Current Journal of Applied Science and Technology

Volume 41, Issue 45, Page 1-27, 2022; Article no.CJAST.94317
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

On the Non-Relativistic Space-Time View and the Covariation of Maxwell's Equations

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/CJAST/2022/v41i454014

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/94317

Original Research Article

Received: 04/10/2022
Accepted: 08/12/2022
Published: 17/12/2022

ABSTRACT

Based on the discussion of Maxwell's equations (ME) and the comparison between the non-relativistic view of time and space and the special theory of relativity (SR), this paper weaved a picture of physical theory breaking the conventional twists and turns. For a long time, many physicists have labeled the classical electromagnetic theory with ME at its core "relativistic electromagnetism." However, 200 years of theoretical and experimental progress have made electromagnetism stand out without the approval of relativity. H. Lorentz insisted that the theory of the existence of ether was correct, and that it was fundamentally different from SR. In this paper, Lorentz relativity is considered superior to Einstein Relativity. The so-called Lorentz transform (LT) has played a historic role in the development of physical theories. However, we are against the one-sided emphasis on the absolute requirement of "physical laws on LT covariation". It is wrong to regard it as an iron law that cannot be violated. Current scientific development has shown that one should not despise and ignore the time-space view based on Galilei transform (GT), so called Generalized GT (i.e. GGT) has shown its value today. In this paper, physical vacuum is proposed as the main option of "new ether". It emphasizes that quantum non-locality is a non-relativistic view of time and space and has been successful. It emphasizes the possibility of superluminal motion

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and suggests the establishment of "Superluminal Light Physics" as a new discipline. This paper makes a sharp criticism on Einstein's SR theory and viewpoint, which can be used for reference.
This paper also say that the 2022 Nobel prize in physics has been awarded to A. Aspect et al. it sent shock waves through the physical world. The Einstein's local realism did not correct, and Einstein's thought logically difinable causalily for quantum non-locality to resolve the EPR paradox. But in this situation, the problems still exist. For example, is quantum entanglement necessity logical or purely statistical?

Keywords: Maxwell's equations (ME); covariance; special relativity (SR); generalized galilei transformation (GGT); superluminal light physics; faster-than-light(FTL); quantum nonlocality.

1. INTRODUCTION

In 1905, A. Einstein [1] published his first paper on Relativity, the basic document of his theory of Special Relativity (SR).The starting point of SR is two postulates (also known as two principles), namely the special relativistic principle and the principle that the speed of light is constant in one direction. The special relativistic principle states that the laws of physics are the same in all inertial systems, and this holds true not only for the laws of Mechanics, but also for the laws of Electromagnetism. Therefore, according to SR, the law of electromagnetism should have the same form in all inertial frames moving in a straight line with uniform velocity relative to each other. It is known that the property of physical laws that remain unchanged in form under transformation of inertial reference frames is called covariation. The space-time transformation between different inertial frames required by the relativistic principle of SR must be the Lorentz transformation (LT). This covariation can be called SR covariation or Lorentz covariation, and it has dominated the rules of physics for a long time. Some non-relativistic views of time and space boldly abandon the principle of Special Relativity because the development of theoretical analysis and experimental facts requires it.It is possible that physics can be changed to a new orbit by assuming that the equations that express physical theories and laws remain unchanged under other transformations, an example of which is the generalized Galilei transform (GGT).These things will be described in this article. We might as well explore whether physics can emerge without SR.

This paper is one of several scientific papers that reject the term "Relativistic Electromagnetics". In taking this view, we shall assume that electromagnetic laws do not obey the principle of Special Relativity; In other words, the absolute reference frame (i.e., the ether) is assumed to exist; In any inertial frame moving uniformly with respect to the absolute reference frame, the form of the electromagnetic field law will be different from that in the absolute reference frame. But the problem can be dealt with appropriately.

Einstein always pursued a physical theory that explained everything. Early SR had a fundamental requirement that the laws of physics should be invariant to LT. And then he decided that this was not enough, that the law should be invariant to any coordinate transformation. He argued that a "generalized covariation" could be derived from the principle of relativity. But these two are different, the former is a statement of the uniformity of space and time, which is reflected in the fact that there is a transformation group; This homogeneity with LT can be stated not only in Galilei coordinates but also in terms of generalized covariation. In fact, following the phrase "law invariance" hides Einstein's conceptual confusion. He argues that General Relativity (GR) differs from SR in that SR uses LT groups and GR uses other groups. Such statements are difficult to understand. He confused the meaning of the word "covariation".

Another example of Einstein's conceptual confusion is his resolute abandonment of ether in SR and his talk of the "ether of General Relativity" in GR. Why is that? He later decided that he could not allow "nothing void," so he tried to pick up the ether that had been thrown away. In this way, Einstein did not do science to explore the laws of nature, but to make nature subject to the needs of his research work — he thought the ether was superfluous in his SR work, so there is no ether in the universe; When he started GR, he decided that "nothingness" would not work without ether, so the universe could be filled with ether again.

This paper discusses the development of physical theory by discussing the covariation of

Maxwell's equations (ME) and comparing SR with the non-relativistic view of time and space. This paper points out that non-locality in quantum mechanics (QM) represents a non-relativistic view of time and space, which is completely opposite to SR. The Schrödinger equation (SE) in QM is derived from Newton mechanics. Although it does not have covariation with LT, it does not prevent it from becoming the most basic and important quantum equation of motion, and its application is not limited to "low speed". This paper puts forward and discusses the "new ether theory". At the same time, on the basis of its criticism of SR and experimental facts, we advocated a new discipline, "Superluminal Light Physics", and pointed out the outstanding contributions of Chinese scientists.

2. COMMENTS ON "RELATIVISTIC ELECTROMAGNETISM"

The theory of Relativity has long been regarded as an absolute truth, a sacred object to be observed by all disciplines. The following terms have become common in the literature: Relativistic Mechanics, Relativistic Quantum Mechanics, Relativistic Electrodynamics, Relativistic Electromagnetism, etc. What has not yet emerged is Relativistic Optics, Relativistic Heat Theory, Relativistic Biology. Now let's take out Relativistic Electromagnetics to see is this concept can holds?

The development of electromagnetism began in Europe and is associated with the names of many great masters. For example, in electrostatics. there were C. Coulomb (1736-1806), S. Poisson (1781-1840), G. Green (1793-1841), K. Gauss (1777-1855) and others. In electrodynamics, there were H. Oersted (1777-1851), A. Ampere (1775-1836), W. Weber (1804-1891), J. Biot (1774-1862), F. Savart (1791-1841), H. Lorentz (1853-1928) and others. In the field of electromagnetic induction and field, there were M. Faraday (1791-1867), J. Henry (1797-1878), J. Maxwell (1831-1879), H. Hentz (1857-1894) and others. These physicists, each with outstanding theoretical and experimental contributions, together performed a grand symphony that lasted for 200 years, and was finally summed up by Maxwell-Hertz in mathematics, achieving the great achievements of the electromagnetic theory mansion.... Table 1 shows several cases of Maxwell's equations (ME) induced by us.

Obviously, none of these developments have anything to do with Einstein. In fact, for some of the most important results in electromagnetism, Einstein was not even born (Einstein was born in 1879).So why did "Relativistic Electromagnetism" emerge after Einstein became famous? As an example, Chapter 9 of reference [2] is entitled "Relativistic Electromagnetic Fields," which departs a section (§2) to "the covariation of

Table 1. Several cases of Maxwell's equations (ME)

Serial number	Common form	Static field	Steady static field①
1	$\nabla \cdot \mathbf{D} = \rho$	$\nabla \cdot \mathbf{D} = \rho$	$\nabla \cdot \mathbf{D} = \rho$
2	$\nabla \cdot \mathbf{B} = 0$	$\nabla \cdot \mathbf{B} = 0$	$\nabla \cdot \mathbf{B} = 0$
3	$\nabla \times \mathbf{H} = \mathbf{J} + \frac{\partial \mathbf{D}}{\partial t}$	$\nabla \times \mathbf{H} = 0$	$\nabla \times \mathbf{H} = \mathbf{J}$
4	$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$	$\nabla \times \mathbf{E} = 0$	$\nabla \times \mathbf{E} = 0$
Serial number	**quasi static field②**	**Free space**	**Free space, single frequency**
1	$\nabla \cdot \boldsymbol{D} = \rho$	$\nabla \cdot \mathbf{E} = 0$	$\nabla \cdot \mathbf{E} = 0$
2	$\nabla \cdot \mathbf{B} = 0$	$\nabla \cdot \mathbf{H} = 0$	$\nabla \cdot \mathbf{H} = 0$
3	$\nabla \times \mathbf{H} = \mathbf{J}$	$\nabla \times \mathbf{H} = \varepsilon_0 \frac{\partial \mathbf{E}}{\partial t}$	$\nabla \times \mathbf{H} = \mathrm{j}\omega\varepsilon_0 \mathbf{E}$
4	$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$	$\nabla \times \mathbf{E} = -\mu_0 \frac{\partial \mathbf{H}}{\partial t}$	$\nabla \times \mathbf{E} = -j\omega\mu_0 \mathbf{H}$

electromagnetic field equations and relativistic time - space transformations."How can we call it Relativistic Electromagnetism, since the core content of Electromagnetism has not chanted, and now only the space - time transformation and covariation have been added?! The key points of "relativistic transformation of electromagnetic field" mentioned in literature [2] are as follows: First, since the special relativistic principle of SR requires all physical laws to have the same form in different inertial systems, ME must also have covariation. Secondly, the relativistic transformation formulas of charge density ρ and current density $\mathbf{J}$ can be derived, and then the equations of ($\nabla \cdot \mathbf{B}$) and ($\nabla \times \mathbf{E}$) in ME can be deduced to be covariant in the inertial system, and then the other two equations ($\nabla \cdot \mathbf{D}$) and ($\nabla \times \mathbf{H}$) can be proved to be covariant in the inertial system. The results are as follows: ME accords with the relativity principle; SR is self-consistent and harmonious.

What's wrong with this argument? First, the question of whether ME has LT covariation, some experts have pointed out that Einstein, in order to prove that the electromagnetic field is relativistic invariant, introduced a so-called relativistic transformation of the electromagnetic field itself, which, unlike the LT of the electromagnetic field, cannot be established. Secondly, the purpose of this self-circular argument is to use ME to enhance the prestige of SR, and at the same time, to express a kind of SR's "approval" of ME. But ME does not need Einstein's approval; it already exists and has proven itself right by being widely used. In short, these superficial arguments do not prove "relativistic electromagnetic fields" or "Relativistic Electromagnetism" was established.

