On Special Relativity

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Abstract Closed form analytical solutions to Maxwell's equations for a moving Gaussian source reveal that Special Relativity produces a non-null result for Michelson-Morley experiment. To examine this unexpected discovery, Special Relativity is examined on its problem raising, its problem solving, and its explanations to the null result of Michelson-Morley experiment. Fundamental mistakes are discovered during the examination of its problem raising and its problem solving, leading to a discovery that Lorentz Covariance of Maxwell's equations is not a physical reality. A mathematical proof is given for a conclusion that Special Relativity only produces non-null results for Michelson-Morley experiments.

Contents

Introduction

Following Einstein's terms, "physical laws" refer to the laws humans formulated about nature, not the laws of nature by God. The laws of nature by God are referred to as "phenomena".

The null-result of the Michelson-Morley experiment (MME) was interpreted as a discrepancy between "phenomena" and "physical laws". The non-null expectation of MME was an asymmetry given by "physical laws". The null-result of MME was a symmetry given by "phenomena".

Einstein discovered a mathematical wonder of Lorentz Covariance of Maxwell's equations (LCM). LCM best explained the null-result of MME without solving Maxwell's equations. Based on two famous postulates, and with LCM in its core, Special Relativity was developed ([1], [2]). Einstein's achievements are considered monumental. Extending Special Relativity to General Relativity, Einstein is recognized as one of the greatest physicists in human history.

The two postulates of Special Relativity are basically two vague-guesses on characteristics of Maxwell's equations. They have been left to be vaguely-guessed for more than a hundred years. Still, we firmly believe that these guesses are true and can be treated as axioms because they were proposed by Albert Einstein who is an icon of human wisdom.

With the availability of analytical solutions to Maxwell's equations ([3], [4], [5]), deeper understanding of electrodynamics is possible. I made some investigations on the null-result of MME using analytical solutions to Maxwell's equations, see [5]. We may also examine those postulates with closed form analytical functions, instead of vaguely-guessing on characteristics of partial differential equations.

The two postulates are vague because they are expressed in wording. For them not to be vague, they should be expressed in mathematical formulas; it is like the concept of Gödel number.

We would think there is no ambiguity in words "speed" and "velocity". Einstein taught us: "The principle of the constancy of the velocity of light is of course contained in Maxwell's equations" [2]. The light is thus an electromagnetic wave since it is a solution to Maxwell's equations.

But in chapter "I. KINEMATICAL PART" of [1], the light is a particle, its speed is defined like a bullet speed by

$$\text{velocity} = \frac{\text{light path}}{time\ interval}$$

Using the above speed definition, Einstein deduced Lorentz coordinate transformation from the postulate of constant light speed.

$$\text{the postulate of constant light speed} \Leftrightarrow \text{Lorentz Coordinate Transformation}$$

However, wave propagation distance and bullet travel distance cannot be defined using the same math formula. Wave speeds are more complicated than a bullet speed. We see concepts of phase-speed, group-speed, etc., which do not apply to a bullet.

Wave speed formula is not defined and used in Special Relativity. Without giving a math formula for the speed of electromagnetic waves, the postulate of constant speed is a vague-guess.

For investigations of the speeds of electromagnetic fields using math formulas, see my reports [8] and [9]. Using analytical solutions to Maxwell's equations, I show that the Dirac delta function can produce an electromagnetic field with constant propagation speed, let's call it the standard light speed; if the magnitude of the field source is limited then the speed of the field rises from 0 to the standard light speed quickly, but never reaches the standard light speed.

The postulate of the principle of relativity is very far away from math formulas. So, it is also a vague-guess.

On finding a way to solve Maxwell's equations, I was playing with the closed form analytical solutions to Maxwell's equations for a moving Gaussian source; I accidentally found that Special Relativity produced a non-null result for the Michelson-Morley experiment. This unexpected discovery made me study the special theory of relativity from Einstein's original paper [1], study its problem raising, its problem solving, and how it explains the null-result of Michelson-Morley experiment. I am reporting my findings here. With my respect and admiration, Special Relativity is found to be a theory not for the real world.

Section "The problem to be solved by Special Relativity" studies the first paragraph of [1]; examines how the problem is raised. By translating the wording in [1] into math formulas, errors are discovered. The problem to be solved actually does not exist.

Section "The principle of relativity" studies the second paragraph of [1], which develops the principle of relativity. The principle of relativity is the solution to the problem raised in the first paragraph of [1].

Section "Apply relativity principle to Maxwell's equations" goes through section 6 of [1], paragraph by paragraph, inferring math formulas from wording of [1] when needed. By doing so, fundamental math errors in section 6 of [1] are spotted, leading to a discovery that Lorentz Covariance of Maxwell's equations is not a physical reality.

Section "Michelson-Morley experiment vs Einstein experiment" points out a fundamental discrepancy between Einstein experiment and Michelson-Morley experiment. The Einstein experiment uses one beam of light observed from two frames; the Michelson-Morley experiment uses two beams of light observing from one frame.

Section "Apply Special Relativity to Einstein experiment" gives an analytical solution to the Einstein experiment using a Gaussian source in Maxwell's equations. Even though comparing one beam with an alternation of itself gives a null-result, applying Special Relativity to the Einstein experiment generates an asymmetry which is the problem Special Relativity is supposed to solve.

Section "Use Einstein Experiment as Michelson-Morley experiment" gives a mathematical proof for a conclusion that Special Relativity only produces non-null results for Michelson-Morley experiments.

The problem to be solved by Special Relativity

Paper [1] begins with “It is known …”. I thought the sentence referred to the well-known discrepancy of non-null expectation and null-result of the Michelson-Morley experiment (MME):

“It is known that Maxwell's electrodynamics—as usually understood at the present time—when applied to moving bodies, leads to asymmetries which do not appear to be inherent in the phenomena.”

But the next sentence starts with “Take, for example, …”. The paragraph describes an example which has nothing to do with MME.

The second paragraph of [1] starts with “Examples of this sort, together with the unsuccessful attempts to discover any motion of the earth relative to the light medium, …”.

“the unsuccessful attempts…” in this sentence refers to MME. This sentence is to say that many examples, including MME, all independently raise a common problem in different phenomena. Thus, a generic problem is raised to be solved by Special Relativity, and the problem is that electrodynamics has “**asymmetries which do not appear to be inherent in the phenomena**”.

Because I found that solutions to Maxwell’s equations contradict the explanation of null-result of MME given by Special Relativity, I want to study how Special Relativity raises the problem, mathematically. On studying the first section of paper [1], I started looking in [1] for answers to the following two independent questions.

1. How is the generic problem raised in MME?
2. How is the generic problem raised by the example presented in the first paragraph of [1]?

For the first question, paper [1] just provides one sentence: “unsuccessful attempts to discover any motion of the earth relative to the light medium”. There is not much information to get math formulas to define what are symmetries and what are asymmetries.

I tried to answer the question by myself. I found that without solutions to Maxwell’s equations, it was impossible to use correct math formulas to get the expectations of MME. Thus, it was impossible to raise the problem from MME if solutions to Maxwell’s equations were not available. That is, the first question cannot be answered by [1]. For my investigations, see [5].

Paper [1] only provides information about the second question. That is, the raising of the problem to be solved by Special Relativity is solely by the example presented in the first paragraph of [1].

Let’s examine the example given in the first paragraph of [1].

The example involves a conductor and a magnet. The symmetric “phenomenon” is the electric current in the conductor. The asymmetric “physical law” is about energy.

The discrepancy between “physical laws” and “phenomena” is described in the following way.

The “symmetry” of the “phenomenon” means moving which object does not matter, and the electric current is the same. The “asymmetry” of the “physical law” means moving which object matters: by moving the magnet, the energy is **not 0**; by moving the conductor, the energy is **0**.

On studying this paragraph, the following issues cannot be ignored. The problem does not exist in the example.

Physical laws are Phenomena

In the first paragraph of [1], the correctness of physical laws are not challenged.

The “phenomena” are not presented with measurements from instruments. The “phenomena” are presented using “physical laws”.

Therefore, it is impossible to find a discrepancy between the “phenomena” and the “physical laws” besides their names.

Amazingly, Einstein convinced himself and all of us to believe that there are discrepancies between “physical laws” and “phenonmena”, even though “physical laws” = “phenomena”.

In the first paragraph of [1], when a description, description A, describes something symmetric, then it is a “phenomenon”; when a description, description B, describes something asymmetric, then it is a “physical law”.

The discrepancy of “phenomena vs physical law” is presented as “description A vs description B”.

It looks OK, and even convincing. But it is a mismatched comparison. Let me elaborate it in the next subsection.

Mismatched comparison

Let’s present the problem “**asymmetries which do not appear to be inherent in the phenomena**” into the following pseudo formulas.

observed phenomena: symmetry	(1.1)
physical laws: asymmetry	(1.2)

We should have expected one of the following demonstrations for showing a discrepancy:

observed phenomena: the current is in symmetry	(1.3)
physical laws: the current is in asymmetry	(1.4)

Or

observed phenomena: the energy is in symmetry	(1.5)
physical laws: the energy is in asymmetry	(1.6)

We see none of the above demonstrations. Instead, paper [1] makes the following demonstration.

observed phenomena: the current is in symmetry	(1.7)
physical laws: the energy is in asymmetry	(1.8)

(1.7) uses the current, (1.8) uses the energy. It is a discrepancy in making comparison, not a discrepancy between physical laws and phenomena.

The first paragraph of [1] does not provide clear comparison as shown above, because formulas are not used.

To make sure a correct understanding of [1], the wording of that example should be translated into math formulas. Let's do it.

The example in math formulas

Let's use a resistor to represent the conductor, and use a magnetic field to represent the magnet:

$\text{conductor resistance} = R$	(c0.1)
$\text{conductor permittivity}: \varepsilon_d$ $\mathit{conductor}\ \text{permeability}: \mu_d$ $c_d = \frac{1}{\sqrt{\varepsilon_d \mu_d}}$	(c0.2)
$\text{magnet's field is } B: \nabla \times B(x,y,z) = 0;\ \forall(x,y,z)$	(c0.3)
$electric\ field: E(x,y,z)$ $integration\ along\ a\ path: \int Edl$	(c0.4)
$electromotive force: V = \int Edl$	(c0.5)

In forming the formulas below, there are simplifications, boundary conditions are not considered, just to make the wording simpler without hurting what to be expressed.

Case 1. Conductor at rest, magnet in move.

Physical laws in cgs units:

magnet in move: $\frac{\partial E(x-vt,y,z,t)}{\partial t} = c\nabla \times B(x-vt,y,z,t);\ \forall(x,y,z,t>0)\ not\ in\ conductor$ $\frac{\partial E(x-vt,y,z,t)}{\partial t} = c_d\nabla \times B(x-vt,y,z,t);\ \forall(x,y,z,t>0)\ in\ conductor$	(c1.a1)
$current\ generated\ by\ E(x,y,z,t>0): I = \frac{1}{R}\int Edl = \frac{V}{R};\ \forall(x,y,z)\ in\ conductor$	(c1.a2)
$energy\ in\ conductor: P = I^2R$	(c1.a3)

Descriptions in [1]:

"there arises in the neighbourhood of the magnet an electric field": $magnet\ in\ move: E(x,y,z,t)\ is\ induced\ in\ space\ (x,y,z,t>0)$	(c1.e1)
"producing a current at the places where parts of the conductor are situated": $current\ generated\ by\ E(x,y,z,t>0): I \neq 0;\ \forall(x,y,z)\ in\ conductor$	(c1.e2)
"with a certain definite energy": $energy\ generated: P > 0$	(c1.e3)

Descriptions in [1] match the physical laws. The descriptions are for "phenomena" and "physical laws".

