Chapter 9

THE MICHELSON AND MORLEY EXPERIMENTS

Michelson & Morley's experiments, designed to detect the absolute[1] velocity of the Earth with respect to the stationary ether, were fraught with false assumptions. These false assumptions included, inter alia*, the existence of stationary ether, Maxwell's assumptions of the greater distance and time interval for the to and fro passage of light in the direction of the absolute solar orbital velocity of the Earth, the existence of an 'ether wind,' that light has lateral inertia, and the assumption that the mirrors in Michelson's apparatus would displace from the stationary ether in the direction of the Earth's solar orbital motion. The null results of M & M's experiments, in combination with such false assumptions, resulted in an absolute paradox. This paradox totally baffled the scientific community and helped to trigger the invention of Special Relativity. Nevertheless, such paradox is now fully explainable.*

During early 1879, James Clark Maxwell was pondering possible experimental methods to detect the absolute velocity of the Earth with respect to the stationary ether. (Goldberg, pp. 433 – 438) In March 1879 he sent a letter to American astronomer D. P. Todd who had been assisting him in his endeavor.[2] In this letter Maxwell described a possible theoretical method to detect such absolute velocity of the Earth, based on the theoretical "effect of the earth's motion on the there-and-back speed of light [from a light source to a mirror and back] as measured in the laboratory." (Hoffman, 1983, pp. 75-76; see Figures 9.1A and 9.2A) A relevant portion of Maxwell's letter states as follows:

> "[I]n the terrestrial methods of determining the velocity of light, the light comes back along the same path again, so that the velocity of the earth with respect to the ether would alter the *time* of the double passage by a quantity depending on the square of the ratio of the earth's velocity to that of light [$(v/c)^2$], and this is quite too small to be observed." (Nature, 1880, Vol. XXI, p. 315)

[1] The term 'absolute' with respect to the ether theory means a measurement with regard to stationary ether as a reference body at rest in absolute space.

[2] Maxwell died shortly after sending this letter. The letter, described as "On a Possible Mode of Detecting a Motion of the Solar System Through the Luminiferous Ether;" was later published by an associate of Mr. Todd in the British scientific journal, 'Nature.' (Nature, 1880, Vol. XXI, pp. 314, 315)

Stated a different way: the round trip time interval for a terrestrial light ray "does in principle depend on the speed of the earth through the ether." (French, p. 50) It is important to realize and remember that these conjectures by Maxwell, French and others with respect to the velocity of light, the ether, and such greater time interval of light propagation were completely false assumptions (even though they may appear to be plausible).

In 1895, H. A. Lorentz interpreted Maxwell's hypothesis to mean that "the time required for a ray of light to travel from a point A to a point B and back to A [on the Earth's surface] must vary when the two points together undergo a displacement…" with respect to the stationary ether. (see Figures 9.1B, 9.2B and 9.2C) Lorentz called this theoretical 'in-tandem displacement' of points A and B "the Maxwell displacement." (Lorentz, 1895 [Dover, 1952, p. 3]) These displacements by Lorentz were also false assumptions, because stationary ether does not exist and something cannot physically displace from nothing.

According to Maxwell, if the time interval for light to travel from point A to point B and back to A on Earth varied in any absolute direction of the Earth's velocity through the theoretical ether (Figures 9.1 and 9.2), then this would be a way to detect the theoretical absolute velocity of the Earth through the stationary ether. But what was the magnitude of the time interval for the double passage of light on the moving Earth varying from? *A priori*, it was altering or varying from the theoretical absolute time interval for the double passage of light assuming that the Earth was at rest in the stationary ether. (Figure 9.1A) This was yet another false assumption which we shall discuss in detail in Chapter 10A.

When Russian-American scientist Albert Michelson (1852-1931) read Maxwell's letter in the scientific journal 'Nature,' he asserted that this miniscule theoretical difference of time interval, if it actually existed, could easily be detected and measured by an interference of light method. (Michelson, 1881, pp. 120 – 121; Hoffman, 1983, p. 76) Acting upon his intuition, Michelson in 1881 created an interference of light experiment to test for Maxwell's theoretical time interval variation, by attempting to detect and measure the assumed absolute solar orbital velocity of the Earth (30 km/s) with respect to the stationary ether.[3] (Michelson, 1881, p 120)

Michelson assumed that "the actual distance that light travels in the [absolute direction of the Earth's solar orbital motion in his experiment] is greater than in the [direction perpendicular to such motion]."[4] (Michelson, 1881, p. 121) Michelson further assumed that light which propagated from Earth perpendicularly to the absolute direction of the Earth's absolute solar orbital motion "would be entirely unaffected" by such motion. (*Id*.) In Michelson's words:

> "Assuming then that the ether is at rest, the earth moving through it, the time required for light to pass from one point to another on the earth's surface, would depend on the direction in which it [light] travels." [5] (*Id*.)

Michelson then concluded that if it were possible to measure the time T required for light to pass from one point to another in "the direction of the earth's motion [less the]

[3] The direction of such velocity was "toward the constellation Hercules." (Michelson, 1881, p. 124) Contrary to Galileo's assertions in 1632, Michelson believed that the inertial "motion of the earth in space can be made perceptible in terrestrial experiments." (Einstein, *Relativity*, p 57)

[4] Some authorities state that an 'ether wind' effect was Michelson's 1881 hypothesis for why he expected to detect an increased time interval for light propagation in the direction of the Earth's motion. (Gamow, 1948, pp. 92 – 95; Goldberg, pp. 433 – 438) This assumption was based on a terrestrial analogy and would imply that the velocity of light would decrease in the direction of such 'ether wind.' (Figure 9.3B) Yet the author can find no mention of this 'ether wind' hypothesis in Michelson's 1881 description of his experiment. Theoretically, an 'ether wind' was the same wind sensation that a woman on the bow of a fast moving ship feels "even through the weather may be perfectly calm." (see Gamow, 1948, p. 92)

[5] These were, of course, more false assumptions by Michelson. As we now know, there is no absolute direction of the Earth's motion through space.

time [T_1] required for it to pass in the opposite [perpendicular] direction, [then] we could find v the velocity of the earth's motion through the ether." [6] (*Id.*) This theoretical difference between T and T_1 was also the theoretical variation between T and T_0. T_0, according to Michelson, was the "time required to perform the journey if the earth were at rest."[7] (Michelson, 1881, p. 120; Figure 9.1A)

How did Michelson propose to measure the theoretical difference between T and T_1? Prior experiments designed to determine this difference time intervals (or in velocity) to the first order or approximation v/*c* (one part in ten thousand), had failed to detect any motion or velocity of the Earth with regard to the ether.[8] Pursuant to Maxwell's suggestion, Michelson proposed to increase the sensitivity and precision of the measurement to an approximation of the second order: v^2/c^2 (one part in one hundred million).[9] (Goldberg, p. 90; Hoffmann, 1983, p. 76; Halliday, pp. 960, 961)

Similarly to the 1851 Experiment of Fizeau, Michelson built a very sensitive apparatus (an 'interferometer') with a 50% reflective glass mirror (a 'beam splitter') that would split a ray of light into two equal parts, called light 'pencils.' (Figure 9.3A) Light pencil 1 would propagate to and fro (between the beam splitter BS and mirror M_1 on the apparatus) parallel (or longitudinal) to the assumed direction of the Earth's absolute solar orbital motion. Light pencil 2 would propagate to and fro in the direction of mirror M_2,

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[6] The magnitude of this miniscule theoretical time interval difference ($T - T_1$) was equal to about 1,000,000,000,000,000th (one quadrillionth) of a second. (Hoffman, 1983, p. 76; Wolfson, p. 72)

[7] Thus, Michelson adopted as a major false premise for his experiment the same false assumption of an absolute variation or difference in time interval for light propagation as Maxwell in 1879, and later Lorentz in 1895 and 1904, and Einstein in 1916. (see Einstein, *Relativity*, pp. 58 – 59)

[8] "By a first-order experiment, we mean one that is refined enough to detect magnitudes of the order of v/*c* where v is the velocity of the earth through the stagnant ether and *c* is the velocity of light." (D'Abro, 1950, p. 132)

[9] "So we see that a second-order experiment is necessarily very much more precise than a first-order one. We may also mention that no experiments have yet been successful in exceeding those of the second order in precision." (D'Abro, 1950, p. 132)

perpendicular (or transverse) to the Earth's assumed absolute solar orbital motion.