Any electromagnetic phenomenon occurs in a certain time and space. The prerequisite for studying electromagnetism is to have a correct view of time and space. We can try to move away from relativity and start with some new assumptions:

① Maxwell and Lorentz believed that ether existed; It is not only the carrier of electromagnetic field, but also the medium on which electromagnetic wave propagates. We therefore assume the existence of an ether, that is an absolute frame of reference.

② The 21st century view of the ether is different from the 19th century; Today's "new ether" has three options: physical vacuum, microwave background radiation (CMB), and gravitational field. We think that ether is the ubiquitous physical vacuum, also a kind of matter, is the basic form of matter in the universe; The demonstration of electromagnetic phenomena itself contains the role played by this background.

③ The law of electromagnetic field does not obey the principle of Special Relativity. The ether is the absolute reference frame by which all matter moves. That is to say, ME is only valid in the absolute reference frame of the ether.

If one starts from the above premise, a problem arises: in any inertial frame moving uniformly with respect to the absolute reference frame, the electromagnetic field law will take a different form from that in the absolute reference frame. This is a complex theoretical problem that may involve many mathematical derivations. The Chinese physicist Shusheng Tan [3] did this work, resulting in a system of equations containing the effect of the term [3]. v/c^2. But it's not relativity's either. It's not relativistic electromagnetics. In fact, Professor Tan proposes and believes in the "Theory of Standard Space and Time", but not SR.

The starting point of the so-called "Standard Space and Time Theory" is also two principles: the absolute reference system principle and the loop speed of light invariant principle. Unlike SR, they do not involve the principle of special relativistic principle. nor the principle that the speed of light is constant in one direction. Prof. Tan started from his own two hypotheses (principles) and combined GGT's way of thinking, so it is his independent contribution.

Therefore, for the theory of space-time which does not accept the principle of special Relativity, there is a task to determine the transformation relationship between the electromagnetic field quantity in the absolute reference frame and the electromagnetic field quantity in the general inertial frame. There is also a definition for the standard form of ME—it refers to a system of electromagnetic fields in an absolute reference frame. Qing-Ping Ma [4,5], professor of the Nottingham University of UK, has made sharp criticism of SR; When I asked him to comment on the so-called relativistic electromagnetic, he said that he agreed with me that the laws of the electromagnetic field did not obey the special relativistic principle, and that the ether system was the superior reference frame for electromagnetic phenomena. In addition, in 1980,

a professor at the University of Yunnan, Yong-Li Zhang [6] has a point, he did not in order to prove the lack of Relativity of electromagnetism "in trouble", the electromagnetic induction phenomenon, for example, said in the magnet coil in and out of the experiment, "if the magnet still, space is only static magnetic field and electric field, and the movement of the coil will generate an electric current, in addition to additional assumptions, It's hard to understand." But Prof. Ma believes that this view is actually using his relativistic view to limit classical electromagnetic theory. Firstly, the classical electromagnetic theory is put into the framework of SR, and then the dynamic electromotive force of electromagnetic induction in the classical electromagnetic phenomenon is difficult to understand. In the classical electromagnetic theory, Faraday electromagnetic induction theory considers the change of magnetic flux in a conductor (especially a closed conductor loop), where the conductor can be regarded as the medium of the electromagnetic field. In the classical electromagnetic theory, the medium reference frame is the superior reference frame, and the electromagnetic induction theory should consider the change of magnetic flux in the conductor medium system. Whether the magnet is moving, the coil is not moving; or the magnet is not moving, the coil is moving; from the point of view of the conductor medium system, there are changes in magnetic flux. Therefore, in the classical electromagnetic theory, there is no such thing as the magnet is not moving, the coil is moving when the induced current is difficult to understand.

It can be considered that Maxwell extended Faraday's electromagnetic induction theory and Ampere's law to non-conducting media systems, especially non-physical space media systems (ether system). The ether can propagate " displacement currents"(changing electric fields), which generate magnetic fields and changing magnetic fields generate changing magnetic fields, resulting in the ether system. The ether system is a superior reference system compared with other reference systems when the internal situation of various physical objects (such as metal conductors and electrolyte solutions) is not considered. Faraday and Maxwell's electric field changes and magnetic field changes are fundamentally changes relative to the medium reference frame.

SR believes that electromagnetic waves electromagnetic fields do not need medium, and the change of electric field and magnetic field in Faraday and Maxwell theory is not the change of reference frame relative to medium, but the change of reference frame relative to motion (observer). Prof. Zhang thinks that the classical electromagnetic theory only considers the space ether system, and does not consider the other medium system. Therefore, he believed that the induction of current when the magnet is stationary and the coil is moving is difficult to understand according to classical electromagnetic theory. SR argues that electromagnetic phenomena are due to changes in the relative motion (observer) frame of reference, a view that leads to paradoxes. If the magnetic phenomenon is only the relative motion effect of the observer, two identical charges at rest on the ground will be repulsed by the Coulomb force, and the moving observer will find that they will also be attracted by the Ampere force, reducing the repulsive force. When the observer moves fast enough, the Ampere force will exceed the Coulomb force, and the moving observer will find that the two charges of the same species attract. An observer on the ground would always find the two charges repealing each other.

It can be seen that Relativity not only does not help electromagnetism, but also leads to wrong understanding and conceptual confusion.

Consider now the papers on electromagnetism written in the non-relativistic mind, and the new work that may be called "non-relativistic electromagnetism". Examples of the former are two papers by Prof. Zhi-Xun Huang [7,8] (one in Chinese and one in English); the paper points out. although there is room for improvement, ME is undoubtedly a brilliant scientific pearl, It not only expresses a way of looking at nature, but also has fascinating scientific beauty. It has been used all over the world to solve many engineering problems. It is also argued that the covariation of ME must be justified by the correctness of Relativity theory. If the theory of Relativity does not hold, the following happens: the relativistic transformation of the field strength does not hold.In this way, ME does not comply with LT covariation. ... An example of the latter is the emergence of Expanded Maxwell Equations (EME); In July 2022, Zhonglin Wang, an academician of the Chinese Academy of Sciences, published a long paper [9], which was both a description of his achievements and an answer to some of the accusations. It is stated that the view of time and space based on GT should not be ignored, and that his own system

of equations (called WE by the author) "does not maintain LT covariability". It was a brave statement.

3. THE SO-CALLED "LOW SPEED APPROXIMATION" MAY BE A DEROGATION OF NON-RELATIVISTIC EQUATIONS

In recent years, Chinese scientists have done a lot of research on the establishment of new electromagnetic theory, and have achieved fruitful results. For example, in order to solve the self-consistent solution of ME, Prof. Wen-Miao Song [10] introduced a new mathematical method, that is, on the basis of Euclid space, he added an intermediate term — the mathematical norm method of vector partial differential operator. Another example is that Zhonglin Wang [9,11] extended ME to the case of moving media, expanding the application scope of the theory. This WE came under a lot of attack for not maintaining LT covariability.

Now let's write the titles of Prof. Wang's two most representative papers:

I. Dynamic Maxwell Equations for engineering electromagnetics and their solutions (published on November 16, 2015) [11].

ll. Maxwell's equations for a mechano-driven varying-speed motion media system under slow motion and nonrelativistic approximations (published on July 8, 2022) [9].

Obviously, paper II is more noteworthy, as Wang will present his final thoughts after spontaneous online discussions in the first half of 2022.The title of thesis II actually says: "My system of equations may contradict or not conform to the requirements of Relativity; But it is an approximation at low speed, so it should be allowed." We are not clear why Prof. Wang said so: is it after careful analysis and calculation to determine that WE can only be used at low speed, or to avoid the criticism of the relativists, to fight for the survival space for WE?

Here, look at the history of how the Schrödinger equation (SE) has been belittered and later gradually corrected by relativists. Erwin Schrödinger (1887-1961) was one of the founders of Quantum Mechanics (QM) [12,13]; In early 1926, he published the first of a series of papers called "Quantisation as a problem of proper values". The idea was to consider simple (non-relativistic and unperturbed) microscopic systems, such as hydrogen atoms, in order to discover the true nature of quantum rules. At this time, he proposed the function $\boldsymbol{\Psi}$, which is a single valued and continuously differentiable real function, and defined $\boldsymbol{S}$ by the Hamilton-Jacobi differential equation:

$$\boldsymbol{S} = K \lg \boldsymbol{\Psi}$$

He tried to replace the quantization condition by a variational problem with discrete eigenvalue spectra (corresponding to Balmer terms) and continuous eigenvalue spectra (corresponding to hyperbolic orbits). The following equation arises for the one-electron case

$$\nabla^2 \boldsymbol{\Psi} + \frac{2m}{\hbar^2}\left(E + \frac{e^2}{r}\right)\boldsymbol{\Psi} = 0 \qquad (1)$$

The latter called the upper equation "a stationary nonrelativistic quantum wave equation," and Schrödinger himself called it "an Euler-type differential equation for variational problems", and said that it had a solution for every positive value. Schrödinger then derives a condition, Equation (15) in his text, from which the Bohr level corresponding to the Balmer terms in hydrogen atom is derived.

Hamilton equations and variational methods are commonly used in classical mechanics, and are now used by Schrödinger to construct new kinetic equations, whose results are consistent with the hypotheses and experimental facts about the hydrogen atom.

On June 23, 1926, Schrödinger submitted paper IV, which was published in 《Ann.d.Pysik》, volume 81, number 4.This long article presented a time-dependent equation that marked the maturity of wave mechanics thinking and the birth of Quantum Mechanics. This combination of the analysis of waves and particles is excellent. If the general expressions of wave function and potential function are $\boldsymbol{\Psi}(\boldsymbol{r}, t)$ and $U(\boldsymbol{r}, t)$, then there is a time-dependent Schrödinger wave equation:

$$\mathrm{j}\hbar \frac{\partial \boldsymbol{\Psi}}{\partial t} = \frac{\hbar^2}{2m}\nabla^2 \boldsymbol{\Psi} + U\boldsymbol{\Psi} \qquad (2)$$

Let $\hat{\boldsymbol{H}} = \frac{\hbar^2}{2m}\nabla^2 + U$, therefore have

$$\mathrm{j}\hbar\frac{\partial \boldsymbol{\Psi}}{\partial \mathrm{t}} = \hat{\boldsymbol{H}}\boldsymbol{\Psi} \tag{2a}$$

This is a quadratic differential equation in time t and space coordinates, so it has no covariation under Lorentz transformation (LT) and does not meet the requirements of Relativity, so it is a non-relativistic equation. In other words, the time and space coordinates must have the same degree of differentiation in the equation that satisfy the requirements of Relativity.