Case 2. Conductor in move, magnet at rest.

Physical laws in cgs units:

$\text{magnet at rest:} \nabla \times B(x,y,z,t) = 0;\ \forall(x,y,z,t)$	(c2.a1)

conductor in move: $\frac{\partial E(x+vt,y,z,t)}{\partial t} = c_d \nabla \times B(x+vt,y,z,t);\ \forall(x,y,z,t>0)\ in\ conductor$	(c2.a2)
$current\ generated\ by\ E(x,y,z,t): I_2 = \frac{-V}{R} = -I;\ \forall(x,y,z,t>0)\ in\ conductor$	(c2.a3)
$energy\ in\ conductor: P = I^2 R$	(c2.a4)

Descriptions in [1]:

"no electric field arises in the neighbourhood of the magnet": magnet at rest: $E(x,y,z,t) = 0;\ \forall(x,y,z)\ near\ magnet$	(c2.e1)
"In the conductor, however, we find an electromotive force": conductor in move: $V(x,y,z,t) \neq 0;\ \forall(x,y,z,t>0)\ in\ conductor$	(c2.e2)
"gives rise to electric currents of the same path and intensity": $current\ generated\ by\ V(x,y,z,t): I_2 = \frac{V}{R} = I;\ \forall(x,y,z,t>0)\ in\ conductor$	(c2.e3)
"to which in itself there is no corresponding energy": $energy\ \text{"}in\ itself\text{"}: P = 0$	(c2.e4)

These math formulas reveal the following issues of inaccurate descriptions.

1. Case 2 "gives rise to electric currents of the same path and intensity" (c2.e3). This is a phenomenon.
   1.1. This description of the phenomenon is inaccurate because "path" is mentioned. According to Ampere's circuital law (c1.a1) and (c2.a2), the paths of the two currents have opposite directions. (c2.e3) is incorrect. That means, moving which object matters. There is an asymmetry in the phenomenon, and thus this is a good asymmetry.
   1.2. If we ignore "path" then the electric current density is indeed symmetric. But the Ampere's circuital law also says that the electric current density depends only on the relative motion; the physical law is also in symmetry. For the current density, there is not a discrepancy between the physical laws and the phenomena.
2. "In the conductor, however, we find an electromotive force, to which in itself there is no corresponding energy" (c2.e4). It is talking about "physical laws". This is the key statement showing where the bad asymmetry appears.
   But it does not say by which physical laws it gives the above claim that "in itself" the energy is 0 while the electromotive force is not 0. It is not obvious to me how to use math formulas to translate "in itself". I'll just enumerate all physical quantities in this example, one by one.
   2.1. "in itself" = the conductor. Since in the conductor, its "corresponding energy" is $I_2^2 R$ and $I_2^2 R > 0$. This interpretation gives an inaccurate description.
   2.2. "in itself" = the electromotive force. Since the current I_2 comes from the electromotive force, the "corresponding energy" contained in the electromotive force is not less than $I_2^2 R$ and $I_2^2 R > 0$. This interpretation gives an inaccurate description.
   2.3. "in itself" = curl of magnetic field $\nabla \times B$.
      2.3.1. The curl is a math concept, suppose we say its energy is 0. If we use this translation then the energy in case 1 is also 0. That is, the energy is symmetric. There is not an asymmetry inherent in the observable phenomena, nor is it in the physical laws.
      2.3.2. It is also an inaccurate description. For example, by moving a wood stick we get exactly the same non-0 curl as we get by moving a conductor. Suppose the permittivity of the wood stick is infinity: $\varepsilon = \infty$, then the electromotive force of the wood is 0. The electromotive force and energy go with the material, conductor or wood, not with the curl. That means the curl itself cannot be used as "in itself".
   2.4. In summary, the keyword "in itself" does not match any physical quantity. Therefore, this key statement of the first paragraph of [1] is invalid.

The key statement "there is no corresponding energy" is saying that the asymmetry of energy is non-zero vs zero, implying that it is a logic error, thus the asymmetry of energy is bad.

In this example, asymmetry of the energy is quantitative, not logical. I'll show it in the next subsection.

The asymmetry of energy is a good one

When we **move the magnet**, we have

$$\nabla \times B = \begin{bmatrix} 0 \\ -\frac{\partial B_z}{\partial x} v \\ \frac{\partial B_y}{\partial x} v \end{bmatrix}$$

which generates

$$E = \begin{bmatrix} 0 \\ E_y \\ E_z \end{bmatrix}$$

by

$$\frac{\partial E}{\partial t} = c\nabla \times B$$

which in turn generates

$$\nabla \times E = \begin{bmatrix} \frac{\partial E_z}{\partial y} - \frac{\partial E_y}{\partial z} \\ -\frac{\partial E_z}{\partial x} \\ \frac{\partial E_y}{\partial x} \end{bmatrix}$$

which in turn generates B in 3D. An electromagnetic wave is generated with energy propagating to the whole universe in 3D to be picked up by any conductors. Such energy propagation in space is described by the Poynting vector. When a conductor picks up some energy, it does not cancel electromagnetic fields in space, there is still energy propagating to the whole universe.
When we **move the conductor**, there is no energy propagating to the whole universe, assuming the conductor does not leak the electromagnetic fields generated inside it, as Einstein assumed it with (c2.e1). The energy is only generated in the conductor. Because the same current intensity is assumed in the conductor in the two cases, the energy in the conductor is the same.

Therefore, moving the magnet involves more energy than moving the conductor. That is, moving which object matters. The energy is asymmetric.
In both cases the energy is not 0. The asymmetry of energy is quantitative, not non-zero vs zero.
It actually does not matter whether the energy asymmetry is quantitative or logical; it is a good asymmetry because it is inherent in the above phenomena.

The problem does not exist

It is shown that the asymmetry of energy in this example is inherent in phenomena. Therefore, the asymmetry is a good one, not a bad one to be removed.

Since the key statement to raise the problem is invalid, by a trial practice that "the benefit of the doubt belongs to the defendant", we have to declare that the physical laws are innocent, and the problem raised does not exist.

Even though this example does not work, the second paragraph of [1] mentions: "Examples of this sort…". So, a doubt exists that there can still be working examples showing bad asymmetries, which can bring some physical laws back on trial. The doubt does not overturn the above conclusion that the problem does not exist, unless such a working example is really found.

For such an example to work, that is, to show a discrepancy between a physical law and a phenomenon, it must separate the physical law from the phenomenon. It cannot use physical laws as phenomena. That is, it must use measurements as phenomena, as the Michelson-Morley experiment did.

Before you make such an effort, beware of the principle of relativity; it does not care who are bad asymmetries and who are good asymmetries, it kills everyone without mercy to collateral damages.

Let's examine the principle of relativity.

The principle of relativity

The principle of relativity is developed in the second paragraph of [1].

The development of the principle of relativity is a process of repeatedly using a necessary condition as a sufficient condition. It could be a good way to explore the unknown world, to make good guesses and get inspiration. But a mature theory cannot keep logic errors in its foundations.

The second paragraph of [1] **suggests** that all asymmetries in electrodynamics are bad, not just in that specific example. Paper [1] says: "They suggest rather that, as has already been shown to the first order of small quantities, the same laws of electrodynamics and optics will be valid for all frames of reference for which the equations of mechanics hold good".

The words "has already been shown" tell us that the deduction is based on the first paragraph of [1] because these words are in the second paragraph of [1]. It bothers me that the math concepts of "the first order" and "small quantities", which "has already been shown", are not defined and used in the first paragraph of [1].

The second paragraph of [1] further suggests/**raises** that all asymmetries in all physics are bad, not just in electrodynamics. Paper [1] says: "We will raise this conjecture (the purport of which will hereafter be called the "Principle of Relativity") to the status of a postulate".

In section "§ 2. On the Relativity of Lengths and Times" of [1], the principle of relativity is defined as

"The laws by which the states of physical systems undergo change are not affected, whether these changes of state be referred to the one or the other of two systems of coordinates in uniform translatory motion".

So, the principle of relativity is to set a goal. The goal is to remove all asymmetries in all physical laws.

To reach such a grand goal, I would expect that lots of big inventions have to be made. Surprisingly, the second paragraph of paper [1] says: “These two postulates suffice for the attainment of a simple and consistent theory of the electrodynamics of moving bodies based on Maxwell's theory for stationary bodies.”

The word “**suffice**” tells us that between {Lorentz transformation + the principle of relativity} and {the solution of the problem of asymmetry}, there are no extra subjective inventions and new physical laws; there are only objective mathematical deductions. That is, the principle of relativity is not only a goal, it is also a means and the solution.

On studying the way {Lorentz transformation + the principle of relativity} is used to solve the problem, I found that the word “**suffice**” is incorrect. An imaginary world has to be invented for the principle of relativity to work.

To apply {Lorentz transformation + the principle of relativity} to Maxwell’s equations, the mathematical deductions are presented in section 6 of [1]. Let’s study it.

Apply the postulates to Maxwell’s equations

I am going through section 6 of [1] paragraph by paragraph, presenting my understanding of the wording by math formulas. Einstein’s equations are numbered by (e.*); equations of my inferences are numbered by (m.*).

Apply Lorentz transformation

The first paragraph presents Maxwell-Hertz equations at rest frame (stationary system K):

$$\begin{gathered}\frac{1}{c}\frac{\partial X}{\partial t}=\frac{\partial N}{\partial y}-\frac{\partial M}{\partial z},\frac{1}{c}\frac{\partial L}{\partial t}=\frac{\partial Y}{\partial z}-\frac{\partial Z}{\partial y}\\ \frac{1}{c}\frac{\partial Y}{\partial t}=\frac{\partial L}{\partial z}-\frac{\partial N}{\partial x},\frac{1}{c}\frac{\partial M}{\partial t}=\frac{\partial Z}{\partial x}-\frac{\partial X}{\partial z}\\ \frac{1}{c}\frac{\partial Z}{\partial t}=\frac{\partial M}{\partial x}-\frac{\partial L}{\partial y},\frac{1}{c}\frac{\partial N}{\partial t}=\frac{\partial X}{\partial y}-\frac{\partial Y}{\partial x}\end{gathered}\tag{e.1}$$

The second paragraph applies Lorentz coordinate transformation to (e.1) and gets the following equations for the moving frame (moving system k).

$$\begin{gathered}\frac{1}{c}\frac{\partial X}{\partial \tau}=\frac{\partial}{\partial \eta}\beta\left(N-\frac{v}{c}Y\right)-\frac{\partial}{\partial \zeta}\beta\left(M+\frac{v}{c}Z\right),\frac{1}{c}\frac{\partial L}{\partial \tau}=\frac{\partial}{\partial \zeta}\beta\left(Y-\frac{v}{c}N\right)-\frac{\partial}{\partial \eta}\beta\left(Z+\frac{v}{c}M\right)\\ \frac{1}{c}\frac{\partial}{\partial \tau}\beta\left(Y-\frac{v}{c}N\right)=\frac{\partial L}{\partial \zeta}-\frac{\partial}{\partial \xi}\beta\left(N-\frac{v}{c}Y\right),\frac{1}{c}\frac{\partial}{\partial \tau}\beta\left(M+\frac{v}{c}Z\right)=\frac{\partial}{\partial \xi}\beta\left(Z+\frac{v}{c}M\right)-\frac{\partial X}{\partial \zeta}\\ \frac{1}{c}\frac{\partial}{\partial \tau}\beta\left(Z+\frac{v}{c}M\right)=\frac{\partial}{\partial \xi}\beta\left(M+\frac{v}{c}Z\right)-\frac{\partial L}{\partial \eta},\frac{1}{c}\frac{\partial}{\partial \tau}\beta\left(N-\frac{v}{c}Y\right)=\frac{\partial X}{\partial \eta}-\frac{\partial}{\partial \xi}\beta\left(Y-\frac{v}{c}N\right)\end{gathered}\tag{e.2}$$

(e.1) and (e.2) use the same function names (X, Y, Z, L, M, N) to indicate that observing from the two reference frames the electromagnetic field is physically “exactly the same thing” (paragraph 4). Thus, in Einstein’s notations, we have

$$[X,Y,Z,L,M,N]^T(\xi,\eta,\zeta,\tau)=[X,Y,Z,L,M,N]^T(x,y,z,t)\tag{m.0}$$

Such notation usage caused confusions to me, because I did not expect that variable names carry math operations and thus change the definitions of the functions.

