at Bogotá. [44-46]

All of these newer studies have basically confirmed the Miller results, including its general axis of ether-drift and sidereal-day velocity components, "down to the details" (as expressed by Galaev). [40]

To close, I ask the reader to imagine that Michelson-Morley's 1887 experiment, which ran over only 6 hours on four days, had resulted in a claim that "the ether has been detected," and that Dayton Miller had undertook his years of work with 200,000 observations showing "the ether cannot be detected." It does not take much consideration to conclude that — in such a fictional case — Miller would today be cited in every physics textbook as having "proved the ether did not exist," and nobody would refer to Michelson-Morley. The fact that the present-day situation is totally opposite of my example is a testament to the intensely political nature of modern science, and how major theories often develop into *belief-systems*, which demand the automatic suppression of any new finding which might undermine the faith and "popular wisdom" of politically-dominant groups of academics. And that "wisdom" today is: *Space is empty and immobile, and the universe is dead.* I submit, these are unproven, and even *disproven* assertions, challenged in large measure by Dayton Miller's exceptional work on the ether drift.

Postscript: The author has developed a comprehensive webpage list with download links, of historical articles on the ether-drift experiments, including for most of the papers cited in this article: www.orgonelab.org/energyinspace.htm

References

[01] A. A. Michelson and E. W.. Morley, "On the Relative Motion of the Earth and the Luminiferous Ether," *American Journal of Science*, Third Series **34** (1887), 333-345.

[02] E. W. Morley and D. C. Miller, "Report of an Experiment to Detect the FitzGerald-Lorentz Effect," *Proceedings, Am. Acad. Arts & Sciences* **41** (1905), 321-328.

[03] E. W. Morley and D. C. Miller, "An experiment to detect the Fitzgerald-Lorentz effect," *Philos. Mag.* Series 6, **9**, 680-685 (1905).

[04] E. W. Morley and D. C. Miller, "Final Report on Ether-Drift Experiments," *Science* **25** (1907), 525.

[05] D. C. Miller, "The Ether-Drift Experiments at Mount Wilson Solar Observatory," *Physical Review* **19** (1922), 407-408.

[06] D. C. Miller, "Ether-Drift Experiments at Mount Wilson," *Proceedings Nat. Acad. Sciences* **11** (1925), 306-314.

[07] D. C. Miller, "Significance of the Ether-Drift Experiments of 1925 at Mount Wilson," *Science* **63** (1926), 433-443.

[08] D. C. Miller, untitled lecture in "Conference on the Michelson-Morley experiment held at the Mount Wilson Observatory, Pasadena, California, February 4 and 5, 1927," *Astrophysical Journal* **68** (1928), 352-367. Also in Contributions From the Mount Wilson Observatory, No.373, Carnegie Institution of Washington (1928).

[09] D. C. Miller, "Ether Drift Experiments in 1929 and Other Evidences of Solar Motion," *J. Royal Ast. Soc. Canada* **24** (1930), 82-84.

[10] D. C. Miller, "The Ether-Drift Experiment and the Determination of the Absolute Motion of the Earth," *Revs. Mod. Phys.* **5** (1933), 203-242.

[11] D. C. Miller, "The Ether-Drift Experiment and the Determination of the Absolute Motion of the Earth," *Nature* **133** (1934), 16-27.

[12] M. G. Sagnac, "L'Ether lumineux Demonstré par l'effet du vent relatif d'ether dans un interferomètre en rotation uniforme," *Comp. Rend. Acad.*

Sci. (Paris) **157** (1913), 710; and, "Sur la preuve de la réalité de l'éther lumineux par l'expérience de l'interferographe tournant," *Comp. Rend. Acad. Sci.* (Paris) **157** (1913), 1410-1413. Also see John Chappell, "Georges Sagnac and the Discovery of the Ether," *Arch. Internat. d'Histoire des Sciences* **18** (1965), 175-190.

[13] A. A. Michelson, H. Gale and F. Pearson, "The Effect of the Earth's Rotation on the Velocity of Light (Parts I and II)," *Astrophysical Journal* **61** (1925), 137-145. Also see: "Letters to the Editor: The Effect of the Earth's Rotation on the Velocity of Light," *Nature* **115**:(1925), 566.

[14] R. S. Shankland, S. W. McCuskey, F. C. Leone, and G. Kuerti, "New analysis of the interferometric observations of Dayton C. Miller," *Revs. Mod. Phys.* **27** (1955), 167-178.

[15] L. Swenson, *The Ethereal Aether: A History of the Michelson-Morley-Miller Aether-Drift Experiments* (Austin: U. Texas Press, 1972), p. 239, 243.

[16] R. Shankland, "Michelson's Role in the Development of Relativity," *Applied Optics* **12** (1973), 2280-2287.

[17] A. A. Michelson, *Studies in Optics* (Chicago: U. Chicago Press, 1927), 153.

[18] R. W. Clark, *Einstein: The Life and Times* (New York: World Publishing Co., 1971), p. 328.

[19] R. Shankland, "Conversations with Albert Einstein," *Am. J. Physics* **31** (1963), 47-57.

[20] R. Shankland, "Conversations with Albert Einstein. II," *Am. J. Physics* **41** (1973), 895-901.

[21] J. DeMeo, "Reconciling Miller's Ether-Drift with Reich's Dynamic Orgone," *Pulse of the Planet* **5** (2002), 137-146.

[22] A. A. Michelson, F. G. Pease, and F. Pearson, "Repetition of the Michelson-Morley Experiment," *Nature* **123** (1929), 88. Also in *J. Optical Society of America* **18** (1929), 181.