On the other hand, if the wave function is stationary, that is, $\boldsymbol{\psi}(\boldsymbol{r})$; If the potential field is constant, i.e., $U(\boldsymbol{r})$, then the time-independent stationary Schrödinger equation can be written as follows.

$$\mathrm{E}\boldsymbol{\Psi} = \hat{\boldsymbol{H}}\boldsymbol{\Psi}$$

Where E is the energy of the system; The above equation is similar to the wave equation of electromagnetic wave.

It can be proved that Schrödinger equation can be obtained by introducing de Broglie wave concept on the basis of Helmholtz scalar wave equation. The fact that SE is "accessible" to the Helmholtz equation will be seen more clearly later on in the application of SE to high-speed particles (for example, the photons).

"Why do we derive SE from Newtonian mechanics instead of relativistic mechanics?" Schrödinger once explained that although he was "a little embarrassed to be forced to abandon Relativity in the search for wave equations, the difficulty of introducing Relativity was increasing, even alarmingly so ".Anyway, he don't need Relativity!

Is the Schrödinger equation "valid for low-speed phenomena"? Some works in physics assert that SE is based on a number of strict approximations, one of which is that "all relevant velocities are assumed to be sufficiently small", so that the non-relativistic nature of the Schrödinger equation is not understood correctly. Those words were not in Schrödinger's original paper.

Newton's equation for particle kinetic energy is well known:

$$E_k = \frac{1}{2}mv^2 = \frac{1}{2}m_0v^2 = \frac{p^2}{2m} \tag{3}$$

The above formulation shows that the mass does not change with velocity in Newton mechanics, and the moving mass m is no different from the rest mass m_0; But in SR, the kinetic energy is:

$$E_k = \sqrt{p^2c^2 + m_0^2c^4} - m_0c^2 \tag{4}$$

In the above equation, momentum $p = mv$, and $m = m_0\left(1 - \frac{v^2}{c^2}\right)^{-1/2}$. The results show that the E_k calculated value of Newton mechanics is larger than that of SR mechanics when the same value is taken. So, the two theories are fundamentally different.

As we all know, SE is useful and effective when dealing with the problem of photons passing through potential barriers, or when dealing with phenomena in optical fibers. Therefore, it is wrong to say that "the Schrodinger equation is derived under the assumption of low speed" (and can only be applied at low speed).

In short, it is not true to say that Newton mechanics and ME can only be applied at low speeds. The non-relativistic quantum wave equation (SE) has been successfully used to calculate the high-speed problem (see [14] for the work of the author on the calculation of optical fibers by SE).

4. AS ONE OF THE NON-RELATIVISTIC SPACE-TIME VIEWS, QUANTUM NON-LOCALITY FINALLY WINS

According to media reports, on October 4, 2022, the Royal Swedish Academy of Sciences announced that the 2022 Nobel Prize in physics has been awarded to French scientist Alain Asper, American scientist Johann Krauser and Austrian scientist Anton Zeilinger. For their contributions to "entangled photon experiments, verification of violations of Bell inequalities, and pioneering quantum information science." ... At the Nobel committee's press conference, the Nobel committee showed an image of a Chinese quantum satellite showing an experiment in intercontinental quantum communication between China and Europe. In fact, in 2017, Chinese and Austrian scientists successfully conducted the world's first quantum confidential

intercontinental video call with the help of China's "Micius" quantum satellite. It is safe to assume that a Chinese physicist won't be far away from winning the Nobel physics prize.

On Oct 8, I wrote an article entitled "A victory not too late — Congratulations to Alain Aspect on winning the 2022 Nobel Physics Prize", published in《Science Network [15]. The article said that quantum mechanics (QM), which was born in 1926, has been advancing rapidly and invincible for more than 90 years. It is regarded as one of the most important and beautiful achievements in the history of human thought, and its application scope is extremely broad. The essence of QM lies in its non-classical, microlity and non-locality, while quantum non-locality can be colloquially interpreted as Superluminality and can obtained quantum entangle states. In contrast to this is the classical, macroscopic and local nature of Relativity (mainly SR). The main contents of this local reality are as follows: believe in the classical physical reality, believe in local causality, and oppose probabilistic thinking; In SR, the light speed is considered to be the limit of the speed of moving bodies in the universe and the speed of information transmission. It does not accept the possibility of physical entanglement.

Einstein's EPR paper in 1935 was against Quantum Mechanics, and the essence of the disagreement was that SR and QM had different worldviews, time and space views [16]. The author believes that these two theoretical systems are not just "existing contradictions" as some people say, but fundamentally incompatible. Some of the content in the EPR paper is only foreshadowing (e.g., "that a physical theory must be not only correct but complete"; Another example is that "wave functions in Quantum Mechanics give an incomplete description of reality"). The fundamental thing is in the analysis of the interaction of "two-body systems" (systems consisting of two subsystems, see Fig. 1), where subsystems I and II should be understood as microscopic particles. The states of the two subsystems are known until t=0, when they interact between t=0 and t=T, and when t>T they no longer interact (e.g. away from apart in different directions). Let be the quantum state of the system is, which can be expanded according to the eigenfunction system of the physical quantity (such as mechanical quantity)A of the measurement Ⅰ, and also according to the eigenfunction system of the physical quantity B of the measurement Ⅰ. According to QM, the wave packet will collapse during measurement and $\Psi(x_1, x_2)$ reduction after measurement, so that measurement of Ⅰ will affect the state of Ⅱ. However, since I and II are separated, such a strange influence at a distance is unlikely to occur. Since SR stipulates that the interactions in nature can only be realized at speeds lower than the speed of light, the spatially separated system should be local, but QM gives a non-local condition, so QM is not self-consistent and incomplete. These are the most important things in the EPR paper.

It follows that there is an invisible thread connecting SR and EPR; In other words, EPR thinking is put forward on the basis of SR. Secondly, we say that there is a sharp contradiction between SR and QM worldviews, which is reflected in the issue of "local realism or non-local realism". The EPR paper was Einstein's maximum use of his intelligence at the age of 56 to give Quantum Mechanics the body blow he had hoped for. Einstein was shocked by the appearance of Heisenberg's uncertainty principle in 1927, but he thought the EPR paper could refute the principle and prove that QM was imperfect. The discussion of "two systems" (Ⅰ and Ⅱ) in EPR seems to indicate that "knowing both position and velocity" is feasible, because the velocity of Ⅰ is the velocity of Ⅱ. When the article was published, Bohr [17] refuted it. Bohr means that the EPR paper's setting can be dismissed — uncertainty affects both I and II, and II is affected immediately when I is measured so that the result is consistent with Newton's law; This effect occurs immediately, even if I and II are far apart. But younger scientists (W. Heisenberg, for example) could not argue with Einstein the way Bohr did. This is not only because Einstein was their predecessor, but also because he was already a well-known figure in the world and enjoyed great prestige. The Russian academician V. Fok said: "It is particularly surprising that Einstein, who has done so much for quantum theory in its early development, has taken a negative attitude towards modern Quantum Mechanics. There is no direct force interaction between the two subsystems of the EPR mind, and one can also affect the other, which Einstein considered incomprehensible and thus incomplete." According to Fok, the interaction (influence) of Pauli's principle in QM is an example of a non-force. The interaction (influence) between two particles with a common wave function (EPR system) is another form of non-force interaction

(influence) of QM. The existence of non-force interaction (influence) is beyond doubt, and it would be wrong to deny it.

The CERN's scientist J. Bell was a fan of Einstein's theory when he developed his inequality (Bell's inequality) in 1965 [18]; Bell's analysis builds on Bohm's theory of spin-dependent schemes (spin two-valued particle systems) and hidden variables. Assume that the spin component of the related particle has only two possible values, namely A(**a**, λ)or B(**b**, λ)=±1, where **a** and **b** are unit vectors. Under ideal correlation conditions, A(**a**, λ)=-B(**a**, λ) in any direction **a**. In addition, it is assumed that when the two particles are separated, the measurement result A(**a**, λ) of Ⅰ is independent of the orientation of **b**, and the measurement result B(**b**, λ) of Ⅱ is independent of the orientation of **a**. There are three assumptions above, namely, spin two state system, perfect correlation and locality condition. The following correlation functions are also defined:

$$P(\mathbf{a},\mathbf{b})=\int \rho(\lambda)A(\mathbf{a},\lambda)B(\mathbf{b},\lambda)d\lambda$$

Where, ρ(λ) is the probability distribution function of λ. From this, Bell derived the following inequality:

$$|P(\mathbf{a},\mathbf{b})-P(\mathbf{a},\mathbf{c})|\leq 1+P(\mathbf{b},\mathbf{c}) \quad (5)$$

This is in conflict with QM's prophecy. From 1981 to 1982, A. Apect led and completed **a** number of experiments in France, and proved that the results greatly violated Bell inequality and were very consistent with QM by high-precision experiments.