I am used to computer languages. People familiar with tensor notations may not be as confused as I am; Einstein summation convention uses indexes to carry math operations, Greece letters and Roman letters carry different operations.

I’ll call Einstein’s notations “variable-name-dominate”. In contrast, the notations I am used to are “function-name-dominate”.

For example, for a function

$$f(x,t)=\sin\big(\omega(x-ct)\big)$$

By normal “function-name-dominate” notation, I would have expected that

$$f(\xi,\tau)=\sin\big(\omega(\xi-c\tau)\big)$$

However, by Einstein’s “variable-name-dominate” natation, the function definition is changed to

$$f(\xi,\tau)=\sin\left(\omega\left(\beta\xi+v\beta\tau-c\left(\frac{v\beta}{c^2}\xi+\beta\tau\right)\right)\right)$$

or

$$f(\xi,\tau)=\sin\left(\omega\sqrt{\frac{1-\frac{v}{c}}{1+\frac{v}{c}}}(\xi-c\tau)\right)$$

Einstein's "variable-name-dominate" notation has an advantage that it is easy to see that (e.1) and (e.2) are describing the same physical quantities observing from different coordinate systems.

But such physical clarity generates mathematical ambiguity, and it might cause mathematical confusions. When reading (e.2), we must be very careful about how to perceive the meaning of the functions, as shown below.

$\textit{normally perceived, but } \boldsymbol{wrong}: \frac{\partial X}{\partial\tau}=\frac{\partial X(\xi,\eta,\zeta,\tau)}{\partial\tau}$ $\textit{unnormally perceived, but } \boldsymbol{correct}: \frac{\partial X}{\partial\tau}=\frac{\partial X\left(\beta\xi+v\beta\tau,\eta,\zeta,\frac{v\beta}{c^2}\xi+\beta\tau\right)}{\partial\tau}$	(m.0)

Because function definitions are determined by its variable names, without giving a variable name list, it is very likely to make the above errors. To avoid causing mistakes in math deductions, we have two options:

1. Explicitly list moving frame variables $\left(\beta\xi+v\beta\tau,\eta,\zeta,\frac{v\beta}{c^2}\xi+\beta\tau\right)$ in all functions. That is, you cannot just use X. You have to use $X\left(\beta\xi+v\beta\tau,\eta,\zeta,\frac{v\beta}{c^2}\xi+\beta\tau\right)$.
2. Use normal "function-name-dominate" notations by defining new function names for the moving frame to match the moving frame variables. For example, $X'(\xi,\eta,\zeta,\tau)=X\left(\beta\xi+v\beta\tau,\eta,\zeta,\frac{v\beta}{c^2}\xi+\beta\tau\right)$. Now, you can just use X' without listing its variables.

Using option 2 we get math clarity but its disadvantage is that we might forget that X and X' are the same physical quantity, even though their function definitions are different in the sense of "function-name-dominate" notations.

Later, Einstein introduced option 2 in his math deductions, and thus we have

In "function-name-dominate" notations: $\begin{bmatrix}X'\\Y'\\Z'\end{bmatrix}(\xi,\eta,\zeta,\tau)=\begin{bmatrix}X\\Y\\Z\end{bmatrix}\left(\beta\xi+v\beta\tau,\eta,\zeta,\frac{v\beta}{c^2}\xi+\beta\tau\right)$ $\begin{bmatrix}L'\\M'\\N'\end{bmatrix}(\xi,\eta,\zeta,\tau)=\begin{bmatrix}L\\M\\N\end{bmatrix}\left(\beta\xi+v\beta\tau,\eta,\zeta,\frac{v\beta}{c^2}\xi+\beta\tau\right)$	(m.1)

(e.2) uses the following "variable-name-dominate" notations.

In "variable-name-dominate" notations: $\begin{bmatrix}X\\Y\\Z\end{bmatrix}(\xi,\eta,\zeta,\tau)=\begin{bmatrix}X\\Y\\Z\end{bmatrix}(x,y,z,t)$ $\begin{bmatrix}L\\M\\N\end{bmatrix}(\xi,\eta,\zeta,\tau)=\begin{bmatrix}L\\M\\N\end{bmatrix}(x,y,z,t)$	(m.1a)

For (m.1), function definitions in the two sides of the equations are independent of variable names, that is, you can change the names of (ξ,η,ζ,τ) without affecting (m.1).

For (m.1a), function definitions in the two sides of the equations are different even though the function names are the same. It will be a nightmare to track the function meanings when both notations are used in one math deduction process, and math errors will be inevitable, as we will see later in Einstein's math deductions.

Omitting the variable list for the functions, (e.2) can be written using (X',Y',Z',L',M',N') in place of (X,Y,Z,L,M,N), as shown below.

$\frac{1}{c}\frac{\partial X'}{\partial\tau}=\frac{\partial}{\partial\eta}\beta\left(N'-\frac{v}{c}Y'\right)-\frac{\partial}{\partial\zeta}\beta\left(M'+\frac{v}{c}Z'\right),\frac{1}{c}\frac{\partial L'}{\partial\tau}=\frac{\partial}{\partial\zeta}\beta\left(Y'-\frac{v}{c}N'\right)-\frac{\partial}{\partial\eta}\beta\left(Z'+\frac{v}{c}M'\right)$ $\frac{1}{c}\frac{\partial}{\partial\tau}\beta\left(Y'-\frac{v}{c}N'\right)=\frac{\partial L'}{\partial\zeta}-\frac{\partial}{\partial\xi}\beta\left(N'-\frac{v}{c}Y'\right),\frac{1}{c}\frac{\partial}{\partial\tau}\beta\left(M'+\frac{v}{c}Z'\right)=\frac{\partial}{\partial\xi}\beta\left(Z'+\frac{v}{c}M'\right)-\frac{\partial X'}{\partial\zeta}$ $\frac{1}{c}\frac{\partial}{\partial\tau}\beta\left(Z'+\frac{v}{c}M'\right)=\frac{\partial}{\partial\xi}\beta\left(M'+\frac{v}{c}Z'\right)-\frac{\partial L'}{\partial\eta},\frac{1}{c}\frac{\partial}{\partial\tau}\beta\left(N'-\frac{v}{c}Y'\right)=\frac{\partial X'}{\partial\eta}-\frac{\partial}{\partial\xi}\beta\left(Y'-\frac{v}{c}N'\right)$	(m.2)

Keep in mind that (m.2) and (e.2) are equivalent. (m.2) is in "function-name-dominate" notations. (e.2) is in "variable-name-dominate" notations.

(e.2) is the result of applying Lorentz coordinate transformation to (e.1). Einstein did not present details of this part of math work in [1].

Now I want to re-do Einstein's math work to verify everything I presented above, including my analysis of "function-name-dominate" and "variable-name-dominate" notations.

Let's start from (e.1).

$\frac{1}{c}\frac{\partial X}{\partial t}=\frac{\partial N}{\partial y}-\frac{\partial M}{\partial z}$	(e.1X)
$\frac{1}{c}\frac{\partial Y}{\partial t}=\frac{\partial L}{\partial z}-\frac{\partial N}{\partial x}$	(e.1Y)
$\frac{1}{c}\frac{\partial Z}{\partial t}=\frac{\partial M}{\partial x}-\frac{\partial L}{\partial y}$	(e.1Z)
$\frac{1}{c}\frac{\partial L}{\partial t}=\frac{\partial Y}{\partial z}-\frac{\partial Z}{\partial y}$	(e.1L)
$\frac{1}{c}\frac{\partial M}{\partial t}=\frac{\partial Z}{\partial x}-\frac{\partial X}{\partial z}$	(e.1M)
$\frac{1}{c}\frac{\partial N}{\partial t}=\frac{\partial X}{\partial y}-\frac{\partial Y}{\partial x}$	(e.1N)

Einstein's result is (e.2). To avoid errors in math deductions, consistent notations should be used; I am using (m.2) instead, it is equivalent to (e.2).

$\frac{1}{c}\frac{\partial X'}{\partial \tau}=\frac{\partial}{\partial \eta}\beta\left(N'-\frac{v}{c}Y'\right)-\frac{\partial}{\partial \zeta}\beta\left(M'+\frac{v}{c}Z'\right)$	(m.2X)
$\frac{1}{c}\frac{\partial}{\partial \tau}\beta\left(Y'-\frac{v}{c}N'\right)=\frac{\partial L'}{\partial \zeta}-\frac{\partial}{\partial \xi}\beta\left(N'-\frac{v}{c}Y'\right)$	(m.2Y)
$\frac{1}{c}\frac{\partial}{\partial \tau}\beta\left(Z'+\frac{v}{c}M'\right)=\frac{\partial}{\partial \xi}\beta\left(M'+\frac{v}{c}Z'\right)-\frac{\partial L'}{\partial \eta}$	(m.2Z)
$\frac{1}{c}\frac{\partial L'}{\partial \tau}=\frac{\partial}{\partial \zeta}\beta\left(Y'-\frac{v}{c}N'\right)-\frac{\partial}{\partial \eta}\beta\left(Z'+\frac{v}{c}M'\right)$	(m.2L)
$\frac{1}{c}\frac{\partial}{\partial \tau}\beta\left(M'+\frac{v}{c}Z'\right)=\frac{\partial}{\partial \xi}\beta\left(Z'+\frac{v}{c}M'\right)-\frac{\partial X'}{\partial \zeta}$	(m.2M)
$\frac{1}{c}\frac{\partial}{\partial \tau}\beta\left(N'-\frac{v}{c}Y'\right)=\frac{\partial X'}{\partial \eta}-\frac{\partial}{\partial \xi}\beta\left(Y'-\frac{v}{c}N'\right)$	(m.2N)

Lorentz coordinate transformation is given below.