Very importantly, using a micrometer screw, Michelson adjusted the light path for light pencil 1 so that it was slightly different in distance than the light path for light pencil 2. (Michelson, 1881, pp. 122 – 123; see Figure 9.4) This adjustment of distance caused the two light pencils to slightly change their relative wave phases by the time they propagated to and fro and joined again at the beam splitter. As a result, Michelson created and observed an interference fringe pattern through the telescope. (Figure 7.4C) Michelson's above described adjustment of distance will be critical for our explanation of Michelson's null result paradox in Chapter 12.

When Michelson's apparatus was then rotated through 90°, the directions of the two light pencils were also rotated 90°. As a result, Michelson assumed that first pencil 1 and then pencil 2 would take longer to propagate between their respective reflecting mirrors in the assumed direction of the Earth's absolute solar orbital motion. Also, as a result of this rotation, Michelson expected that the observed interference fringe would shift about $1/10^{th}$ of a light wave.[10] (*Id.*, pp. 122, 125) Theoretically, this shift of interference fringes (see Figures 7.4D-1 and 7.4D-2) would indicate the difference in time interval between T and T_0 (or T_1) in the apparatus. In turn, Michelson assumed that such time interval difference would indicate the magnitude of the absolute solar orbital velocity of the Earth through the stationary ether (30 km/s).

As previously mentioned, Michelson based this theoretical magnitude of the distance/time interval difference for light propagation solely on "the velocity of the earth in its orbit" as compared to "the earth at rest" in stationary ether. (Michelson, 1881, p.

[10] Any specific magnitude of fringe shift because of a specific displacement of mirrors in a specific direction of the Earth's absolute velocity through space is a false absolute concept. (see Chapter 10A)

121) However, Michelson did not realize that this theoretical difference in magnitudes of velocity was a completely meaningless assumption on its face. Why was it meaningless? First, because the false concepts of stationary ether, the Earth at rest in the ether, and the absolute velocity and absolute direction of the Earth's solar orbital motion with respect to stationary ether as reference body, have no meaning. (Chapter 10A) Secondly, because such theoretical difference in velocity did not take into account the infinite number of other relative velocities of the Earth, such as the 7 times greater relative velocity of the Earth (together with the solar system) around the core of the Milky Way Galaxy at 225 km/s. (see Figures 10.3 and 10.4, and Chart 10.5) Thirdly, since the Earth cannot be at rest in non-existent ether, such comparison of time intervals is impossible.

Nevertheless, Michelson repeatedly pointed his 1881 apparatus in all possible directions over several periods of time as the Earth orbited the Sun. However, the result of this experiment was only a very nominal shift of the interference fringes when the pencils of light were pointed in any different direction.[11] The observed nominal fringe shift averaged only about 2% of that which Michelson expected, and he attributed these nominal fringe shifts to observational error. (Michelson, 1881, pp. 127, 128)

Very importantly, Michelson concluded from this basically null result [12] that: "the hypothesis of a stationary ether…is erroneous…This conclusion directly contradicts [the hypothesis]…that the earth moves through the ether, the latter remaining at rest." (Michelson, 1881, p. 128)

It was not realized at the time, but Michelson's 1881 experiment, its empirical

[11] *A priori* a different time interval should also have been observed as a fringe shift when the light ray was pointed in the direction opposite to the direction of assumed motion. But Michelson observed no fringe shift in such opposite direction either. (see Figure 9.8)
[12] In effect, the result of the experiment was that $T - T_1 = 0$.

null result and Michelson's above conclusions concerning non-existent ether, necessarily implied the most profound changes in the philosophy of physics. If there was no ether absolutely at rest in space, then: 1) there was no absolute reference frame (body or material substance) at rest in space from which the absolute motions of celestial objects could be measured; and 2) there were no such things as absolute space, absolute time, absolute rest, absolute positions, absolute directions, and absolute motions or absolute velocities. Thus, all positions, time intervals, states of rest, motions, velocities, directions of motion, and trajectories of co-moving celestial objects must be completely relative. But the scientific community was not ready to consider or accept such 'radical' and unorthodox conclusions.

It is one thing to realize and state (or infer) that there is no such thing as ether, absolute rest or absolute motion in the universe, as Einstein also did twenty-four years later in 1905. (Einstein, 1905d [Dover, 1952, pp. 37 – 38]) It is quite another thing to make the *ad hoc* claim that relative motion and relative velocity (of itself and at a distance) alter the dimensions, mass and time intervals of physical objects. But this is exactly what Einstein asserted in his 1905 Special Theory of Relativity. (*Id.*, pp. 41 – 65)

It follows from the null results of Michelson's 1881 experiment that, if a light ray emitted on the moving material Earth in all directions takes the same interval of time to travel from light source to mirror and back in all directions of the Earth's motion, then light constantly propagates in all directions through empty space at the same constant transmission velocity, regardless of the assumed motions or velocities of its source body (the Earth). It also follows that the assumed solar orbital motion of relatively stationary bodies (i.e. Michelson's mirrors) toward which such light ray propagates are irrelevant to

such transmission velocity of light and to the time interval of such propagation. [13] Likewise, Michelson's 1881 experiment also implied that the inertial motions of any material body (the Earth, the mirrors or any distant other body) are irrelevant to such transmission velocity of light. But none of these implications were either realized or articulated at the time, and the paradoxical null results of Michelson's 1881 experiment completely baffled the scientific community of the late 19th century.

For many decades astronomers had observed, measured and documented the Earth's orbital motion around the Sun. So seemingly obvious and ingrained was the absoluteness of this observation, and that the Earth's constant solar orbital motion would cause a specific absolute in-tandem displacement of the light source and longitudinal mirror from the light ray, that the great minds of Maxwell, Michelson, Morley, Fitzgerald, Lorentz, Einstein, and others never seemed to doubt its validity.[14] Nor did they doubt that such absolute displacement and time interval comparison could be detected by Michelson's interference method. Thus they also reasoned that the time interval traveled by a light ray in the absolute direction of such constant solar orbital motion would be greater over the increasing distance caused by such absolute in-tandem displacement (Figures 9.1B, 9.2B and 9.2C) than if the Earth were absolutely at rest in the stationary ether. (Figures 9.1A and 9.2A; see Einstein, *Relativity*, pp. 58 – 59) But if the distance was greater, why had not Michelson detected a fringe shift which would indicate a greater time interval in the direction of motion? What was the answer to this

[13] In effect, Michelson's 1881 experiment, flawed as it was, could be considered as the genesis of many new concepts. But it was not until 1905 that Einstein would postulate one of the implied results of Michelson's 1881 experiment, vis.: that the velocity of "light is…independent of the state of motion of the emitting body." (Einstein, 1905d [Dover, 1952, p. 38])

[14] In effect, the Sun at rest in the ether was assumed to be the stake in space from which to measure the absolute orbital motion of the Earth and motions that occurred on it. (Figure 2.2B)

paradox, this missing time interval?