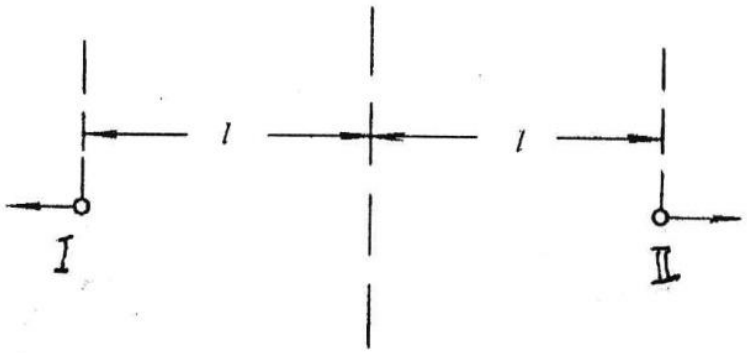

Fig. 1. EPR test

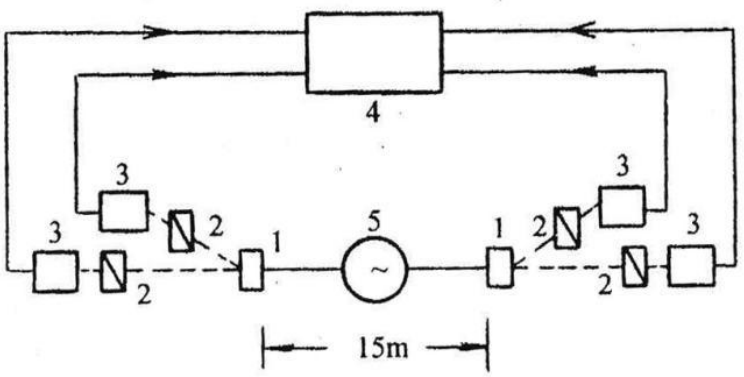

Fig. 2. Aspect experiment
(1: switch, 2: polarization sheets, 3: photo-electric tube, 4: monitor, 5: source of photons）

Although the initial experiments (e.g. R. Holt, 1973; G. Faraci, 1974) had obtained the result of "deviation from QM, consistent with Bell Inequality", it was not recognized by the scientific community due to its low accuracy and poor credibility. Another 10 experiments from 1972 to 1982(including the experiment done by Jian-Xiong Wu in 1975 and the 3 experiments done by Aspect and others in 1981 to 1982, see Fig. 2) were all "in violation of Bell inequality and consistent with QM", and very consistent with QM prediction. This is no accident, nor is it a surprise to QM experts. It is worth noting that Aspect experiment is dynamic rather than static, that is, the experimental device changes with time during particle flight; This was J. Bell's hope, because the local conditions would then be a direct result of Einstein causality (the inability of any signal to travel faster-than-light). The measured result, Bell parameter S=0.101±0.020, is very close to the QM calculation result(S=0.112), but far from the specified data of Bell inequality(-1≤S≤0). Not only that, but in 1998, the magazine 《 Phys. Rev. Lett 》 In the experiment completed by G. Weihs et al, under the condition of space distance of 400m(Aspect experiment is only 15m), the experiment was conducted with two-photon wavelength of 702nm, and the result also violated the inequality and fully supported QM. Of these experiments the French physicist B. d'Espagnat commented that "there is almost certainly something wrong with local realism"; "The violation of the Bell Inequality can only be explained by abandoning the hypothesis of Einstein separability". He also argues that although J. Bell had three premises in deriving the inequality, the local reality hypothesis is the most basic. In the author's opinion, in fact, N. Bohr has already clarified the principle of "indivisibility", that is, in the quantum field, the two subsystems of the indivisibility failure system do not exist completely independently even if separated, and the measurement of one must affect the other.

From the quantum entanglement (quantum entangled state) research progress can be seen, QM worldview has completely defeated the SR - EPR worldview. The distance of entanglement between two photons successfully developed from 15m in the earliest Aspect to 25km, and even 144km in 10 years ago. According to a report in the June 15, 2017 issue of 《Science》, a team of Chinese scientists led by academician Jian-Wei Pan made a new achievement with a quantum satellite — achieving quantum entanglement at the thousand-kilometer level (the distance from Delingha Station in Qinghai province to Gaomeigu Station in Yunnan Province is 1203km).The result shocked the world. In a word, a series of experiments perfectly prove that wrong of SR space-time view is an indisputable fact.

In the mid-1960s, J. Bell of CERN published two papers proposing a hidden variable model compatible with QM, arguing that "no local variable theory can reproduce all the statistical predictions of Quantum Mechanics". Some inequalities for correlation functions when two particles spin projection along different directions of space and time are presented. Bell turned out to be a staunch supporter of Einstein and a believer in physical reality and locality. He believes that some hidden variables are responsible for the mysterious action at a distance in QM. In fact, it is possible to construct a theoretical inequality (which must be followed by particle observations) to confirm the QM incompleteness stated in the EPR paper. Bell's analysis builds on Bohm's spin-dependent scheme and hidden variable theory. We now dispense with the mathematical analysis and emphasize that Bell's inequality is not consistent with QM. Bell's theorem says that a hidden variable theory cannot reproduce all the predictions of QM. ... But just how that is must be determined experimentally. The breakthrough was due to the precise experiments of the French physicist Alain Aspect. Experiments led by spect show that the results violate Bell's inequality with high accuracy and are in good agreement with the predictions of Quantum Mechanics [19]. The Bell inequality is not proved to be true by exact experiment, which means that the EPR paper is wrong and the QM is correct. John Bell opened the door to quantum informatics!

It is important to note that advances in experimental physics can change the views of some of the best theoretical physicists. Examples are P. Dirac and J. Bell; Although they maintained their faith in Einstein and Relativity in their early years, they changed a lot in their later years. In the second half of the 20th century, experimental physicists made two major discoveries; First, American microwave scientists A. Panzias and R. Wilson jointly discovered the microwave background radiation. This was in 1965, and the experiment was conducted in the centimeter-wave band, measuring noise temperatures of (2.5 to 4.5) K; Finally, the Cosmic Microwave Background (CMB)

temperature was determined by the physical community, and the standard value was 2.7K.The CMB is isotropic in nature and has nothing to do with Earth's rotation or revolution. It is thought (debatable) to be an ember of the Big Bang; The other, more important, is considered an alternative to the "new ether". Anyway, the 1978 Nobel Physics Prize was awarded to Penzias and Wilson....Another thing happened in 1982, when the American journal PRL published an experiment led by a team of A. Aspect, which examined whether two photons emitted simultaneously by an energy level transition in a single atom followed Bell's inequality. It turned out that QM was correct, while Einstein's space-time and world views (represented by the EPR paper) were wrong. ... Both of these experiments sent shock waves through the physics world.

We think Ohanian's 《Einstein's Mistakes [20] is a good book, but the author obviously doesn't know the details of P. Drac's and J. Bell's life work and falsely asserts that both men supported Einstein and the theory of Relativity. Yes, they were strong supporters in the early days; But as new experiments continued to emerge, such as these two and others, the late Dirac distanced himself from Relativity, saying "Lorentz was right and Einstein was wrong". As for Bell in his later years, he not only said, "go back to before Einstein(1905), namely Lorentz and Poincarè," but also condemned Relativity for bringing various difficulties to the development of quantum theory, and affirmed the fact possibility of superluminal phenomenon. Dirac died in 1984 and Bell died in 1990. The transformation of the two masters of physics was dramatic -- E. Schödinger and P. Darc shared the Nobel Prize in 1933; In his speech of thanks, Schrödinger, who succeeded from Newton's mechanics, avoided the theory of Relativity. The young Dirac made the mistake of raving about his "derivation from Relativity". In fact, the equations for mass-velocity and mass- energy that he used as his starting point had been derived by Lorentz in 1904 and by Poincarè in 1900, both without Relativity. Late in his life, Dirac [21] said, "There are insuperable difficulties in combining Relativity with Quantum Mechanics," a euphemism for saying that he had invented "Relativistic Quantum Mechanics."In fact, since Einstein went through life rejecting QM, it makes no sense that this RQM exists at all. As for J. Bell, he came up with the theory of hidden variables in 1965, and he gave inequalities, which was supposed to support Relativity; The results were contradicted by Aspect's precise experiments (which were later supported by multiple experiments). In addition, considering the impact of the CMB's discovery, Bell was finally announced Einstein's Relativity in 1985.

"All three scientists experimented with quantum entanglement," Reuters reported on Oct. 4, 2022, after the Nobel committee announced its decision for the physics prize. "In quantum entanglement experiments, two particles are connected to each other no matter how far apart they are. This bothered Einstein, who called it spooky action in distance".

But I have a different view. The Bell inequality has been widely tested since 1982 and has become an important means of identifying entanglement that can be described by discrete measurements. Such as measuring the spin direction of one quantum particle, and then determining whether that measurement correlates with the spin of another particle. If a system violates this inequality, then entanglement exists. In short, the Bell inequality became a signature method of checking whether it was obeyed. Both theory and experiment show that nonlocality is a fundamental feature of QM — the experimental results violate Bell's inequality and suggest that nonlocality exists. John Bell's name entered the history of science, and his inequality was hailed as "one of the greatest scientific discoveries in human history".

In short, Alain Aspect has become a figure in the history of physics, and his award is well deserved. John Bell would have been eligible, but he died young and the Nobel Prize can only be awarded to people who are still alive. In fact, whether the award itself is not important, the key is to establish a correct view of time and space, world outlook. Professor Wen-Miao Song, a famous Chinese expert on electromagnetic theory and a good friend of mine, once commented on the widespread belief in the theory of Relativity: "Truth cannot be obtained by faith and worship, only the nature is the standard by which we scientists test everything."He speaks very well!

From 1982 to 2022, that's exactly 40 years. The Nobel Committee is late, but not too late. We congratulate Alain Aspect!... From this matter, we can also see that the study of natural science is a difficult thing, of course, is also a happy thing. The right concept to establish, not in the short term can be effective. For example, it can be seen that the local description in relativity is not compatible with the particle fluctuation in QM, nor

is it compatible with allowing particle transformation in QM. In particle physics, non-relativistic QM is a logically self-consistent single-particle theory, but the premise of the so-called "relativistic QM" is logically inconsistent. It is difficult to act as a single particle equation of motion like SE.

5. WHY IS POSSIBLE OF FASTER-THAN-LIGHT

Let us now turn to the early faster-than-light studies, when the goal was not to "overthrow the SR". However, in the process of research, the theory of Relativity is changed from belief to doubt, and finally may be deviated and abandoned. In addition, in the 21 century, there have been a series of decisive experiments that deny the principle of the invariance of light speed, some of which are organized and carried out by faster-than-light researchers. All this suggests that researchers have a key code in Relativity and are working to crack it.