$\beta=\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$	(m.3)
$\tau=-\beta\frac{v}{c^2}x+\beta t$ $\xi=\beta x-\beta vt$ $\eta=y$ $\zeta=z$	(m.4)
$\frac{\partial\tau}{\partial t}=\beta;\ \frac{\partial\tau}{\partial x}=-\beta\frac{v}{c^2};\ \frac{\partial\tau}{\partial y}=0;\ \frac{\partial\tau}{\partial z}=0$ $\frac{\partial\xi}{\partial t}=-\beta v;\ \frac{\partial\xi}{\partial x}=\beta;\ \frac{\partial\xi}{\partial y}=0;\ \frac{\partial\xi}{\partial z}=0$ $\frac{\partial\eta}{\partial t}=0;\frac{\partial\eta}{\partial x}=0;\frac{\partial\eta}{\partial y}=1;\frac{\partial\eta}{\partial z}=0$ $\frac{\partial\zeta}{\partial t}=0;\frac{\partial\zeta}{\partial x}=0;\frac{\partial\zeta}{\partial y}=0;\frac{\partial\zeta}{\partial z}=1$	(m.5)

Let me present the detailed deduction steps for **(m.2X)** first.

By (m.1), we have

$$\frac{\partial X}{\partial t}=\frac{\partial X'}{\partial \xi}\frac{\partial \xi}{\partial t}+\frac{\partial X'}{\partial \eta}\frac{\partial \eta}{\partial t}+\frac{\partial X'}{\partial \zeta}\frac{\partial \zeta}{\partial t}+\frac{\partial X'}{\partial \tau}\frac{\partial \tau}{\partial t}$$

$$\frac{\partial N}{\partial y}=\frac{\partial N'}{\partial \xi}\frac{\partial \xi}{\partial y}+\frac{\partial N'}{\partial \eta}\frac{\partial \eta}{\partial y}+\frac{\partial N'}{\partial \zeta}\frac{\partial \zeta}{\partial y}+\frac{\partial N'}{\partial \tau}\frac{\partial \tau}{\partial y}$$

$$\frac{\partial M}{\partial z}=\frac{\partial M'}{\partial \xi}\frac{\partial \xi}{\partial z}+\frac{\partial M'}{\partial \eta}\frac{\partial \eta}{\partial z}+\frac{\partial M'}{\partial \zeta}\frac{\partial \zeta}{\partial z}+\frac{\partial M'}{\partial \tau}\frac{\partial \tau}{\partial z}$$

By (m.5), the above equations become

$$\frac{\partial X}{\partial t} = \frac{\partial X'}{\partial \xi}(-\beta v) + \frac{\partial X'}{\partial \tau}\beta$$

$$\frac{\partial N}{\partial y} = \frac{\partial N'}{\partial \eta}$$

$$\frac{\partial M}{\partial z} = \frac{\partial M'}{\partial \zeta}$$

Substitute the above into (e.1X), we have

$$\frac{1}{c}\left(\frac{\partial X'}{\partial \xi}(-\beta v) + \frac{\partial X'}{\partial \tau}\beta\right) = \frac{\partial N'}{\partial \eta} - \frac{\partial M'}{\partial \zeta}$$

Re-group the above, we get

$$\frac{\beta}{c}\frac{\partial X'}{\partial \tau} = \frac{v}{c}\beta\frac{\partial X'}{\partial \xi} + \frac{\partial N'}{\partial \eta} - \frac{\partial M'}{\partial \zeta}$$

Use the divergence condition

$$\frac{\partial X}{\partial x} + \frac{\partial Y}{\partial y} + \frac{\partial Z}{\partial z} = 0$$

By (m.1), we have

$$\frac{\partial X}{\partial x} = \frac{\partial X'}{\partial \xi}\frac{\partial \xi}{\partial x} + \frac{\partial X'}{\partial \eta}\frac{\partial \eta}{\partial x} + \frac{\partial X'}{\partial \zeta}\frac{\partial \zeta}{\partial x} + \frac{\partial X'}{\partial \tau}\frac{\partial \tau}{\partial x}$$

$$\frac{\partial Y}{\partial y} = \frac{\partial Y'}{\partial \xi}\frac{\partial \xi}{\partial y} + \frac{\partial Y'}{\partial \eta}\frac{\partial \eta}{\partial y} + \frac{\partial Y'}{\partial \zeta}\frac{\partial \zeta}{\partial y} + \frac{\partial Y'}{\partial \tau}\frac{\partial \tau}{\partial y}$$

$$\frac{\partial Z}{\partial z} = \frac{\partial Z'}{\partial \xi}\frac{\partial \xi}{\partial z} + \frac{\partial Z'}{\partial \eta}\frac{\partial \eta}{\partial z} + \frac{\partial Z'}{\partial \zeta}\frac{\partial \zeta}{\partial z} + \frac{\partial Z'}{\partial \tau}\frac{\partial \tau}{\partial z}$$

By (m.5), the above equations become

$$\frac{\partial X}{\partial x} = \frac{\partial X'}{\partial \xi}\beta - \beta\frac{v}{c^2}\frac{\partial X'}{\partial \tau}$$

$$\frac{\partial Y}{\partial y} = \frac{\partial Y'}{\partial \eta}$$

$$\frac{\partial Z}{\partial z} = \frac{\partial Z'}{\partial \zeta}$$

The divergence condition becomes

$$\frac{\partial X'}{\partial \xi}\beta - \beta\frac{v}{c^2}\frac{\partial X'}{\partial \tau} + \frac{\partial Y'}{\partial \eta} + \frac{\partial Z'}{\partial \zeta} = 0$$

Substitute the divergence condition into what we got earlier, we have

$$\frac{\beta}{c}\frac{\partial X'}{\partial \tau} = \frac{v}{c}\left(\beta\frac{v}{c^2}\frac{\partial X'}{\partial \tau} - \frac{\partial Y'}{\partial \eta} - \frac{\partial Z'}{\partial \zeta}\right) + \frac{\partial N'}{\partial \eta} - \frac{\partial M'}{\partial \zeta}$$

Re-group the above, we have

$$\frac{\beta}{c}\frac{\partial X'}{\partial \tau} - \beta\frac{v}{c}\frac{v}{c^2}\frac{\partial X'}{\partial \tau} = \frac{\partial N'}{\partial \eta} - \frac{v}{c}\frac{\partial Y'}{\partial \eta} - \frac{\partial M'}{\partial \zeta} - \frac{v}{c}\frac{\partial Z'}{\partial \zeta}$$

The above can be written as

$$\frac{\beta}{c}\frac{\partial X'}{\partial \tau}\left(1 - \frac{v^2}{c^2}\right) = \frac{\partial}{\partial \eta}\left(N' - \frac{v}{c}Y'\right) - \frac{\partial}{\partial \zeta}\left(M' + \frac{v}{c}Z'\right)$$

Because

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

We have

$$\frac{1}{c}\frac{\partial X'}{\partial \tau}=\frac{\partial}{\partial \eta}\beta\left(N'-\frac{v}{c}Y'\right)-\frac{\partial}{\partial \zeta}\beta\left(M'+\frac{v}{c}Z'\right)$$

The above is (m.2X). Thus, from (e.1X) and (m.1), we deduced (m.2X).

Next, let me present detailed deduction steps for **(m.2Y)**.

By (m.1), we have

$$\frac{\partial Y}{\partial t}=\frac{\partial Y'}{\partial \xi}\frac{\partial \xi}{\partial t}+\frac{\partial Y'}{\partial \eta}\frac{\partial \eta}{\partial t}+\frac{\partial Y'}{\partial \zeta}\frac{\partial \zeta}{\partial t}+\frac{\partial Y'}{\partial \tau}\frac{\partial \tau}{\partial t}$$

$$\frac{\partial L}{\partial z}=\frac{\partial L'}{\partial \xi}\frac{\partial \xi}{\partial z}+\frac{\partial L'}{\partial \eta}\frac{\partial \eta}{\partial z}+\frac{\partial L'}{\partial \zeta}\frac{\partial \zeta}{\partial z}+\frac{\partial L'}{\partial \tau}\frac{\partial \tau}{\partial z}$$

$$\frac{\partial N}{\partial x}=\frac{\partial N'}{\partial \xi}\frac{\partial \xi}{\partial x}+\frac{\partial N'}{\partial \eta}\frac{\partial \eta}{\partial x}+\frac{\partial N'}{\partial \zeta}\frac{\partial \zeta}{\partial x}+\frac{\partial N'}{\partial \tau}\frac{\partial \tau}{\partial x}$$

By (m.5), the above equations become

$$\frac{\partial Y}{\partial t}=\frac{\partial Y'}{\partial \xi}(-\beta v)+\frac{\partial Y'}{\partial \tau}\beta$$

$$\frac{\partial L}{\partial z}=\frac{\partial L'}{\partial \zeta}$$

$$\frac{\partial N}{\partial x}=\frac{\partial N'}{\partial \xi}\beta+\frac{\partial N'}{\partial \tau}\left(-\beta\frac{v}{c^2}\right)$$

Substitute the above into (e.1Y), we have

$$\frac{1}{c}\left(\frac{\partial Y'}{\partial \xi}(-\beta v)+\frac{\partial Y'}{\partial \tau}\beta\right)=\frac{\partial L'}{\partial \zeta}-\left(\frac{\partial N'}{\partial \xi}\beta+\frac{\partial N'}{\partial \tau}\left(-\beta\frac{v}{c^2}\right)\right)$$

Re-group the above, we have

$$\frac{1}{c}\frac{\partial}{\partial \tau}\beta\left(Y'-\frac{v}{c}N'\right)=\frac{\partial L'}{\partial \zeta}-\frac{\partial}{\partial \xi}\beta\left(N'-\frac{v}{c}Y'\right)$$

The above is (m.2Y).

In the same deduction steps, I went through each of (m.2Z), (m.2L), (m.2M) and (m.2N). Thus, it is verified that Einstein indeed used (m.1) to get (m.2), or equivalently, use (m.1a) to get (e.2).

The major things to keep in mind are the following.

1. There is only one electromagnetic field observed from a rest frame (stationary system K) and a moving frame (moving system k)
2. (e.2) is in "variable-name-dominate" notations; math-text-books usually use "function-name-dominate" notations, thus, extra attention should be paid to it to avoid math errors.
3. In "function-name-dominate" notations, (e.2) is written as (m.2).
4. Einstein applied Lorentz transformation (m.5) to (e.1) and got the following equivalent deductions
    a. if "variable-name-dominate" notations are used then (e.2) is deduced using (e.1), (m.1a) and (m.5)
    b. if "function-name-dominate" notations are used then (m.2) is deduced using (e.1), (m.1) and (m.5)

Next, Einstein used (e.2) (and hence (m.1) and (m.2)) as a base for applying the principle of relativity.

It is important to keep in mind that Einstein used (m.1) and (m.2), but (m.1) and (m.2) are not explicitly listed in paper [1].

Apply the principle of relativity

The third paragraph introduces new function names (X', Y', Z', L', M', N') for the moving frame. Thus, the "function-name-dominate" notations are used. At the same time, gives the following set of equations.

$\frac{1}{c}\frac{\partial X'}{\partial \tau}=\frac{\partial N'}{\partial \eta}-\frac{\partial M'}{\partial \zeta},\frac{1}{c}\frac{\partial L'}{\partial \tau}=\frac{\partial Y'}{\partial \zeta}-\frac{\partial Z'}{\partial \eta}$ $\frac{1}{c}\frac{\partial Y'}{\partial \tau}=\frac{\partial L'}{\partial \zeta}-\frac{\partial N'}{\partial \xi},\frac{1}{c}\frac{\partial M'}{\partial \tau}=\frac{\partial Z'}{\partial \xi}-\frac{\partial X'}{\partial \zeta}$ $\frac{1}{c}\frac{\partial Z'}{\partial \tau}=\frac{\partial M'}{\partial \xi}-\frac{\partial L'}{\partial \eta},\frac{1}{c}\frac{\partial N'}{\partial \tau}=\frac{\partial X'}{\partial \eta}-\frac{\partial Y'}{\partial \xi}$	(e.3)

In the next paragraph, Einstein reminded us that the new function names represent “exactly the same thing” as the old function names do. This fact is represented by (m.1). In the last subsection, it is proven that Einstein used (m.1).