Because of the numerous theoretical and technical problems that Michelson had encountered during his 1881 experiment,[15] he decided to repeat the experiment in 1887 with fellow American scientist Edward Morley (1838-1923). As in the 1881 experiment, Michelson and Morley (M & M) assumed that an in-tandem physical displacement of the light source and the longitudinal mirror would occur relative to the light ray, because of the known solar orbital motion of the Earth at 30 km/s. (Figures 9.1B, 9.2B and 9.2C) M & M further assumed that this displacement would increase the distance interval and the time interval for the light ray to travel in the absolute direction of such solar motion from beam splitter to the longitudinal mirror and back, and that such increased time interval should be detectable by his interferometer. [16]

In 1887, the design of Michelson's apparatus was improved, and the path that each pencil of light would propagate in each perpendicular direction was increased eleven fold to about twenty-two meters (to and fro). (M & M, 1887, pp. 337, 341) During this second experiment, only the solar orbital velocity of the Earth was again considered, because Michelson & Morley acknowledged that "little is known [of] the motion of the solar system" relative to the motion of the other celestial bodies. (*Id*., p. 341) M & M also acknowledged that it would be hopeless to attempt to solve the question of the motion of the solar system, but if it were added in, "the result would have to be modified." (*Id*.)

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[15] These problems included vibrations (i.e. the location of the apparatus was near busy roads), difficulties in rotating the apparatus, variations in temperature, and the minimal distance (about 2 meters) that each pencil of light would propagate along each arm of the apparatus. (Michelson & Morley, 1887, pp. 336-338)

[16] Restated: The distance and time interval which a light ray must propagate within the apparatus (from light source to longitudinal mirror and back) was assumed to be longer in the direction of the apparatus' solar orbital motion, because the mirrors were theoretically assumed to be displacing in-tandem relative to the light ray.

The most significant theoretical modification that Michelson made for his 1887 experiment was to change his hypothesis concerning the path of the light pencil that was transverse to the solar orbital motion of the Earth. In this regard he stated that in 1881, "the effect of the motion of the earth through the ether on the path of the ray at right angles [transverse] to this motion was overlooked." [17] (*Id*., p. 334)

Michelson then asserted that the paths of the two light pencils would only be perpendicular to each other if his apparatus was at rest in the ether. (M & M, 1887, p. 335) According to Michelson, when the apparatus moves through the ether in the direction of the Earth's solar orbital motion, the to and fro path of the transverse light pencil would be at an angle relative to the longitudinal light pencil, which angle would be in the direction of such solar orbital motion. (*Id*., pp. 335 – 336; see Figure 9.5) Michelson then concluded, that because this angle would increase the time interval which the transverse light pencil would have to propagate, the difference between T and T_1 would actually only be 40% of the magnitude which he had assumed in his 1881 experiment. This new magnitude of time interval difference would only be about 0.04 of a fringe, instead of the 0.10 of a fringe that Michelson assumed in 1881. (*Id*., pp. 335, 336)

Michelson's new hypothesis was, of course, yet another major false assumption. We now know that the photons that comprise a light ray do not have mass and therefore the light ray is not subject to the lateral inertial motion nor the momentum of its material light source (the Earth), which inertial motion would be necessary to create the angled path of light propagation envisioned by Michelson. In reality, the transverse light pencil

[17] *Inter alia*, in 1881Michelson forgot that the transverse reflecting mirror (mirror C in Figure 9.5) should also theoretically displace in the absolute direction of the Earth's motion.

would always propagate perpendicularly to the longitudinal light pencil and rectilinearly toward the transverse reflecting mirror. It would then reflect back toward the beam splitter in a perpendicular and rectilinear path.[18] (see Figure 9.6)

The significance of these latest false assumptions by Michelson (for the purposes of this treatise) is two-fold:

1. In 1895, Lorentz created his contraction of matter theory and his contraction factor $\sqrt{1 - v^2/c^2}$ in order to explain why Michelson's 1887 theoretical magnitude of a fringe shift (0.04% of a fringe) could not be detected by Michelson's 1887 experiment. (Lorentz, 1895 [Dover, 1952, pp. 3 – 7]) Lorentz's incorrect 1895 assumptions and contraction concepts were then incorporated into his 1904 transformation equations for distance and time (*Id*., p. 14), which were in turn 'borrowed' by Einstein in 1905 as the foundation for his Special Theory.[19]

2. Michelson's false assumption concerning the angular path of the transverse light pencil was later adopted by Einstein and his followers, incorporated into Einstein's relativistic moving light clock theory, and asserted as an experimental confirmation for the validity of Special Relativity. (Cropper, pp. 209 – 213) But as explained by the above analysis and in Chapter 26D, Einstein's moving light clock hypothesis and its asserted confirmation of Special Relativity were both based on a false premise: the lateral inertial and angular propagation of a perpendicular light ray. Thus, what validity does Einstein's relativistic moving

[18] Theoretically, if the transverse mirror was small enough and/or if the longitudinal speed of the apparatus was fast enough, the transverse light pencil might miss the theoretically moving transverse mirror completely and continue to propagate rectilinearly into space (Figure 9.5, Note 3), or it might miss the beam splitter upon its return path. (Figure 9.6B) In either hypothetical case, Michelson would see no interference fringe at all.

[19] If Lorentz's 1904 transformation equations incorporated and attempted to explain an incorrect theoretical magnitude by Michelson, then what validity did such transformation equations have for both Lorentz's and Einstein's contraction explanation of the M & M paradox? Or for any other reason? The answer is none.

light clock hypothesis have for any purpose? None. (Chapters 26D, 28 and 36)

Very importantly, just before the 1887 experiment began, M & M adjusted the micrometer "screw altering the length of [the] path" for one light pencil to propagate. (M & M, 1887, p. 339) As in the 1881 experiment, this adjustment of distance caused two slightly out-of-phase light pencils to result in an interference fringe pattern. (*Id.*; see Figures 9.4 and 7.4C) This seemingly insignificant change of distance for one light pencil to propagate to and fro will be exceedingly important for our analysis in Chapter 12.B of one empirical and technical reason for Michelson's null results.

M & M then pointed their new apparatus in all possible directions over a six-month period hoping to detect some fringe shift (time interval difference) in some direction. But at the end of the day, the outcome of the M & M experiment in 1887 was substantially the same as Michelson's 1881 experiment. Again, only a very nominal shift of the interference fringes was observed (*Id.*, pp. 340, 341); and basically it was considered to be yet another null result with the same conclusions as the 1881 experiment.[20] (*Id.*; see Figure 9.7) The scientific community remained baffled.[21]

Why had not the absolute orbital velocity of the Earth and the displacement of Michelson's mirrors relative to the light ray, produced the expected fringe shift and time interval difference? How could light propagate at *c* over two theoretically different distances (longitudinal and transverse) during the same time interval? Did this mean that

[20] *A priori* a difference in time interval should also have been observed as a fringe shift when the light ray was pointed in the direction opposite to the direction of assumed motion, because of the to and fro propagation of light vis-à-vis the assumed in-tandem displacement of the mirrors. But M & M observed no fringe shift in such opposite direction either. (Figure 9.8) The observed nominal fringe shift again averaged only about 2% of that which was expected. M & M again attributed these nominal fringe shifts to observational error. (M & M, 1887, pp. 340, 341)

[21] Even Michelson and Morley were mystified by their paradoxical 1887 null result, and they repeated their experiment numerous times in several different ways and at different altitudes (to avoid the possibility that the ether might be dragged along), but always obtained the same null result. (Gamow, 1948, p. 96; Born, p. 218)

the transmission velocity of light changed in different directions of motion? Did it mean that the concepts of ether and ether at rest in space were invalid, as Michelson concluded in 1881? Did it mean that Michelson's interference fringe shift experiments and the assumptions that they were based upon were at fault? Did it mean that Maxwell's law of the constant transmission velocity of light at *c* needed to be revised? (Einstein, ***Relativity***, p. 23) What could be the answers to these riddles? These were some of the baffling questions that faced the scientific community after 1887.