SR proposed the "light speed limit" using simple logic, such as from the so-called "mass - velocity formula", the motion and state of $v > c$ can not exist. In 1904 Lorentz [22] derived the following formula:

$$m = \frac{m_0}{\sqrt{1-\beta^2}} \tag{6}$$

Where, $\beta = v/c$, m is the mass of moving body, and m_0 is the rest mass when v =0. This was Lorentz's formulation for the motion of the electron, which he assumed to be a sphere of radius R at rest, with electron charge e uniformly distributed on the surface. Before In 1892, Lorentz had proposed "the ruler shortening in motion"; and in 1895 the contraction factor was defined as $\sqrt{1-\beta^2}$ [15]. So in 1904 he assumed that "electrons change shape when they move in a straight line," and that electrons shrink in size in the direction they move. This clearly indicates that the source of the denominator term ($\sqrt{1-\beta^2}$) in the mass-velocity formula is the ruler factor. If the physical assumption of "ruler shrinkage" is wrong, Lorentz's formula for mass - velocity is also wrong.

However, referring to Einstein's paper [1], he failed to derive the same result as the above equation. Later, however, SR incorporated Lorentz's mass-velocity formula, and Einstein also acknowledged Lorentz's invention right to this formula. Now SR extends this formula, derived for the electromagnetic mass of electrons, to any neutral particle or neutral matter, and the mass is general, which is very problematic. In 1909, Lewis and Tolman [23] analyzed it as a two-ball collision; When the conservation of momentum and mass is assumed in the collision process, the formula of mass-velocity can be derived. But the premise of the derivation is not only "the conservation of total mass and total momentum of the two particles in the collision process", the velocity addition formula SR should be quoted. The author thinks this is "using the formula in his own theory to prove the theory is correct", it is a circular argument. Lewis and Tolman's treatment, therefore, does not prove that the mass of a neutral particle depends on the speed of motion. Although experiments on electrons have been proved to be consistent with Lorentz's mass-velocity formula (for example, Kaufman [24] and Buchrer [25]). But the experiments on neutral particles are still not available (neither confirmed nor falsified), because there is no technology to accelerate neutral particles efficiently.

However, SR ignored all this and asserted that Lorenz's mass-velocity formula holds for any motion of matter; It says that if the speed of motion is close to c, the mass will be very large, and if $v = c$ (β =1), the mass and energy will be infinite. Therefore, it is not possible to use accelerators to make particles reach and exceed the speed of light, nor is it possible for any object, such as a spaceship. ... Although many physicists disagreed with the "light speed limit" theory, few publicly raised objections to SR before the 1960s.In 1967, Professor G. Feinberg [26] of Colombia University wrote a paper like the "ice-breaking journey". He pointed out that photons travel at the speed of light c, and that they are not artificially accelerated, but are naturally present in nature. Second, quantum theory suggests the possibility of faster-than-light speeds (later echoed in 1985 by J. Bell). Finally, one can try to circumvent the difficulties caused by SR in theory—if $m_0 = j\mu$, then:

$$m = \frac{j\mu}{\sqrt{1-\beta^2}} = \frac{\mu}{\sqrt{\beta^2-1}} \tag{7}$$

In this case, the real number m remains real even if β >1. He called such particles with

imaginary resting masses "tachyon." We know that some physicists still insist that neutrinos are tachyons recently.

Radio astronomy has long developed a technique for combining radio telescopes around the world called Very Long Baseline Interferometry (VLBI), which is equivalent to building a radio telescope about the diameter of the Earth. VLBI observations of the universe have yielded rich results. For example, on quasars (objects that look like stars), observations have shown complex structures in some quasars and galactic nuclei. There may be two internal radio sources (light-years apart); And they're moving away from each other at tremendous speeds (faster-than-light speed). For example, quasar 3C345, observations since 1971 show that the two parts fly apart at eight times the speed of light (v =8 c). Observations of quasar 3C273 show that the separation velocity is 9.6 c . In addition, quasar 3C279 and radio galaxy 3C120 were also found to be separated from each other at superluminal speeds. This is completely unexpected to astronomers, and has profound implications. Because after ruling out some possible explanations, it was accepted that these objects might indeed be moving faster than light.

As early as 1986, Prof. Sheng-Lin Cao of astronomy department of Beijing Normal University made a research on the discovery obtained with VLBI technology on the world, and thought that the superluminal expansion of radio source is the evidence that the real superluminal motion can exist [27]. Further research using mathematical methods and statistical fitting of Finsler geometry was included in a monograph published in 2001 [28] In 2019, Prof. Cao [29] pointed out that NASA's Hubble Telescope observed supergiant star bursts, which showed stars in the Milky Way expanding at superluminal speeds (4.3 c), this is a remarkable superluminal phenomenon.

In 2005, Xian-Gang Liu, an associate professor at Beijing Normal University, pointed out that Einstein's 1905 paper had an achilles' heel in its analysis, which treated electrons as general agents of mass m and speed v , while electrons were special agents of electric charge [30]. Clearly, a kinetic theory of moving charges is needed. Assuming two stationary point charges q_1 、 q_2 , position $\boldsymbol{r}_1$ 、 $\boldsymbol{r}_2$, and, using Coulomb's law, the electric field intensity equation can be derived. And let's say that q_1 we're at rest, q_2 moving with velocity $\boldsymbol{v}$, and arrive $\boldsymbol{r}_2$ at time t , where the force of q_1 action on q_2 is

$$\boldsymbol{F}_{12} = \mathrm{k} q_1 q_2 \frac{1}{|\boldsymbol{r}_1 - \boldsymbol{r}_2|} \left| 1 - \frac{\boldsymbol{v}\boldsymbol{v}}{c^2} \right| (\boldsymbol{r}_2 - \boldsymbol{r}_1) \tag{8}$$

This is a vector equation, where $k = 1/4\pi\varepsilon_0$ Taking $\boldsymbol{r}_2 = \boldsymbol{r}$, $q_2 = q$, it can be proved that:

$$\boldsymbol{F} = \mathrm{k} q \left(1 - \frac{\boldsymbol{v}\boldsymbol{v}}{c^2} \right) \boldsymbol{E}$$

Where $\mathbf{E}$ is the electric field intensity vector; In the 1-dimensional case when we only think about the value of vector, then

$$F = \mathrm{k} q \left(1 - \frac{v^2}{c^2} \right) \boldsymbol{E} \tag{9}$$

Where v is the speed of charge movement. Now consider the motion of the electron, which increases from its initial velocity v_0 due to the acceleration of the electric field to v , and we can see that:

$$v = c \sqrt{1 + \left(\frac{v_0^2}{c^2} - 1 \right) e^{-2w/mc^2}} \tag{10}$$

Where m is the electron mass and w is the energy; The work can be calculated by integrating the force $\boldsymbol{F}$, we obtain:

$$J = \frac{m}{2} \left(c^2 - v_0^2 \right) \tag{11}$$

Since $v_0 \ll c$, we obtain

$$J = \frac{m}{2} c^2 \tag{11a}$$

So the work done by the electric field on the electron, even at the speed of light, energy is not infinite.

In 2010, Liu [31] published a monograph titled 《Research on Electrodynamics of Moving

Bodies》, and there is an interesting metaphor in the book. He used the term "bat mechanics" to explain Einstein's error — bats use sound waves to navigate; If the speed of signal propagation and response were the speed of sound, the bats would believe this to be the highest speed in the universe, according to Einstein's SR moving body theory, where the equations for mass, momentum, and energy are unchanged.

We give the examples above to show that Einstein and Relativity were respected at first; Although it points out that SR theory has problems, it is not completely negative. Discarding SR happens gradually.

6. THE NEW DISCIPLINE "SUPERLUMINAL LIGHT PHYSICS" CAN BE ESTABLISHED

The term "Superluminal Light Physics" first appeared in an English paper by Chinese scholars around 2012.The author thinks from the domestic and foreign research situation, it seems that the condition is ripe to put it forward as a branch of discipline. In 2014, I published a monograph with the title 《Wave Science and Superluminal Light Physics [32], a bold step for Chinese scientists. In the "foreword" of the book, I wrote:

"The creation of any new discipline is not at the will of anyone or an academic institution, nor does it need to be approved by anyone. As more people studied it, its achievements and implications became apparent, the direction gained more attention, and the discipline was established. This is the case with Superluminal Light Physics, a term that was never (or rarely) mentioned before. We think that after decades of work by scientists from all over the world, this discipline has been born."

It must be pointed out that there is also a very special case in China, that is, space-farer's advocacy and promotion of FTL research, which is also rare in the world. Maybe NASA does it, too; However, in China, as early as 2004, the academic conference of "Frontier Issues on Astronautics and Light Barriers" was convened by the aerospace community. About 50 experts and scholars (including 9 academicians) attended the conference. This is something the world does not know. A key leader is academician Jian Song, a former deputy minister and chief engineer of the Ministry of Space Industry and later director of the State Science and Technology Commission. He pointed out that [33]:

"In 1905 Einstein declared that faster-than-light speeds were impossible, later known as the 'light barrier'. But this is only hypothetical. Because of the difficulty of observing faster-than-light movements, where nothing can be seen it can only be guessed or hypothesized. Now we call it spaceflight within the solar system, and astronautic flight outside the solar system. It is expected that the first astronauts will fly out of the solar system and return safely in this century, and flying out of the solar system is the great dream of mankind. But there are many theoretical and technical problems to solve. We must go faster; faster than the speed of light, if possible."

This is a forward-looking statement, and it is Song's words that have made many people (including me) realize that doing FTL research is not just a personal interest, but may be part of the larger cause. This is also an important research direction of "Superluminal Light Physics". Song also points out that examining SR from 40 years of space technology practice shows that the engineering practice of autonomous navigation conflicts with SR dynamics even at speeds well below the speed of light, such as the dependence of engine thrust on its inertial velocity, which has never been seen.

In 1999, Zhi-Xun Huang, a professor at the Communication University of China, published the first monograph on the problem of superluminal — 《Research on Faster-than-Light: The Intersection of Relativity, Quantum Mechanics, Electronics and Information Theory [34]. One of the features of this book is that the author uses his knowledge of cutoff waveguides and evanescent state electromagnetic theory to analyze the existing experimental phenomenon of superluminal group velocities of microwaves passing through waveguides below-cutoff. Wen-Miao Song, a research fellow at the Institute of Electronics, Chinese Academy of Sciences, said:

"Professor Zhi-Xun Huang, a visiting fellow in our laboratory, has done a lot of research on the connection between the macroscopic law of attenuation waves in cutoff waveguides and the law of quantum mechanics [35]. Through these studies, the attenuation electromagnetic wave is related to the motion state of the photon quantum in the quantum potential and the motion state of

the electron when it penetrates the barrier. The wave's propagation constant is imaginary, and its momentum is imaginary from the point of view of QM. It is a very difficult problem to study the conversion law between the physical wave with virtual momentum and the general propagating wave. However, the virtual electromagnetic wave is an inseparable part of the whole electromagnetic wave propagation process. For example, the propagation of light wave in optical fiber is the coexistence of virtual electromagnetic wave and normal electromagnetic wave ".