The third paragraph gives a reason for introducing equation (e.3). The reason is that by the principle of relativity, if for the rest frame (x,y,z,t) the equation is (e.1) then for the moving frame (ξ,η,ζ,τ) the equation must be (e.3).

Let’s examine the above reasoning.

When I read the principle of relativity the very first time, I understood it as a common sense: you run inside an airplane cabin or you run on a street, the equations for the running are the same; the sound wave equations inside an airplane cabin and on a street are also the same. If we stand on a street and watch an airplane flying, we need to apply a coordinate transformation to the equations for phenomena inside the airplane cabin. Einstein applied Lorentz coordinate transformation to (e.1), and got (e.2). So, my understanding of the principle of relativity matches what Einstein did.

However, the above reasoning for (e.3) is saying that when you stand on a street and observe an airplane flying, you get the same equations for phenomena inside the airplane cabin as you observing phenomena on the street.

No matter what coordinate transformation you use, be it Galilean or Lorentz, if we use the above “common sense” understanding of the principle of relativity, we cannot get the same equations. By using the Lorentz transformation, Einstein got (e.2), not (e.3); (e.3) directly contradicts (e.2) and (m.2).

The vague wording of the principle of relativity creates a room of ambiguity big enough to host two contradictory equations: (e.3) and (e.2), or equivalently (e.3) and (m.2).

Due to mixing of “variable-name-dominate” and “function-name-dominate” notations, Einstein failed to see that (e.3) and (e.2) are contradictory. Using both (e.2) and (e.3) simultaneously as a common base for math deductions will generate math errors, as we will see.

The fourth paragraph introduces a new set of equations (e.4).

$X'=\psi(v)X,L'=\psi(v)L$ $Y'=\psi(v)\beta\left(Y-\frac{v}{c}N\right),M'=\psi(v)\beta\left(M+\frac{v}{c}Z\right)$ $Z'=\psi(v)\beta\left(Z+\frac{v}{c}M\right),N'=\psi(v)\beta\left(N-\frac{v}{c}Y\right)$	(e.4)

The first sentence of this paragraph is “Evidently the two systems of equations found for system k must express exactly the same thing, since both systems of equations are equivalent to the Maxwell-Hertz equations for system K.”.

Let’s examine this sentence.

“the two systems of equations found for system k” refers to equations (e.2) and (e.3). “system K” refers to (e.1). “equivalent to … system K” says that (e.1), (e.2) and (e.3) all represent the same physical quantities.

But (e.2) is in “variable-name-dominate” notations, and (e.3) is in “function-name-dominate” notations. To be consistent and avoid math errors, (m.2) should have been used instead of (e.2). But (m.2) is not in paper [1]. A room for errors appears.

The next sentence of this paragraph is “… it follows that the functions occurring in the systems of equations at corresponding places must agree, with the exception of a factor”. I’ll use math formulas to translate this sentence, using one of the functions

$in\ (e.2)\colon \frac{1}{c}\frac{\partial X}{\partial \tau}=\frac{\partial}{\partial \eta}\beta\left(N-\frac{v}{c}Y\right)-\frac{\partial}{\partial \zeta}\beta\left(M+\frac{v}{c}Z\right)$ $in\ (e.3)\colon \frac{1}{c}\frac{\partial X'}{\partial \tau}=\frac{\partial N'}{\partial \eta}-\frac{\partial M'}{\partial \zeta}$ at corresponding places must agree: $differential\ operators\ can\ be\ removed$ $deduced\colon N'=\beta\left(N-\frac{v}{c}Y\right);M'=\beta\left(M+\frac{v}{c}Z\right)$ $deduced\ and\ adding\ a\ factor\colon N'=\psi(v)\beta\left(N-\frac{v}{c}Y\right);M'=\psi(v)\beta\left(M+\frac{v}{c}Z\right)$	(m.6)

In this manner, (e.4) is deduced from (e.2) and (e.3). But this deduction is wrong. Let me show the error using formulas:

$in\ (e.2): \frac{1}{c}\frac{\partial X}{\partial \tau} = \frac{\partial}{\partial \eta}\beta\left(N - \frac{v}{c}Y\right) - \frac{\partial}{\partial \zeta}\beta\left(M + \frac{v}{c}Z\right)$ $in\ (e.3): \frac{1}{c}\frac{\partial X'}{\partial \tau} = \frac{\partial N'}{\partial \eta} - \frac{\partial M'}{\partial \zeta}$ at corresponding places must agree: $differential\ operators\ can\ be\ removed$ $left\ side: X = X' \rightarrow (m.1)\ holds$ $right\ side: N' \neq N; M' \neq M \rightarrow (m.1)\ does\ not\ hold$	(m.7)

Because at the left side of (e.2) and (e.3) $X = X'$ is assumed as if (m.1) holds; this is correct because (e.2) uses (m.1); but at the right side of (e.2) and (e.3), $N \neq N'$ and $M \neq M'$, as if (m.1) does not hold. The discrepancy on the two sides of the equations proves that the deduction is mathematically incorrect.

The math error shown in (m.7) is caused by wrongly perceiving the variable lists for functions on the right side of the equation (e.2).

To avoid wrongly perceiving of the variable list, (m.2) should have been used instead of (e.2). Let's use (m.2) to see what will happen. The deduction step of "at corresponding places must agree: differential operators can be removed" is no longer needed. And we can see what is wrong with Einstein's deduction:

$in\ (m.2): \frac{1}{c}\frac{\partial X'}{\partial \tau} = \frac{\partial}{\partial \eta}\beta\left(N' - \frac{v}{c}Y'\right) - \frac{\partial}{\partial \zeta}\beta\left(M' + \frac{v}{c}Z'\right)$ $in\ (e.3): \frac{1}{c}\frac{\partial X'}{\partial \tau} = \frac{\partial N'}{\partial \eta} - \frac{\partial M'}{\partial \zeta}$ $\boldsymbol{cannot\ deduce}: N' = \beta\left(N' - \frac{v}{c}Y'\right); M' = \beta\left(M' + \frac{v}{c}Z'\right)$	(m.8)

The above errors show how dangerous it is to mix "variable-name-dominate" and "function-name-dominate" notations; by doing so, even a greatest physicist like Einstein could make math deduction errors.

Because both (e.3) and (m.2) use the same "function-name-dominate" notations, (m.8) can show that (e.3) and (m.2) are contradictory, and thus (e.3) and (e.2) are contradictory.

Because (e.2) use "variable-name-dominate" notations, Einstein failed to see that (e.3) and (e.2) are contradictory.

The fifth paragraph says that the factor should be 1, and the final equation (e.5) is obtained as shown below. I do not have a problem with it.

$X' = X, L' = L$ $Y' = \beta\left(Y - \frac{v}{c}N\right), M' = \beta\left(M + \frac{v}{c}Z\right)$ $Z' = \beta\left(Z + \frac{v}{c}M\right), N' = \beta\left(N - \frac{v}{c}Y\right)$	(e.5)

The correct deduction should be deriving (e.5) from **(e.1)** and (e.3), see [7]. Einstein's mistake was deriving (e.5) from contradictory **(e.2)** and (e.3).

Given (e.1), it is proven that (e.5) is a necessary and sufficient condition for (e.3). See [7].

Since (e.5) is a necessary and sufficient condition for (e.3), deriving (e.5) from (e.1) and (e.3) is equivalent to deriving (e.3) from (e.1) and (e.5).

I'll provide a deduction of (e.3) from (e.1) and (e.5), because it is simpler than what is presented in [7], which derives (e.5) from (e.3) and (e.1).

Express (e.3) by

$\frac{1}{c}\frac{\partial X'}{\partial \tau} = \frac{\partial N'}{\partial \eta} - \frac{\partial M'}{\partial \zeta}$	(e.3X)
$\frac{1}{c}\frac{\partial Y'}{\partial \tau} = \frac{\partial L'}{\partial \zeta} - \frac{\partial N'}{\partial \xi}$	(e.3Y)
$\frac{1}{c}\frac{\partial Z'}{\partial \tau} = \frac{\partial M'}{\partial \xi} - \frac{\partial L'}{\partial \eta}$	(e.3Z)
$\frac{1}{c}\frac{\partial L'}{\partial \tau} = \frac{\partial Y'}{\partial \zeta} - \frac{\partial Z'}{\partial \eta}$	(e.3L)
$\frac{1}{c}\frac{\partial M'}{\partial \tau} = \frac{\partial Z'}{\partial \xi} - \frac{\partial X'}{\partial \zeta}$	(e.3M)
$\frac{1}{c}\frac{\partial N'}{\partial \tau} = \frac{\partial X'}{\partial \eta} - \frac{\partial Y'}{\partial \xi}$	(e.3N)

Express (e.5) by

$X' = X$	(e.5X)
$Y' = \beta\left(Y - \frac{v}{c}N\right)$	(e.5Y)

$Z' = \beta\left(Z + \frac{v}{c}M\right)$	(e.5Z)
$L' = L$	(e.5L)
$M' = \beta\left(M + \frac{v}{c}Z\right)$	(e.5M)
$N' = \beta\left(N - \frac{v}{c}Y\right)$	(e.5N)

Lorentz coordinate transformation is

$t = \frac{v\beta}{c^2}\xi + \beta\tau$ $x = \beta\xi + v\beta\tau,$ $y = \eta$ $z = \zeta$	(m.9)
$\frac{\partial t}{\partial \tau} = \beta;\ \frac{\partial t}{\partial \xi} = \frac{v\beta}{c^2};\ \frac{\partial t}{\partial \eta} = 0;\ \frac{\partial t}{\partial \zeta} = 0$ $\frac{\partial x}{\partial \tau} = v\beta;\ \frac{\partial x}{\partial \xi} = \beta;\ \frac{\partial x}{\partial \eta} = 0;\ \frac{\partial x}{\partial \zeta} = 0$ $\frac{\partial y}{\partial \tau} = 0;\ \frac{\partial y}{\partial \xi} = 0;\ \frac{\partial y}{\partial \eta} = 1;\ \frac{\partial y}{\partial \zeta} = 0$ $\frac{\partial z}{\partial \tau} = 0;\ \frac{\partial z}{\partial \xi} = 0;\ \frac{\partial z}{\partial \eta} = 0;\ \frac{\partial z}{\partial \zeta} = 1$	(m.10)

Deduce (e.3X):

Multiply (e.1X) with β:

$$\frac{1}{c}\frac{\partial X}{\partial t}\beta = \beta\frac{\partial N}{\partial y} - \beta\frac{\partial M}{\partial z}$$

Divergence condition is

$$\frac{\partial X}{\partial x} + \frac{\partial Y}{\partial y} + \frac{\partial Z}{\partial z} = 0$$

Or

$$\beta\frac{v}{c}\left(\frac{\partial X}{\partial x} + \frac{\partial Y}{\partial y} + \frac{\partial Z}{\partial z}\right) = 0$$

Add divergence condition to β (e.1X):

$$\frac{1}{c}\frac{\partial X}{\partial t}\beta = \beta\frac{\partial N}{\partial y} - \beta\frac{\partial M}{\partial z} - \beta\frac{v}{c}\left(\frac{\partial X}{\partial x} + \frac{\partial Y}{\partial y} + \frac{\partial Z}{\partial z}\right)$$