The first attempted explanation for the null result was that the ether was completely carried along with the moving Earth at its surface, and thus the velocity of the Earth's surface relative to the carried (dragged) along ether was zero (relatively at rest). (Figure 9.7A) But this theory, first suggested by English physicist George Stokes in 1845, was soon totally discredited by experiments, calculations and logic. (Hoffmann, 1983, p. 81) Another attempted explanation of the M & M null results was the ballistic theory of light, which asserts that light consists of particles rather than waves. This theory claims that the velocity of light "is uniquely defined with respect to the source…" (French, p. 57) In other words, that the transmission velocity of light varies depending upon the velocity of its source body. But this explanation was also discredited by Willem de Sitter and others. (see Figure 7.2)

The empirical null results of Michelson's experiments implied that the light source and longitudinal mirror rigidly attached to the Earth might not be physically displacing in-tandem away from the ray of light (propagating within the same apparatus), contrary to the assertion of such displacement in Maxwell's 1879 letter. But how could this be? The Earth's orbital velocity around the Sun was intuitive and obvious, so

everyone assumed that the in-tandem displacement of the light source and longitudinal mirror from the propagating light ray must also exist. They also assumed that this displacement would increase the distance interval and time interval that the light ray must propagate relative to the light source and longitudinal mirror in the direction of such motion. Must not there be some plausible explanation for these paradoxes? For many frustrated scientists, any explanation might do.

The quest for a plausible explanation led Fitzgerald, Lorentz, and ultimately Einstein to somewhat different radical *ad hoc* theories that the Earth and Michelson's apparatus must be physically contracting in proportion to the solar orbital velocity of the Earth relative to the velocity of light. (see Chapters 10A, 15 and 16) "[T]he amount of [such] contraction being just sufficient to compensate for the difference in time." (Einstein, *Relativity*, p. 59) Miller characterized these radical contraction theories as "clearly a physics of desperation." (Miller, p. 28)

Why are we even concerned about the above paradox and the possible or real reasons for the M & M null result in the twenty-first century? Because: (1) the baffling theoretical paradoxes which such null results and the ether theory created ultimately led Einstein to his own radical *ad hoc* contraction explanation for such absolute paradoxes which he called the Special Theory of Relativity; and (2) the null result of the M & M experiment is now claimed by the followers of Einstein to be one of the major experimental confirmations for Special Relativity.[22] (Resnick, 1968, p. 37; French, p. 56 – 57; see Chapter 36)

Despite such desperate and contrived contraction explanations, we now ask the

[22] The rationale being that such absolute paradox must have been true and Einstein's absolute contraction solution for such paradox must have been correct, because there has never been another plausible explanation for such null results.

questions: Were the paradoxical results of Michelson's experiments, and the contraction explanations of them, properly analyzed and adequately scrutinized? Are there other much more probable explanations for these puzzling null results? In the next three chapters we shall discuss the many false assumptions that caused M & M's null results to become a monumental paradox, and the much more probable real, empirical, and technical answers for this 120-year-old absolute mystery.

Figure 9.1 Maxwell's 1879 Assumption

(not to scale)

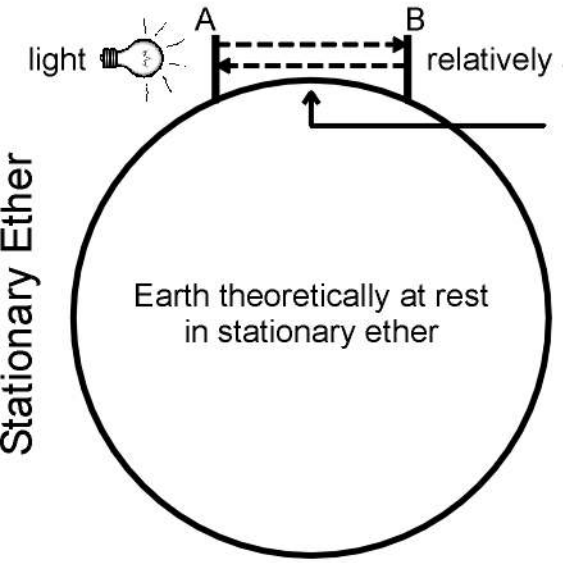


Figure 9.1A Light Propagating In Any Direction Of The Earth At Rest In The Stationary Ether

(Note: This figure also illustrates the theoretical distance and time interval ($T_\perp$) for light to propagate in the direction perpendicular to the Earth's absolute solar orbital motion).

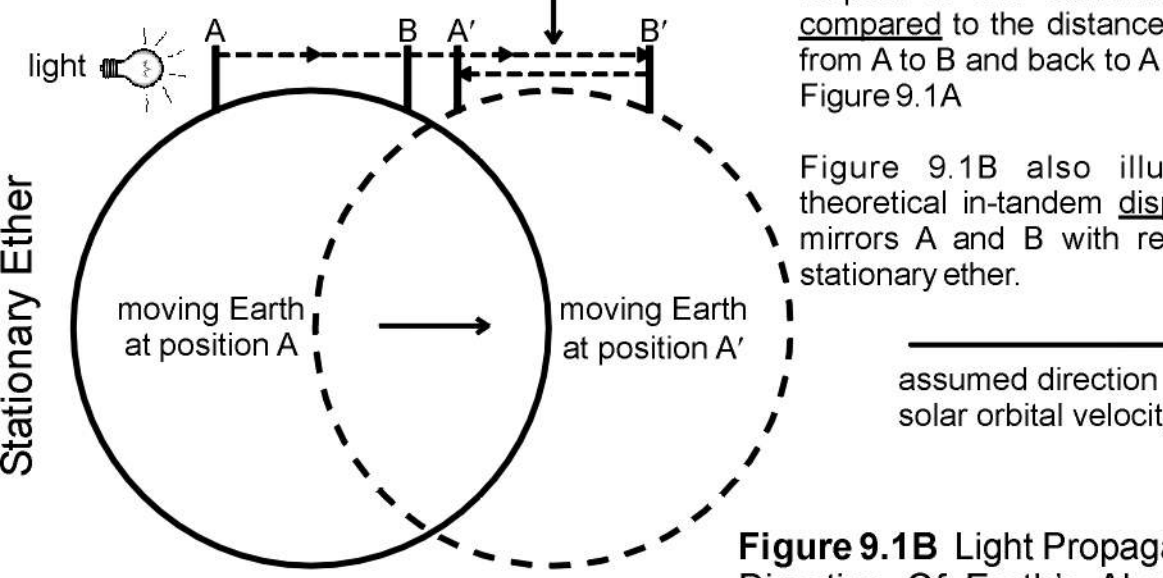
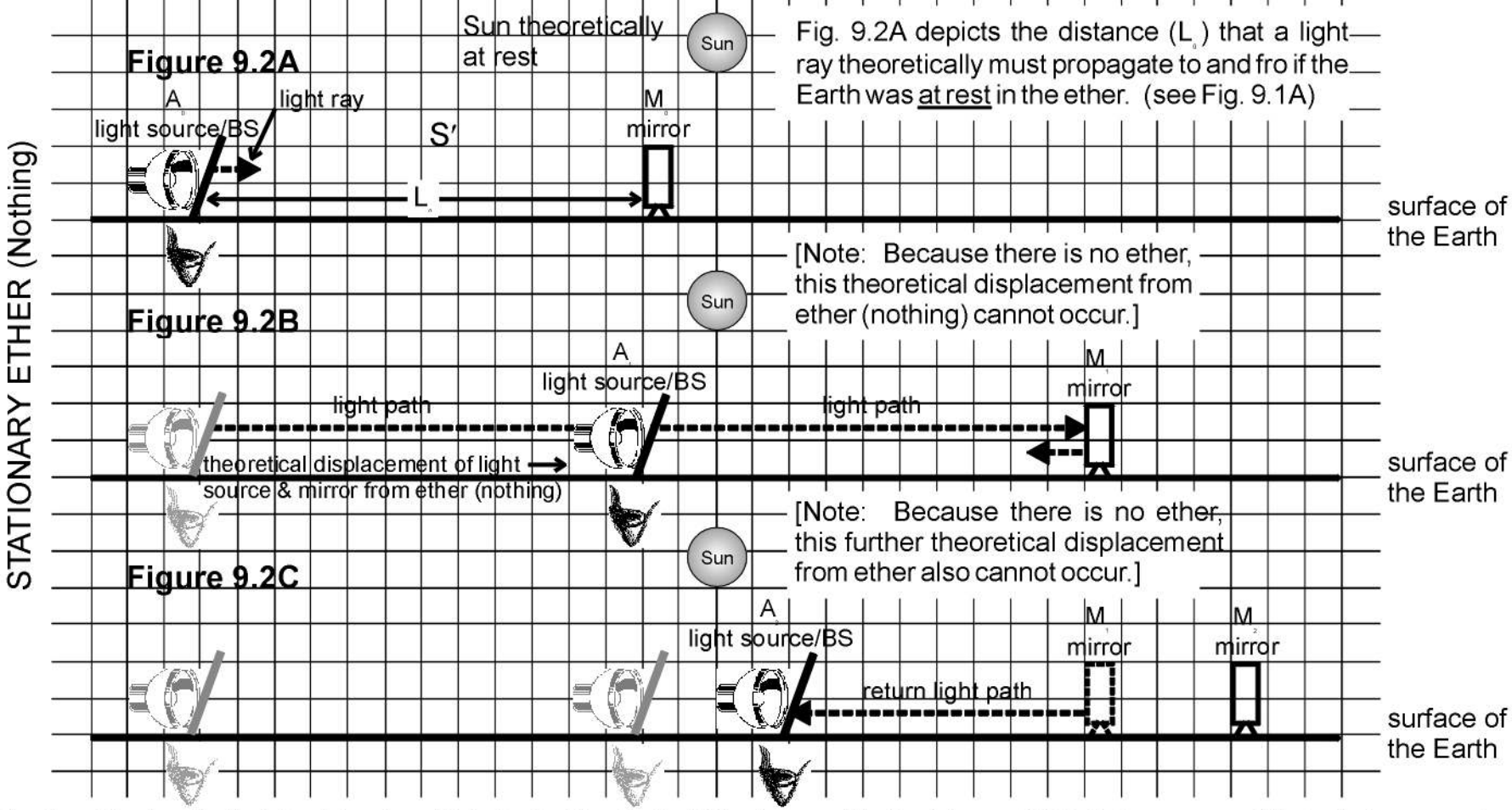