Since then, the author (i.e.me) has been working on the FTL problem for 20 years and has published many theoretical and experimental works [36-40].

In 2000, Dr. Li-Jun Wang, a young Chinese scientist, performed an experiment in the laboratory of the United States, which was published in the famous journal 《Nature [41]. The experiment caused much controversy. Taking quantum optics, rather than classical physics, makes it unique. The experiment succeeded in passing a pulse of light at a negative group velocity (v_g =-*c*/310) through a cell of size 6cm, in which the cesium gas was excited by a sophisticated technique. The negative group velocity (NGV) means that not only will the light pulse travel faster than light as it passes through the vacuum, but it will leave the cell before it enters it. Some people think this is impossible. I wrote to Dr. Wang in 2001, and he replied:

"Our experiment achieved negative group velocity; In short, this only occurs in fluctuations and is not inconsistent with causality because group velocity is not information velocity. The laser pulse passing through the gas cell (medium) arrives earlier than that from the vacuum condition, which is an equivalent condition for the group velocity of light in the medium to be greater than *c*. When this advance is larger than the vacuum propagation time L/c, the group velocity of light is negative. In our experiment, this advance is about 20m, the corresponding vacuum propagation distance is 6cm, and the corresponding group velocity is about (-*c*/310)".

In short, Dr. Wang insists that he has performed a faster-than-light experiment, which does not violate the law of causality or SR. But not everyone else sees it that way. Interestingly, Liao Liu, a well-known expert on Relativity and a professor at Beijing Normal University, has a different opinion. In 2002, Prof. Liu [42] wrote that "we should see the possibility of faster-than-light pulses in the experiments, which would constitute a shock to the theory of Relativity. Specifically, the occurrence of negative velocity transforms a delayed (conventional) light pulse into a leading light pulse, resulting in the outgoing pulse being ahead of the incoming pulse in time. This seems to violate the conventional temporal causality, that is, the effect is ahead of the cause in time". Prof. Liu believes that the time sequence limitation should not be regarded as absolute, but the law of causality should be expressed as "effect can not affect cause through any way". In this way, the objectivity of the law (men cannot change history) is maintained, and new experiments are explained. In addition, Liu suggested the concept of "advance wave" to explain the work of Dr. Wang et al.

Some people think that "negative velocity" says "the direction of motion is reversed", but the former concept is different. Borm and Wolf's book 《Principles of Optics》 says the phase speed is a scalar, Brillouin's book《Wave Propagation and Group Velocity》 stated that negative group velocity(NGV) is"a velocity faster than an infinite velocity". Now many countries have done successful NGV experiments, which has become a unique landscape of FTL research.

Whatever the evaluation of the experiment, it is a sign that a new field has been opened up, characterized by the experimental demonstration that light pulses can travel faster-than-light in a negative group velocity (NGV) mode, a possibility established by A. Sammerfeld [43] and L. Brillouin [44] in their wave velocity theory. Wang's experiment also shows the necessity of introducing quantum theory, which in turn makes the experimental system more complicated. Nevertheless, some universities, such as Peking University and Jilin University, have carried out relevant experiments [45,46].

In 2014, I conducted a study with my doctoral student Rong Jiang. In theory, we point out that because the wave velocity (such as phase velocity v_p and group velocity v_g) is a scalar rather than a vector in wave mechanics, the negative group velocity (NGV) can not be understood as the opposite direction of motion, but the advance in time, so we call it "negative characteristic motion of electromagnetic wave".

Second, we obtained NGV, or the advance propagation of microwave pulses, from (-0.13*c*) to (-1.85*c*) using a left-handed transmission line composed of complementary Ω-like structures [see: Frontier Science, 8(1): 54~68].Our study uses classical physics rather than quantum optics, see Fig. 3 and Fig. 4.

That is the enlarged picture of step raise range. It's obviously shown that output pulse advance.

Since the beginning of the new century, two Chinese scientists have done valuable experimental research to against SR — Professor Ru-Yong Wang (St. Cloud State University, USA) and Academician Jin Lin (China Academy of Launch Vehicle Technology).Wang specially designed experiments to falsify two principles of SR (Einstein called "postulates"); For example, either the generalized Sagnac effect or the GPS system can be used to prove that the principle of constant speed of light is wrong [47]. In particular, Sagnac-type experiments were redone with modern technology, using moving optical fibers, hollow fibers, zigzagging fibers, and segmented fibers. Modern Sagnac experiments were performed at different speeds, proving that speed has an effect on the propagation of light in back-and-forth moving fibers, and the propagation time of light is different. "Our result," Prof. Wang said in 2005, "our result falsifying the principle of the light-speed constancy." [48]. For many years, Prof. Wang has been thinking and experimenting on the two principles of falsifying SR in the spirit of unrelenting pursuit of truth. As for the principle of SR, Wang pointed out in 2006 that the most uncontroversial judgment experiments of SR are those that test the principle of Relativity [49]. If you do an experiment in a closed system and find that the results are not the same for two states of uniform motion in a straight line, you falsify the relativistic principle of (and if the experiment uses the speed of light, you also falsify the principle of constant speed of light). He called it the "speedometer" project.

Lin is a renowned expert in satellite navigation and inertial navigation. He was praised in the scientific community for his original and novel insights and methods of redefining space and time based on rocket measurements [50]. Different from Einstein's abstract discussion of time and space, he treated the concept of time and space with the thinking of space experts. Based on the experiments conducted in 2007-2008, Lin and his team published an important paper entitled "The crucial experiment for checking Einstein's postulate of the constancy of the light" [51]. The significance of Lin's experiment is as follows: ① unidirectional light speed measurement; ② To conduct experiments on a large distance of tens of thousands of kilometers, even the space powers (the United States, Russia) have not done; ③ It is proved that the speed of light traveling in different directions may be different; Thus, the "speed of light invariant principle" of SR is falsified. This shakes up one of the cornerstones of SR. we think it's a potential Nobel physics prize experiment (but Lin died in 2016).

In a word, Superluminal Physics as a new subject has a lot of rich and vivid content. And then there's the case of entangled states traveling faster than the speed of light [52], and that's included. This subject has attracted more and more attention.

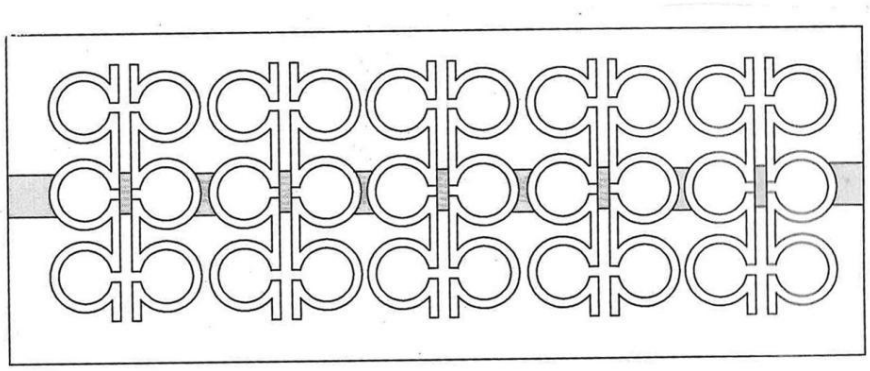

Fig. 3. The structure chart of the microstrip transmission line with complementary omega-like structures etched in the ground plane. The gray strip is the microstrip transmission line at the reverse side of printed circuit board

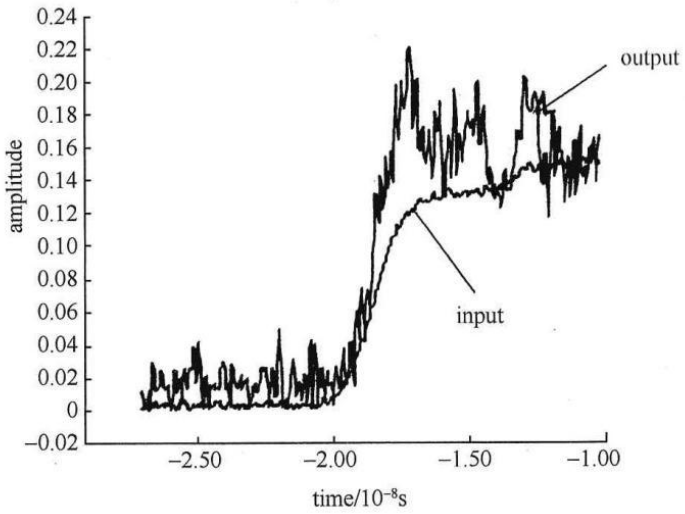

Fig. 4. Experimental results by using E5071C network analyser

We believe that FTL physics is an interdisciplinary and integrated discipline, including classical physics, quantum optics, particle physics, accelerator technology, electromagnetic field theory, microwave technology, etc. It is a model of crossover, penetration and synthesis. In addition, the development of aeronautical engineering, space technology, inertial navigation and satellite navigation progress, are closely related to the physics of FTL. It can be seen that this is a promising research direction, and we welcome the participation of experts from all aspects.

7. "LORENTZ RELATIVITY" IS SUPERIOR TO EINSTEIN RELATIVITY

When we study and discuss many problems in classical physics (such as space-time view, mass, covariation, FTL), we cannot do without the master Lorentz. The fact that the Dutch physicist Hendrik Lorentz(1853-1928) created the Relativity of Electro-magnetism in 1904 was known by people，but not by many others.Lorentz had been an expert in electromagnetic theory; He submitted his doctoral thesis on ME to Leyden University in 1873, only eight years after Maxwell published his brilliant work. Later he became an authority on electromagnetism at the time, and he did not start from Newton mechanics, but from electromagnetic theory, to study the relativistic problems. Lorentz had some prominent scientific ideas, such as:

— The idea of space-time transformation in motion, i.e. the Lorentz transform (LT);
— Thoughts on the existence of the ether (that is, the absolute coordinate system);
—Thoughts on shortening the length of moving body and delaying the time of moving clock;

As these three are interrelated, the situation is more complicated.