Re-group, we get:

$$\frac{1}{c}\left(\frac{\partial X}{\partial t}\beta + \frac{\partial X}{\partial x}v\beta\right) = \frac{\partial\left(\beta\left(N - \frac{v}{c}Y\right)\right)}{\partial y} - \frac{\partial\left(\beta\left(M + \frac{v}{c}Z\right)\right)}{\partial z}$$

Apply Lorentz transformation (m.10) to (e.5X), (e.5N) and (e.5M), we have

$$\frac{\partial X'}{\partial \tau} = \frac{\partial X}{\partial t}\frac{\partial t}{\partial \tau} + \frac{\partial X}{\partial x}\frac{\partial x}{\partial \tau} + \frac{\partial X}{\partial y}\frac{\partial y}{\partial \tau} + \frac{\partial X}{\partial z}\frac{\partial z}{\partial \tau} = \frac{\partial X}{\partial t}\beta + \frac{\partial X}{\partial x}v\beta$$

$$\frac{\partial N'}{\partial \eta} = \frac{\partial\left(\beta\left(N - \frac{v}{c}Y\right)\right)}{\partial t}\frac{\partial t}{\partial \eta} + \frac{\partial\left(\beta\left(N - \frac{v}{c}Y\right)\right)}{\partial x}\frac{\partial x}{\partial \eta} + \frac{\partial\left(\beta\left(N - \frac{v}{c}Y\right)\right)}{\partial y}\frac{\partial y}{\partial \eta} + \frac{\partial\left(\beta\left(N - \frac{v}{c}Y\right)\right)}{\partial z}\frac{\partial z}{\partial \eta}$$

$$= \frac{\partial\left(\beta\left(N - \frac{v}{c}Y\right)\right)}{\partial y}$$

$$\frac{\partial M'}{\partial \zeta} = \frac{\partial\left(\beta\left(M + \frac{v}{c}Z\right)\right)}{\partial t}\frac{\partial t}{\partial \zeta} + \frac{\partial\left(\beta\left(M + \frac{v}{c}Z\right)\right)}{\partial x}\frac{\partial x}{\partial \zeta} + \frac{\partial\left(\beta\left(M + \frac{v}{c}Z\right)\right)}{\partial y}\frac{\partial y}{\partial \zeta} + \frac{\partial\left(\beta\left(M + \frac{v}{c}Z\right)\right)}{\partial z}\frac{\partial z}{\partial \zeta}$$

$$= \frac{\partial\left(\beta\left(M + \frac{v}{c}Z\right)\right)}{\partial z}$$

Substitute the above into what we got earlier, we have

$$\frac{1}{c}\frac{\partial X'}{\partial \tau} = \frac{\partial N'}{\partial \eta} - \frac{\partial M'}{\partial \zeta}$$

The above is (e.3X).

Deduce (e.3Y):

Apply Lorentz transformation (m.10) to (e.5Y), (e.5L), and (e.5N), we get

$$\frac{\partial Y'}{\partial \tau} = \frac{\partial\beta\left(Y - \frac{v}{c}N\right)}{\partial t}\frac{\partial t}{\partial \tau} + \frac{\partial\beta\left(Y - \frac{v}{c}N\right)}{\partial x}\frac{\partial x}{\partial \tau} + \frac{\partial\beta\left(Y - \frac{v}{c}N\right)}{\partial y}\frac{\partial y}{\partial \tau} + \frac{\partial\beta\left(Y - \frac{v}{c}N\right)}{\partial z}\frac{\partial z}{\partial \tau}$$

$$= \frac{\partial\beta\left(Y - \frac{v}{c}N\right)}{\partial t}\beta + \frac{\partial\beta\left(Y - \frac{v}{c}N\right)}{\partial x}v\beta$$

$$\frac{\partial L'}{\partial \zeta} = \frac{\partial L}{\partial t}\frac{\partial t}{\partial \zeta} + \frac{\partial L}{\partial x}\frac{\partial x}{\partial \zeta} + \frac{\partial L}{\partial y}\frac{\partial y}{\partial \zeta} + \frac{\partial L}{\partial z}\frac{\partial z}{\partial \zeta} = \frac{\partial L}{\partial z}$$

$$\frac{\partial N'}{\partial \xi} = \frac{\partial\beta\left(N - \frac{v}{c}Y\right)}{\partial t}\frac{\partial t}{\partial \xi} + \frac{\partial\beta\left(N - \frac{v}{c}Y\right)}{\partial x}\frac{\partial x}{\partial \xi} + \frac{\partial\beta\left(N - \frac{v}{c}Y\right)}{\partial y}\frac{\partial y}{\partial \xi} + \frac{\partial\beta\left(N - \frac{v}{c}Y\right)}{\partial z}\frac{\partial z}{\partial \xi}$$

$$= \frac{\partial\beta\left(N - \frac{v}{c}Y\right)}{\partial t}\frac{v\beta}{c^2} + \frac{\partial\beta\left(N - \frac{v}{c}Y\right)}{\partial x}\beta$$

Because

$$\beta^2 - \frac{v^2}{c^2}\beta^2 = 1$$

(e.1Y) can be written as

$$\frac{\partial}{\partial t}\left(\frac{1}{c}\beta^2 Y - \frac{v^2}{c^2}\beta^2\frac{1}{c}Y\right) = \frac{\partial L}{\partial z} - \frac{\partial}{\partial x}\left(N\beta^2 - \beta^2\frac{v^2}{c^2}N\right)$$

Add terms N and Y to the above equation:

$$\frac{\partial}{\partial t}\left(\frac{1}{c}\beta^2 Y - \frac{1}{c}\beta^2\frac{v}{c}N + \frac{v}{c^2}\beta^2 N - \frac{v^2}{c^2}\beta^2\frac{1}{c}Y\right) = \frac{\partial L}{\partial z} - \frac{\partial}{\partial x}\left(N\beta^2 - \frac{v}{c}\beta^2 Y + \frac{v}{c}\beta^2 Y - \beta^2\frac{v^2}{c^2}N\right)$$

Re-group the terms:

$$\frac{1}{c}\frac{\partial\beta\left(Y - \frac{v}{c}N\right)}{\partial t}\beta + \frac{\partial\beta\left(N - \frac{v}{c}Y\right)}{\partial t}\frac{v\beta}{c^2} = \frac{\partial L}{\partial z} - \frac{\partial\beta\left(N - \frac{v}{c}Y\right)}{\partial x}\beta - \frac{1}{c}\frac{\partial\beta\left(Y - \frac{v}{c}N\right)}{\partial x}v\beta$$

Re-arrange:

$$\frac{1}{c}\left(\frac{\partial\beta\left(Y - \frac{v}{c}N\right)}{\partial t}\beta + \frac{\partial\beta\left(Y - \frac{v}{c}N\right)}{\partial x}v\beta\right) = \frac{\partial L}{\partial z} - \left(\frac{\partial\beta\left(N - \frac{v}{c}Y\right)}{\partial t}\frac{v\beta}{c^2} + \frac{\partial\beta\left(N - \frac{v}{c}Y\right)}{\partial x}\beta\right)$$

Substitute the above into what we got earlier, we have

$$\frac{1}{c}\frac{\partial Y'}{\partial \tau} = \frac{\partial L'}{\partial \zeta} - \frac{\partial N'}{\partial \xi}$$

The above is (e.3Y).

The above deduction steps show deducing (e.3X) and (e.3Y) from (e.1) and (e.5).

(e.3Z), (e.3L), (e.3M), and (e.3N) can be deduced from (e.1) and (e.5) in the same way. Lorentz Covariance of Maxwell’s equations (LCM), represented by (e.3), is thus correctly deduced from (e.1) and (e.5).

LCM is a beautiful and admirable mathematical wonder discovered by Einstein.

The correct deduction of LCM reveals that it is not a physical reality. I’ll elaborate on it in the next subsection.

Lorentz Covariance of Maxwell’s equations contradicts reality

I am not going to define what physical reality is. I am going to show what will mathematically contradict physical reality believed by all physicists.

Use a vector to represent function variables:

$$p = [\xi, \eta, \zeta, \tau]^T \qquad \text{(m.11)}$$

(m.1) can be written as

Use the Lorentz coordinate transformation:

$$[X' \quad Y' \quad Z']^T(p) = [X \quad Y \quad Z]^T(Ap)$$
$$[L' \quad M' \quad N']^T(p) = [L \quad M \quad N]^T(Ap)$$

Where

$$A = \begin{bmatrix} \beta & 0 & 0 & v\beta \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ \frac{v\beta}{c^2} & 0 & 0 & \beta \end{bmatrix}$$

(m.1b)

Michelson and Morley used Galilean coordinate transformation:

Use the Galilean coordinate transformation:

$$[X' \quad Y' \quad Z']^T(p) = [X \quad Y \quad Z]^T(Bp)$$
$$[L' \quad M' \quad N']^T(p) = [L \quad M \quad N]^T(Bp)$$

Where

$$B = \begin{bmatrix} 1 & 0 & 0 & v \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

(m.1c)

Collectively, (m.1b) and (m.1c) can be written as

$$[X' \quad Y' \quad Z']^T(p) = [X \quad Y \quad Z]^T(Cp)$$
$$[L' \quad M' \quad N']^T(p) = [L \quad M \quad N]^T(Cp)$$
$$C \in \{A, B\}$$

(m.1d)

I have proved that Einstein used (m.1), or equivalently (m.1a) or (m.1b), to get (e.2). That is, Einstein believed (m.1b) is a physical reality. Since physicists believe in Einstein, this should be the opinion of the present physicists.

Michelson, Morley, and physicists of their times, believed that (m.1c) was a physical reality.

Now we see a common belief in all physicists, past and present, including Einstein: if something contradicts (m.1d) then it contradicts physical reality.

Because (e.5) is a necessary and sufficient condition for (e.3), and (e.5) contradicts (m.1d), we get a conclusion that Lorentz Covariance of Maxwell’s equations (LCM) contradicts a physical reality.

Therefore, Special Relativity is not a physical reality.

Let me show the deduction dependencies in a table, including Michelson-Morley Experiment (MME).

<table>
<tr><td>(e.3): LCM</td><td colspan="3">(e.1):Maxwell’s equations in the rest frame</td></tr>
<tr><td colspan="2" rowspan="3">(e.5)</td><td colspan="2">(m.1d)</td></tr>
<tr><td>(m.1b)</td><td>(m.1c)</td></tr>
<tr><td>(e.2)</td><td>Equations for MME</td></tr>
<tr><td colspan="2" rowspan="2">Non-reality:
(e.3) contradicts (e.2)
(e.5) contradicts (m.1b)</td><td>Reality by Lorentz transformation</td><td>Reality by Galilean transformation</td></tr>
<tr><td colspan="2">Reality believed by all physicists including Einstein</td></tr>
</table>

Table 1. correct deduction dependency

Table 1 shows that (e.5) depends on (e.1) and (e.3), (e.2) depends on (e.1) and (m.1b). “Equations for MME” depends on(e.1) and (m.1c); it is not used in this report, and I do not bother to deduce it.

Since (e.5) contradicts (m.1b) and (e.3) contradicts (e.2), (e.5) and (e.3) contradict a reality believed by all physicists, including Einstein.

Note that we are not talking about Einstein vs other physicists; it is Einstein vs {Einstein + other physicists}.