Figure 9.1B Light Propagating In The Direction Of Earth's Absolute Solar Orbital Motion Relative To The Stationary Ether

[Note: Because empirically there is no ether, this theoretical displacement from ether cannot occur.]



The light source, the beam splitter (BS) and the mirror M are affixed to the surface of the Earth at a finite distance of 12 squares apart, and for purposes of illustration we assume that they move in tandem to the right at 50% of *c* relative to the stationary ether and the Sun theoretically at rest in the ether. A light ray leaves the terrestrial light source at point A_0 and transmits at 100% of *c* toward the mirror at point M_0. (Figures 9.2A and 9.2B) During such propagation, the mirror theoretically displaces from point M_0 to point M_1 due to such absolute solar orbital velocity with respect to the stationary ether. The light ray contacts the mirror at point M_1 after traveling 24 squares (from A_0 to M_1). The light ray then reflects from the mirror at M_1 and begins to propagate back toward the light source. (Figure 9.2B) During such propagation, the material light source theoretically displaces from point A_0 to point A_1 and then to point A_2.

When the light ray returns to the light source at point A_2 (Figure 9.2C) the light ray has traveled a total distance/time interval of 32 squares while the light source and the mirrors have theoretically displaced in-tandem 16 squares, an increase of 8 squares (over Fig. 9.2A) because of the theoretical displacement. These were also Einstein's computations for a greater distance/time interval of light propagation, which he referred to in *Relativity* at pp. 58 - 59. On the other hand, if there had been no motion of the Earth in an absolute direction(and thus no absolute displacement), then the light ray would only have traveled a total distance/time interval of 24 squares (Figure 9.2A). Strangely enough, Fig. 9.2A is what actually happened, because there is no ether and can be no physical displacement from nothing.

Figure 9.2 A Detailed Illustration Of Figure 9.1, Which Depicts Maxwell's Theory Of An Absolute In-Tandem Displacement Of The Light Source And Reflecting Mirror From The Light Pencil Propagating To And Fro On The Surface Of The Earth, Due To The Absolute Solar Orbital Velocity Of The Earth With Respect To The Stationary Ether