Ether and ME were popular topics from the late 19th to the early 20th century. Lorentz, an expert in electron motion theory and electromagnetic theory, proposed that LT also came from thinking about both. If LT comes from the derivation of the electromagnetic field transformation relation, then is the ME naturally covariant with LT? We have to think independently about many problems. ... LT was born because Lorentz was trying to deal with the electrodynamics of moving bodies. He found that acording to the Galilei transforms

$$x' = x, \quad y' = y, \quad z' = z - vt, \quad t' = t$$

When the coordinate transformation between different reference frames was realized, the basic equations of electrodynamics changed obviously, which he thought was unreasonable. The point of GT is that the time in different reference frames is the same ($t' = t$), but LT has no such restriction.

Let inertial system A(coordinate x, y, z) with A '(coordinate x', y', z') of the axis parallel to each other, A 'along the z (z') direction for uniform motion (velocity v); An event (z, t) occurring in A corresponds to (z', t') of A'; Take the linear transformation:

$$z' = az + ht \tag{12}$$

$$t' = bt + gz \tag{13}$$

Where, a 、 b 、 h 、 g are undetermined constants. At time t , $z = vt$, corresponds to o' position (z'=0), and can be substituted into equation (12) to obtain $h = -av$. Now the number of undetermined constants is down to three. Suppose that a pulse of light occurs when two reference frames coincide instantaneously, that is, a flash of light is emitted at o, o' (they are now a same point), and then the motion of a spherical wave front diffusing outward in both reference frames is observed. Assuming that the speed of light is the same in different reference frames, the equation of spherical wave front in different reference frames is respectively

$$x^2 + y^2 + z^2 = (ct)^2 \tag{14}$$

$$x'^2 + y'^2 + z'^2 = (ct')^2 \tag{15}$$

Where c is the speed of light.If we substitute the transformation of GT into Equation (15), we can obtain

$$x^2 + y^2 + (z - vt)^2 = (ct)^2 \tag{16}$$

Equation (16) is different from Equation (14). The reason for the problem is that the speed of light is different in different reference frames, or the speed of light is not constant. The reason for this situation is that the time in different reference frames is assumed to be equal in GT transformation. Substituting $x' = x$, $y' = y$ and equations (12) and (13) into Equation (15) and arranging; Then, by comparing with Equation (14), three equations composed of a 、 b 、 g , can be obtained. Solve the simultaneous equations and substitute a 、 b 、 g , and into equations (12) and (13), and specify $\beta = v/c$ to obtain the common expression of LT:

$$x' = x \text{ , } y' = y \text{ , } z' = \frac{z - vt}{\sqrt{1-\beta^2}} \text{ , } t' = \frac{t - \beta z/c}{\sqrt{1-\beta^2}} \tag{17}$$

Clearly, when $v \ll c$, LT reduces to GT.

We still going to take the inertial frame *A*, *A*' prime, but we don't want the axes to be parallel to each other. It is still assumed that the flash is emitted from o(o') point at $t = t'$=0, and the speed of light c in the two systems is the same, then the event satisfying Equation (14) must satisfy Equation (15). Now let's introduce the function s :

$$s^2 = x^2 + y^2 + z^2 - c^2t^2 \tag{18}$$

It can be proved by the second postulate of SR that $s'^2 = s^2$, that is, s^2 has invariance. There are now

$$x^2 + y^2 + z^2 - c^2t^2 = x'^2 + y'^2 + z'^2 - c^2t'^2 \tag{19}$$

The square root of the above equation(s) is the norm of a 4-dimensional vector, which remains the same in different systems. This analysis is called the 4-dimensional space-time continuum and is also called Minkowski space-time. Since $(jct)^2 = -c^2t^2$, jt is Minkowski imaginary time. Due to the introduction of virtual time, the 4D continuum invariant theory of space-time is similar to the 3D Euclid continuum invariant theory. However, in Euclidean geometry s^2 is always positive (s^2 >0), so it must be real (s >0); Now, in Minkowski's space-time, s^2 it might be negative.... Here we must point out that imaginary time has no physical meaning. We should also point out that the author does not agree with the "integration of time and space" at all, we say that time and space are independent.

Now Lorentz called t' local time or coordinate time. In 1904, Lorentz [22] first considered the relation of time transformation, at which time the covariability of ME was guaranteed. But that can not explain the Michelson-Morley experiment, so "length contraction" was introduced.

The French mathematician Henri Poincarè (1854-1912) was an excellent and famous scientist. In 1904 he presented the idea of relativity in a lecture, and in 1905 he published a revision of Lorentz's paper [53]. He pointed out that Lorentz's work actually provided a mathematical transformation group:

$$\begin{bmatrix} x' \\ y' \\ z' \\ ct' \end{bmatrix} = L, \quad L = \begin{bmatrix} x \\ y \\ z \\ ct \end{bmatrix} \begin{bmatrix} \gamma & 0 & 0 & \gamma\beta \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ \gamma\beta & 0 & 0 & \gamma \end{bmatrix} \tag{20}$$

In the type $\gamma = \left[1 - \beta^2\right]^{-1/2}$

Reference [1] makes no mention of the Michelson-Morley experiment, nor of Lorentz and Poincare, although these works were done before 1905. According to Einstein, he wrote his paper [1] without knowing (or having read) the papers of Lorentz and Poincare. But this is highly unlikely. Professor Qing-Ping Ma pointed out that Einstein's 1905 paper[1] might have plagiarized the ideas of Lorentz and Poincare. Einstein himself said, "The secret to creativity is to hide your sources." This sounds like a plagiarist's principle, says H. Ohanian [20] in his 2008 book 《Einstein's Mistakes》. In his 2002, the book 《Einstein: An Incorrigible Plagiarist》, C. Bjerknes [54] was even more scathing.... However, Lorentz was a modest and gentleman. Instead of arguing for "priorities", he was generous and polite enough to say a few nice things about Einstein, but he never accepted SR. Einstein referred to Lorentz several times in the rest of his life as a public display of intimacy.The truth is, Lorentz kept a distance and never really had a close relationship with Einstein.

SR is based on two postulates (the special relativistic principle and the invariance of the speed of light), and the relation of space-time transformation depends on LT. Although we now know that LT is not absolutely necessary to establish a correct view of time and space; There are better transformation relation equations, such as generalized GT(i.e. GGT).But Einstein was eager to disavow Newton mechanics, and of course he wouldn't go back to GT(or anything like that).In this way, his fundamental need was to start from two postulates and develop a transformation of the space-time relationship like LT, published in 1904, in order to prove that Einstein, and no one else, had created a new theoretical system, SR, that differed from Newton. Thus, in his first paper, he not only made no mention of his earlier scientific work (Lorentz and Poincarè), but even pretended to be unaware of the Michelson-Morley experiment. In this state, one must come up with a derivation of the same result as LT's equation. Einstein actually knew the results of the MM experiment, as well as Lorentz's or Poincarè's papers, and all he had to do was piece together a "proof" based on "two principles."He handles theoretical relationships like magic, and the examples of his "trick" of switching concepts are endless. Thus, [1] is by no means an "unparalleled masterpiece" that will not stand up to expert scrutiny. Of course, when Einstein became famous, he was generous and attributed the space-time transformation entirely to Lorentz, instead of calling it Lorentz-Einstein transformation (LET),This is because LT is only part of SR (at least according to Einstein), and therefore it doesn't matter what the space-time transform is called.

Although LT and SR are formally identical, they are very different theories. This is because Lorentz theory takes absolute space-time and the existence of ether as its starting point, while SR abandons both and builds on the principle of relativistic and the constant speed of light in one way.

In fact, Lorentz's adherence to ether theory was based on Newton mechanics and GT, plus two assumptions (length contraction and time delay).In this way, the principle of Relativity will not hold and the covariability of ME to LT will be lost. However, LT was proposed to ensure ME covariation under the condition of the relativistic principle — which leads to a paradox.

Now the question is about the value of LT. It can be proved from LT that the speed of light is constant one way, but not from ether. So stick with ether or stick with LT? We think of course the former is more important. This corresponds to Prof. Ma's statement that "LT is not actually necessary".

If only the length is shortened while the time remains the same, there will be conceptual confusion. In 1904 Lorentz proposed "time dilation". Now he thinks: the absolute motion ruler is shorter, the absolute motion clock is slower. These are reflected in his paper.

In short, Lorentz deserves his reputation as a master of physics only in aspects unrelated to Relativity. But there are many things about Relativity that many people find confusing and controversial because they are mixed up with Relativity (Einstein's SR).The author discussed this with Professor Qing-Ping Ma. He said that Lorentz (and Fitzgerald respectively) proposed the contraction of the length of moving objects and the slowing of the moving clock (time dilation) in terms of contributions related to the theory of Relativity. Mass-velocity formula; Space time transformation; Lorentz theory of the ether. This LT later became the core formula for SR.

His lasting contribution, so to speak, was his formula for the slow-down of the movement clock and the mass-velocity formula. The current

interpretation of both the motion clock slowing and the mass-velocity formula by Lorentz and SR may be wrong. The formula of moving clock slowing and mass-velocity reflects the effect of moving speed relative to the (electromagnetic) interacting medium on the interaction, that is, the electromagnetic interaction speed between objects moving relative to the (electromagnetic) interacting medium slows down, resulting in a slower clock (atomic clock with electromagnetic interaction as the mechanism); The electromagnetic interaction between objects in motion relative to the interacting medium becomes weaker, resulting in an apparent "increase in mass of motion" when in fact there is a decrease in force and acceleration. The great thing about Lorentz's contribution here is that even if we adopt the right interpretation, we may still have to use his formula for clock slowing; Then change the mass-speed formula to force-speed formula. This factor $\sqrt{1-v^2/c^2}$ will continue to be used in these formulas.

Lorentz's biggest weakness or mistake was that he insisted that the ether was absolutely stationary and could not be dragged due to the phenomenon of optical aberration, so he had to propose "motion length contraction" to explain the negative results of MM experiment. "motion length contraction" leads to "slowing of motion clock" and "increasing of motion mass", laying the foundation of Relativity theory. However, the "length shortening" has never been confirmed by experiments, so Lorentz's "length shortening" is fundamentally wrong! This mistake came from his insistence that the ether was absolutely stationary and could not be dragged.