When (e.5) is erroneously deduced from (e.2) and thus from (m.1b), an erroneous dependency is created, as shown in Table 2.

<table>
<tr><td rowspan="3">(e.3)</td><td>(e.1)</td></tr>
<tr><td>(m.1b)</td></tr>
<tr><td>(e.2)</td></tr>
<tr><td colspan="2">(e.5)</td></tr>
</table>

Table 2. **Erroneous** deduction dependency

Merge Table 1 and Table 2, we can see the effects of erroneous deductions.

<table>
<tr><td rowspan="4">The principle of relativity
(e.3): Lorentz Covariance of Maxwell's equations</td><td colspan="2">(e.1): Maxwell's equations in the rest frame</td></tr>
<tr><td colspan="2">(m.1d)</td></tr>
<tr><td>(m.1b)</td><td>(m.1c)</td></tr>
<tr><td>(e.2)</td><td rowspan="2">Equations for MME</td></tr>
<tr><td colspan="2">(e.5): Einstein State Transformation</td></tr>
<tr><td rowspan="2">Being Reality depends on (e.3)</td><td>Reality by Lorentz transformation</td><td>Reality by Galilean transformation</td></tr>
<tr><td colspan="2">Reality believed by all physicists including Einstein</td></tr>
</table>

Table 3. Effects of **erroneous** deduction dependency

Not knowing that (e.3) contradicts (e.2), (e.3) was believed to be a reality. In Table 3, (e.5) belongs to the reality half by (e.2) and half by (e.3). It is incorrect that (e.5) depends on (e.2).

Recall that (e.3) and (e.5) are used to solve a problem which does not exist in reality, it should not be a surprise to discover that (e.3) and (e.5) are not reality.

Because (e.5) gives system states which contradict reality which is represented by (m.1b), (e.5) represents an imaginary world.

Now we know how the problem of asymmetry is solved. It is not just by the principle of relativity (e.3), it is also by creating an imaginary world (e.5). Without this imaginary world (e.5), (e.3) does not hold; that is, the principle of relativity does not hold.

That is, the principle of relativity only works for an imaginary world.

Explain the null-result of Michelson-Morley experiment

In the second paragraph of [1], it claims that Special Relativity explains the null-result of the Michelson-Morley experiment. This claim has convinced Einstein and all of us that Special Relativity is a physical reality.

There may be people who doubt the theory and math of Special Relativity, but no one doubts the above claim. Belief in this claim has forced brilliant scientists to try hard to reconcile Special Relativity with reality.

On finding a way to solve Maxwell's equations, I accidentally discovered that the claim is denied by solutions to Maxwell's equations.

Let's examine the claim.

The claim is presented at the beginning of paper [1], in the second paragraph, in the following wording:

"**the unsuccessful attempts to discover any motion of the earth relative to the light medium**"

In paper [1], the only formula which matches the claim is (e.5), because (e.5) can also be written as

$$X' - X = 0, L' - L = 0$$

$$Y' - \beta\left(Y - \frac{v}{c}N\right) = 0, M' - \beta\left(M + \frac{v}{c}Z\right) = 0$$

$$Z' - \beta\left(Z + \frac{v}{c}M\right) = 0, N' - \beta\left(N - \frac{v}{c}Y\right) = 0$$

Because Einstein said that electromagnetic fields are inertial, see [2], we are also taught that the null-result of the Michelson-Morley Experiment is a consequence of the electromagnetic fields being inertial.

"Being inertial" comes from (e.3); and (e.5) is a necessary and sufficient condition for (e.3), see [7]; again, we get the conclusion that (e.5) mathematically represents the claim.

By the way, “inertia” is an impersonated concept in Special Relativity. See [10].

But, (e.5) actually is not the Michelson-Morley Experiment (MME). Let me call it the Einstein Experiment (EE). Let’s see their differences.

Michelson-Morley experiment vs Einstein experiment

Michelson-Morley Experiment

Michelson-Morley Experiment (MME) is to compare two beams of lights. For the sake of analysis, we may say one beam goes in the rest frame and one beam goes with the moving frame. Mirrors are used to make the two beams meet and thus we may compare the two beams.

The propagations of the two beams are totally independent of each other. The two beams may be generated using a single light source, but it does not need to be because the expectations of the experiment is not based on using a single light source.

Using a single source can make sure that the light frequencies are the same; it is important because what to be measured are phase differences; but there can be other means to make sure that the light frequency deviations do not damage the experiment expectations.

Using the symbols Einstein used, we have

$MME\ Beam\ 1 = [X,Y,Z,L,M,N]^T(x,y,z,t)$	(x.1)
$MME\ Beam\ 2 = [X',Y',Z',L',M',N']^T(\xi,\eta,\zeta,\tau)$	(x.2)

The initial values for the two beams are given below.

$MME\ Beam\ 1(x,y,z,0) = [X,Y,Z,L,M,N]^T(x,y,z,0) = \vec{0}$	(x.3)
$MME\ Beam\ 2(\xi,\eta,\zeta,0) = [X',Y',Z',L',M',N']^T(\xi,\eta,\zeta,0) = \vec{0}$	(x.4)

It is important to keep in mind that

- The above functions are in “function-name-dominate” notations.
- $[X,Y,Z,L,M,N]^T$ and $[X',Y',Z',L',M',N']^T$ are two independent physical quantities. That is, not only their function definitions are mathematically different, they also represent separate physical quantities.
- In Special Relativity, $[X,Y,Z,L,M,N]^T$ and $[X',Y',Z',L',M',N']^T$ are for the same physical quantities.

Since the two beams are independent, (x.3) and (x.4) are also independent. The two initial values are independently given without deducing one from the other, and without a relationship between them.

Because we are doing mathematical analysis, not doing physical experiments, mirrors are not needed.

The expectation of Michelson-Morley experiment (MME) is that

$MME\ Beam\ 1 \neq MME\ Beam\ 2$ $[X,Y,Z,L,M,N]^T(x,y,z,t) \neq [X',Y',Z',L',M',N']^T(\xi,\eta,\zeta,\tau)$	(x.5)

Physical measurements failed to demonstrate (x.5). I made some investigations on such a result using analytical solutions to Maxwell’s equations, see [5].

The failure of detecting (x.5) leads to an incorrect conclusion that the two beams are identical, as stated below.

$MME\ Beam\ 1 = MME\ Beam\ 2$ $[X,Y,Z,L,M,N]^T(x,y,z,t) = [X',Y',Z',L',M',N']^T(\xi,\eta,\zeta,\tau)$	(x.6)

It became a challenge to explain the above conclusion, because it is a wrong conclusion.

Einstein Experiment

The claim made in [1] is to say that Special Relativity explained (x.6). However, Special Relativity uses a different experiment, Einstein Experiment (EE), to replace Michelson-Morley experiment (MME).

The Einstein Experiment is given in section 6 of [1]. As previously described in this report, the first paragraph of section 6 of [1] gives equation (e.1). The second paragraph applies Lorentz coordinate transformation to (e.1) and gets (e.2). Let’s use “**variable-name-dominate**” notations to present math work in [1].

$EE\ Beam\ 1 = [X,Y,Z,L,M,N]^T(x,y,z,t)$ $EE\ Beam\ 2 = [X,Y,Z,L,M,N]^T(\xi,\eta,\zeta,\tau)$	(x.7)
$EE\ Beam\ 2 = observing\ EE\ Beam\ 1\ from\ (\xi,\eta,\zeta,\tau)$ $[X,Y,Z,L,M,N]^T(\xi,\eta,\zeta,\tau) = [X,Y,Z,L,M,N]^T(x,y,z,t)$	(x.8)

Section 6 of [1] uses erroneous math deductions to get (e.5) which can be written as

$EE\ Beam\ 2 = A\ \{EE\ Beam\ 1\}$ $[X, Y, Z, L, M, N]^T(\xi, \eta, \zeta, \tau) = A\{[X, Y, Z, L, M, N]^T(x, y, z, t)\}$	(x.9)

where A is a constant matrix.

We can see that (x.8) and (x.9) are contradictory. Because in paper [1], (x.9) is in "function-name-dominate" notations, no one noticed this contradiction. Here, I'll just ignore (x.8) as Einstein and everyone did.

(x.7), (x.8) and (x.9) are work in [1], explicitly or implicitly.

For the Einstein Experiment, there are not two beams of light, there is only one beam of light observing from two reference frames. That is the reason I use Einstein's "variable-name-dominate" notations in (x.7), (x.8) and (x.9).

This is not a Michelson-Morley experiment, because MME uses two independent beams of light observing from one reference frame.

(x.9) is the expectation of the Einstein Experiment.

To use EE to replace MME is to say

$MME\ Beam\ 1 = EE\ Beam\ 1$ $MME\ Beam\ 2\ [X', Y', Z', L', M', N']^T(\xi, \eta, \zeta, \tau) = EE\ Beam\ 2 = A\left\{[X, Y, Z, L, M, N]^T\left(\beta\xi + v\beta\tau, \eta, \zeta, \frac{v\beta}{c^2}\xi + \beta\tau\right)\right\}$	(x.10)

(x.10) is in "**function-name-dominate**" notations.

In summary, we have

- (x.3) and (x.4) are initial values for MME.
- (x.9) is the null-result of EE
- (x.10) is the null-result of MME using EE as MME

Because we can solve Maxwell's equations analytically, we may examine the experiments analytically. Let's do it.

Analytical solutions to Einstein Experiment

Let's solve Maxwell's equations in the two frames of the Einstein Experiment.

Let's do the Einstein Experiment with a Gaussian source.

For simplicity, consider 1D fields. Maxwell's equations along x-axis are

$\frac{\partial H_y(x,\theta)}{\partial\theta} = \frac{1}{\eta}\frac{\partial E_z(x,\theta)}{\partial x}$	(1d.1)
$\frac{\partial E_z(x,\theta)}{\partial\theta} = \eta\frac{\partial H_y(x,\theta)}{\partial x} - \eta J_z(x,\theta)$	(1d.2)

Where

$$\theta = ct$$

$$c = \frac{1}{\sqrt{\varepsilon\mu}}$$

$$\eta = \sqrt{\frac{\mu}{\varepsilon}}$$

The field source I am using is a time-invariant Gaussian function,

$$J_z(x,\theta) = be^{-ax^2}; a > 0, b \neq 0$$

The 1D frames are simplified as

$$(x', y', z', t') \rightarrow (x', \theta')$$

$$(x, y, z, t) \rightarrow (x, \theta)$$

Lorentz coordinate transformation and Einstein state transformation are defined as

$\gamma = \frac{1}{\sqrt{1 - v^2}}$	(t.0)

$\theta' = \gamma(\theta - vx)$	(t.1)
$x' = \gamma(x - v\theta)$	(t.2)
$H'_y = \frac{1}{\eta}\gamma v E_z + \gamma H_y$	(t.3)
$E'_z = \gamma E_z + \gamma\eta v H_y$	(t.4)

In frame (x', θ') , by the principle of relativity, Maxwell's equations are

$\frac{\partial H'_y(x',\theta')}{\partial\theta'} = \frac{1}{\eta}\frac{\partial E'_z(x',\theta')}{\partial x'}$	(i.1)
$\frac{\partial E'_z(x',\theta')}{\partial\theta'} = \eta\frac{\partial H'_y(x',\theta')}{\partial x'} - \eta b' e^{-a'x'^2}$	(i.2)

Apply Lorentz transformation and Einstein transformation to the above equations, we have

$a = a'\gamma^2$ $b = b'e^{-a(v^2\theta^2 - 2xv\theta)}$	(i.3)
$\frac{\partial H_y(x,\theta)}{\partial\theta} = \frac{1}{\eta}\frac{\partial E_z(x,\theta)}{\partial x}$	(i.4)
$\frac{\partial E_z(x,\theta)}{\partial\theta} = \eta\frac{\partial H_y(x,\theta)}{\partial x} - \eta b e^{-ax^2}$	(i.5)

(i.3) forms a kind of source format symmetry ([6]).