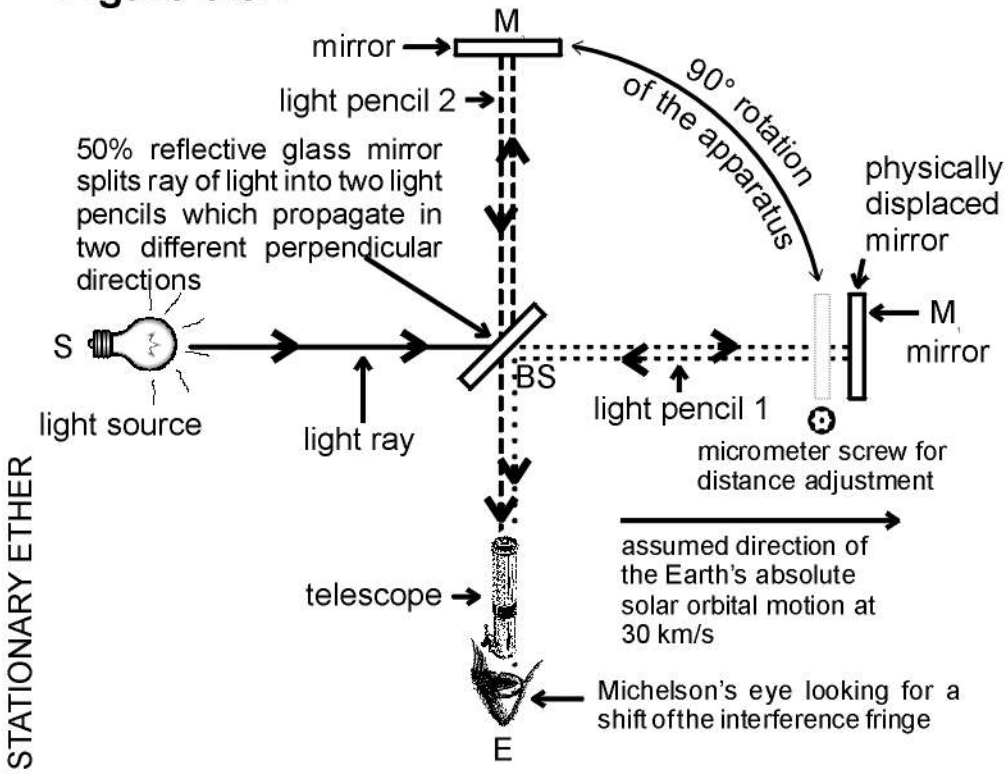
Figure 9.3 Michelson's 1881 Experiment

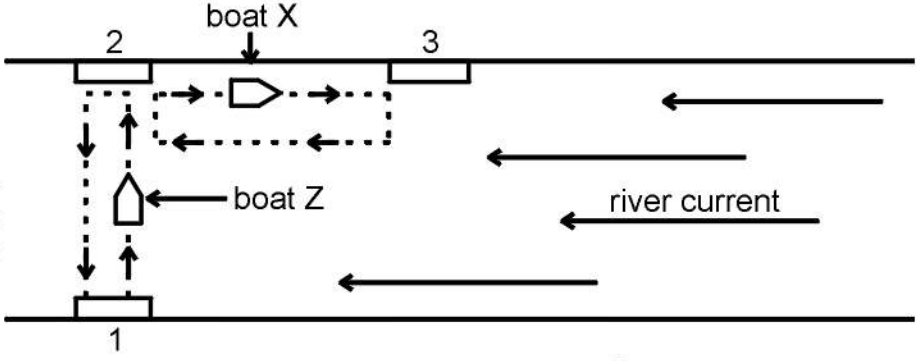
In 1881, Michelson used a micrometer screw on his apparatus to adjust the path of light pencil 1 so that it was slightly different in <u>distance</u> than the light path for light pencil 2. (Michelson, 1881, p. 123) This caused the out-of-phase waves of the two light pencils to interfere and create an interference fringe. (see Figures 9.3A and 6.4C)

Because Michelson assumed that the longitudinal mirror M_1 would theoretically displace from the light source and the tip of light pencil 1 in the direction of the Earth's absolute solar orbital motion, he also assumed that light would propagate further in such absolute direction than transversely thereto. Therefore, he also assumed that it would take a <u>longer</u> time interval for light to propagate from BS to M_1, and back to BS, than from BS to M_2 and back to BS. When Michelson rotated the apparatus through 90°, he expected to see a shift of the interference fringe at E, which would signify an increase in the distance/time interval of light propagation in the direction of motion, from one arm of the apparatus to the other.

But he observed no fringe shift at E (a null result). This null result contradicted Maxwell's assumption of a greater distance/time interval in the presumed direction of the Earth's absolute motion relative to the stationary ether.

Figure 9.3A



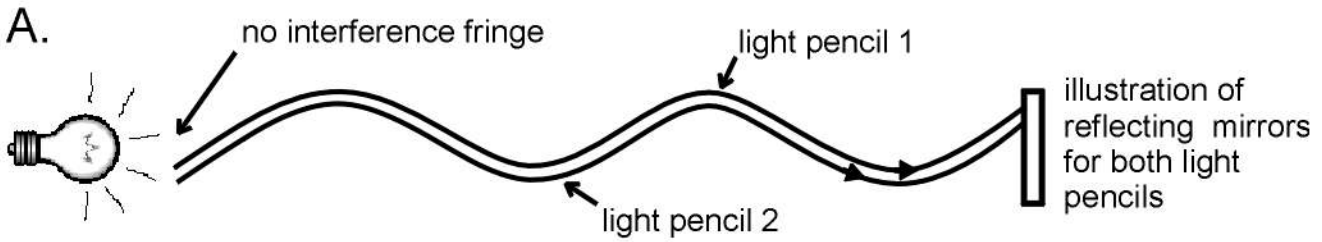


On Earth, empirically it takes longer for boat X to travel with and against the current than it takes for boat Z to travel to and fro across the current. (Gamow, 1948, pp. 92 - 95)

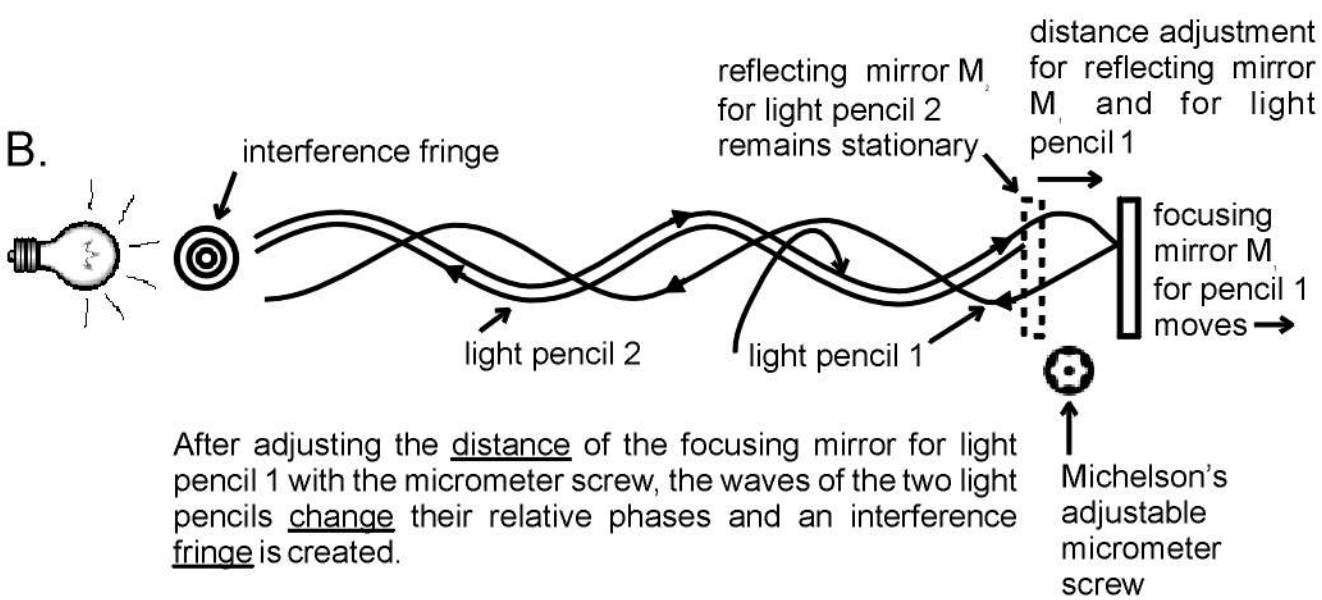
Figure 9.3B Ether Wind-River Current Analogy
(see text on left)

Figure 9.4 What Happened When Michelson Adjusted The Distance Of One Mirror In The Path Of One Light Pencil?