[23] R. J. Kennedy and E. M. Thorndike, "Experimental establishment of the relativity of time," *Phys. Rev.* **42** (1932), 400-418.

[24] A. A. Michelson, F. G. Pease, and F. Pearson, "Measurement of the Velocity of Light in a Partial Vacuum," *Astrophys. J.* **82** (1935), 26-61.

[25] D. Dietz, "Case's Miller Seen Hero of 'Revolution'. New Revelations on Speed of Light Hint Change in Einstein Theory," *Cleveland Press* (30 Dec. 1933).

[26] R. Shankland, "The Michelson Morley Experiment," *Am. J. Physics* **32** (1964), 16-35. Also, "The Michelson-Morley Experiment," *Scientific American* **211** (1964), 107-114.

[27] M. Kimball, "An Interview with Dr. Robert S. Shankland, Subject: Dayton Miller," Transcript of audio tape, 15 Dec. 1981, original with hand-corrections, Case Western Reserve University Archive, Cleveland, Ohio.

[28] R. L. Stearns, *A Statistical Analysis of Interferometer Data,* M. Sc. Thesis, Physics Department, Case Institute of Technology (1952).

[29] G. Joos and D. C. Miller, "Letters to the Editor," *Phys. Rev.* **45** (1934), 114.

[30] J. DeMeo, *Evidence for the Existence of a Principle of Atmospheric Continuity,* Thesis, Geography-Meteorology Dept., University of Kansas, Lawrence (1979). Republished: Orgone Biophysical Research Lab, Ashland, Oregon (2010).

[31] J. DeMeo, "Independent Discovery of An Unusual Energy" in *The Orgone Accumulator Handbook*, Natural Energy, Ashland, Oregon (1989). See 3rd Revised Ed. (2010).

[32] J. DeMeo, "The Orgone Energy Continuum: Some Old and New Evidence," *Pulse of the Planet* **1** (1989), 3-8.

[33] J. DeMeo, "Critical Review of the Shankland, *et al*, Analysis of Dayton Miller's Ether-Drift Experiments," Presented to the Natural Philosophy Alliance, Berkeley, California, (May 2000).

[34] J. DeMeo: "A Dynamic and Substantive Cosmological Ether," *Proc. of the Natural Philosophy Alliance*, Cynthia Whitney, Editor, **1** (2004), 15-20.

[35] M. Allais, *L'Anisotropie de L'Espace: La nécessaire révision de certains postulats des théories contemporaines* (Paris: Clément Juglar, 1997).

[36] M. Allais, "Experiments of Dayton C. Miller (1925-1926) and the Theory of Relativity," *Pulse of the Planet* **5** (2002), 131-136.

[37] R. T. Cahill, "A New Light-Speed Anisotropy Experiment: Absolute Motion and Gravitational Waves Detected," *Progress in Physics* (Oct. 2006), 73-92.

[38] R. T. Cahill, "Optical-Fibre Gravitational Wave Detector: Dynamical 3-Space Turbulence Detected," *Progress in Physics* (Oct. 2007), 63-68.

[39] R. T. Cahill, "The Roland De Witte 1991 Experiment (to the Memory of Roland DeWitte)," *Progress in Physics* (July 2006), 60-65. Also in: arXiv:physics/0608205v (21 Aug. 2006).

[40] Yu.M. Galaev, "Ethereal Wind in Experience of Millimetric Radiowaves Propagation," *Spacetime and Substance* **2** (2001), 211-225.

[41] Yu.M. Galaev, "The Measuring of Ether-Drift Velocity and Kinematic Ether Viscosity Within Optical Waves Band," *Spacetime and Substance* **3** (2002), 207-224.

[42] H. A. Múnera, "The effect of solar motion upon the fringe-shifts in a Michelson-Morley interferometer à la Miller," *Annales de la Fondation Louis de Broglie* **27** (2002), 463-484.

[43] H. A. Múnera, "Towards the reinstatement of absolute space: Some possible cosmological implications," *ICFAI University Journal of Physics* **2** (2009), 9-24.

[44] H. A. Múnera, D. Hernández-Deckers, G. Arenas, and E. Alfonso, "Observation during 2004 of periodic fringe-shifts in an adialeiptometric stationary Michelson-Morley experiment," *Electromagnetic Phenomena (Institute for Electromagnetic Research Kharkov, Ukraine)*, **6** (2006), 70-92.

[45] H. A. Múnera, D. Hernández-Deckers, G. Arenas, and E. Alfonso, "Observation of a significant influence of Earth's motion on the velocity of photons in our terrestrial laboratory," in C. Roychoudhuri, A. F. Kracklauer and K. Creath, eds., *The Nature of Light: What are Photons?, Proceedings of SPIE* **6664** (2007), 66640K 1-8 (ISBN: 9780819468123, ISSN: 0277-786X,

[46] H. A. Múnera, D. Hernández-Deckers, G. Arenas, E. Alfonso, and I. López, "Observation of a non-conventional influence of Earth's motion on the velocity of photons, and calculation of the velocity of our galaxy," *Progress in Electromagnetics Research Symposium PIERS-2009*, Beijing, China (23-27 March 2009) (ISSN:1559-9450).

[47] J. DeMeo, "Water as a Resonant Medium for Unusual External Environmental Factors," *Water* **2** (2011) 152-198. (In Press)

Should the Laws of Gravitation Be Reconsidered?

The Scientific Legacy of Maurice Allais

Edited by Héctor A. Múnera