Equations [(i.1),(i.2)] and [(i.4),(i.5)] are in symmetric format, as required by the principle of relativity.

Let's solve Maxwell's equations to get closed-form analytical solutions.

For simplicity, I choose $b' = 1$. Using initial values (x.3) and (x.4) for the two frames, we can deduce the solutions from the generic analytical solution (see [4] and [5]):

$H'_y(x', 0) = 0$	(i.6)
$E'_z(x', 0) = 0$	(i.7)
$H'_y(x',\theta') = \frac{1}{\sqrt{a'}}e^{-a'x'^2} esinh(\xi', \varrho')_1$	(i.8)
$E'_z(x',\theta') = -\eta\frac{1}{\sqrt{a'}}e^{-a'x'^2} eicoshi(\xi', \varrho')$	(i.9)
$\xi' = \sqrt{a'}\theta'$	(i.10)
$\varrho' = 2\sqrt{a'}x'$	(i.11)

And

$H_y(x, 0) = 0$	(i.12)
$E_z(x, 0) = 0$	(i.13)
$H_y(x,\theta) = \frac{\gamma^2}{\sqrt{a}}e^{-ax^2}(esinh(\xi,\varrho)_1 - esinh(v\xi,\varrho)_1 + v\ eicoshi(\xi,\varrho) - eicoshi(v\xi,\varrho))$	(i.14)
$E_z(x,\theta) = \eta\frac{\gamma^2}{\sqrt{a}}e^{-ax^2}(-eicoshi(\xi,\varrho) + v\ eicoshi(v\xi,\varrho) - v\ esinh(\xi,\varrho)_1 + v\ esinh(v\xi,\varrho)_1)$	(i.15)
$\xi = \sqrt{a}\theta$	(i.16)
$\varrho = 2\sqrt{a}x$	(i.17)

Where $esinh_1$ and $eicoshi$ are two hyper-exponential functions, see [4].

Generic speaking, it is harder to deduce solutions for moving sources than for stationary sources. Since LCM (Lorentz Covariance of Maxwell's equations) only uses constant linear transformations, it is easy to apply. Thus LCM provides a short cut to get solutions for moving sources.

To verify the idea, I applied Lorentz and Einstein transformations [(t.0) … (t.4)] to (i.8) and (i.9). I expected to get (i.14) and (i.15), which I got the hard way. But I did not get (i.14) and (i.15). Instead, I got following solutions:

$H_y(x,\theta) = \frac{\gamma^2}{\sqrt{a}}e^{-a(x-v\theta)^2}\left(esinh\left(\xi - \frac{1}{2}v\varrho, \varrho - 2v\xi\right)_1 + v\ eicoshi\left(\xi - \frac{1}{2}v\varrho, \varrho - 2v\xi\right)\right)$	(i.18)
$E_z(x,\theta) = -\eta\frac{\gamma^2}{\sqrt{a}}e^{-a(x-v\theta)^2}\left(v\ esinh\left(\xi - \frac{1}{2}v\varrho, \varrho - 2v\xi\right)_1 + eicoshi\left(\xi - \frac{1}{2}v\varrho, \varrho - 2v\xi\right)\right)$	(i.19)

For several days I was confused by getting two different solutions for the same set of equations until it dawned on me that these two solutions were for different initial values.

Solution (i.14) and (i.15) is for initial values (i.12) and (i.13), they are for MME:

$H_y(x, 0) = 0$	(i.12)

$E_z(x,0) = 0$	(i.13)

Solution (i.18) and (i.19) is for the following initial values which are needed for EE's null-result.

$H_y(x,0) = \frac{\gamma^2}{\sqrt{a}} e^{-ax^2} \left(esinh\left(-\frac{1}{2}v\varrho, \varrho\right)_1 + v\ eicoshi\left(-\frac{1}{2}v\varrho, \varrho\right)\right)$	(i.20)
$E_z(x,0) = -\eta \frac{\gamma^2}{\sqrt{a}} e^{-ax^2} \left(v\ esinh\left(-\frac{1}{2}v\varrho, \varrho\right)_1 + eicoshi\left(-\frac{1}{2}v\varrho, \varrho\right)\right)$	(i.21)

It is a surprising discovery that for the rest frame the initial values for EE and MME are different.

- Initial values for MME are (x.3) and (x.4). In this example, they are (i.6), (i.7), (i.12) and (i.13)
- Initial values for EE are (i.6), (i.7), (i.20) and (i.21)
- Because solution (i.18) and (i.19) gives a null result for EE, we know a different solution (i.14) and (i.15) gives a non-null result for MME. The claim of explaining a null-result of the Michelson-Morley experiment is mathematically denied. This is an unexpected discovery.

Asymmetry in the initial values for EE arises. Let me use math formulas to show it.

(i.6) and (i.7) can be written as

$\lim_{\theta' \to 0^-} H'_y(x', \theta') = 0$	(i.6a)
$\lim_{\theta' \to 0^-} E'_z(x', \theta') = 0$	(i.7a)

(i.12) and (i.13) can be written as

$\lim_{\theta \to 0^-} H_y(x, \theta) = 0$	(i.12a)
$\lim_{\theta \to 0^-} E_z(x, \theta) = 0$	(i.13a)

At time $\theta' = 0$ and $\theta = 0$ the source is turned on at the moving frame, we have

$\lim_{\theta' \to 0^+} H'_y(x', \theta') = 0$	(i.6b)
$\lim_{\theta' \to 0^+} E'_z(x', \theta') = 0$	(i.7b)

In the rest frame, we need the following initial values for EE.

$\lim_{\theta \to 0^+} H_y(x,\theta) = \frac{\gamma^2}{\sqrt{a}} e^{-ax^2} \left(esinh\left(-\frac{1}{2}v\varrho, \varrho\right)_1 + v\ eicoshi\left(-\frac{1}{2}v\varrho, \varrho\right)\right)$	(i.12b)
$\lim_{\theta \to 0^+} E_z(x,\theta) = -\eta \frac{\gamma^2}{\sqrt{a}} e^{-ax^2} \left(v\ esinh\left(-\frac{1}{2}v\varrho, \varrho\right)_1 + eicoshi\left(-\frac{1}{2}v\varrho, \varrho\right)\right)$	(i.13b)

Special Relativity is getting into the following troubles.

- Using (i.12b) and (i.13b) as initial values is bizarre, it is like getting a distance by just having a speed without a time duration. For a field source to generate fields, in reality it needs a time duration, but these bizarre initial values do not need a time duration. A space distance in the rest frame acts as a time duration.
- In the moving frame, we have continuous states from (i.6a) and (i.7) to (i.6b) and (i.7b). In the rest frame, we have discontinuous states jumping from (i.12a) and (i.13a) to (i.12b) and (i.13b). This asymmetry in physical laws is opposite to the principle of relativity, which says "The laws by which the states of physical systems undergo change are not affected" for the moving and resting frames.

We see an asymmetry is created by Special Relativity which is supposed to remove all asymmetries in the physical laws. It turns out that the crime on trial in [1] is not committed by the defendant but by the plaintiff.

Use Einstein Experiment as Michelson-Morley Experiment

Now, let's try to use the Einstein Experiment as the Michelson-Morley Experiment (MME).

The initial values for MME must be (x.3) and (x.4). That is, the bizarre and unrealistic initial values (i.20) and (i.21) cannot be used for MME. Thus, we have the following mathematical conclusion.

Conclusion: Special Relativity only produces non-null results for Michelson-Morley experiment.

Proof.

Suppose Special Relativity produces a null result of Michelson-Morley experiment, thus (x.10) must hold. From (x.10), we have

$MME\ Beam\ 2\ [X', Y', Z', L', M', N']^T(\xi, \eta, \zeta, 0) = EE\ Beam\ 2 = A\left\{[X, Y, Z, L, M, N]^T\left(\beta\xi, \eta, \zeta, \frac{v\beta}{c^2}\xi\right)\right\}$	(x.10a)

Since $[X, Y, Z, L, M, N]^T\left(\beta\xi, \eta, \zeta, \frac{v\beta}{c^2}\xi\right) \neq 0$ and A is of full rank, from (x.10a), we have

$$MME\ Beam\ 2\ [X',Y',Z',L',M',N']^T(\xi,\eta,\zeta,0) \neq \vec{0}$$	(x.10b)

(x.10b) contradicts (x.4). Therefore, (x.10a) does not hold. Thus, (x.10) does not hold. Thus, Special Relativity does not produce a null result of Michelson-Morley experiment.

QED.

Summary

Einstein discovered a mathematical wonder of Lorentz Covariance of Maxwell's equations and thus developed an ingenious and drastic theory of Special Relativity which best explained the null-result of Michelson-Morley experiment while solutions to Maxwell's equations were not available.

I found a way to solve Maxwell's equations; the solutions of Maxwell's equations contradict Special Relativity. My studying on paper [1] led to the following discoveries.

1. Paper [1] makes mistakes in raising the problem to be solved; the problem it sets out to solve does not exist in the real world.
2. In solving the problem raised, paper [1] made fundamental mathematical mistakes.
3. Lorentz Covariance of Maxwell's equations is not a physical reality. That is, the problem and its solution both do not belong to the real world.
4. Special Relativity uses the Einstein Experiment to replace Michelson-Morley Experiment.
5. The Einstein Experiment observes one electromagnetic wave from two reference frames; the Michelson-Morley Experiment observes two independent electromagnetic waves from one reference frame.
6. Special Relativity produces null-result for Einstein Experiment.
7. Special Relativity produces non-null results for Michelson-Morley Experiments.

In summary, Special Relativity is such a theory which uses erroneous math deductions to solve such a problem which does not exist in reality.

References

[1] Albert Einstein, On the Electrodynamics of Moving Bodies, June 30, 1905, from The Principle of Relativity, published in 1923 by Methuen and Company, Ltd. of London. Most of the papers in that collection are English translations by W. Perrett and G.B. Jeffery

[2] Albert Einstein, DOES THE INERTIA OF A BODY DEPEND UPON ITS ENERGY-CONTENT? September 27, 1905, https://www.fourmilab.ch/etexts/einstein/E_mc2/www/

[3] David Wei Ge, 2023, Solving Maxwell's Equations in Open Space

[4] David Wei Ge, 2023, A Closed Form Analytical Solution to Maxwell's Equations in Response to a Time Invariant Gaussian Source

[5] David Wei Ge, 2023, 1D Solution to Maxwell's Equations in Response to a Moving Source

[6] D V Redžić, 2017, Are Maxwell's equations Lorentz-covariant?, Eur. J. Phys. 38 (2017) 015602 (4pp)

[7] David Wei Ge, 2022, Linear-Covariance of Maxwell's Equations

[8] David Wei Ge, 2023, Speeds of Electromagnetic Fields of a Gaussian Source

[9] David Wei Ge, 2024, Electrodynamics of a Moving Gaussian Source

[10] David Wei Ge, 2024, Imaginary Inertia of Special Relativity