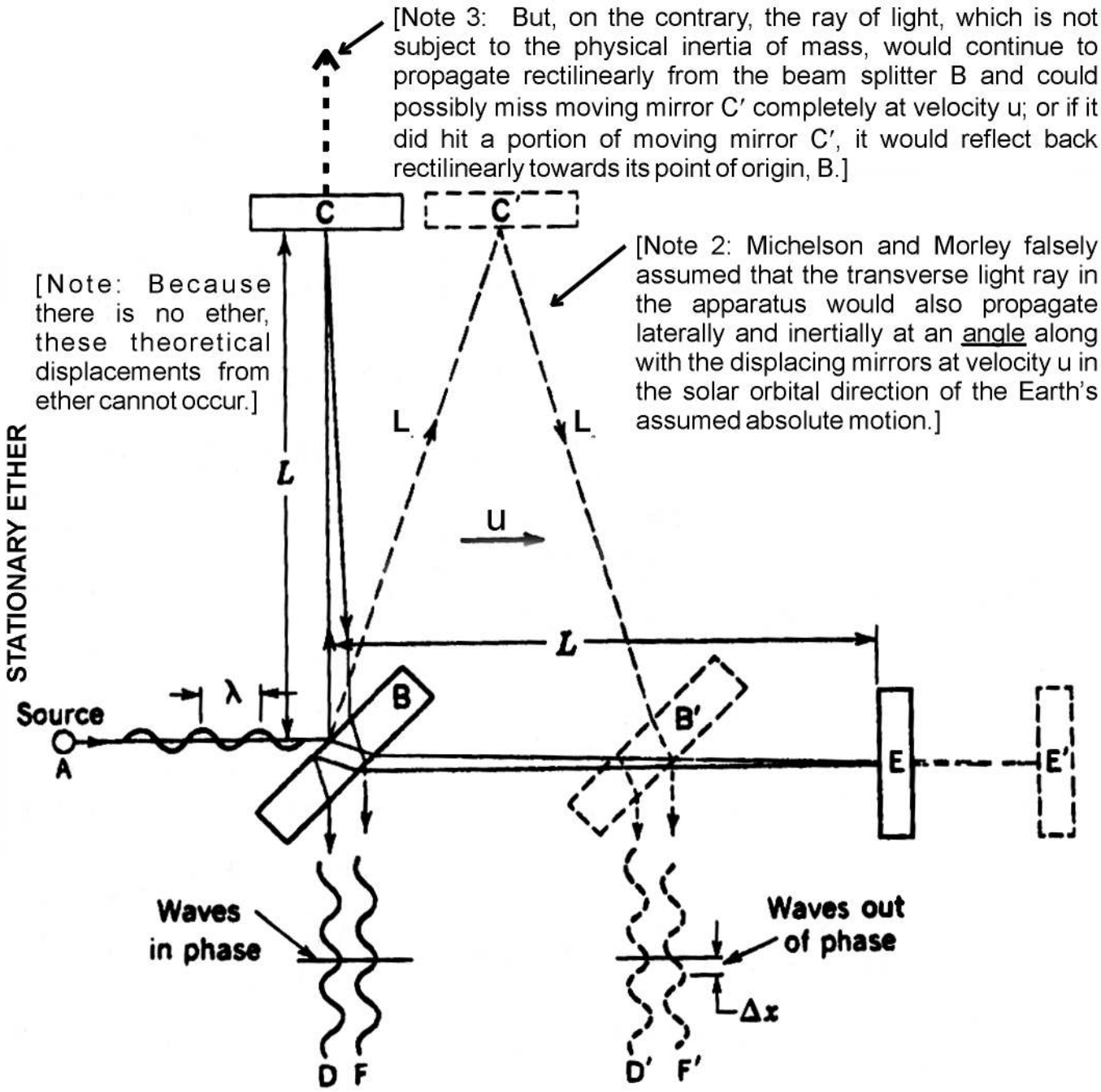
(NOT TO SCALE)



Before adjustment, the relative phase of the two light pencils remains the same during the journey to and from their respective mirrors.



After adjusting the distance of the focusing mirror for light pencil 1 with the micrometer screw, the waves of the two light pencils change their relative phases and an interference fringe is created.



[Note 1: The 'transverse' ray of light from B to C and back to B is an illustration of the path of such light ray if the Earth is assumed to be at rest in the stationary ether. The velocity u of the apparatus is shown at about 30% of *c* for purposes of illustration. M & M's concept is incorrect on its face, because it shows the 'transverse' ray of light to also be propagating laterally at an angle relative to beam splitter B.]

Figure 9.5 M & M's Incorrect 1887 Concept Of The Assumed Inertial Path Of A Light Ray Propagating Laterally At An Angle To The Direction Of Motion

(Not exactly to scale)

Sources: M & M, 1887, p. 334; Bohm, p. 15; Born, p. 215; Feynman, 1963, p. 15-3

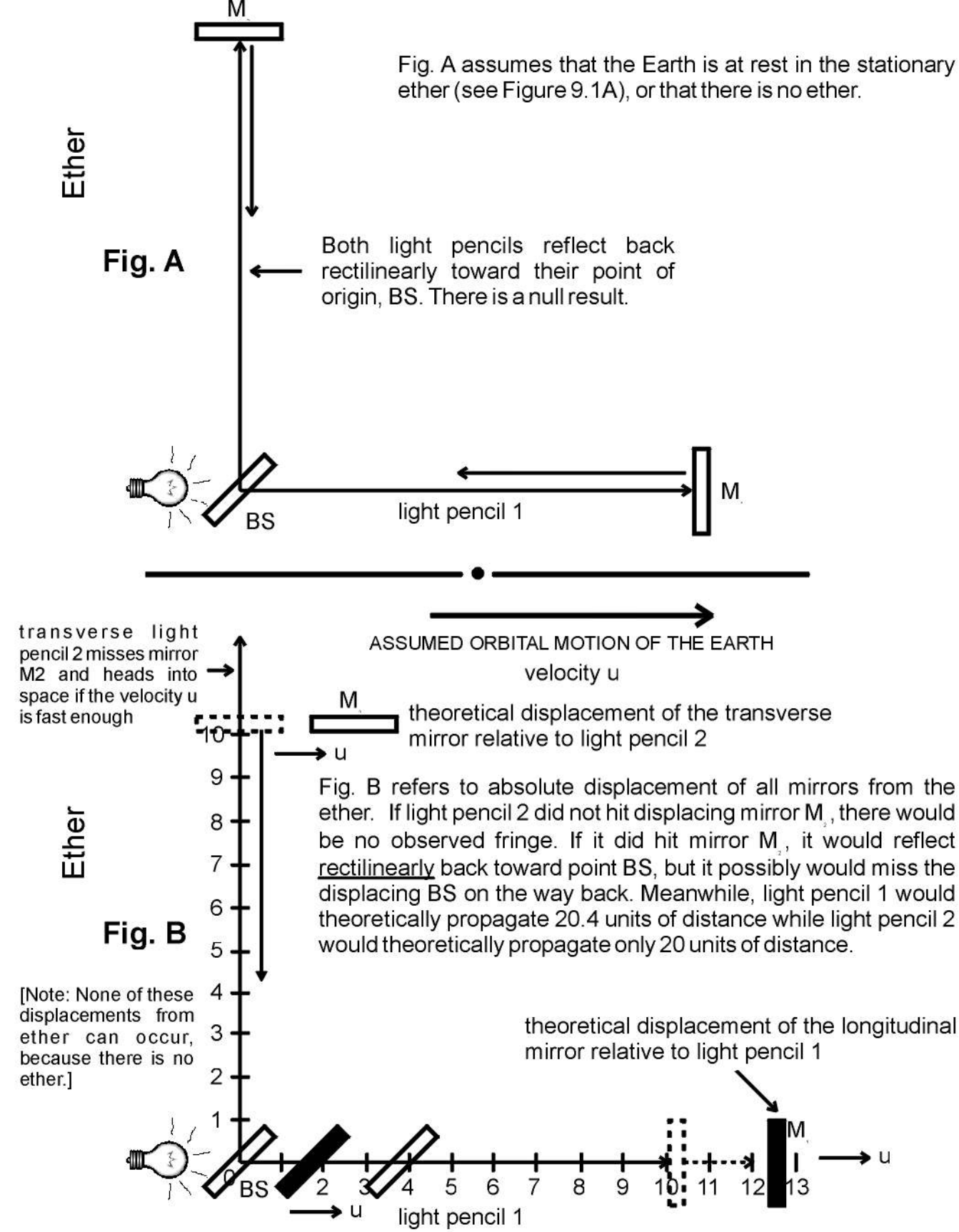


Figure 9.6 The Correct Rectilinear Path Of The Transverse Light Ray In The 1887 M & M Experiment

(NOT EXACTLY TO SCALE)

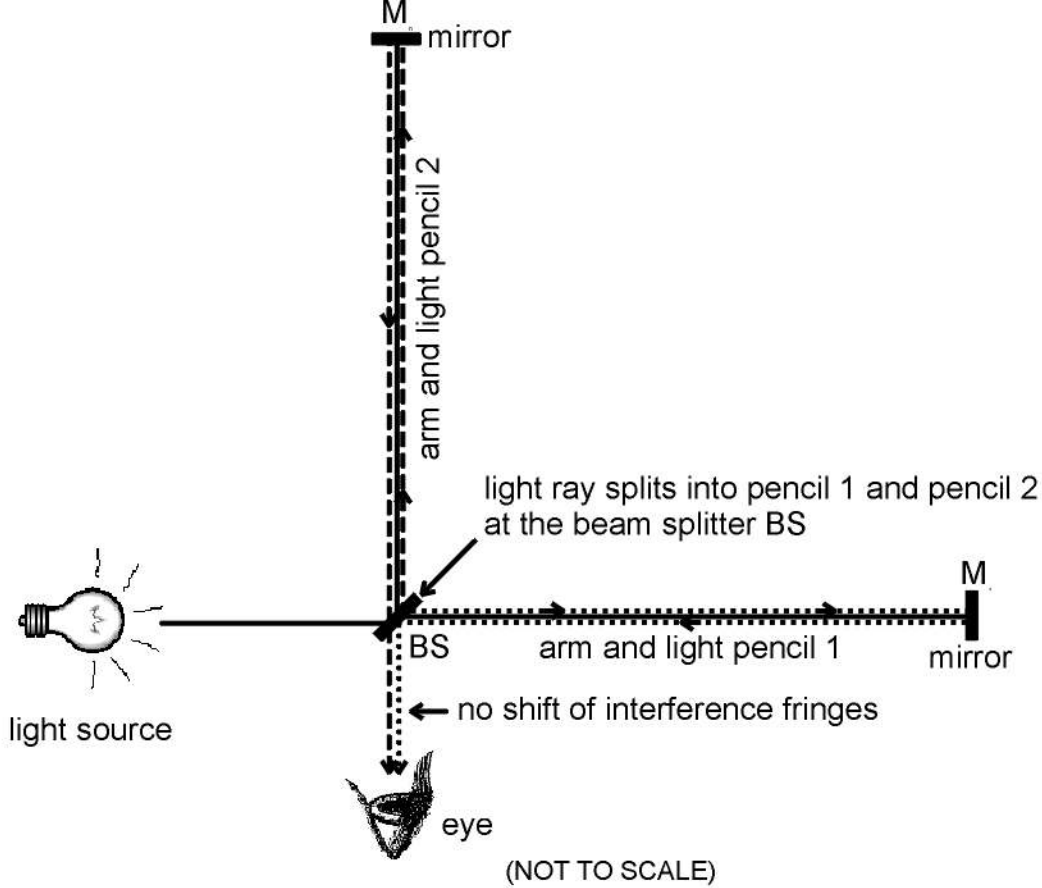
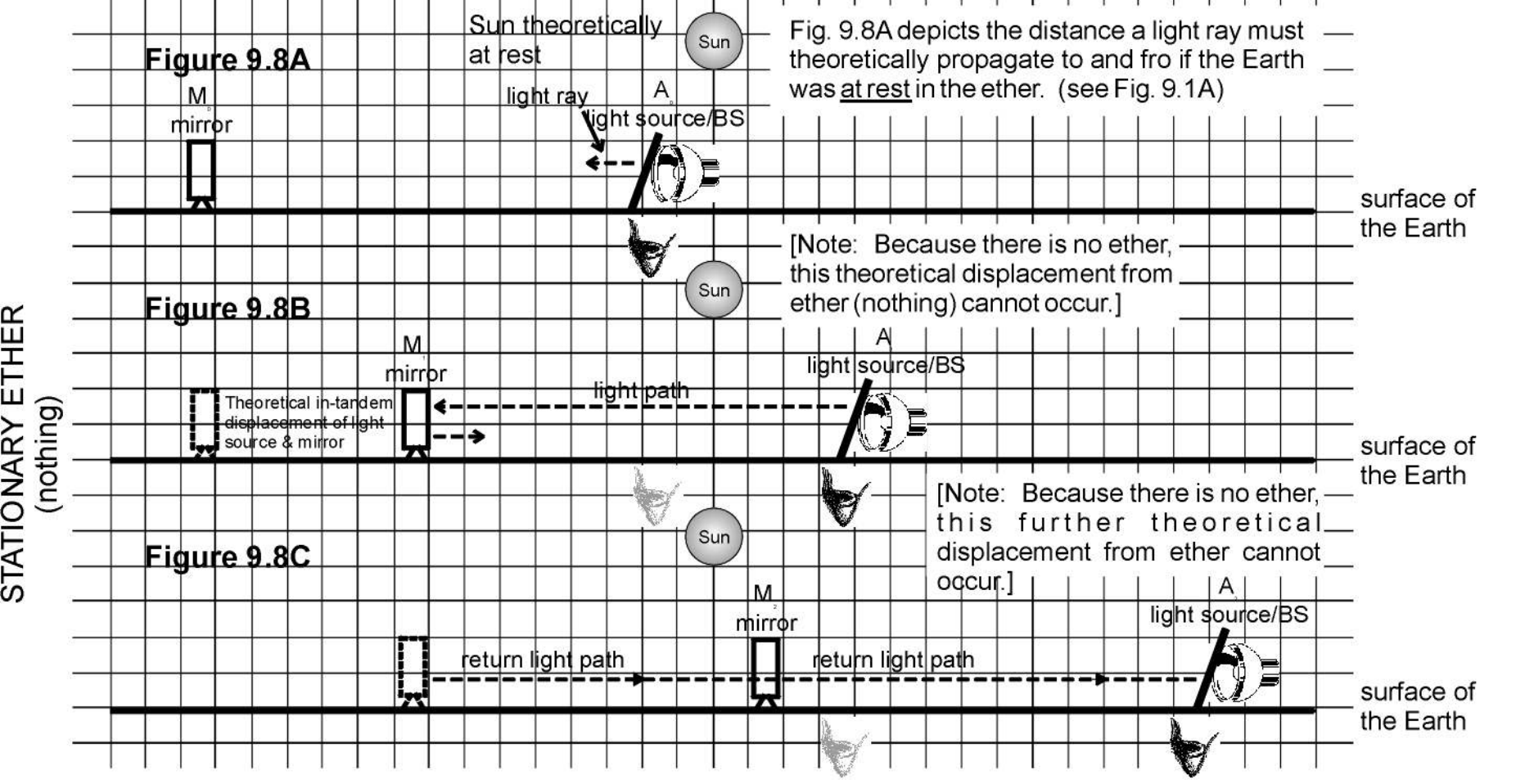


Figure 9.7

The Path Of Two Light Pencils In The Michelson-Morley Experiment *A Priori* Necessary To Produce A Time Interval Difference Null Result For Propagating Light Pencils Relative To Michelson's Mirrors. How Could This Null Result Theoretically Occur?

A) If the apparatus is theoretically and absolutely at rest relative to the dragged along ether. (not possible, there is no ether)
B) The *ad hoc* contraction way in which Fitzgerald, Lorentz and/or Einstein speculated. (See Chapters 10A, 15 & 16)
C) If there is no absolute velocity of the Earth or there is no in-tandem physical displacement of the beam splitter and the mirrors relative to the light pencils. (Chapters 10 and 11)
D) If there is no greater distance/time interval for light to propagate the finite distance between two relatively stationary objects regardless of their assumed in-tandem motion through space. (Chapters 11D and 12A)
E) If the change of position of the Earth relative to other celestial bodies (including the Sun) cannot be detected by Michelson's interference of light method. (Chapter 12B)



(See Figure 9.2 for a comparison of what happens in reverse.)

Figure 9.8 What *A Priori* Happens When A Light Pencil Travels From The Beam Splitter (BS) To The Reflecting Mirror, And Back Toward Beam Splitter, In The Direction Opposite To The Direction Of Motion Of The Apparatus?

[Important Note: The above illustrations (B and C) show the mirror theoretically displacing from the ether, as Maxwell and Michelson assumed. However, because there is no ether these displacements from ether cannot occur; it was a false assumption.]