So, if Lorentz were alive today, would he approve of us doing FTL research? ... We figured he'd agree that FTL exists. For him, because anything moving at the speed of light has an infinite mass, the speed of light relative to the ether cannot be surpassed. But the combined velocity between two objects moving in opposite directions can exceed the speed of light, because they can both move at close to the speed of light in the ether. Lorentz's velocity composition is Galilei's. This is consistent with the view of T. Flandern, the scientist who in 1998 obtained the result that gravity travels faster than the speed of light, which he thought could be explained by Lorentz's theory of Relativity, but not by SR.

There used to be a common view that, because of Lorentz's formula for mass-velocity, it was obvious that faster-than-light motion was impossible, and that faster-than-light spacecraft were absurd. But we does not agree with this view, because Lorentz mass-velocity formula is derived for the electromagnetic mass of electrons, whether it is applicable to neutral particles and neutral matter has not been directly proved by experiments.

In short, Lorentz's relativity, unlike Einstein's, is superior. But we don't think Lorentz's theory is the best view of time and space. This gives rise to the Modified theory of Lorentz (MOL), that is, the modified Lorentz theory. MOL mainly has two kinds, one is to connect the ether with the gravitational field, for example, the earth's gravitational field around the earth corresponds to the ether; the other does not do much change, length contraction and time dilation and the speed of the earth prevail. The other is generalized GT, which combines length contraction and time dilation into GT, such as Mansouri and Sexl (MS) transformation and Modified Lorentz ether Theory of Ronald Hatch. Then there are also other people's GGT theories.

8. SEVERAL NON-RELATIVISTIC VIEWS OF TIME AND SPACE

From 1892 to 1904, Lorentz postulated a shortening in length and a delay in time of motion in order to explain the Michelson-Morley experiment. Einstein gave the derivation of length reduction in 1905 and 1952, but these relativistic length reductions were logically contradictory. Lorentz's theory is that there is a relationship between the length of an object stationary in the ether and the length of an object moving relative to the ether. But there are many paradoxes in SR in which the mutual view of physical phenomena causes length reduction. This is because the logical basis of SR is relative motion, which causes a paradox in principle. There is actually no experimental proof of the length reduction theory.

In Lorentz theory, the time delay is caused by the absolute motion of a moving body. A clock with a high absolute speed slows down relative to a stationary clock; This is Lorentz's etheric delay of time. However, when the relative velocity of the moving body is used to replace the absolute velocity in SR, the situation is completely different. Einstein explains length reduction and time delay by replacing the relationship between the observer and the ether with the relative motion of the reference frames of different observers. As a result, many paradoxes arise questioning the self-consistency of SR.

The relativistic principle, one of the laws of physics, was first introduced by Poincarè, and the Lorentz transform (LT) embodies the principle of consistency in terms of arbitrary inertial frames. But Lorentz's idea of relativity, published in 1904, was based on the existence of the ether. Einstein's 1905 paper included a postulate — the principle of the invariance of the speed of light — that there was no need for an ether, that is, a preferred frame of reference. Subsequent discussions have always included the question: which better describes nature, Einstein's special theory of relativity (SR) or the modified Lorentz theory (MOL)? The main difference between the two is that SR considers all inertial frames to be equal and equivalent, while MOL considers the existence of preferential reference frames. Over the years, numerous studies and discussions have shown that SR is logically inconsistent and lacks of truly confirmed experimental confirmation. It is important to note that SR cannot explain the recent advances in gravity propagation and quantum entanglement propagation, while MOL does.

SR no absolute space and absolute motion and absolute reference frame, which denies the absoluteness of material movement, into a mire of relativism—the same events observed different results in different reference frame, there is no judgment standard of the test results, relative motion of two observers say that the other side of the clock is slow, short feet. In addition, SR insists on "simultaneous relativity", "superluminal impossibility", and locality opposite to (QM).All of this contradicts the experimental facts. The internal logic of SR is chaotic, and it cannot get true recognition and support. On the other hand, although Lorentz theory also has obvious defects, it is superior to SR in insisting on the absoluteness of material motion as well as the absoluteness at the same time.

In 1959, F. Tangherlini [55] proposed a space-time transformation called Generalized Galileian Transformation (GGT). Chinese scientist Professor Cao Zhang has been trying to introduce this non-relativistic spatiotemporal transformation since 1979.The space-time coordinate transformation formula is

$$x = \gamma (X - vT), \quad y = Y, \quad z = Z, \quad t = \gamma^{-1} T \qquad (21)$$

This means that one particular inertial frame is Σ_0 (X , Y , Z , T), and the other inertial frame Σ is moving in a direction X with a constant velocity v relative to Σ_0 .

Coefficient $\gamma = \left(1 - v^2 / c^2\right)^{-1/2}$. Similar to GT, GGT adopts the external synchronization method, that is, when ΔT =0, there is Δt =0. But GGT does not require $t = T$ and allows the moving clock to slow down, unlike GT.Note that GGT asserts absolute simultaneity, which occurs between inertial frames Σ and Σ_0 . In the space transformation between the two systems, there is a scaling factor; The change of time has a clock slowness factor. In Σ , the one-way speed of light is non-isotropic, while the round-trip loop has the same average speed of light.

GGT is a nonstandard form of LT, which is also the inheritance and development of Lorentz's physical thought. As mentioned above, Lorentz believed that there was an absolute frame of reference; And that there is a real time. ...In addition, the MM experiment can be easily explained by GGT. Superluminal motion is also allowed in GGT. From GGT's point of view, there is no problem of causality breaking, time traveling backwards and the like when FTL occurs -- the opposite of SR in this respect. When we say that GGT is the inheritance of Lorentz's physical thought, we should not simply understand it as the inheritance of LT; The fundamental point is to acknowledge the existence of a superior reference frame (absolute reference frame). At the same time, GGT is the inheritance of GT — Cao Zhang met Professor Tangherlini to discuss this point in the United States [56-58]. He agreed to change the original name of the "absolute Lorentz transform" to generalized GT, which he had elaborate mathematically and physically. Therefore, now that Professor Cao Zhang has passed away for several years, the author suggests to call GGT also Tangherlini-Chang Transformation, or TCT for short, as a memorial to the two professors.

In 2007, Shu-Sheng Tan [3], a professor at National University of Defense Science and Technology, published his theoretical achievement 《Standard Space-Time Theory》 (SSTT) in the form of a monograph. The book points out that Lorentz theory has three basic assumptions (the existence of an absolute reference frame of the ether; the shortening of its length; and the delay of its time), which view of time and space is logically self-consistent with it? Not LT, but GGT. SSTT is unwilling to adopt Lorentz's length contraction and time delay hypothesis, but takes the theory as the basis of two principles, namely, the absolute reference

frame principle and the loop average speed of light constant principle, because the former is the essence of Lorentz's theory, and the latter has been proved by a large number of experiments. Now, SSTT is different from SR, but consistent with QM; It argues for the absoluteness of simultaneity, allowing faster-than-light movements without violating the law of causality. SR denies absolute space, absolute motion and absolute reference frame, thus denying the absoluteness of matter motion and falling into complete relativism. The results (such as the relativity of "simultaneously", the void with nothing, the theory of the speed of light limit, and the theory of locality) are all inconsistent with experiments. Tan said that SSTT derived GGT strictly from two hypotheses and established a complete theoretical system, which is his own independent contribution.

9. SUMMARY OF THE NEW ETHER THEORY

Fans of faster-than-light research like to point to 1947, when the United States achieved the first supersonic flight of an airplane, as a motivator. But it has been argued that sound waves need compressible media to travel, while light waves do not. They said, this is an essential difference, that the similarity of equations does not translate into the similarity of physical mechanisms, and so on.... But we have to ask: does light really need no medium to travel?

Until the middle of the 19th century, it was thought that there was no such thing as a wave that could be transmitted without media. Therefore, since light fluctuates and travels in a vacuum, as evidenced by the fact that sunlight strikes the Earth, there must be a medium of light. It can be invisible but pervasible in the universe, known to physicists as ether. So from the beginning of the 19th century, through the middle of the century and into the later part of the century, the scientific community made a big deal out of studying the ether. To this end, Fresnel, Fizeau, Lorentz, Maxwell, Michelson, et al. The ether was thought to be absolutely stationary, and the speed of the earth relative to the aether was the speed of the earth's revolution around the sun. Measuring this relative velocity would be difficult, but not impossible.

After taking into account the speed of the Earth's orbit around the Sun, it was concluded that the speed of the smooth and inverse ether should not be the same (2.15×10^{-9} difference to be exact).But the Michelson-Morley experiment did not discovered. In July 1887, the two men jointly conducted extremely accurate experiments that denied the existence of the ether [59].

Historians of science have shown that Michelson had a certain preference for the ether; This contradicts the popular belief that he experimented to deny the ether. In fact, he won the Nobel Prize in 1907 mainly for inventing the very sophisticated interferometer. In 1926-28, when Michelson was in his 70s, he tried again to find the drift of the ether. However, he never announced that he had given up the ether. He also had reservations about the special theory of relativity (SR) and actually disagreed with it [20].

Lorentz's physical ideas are getting renewed attention for a reason. In 1977 Smoot [60] reported that it had measured the Earth's velocity relative to the microwave background (CMB) at 390km/s;So the great physicist P. Dirac said, in a sense Lorentz was right and Einstein was wrong. American physicist T. Flandern [61] published in 1997-1998 that the speed of gravity was $v \geq(10^{9}\sim2\times10^{10})\,c$, and he claimed that Lorentzian relativity could explain these results. on the other hand, SR is can't explained superluminal gravitational velocities.

In 2007, 《New Scientist》 reported on "ether's high-profile comeback as a replacement for dark matter", saying that G. Starkman and T.Zlosnik et al. were pushing the ether to explain "dark matter" in a new way. The latter was proposed because the Milky Way seems to contain much more mass than visible matter. They argued that the ether was a field that would form an absolute coordinate system, thus contradicting SR.

In recent years, many scientists have proposed the existence of prefered frame, that is, the formation of an absolute coordinate system. Therefore, the Lorentz-Poincarè time-space view has received renewed attention, and further theories have emerged. The "high-profile comeback of ether theory", reported in the science publication 《New Scientist》 a few years ago, is a reminder that we should not completely dismiss the scientific work done before SR. If there is a shift back towards Galilei, Newton and Lorentz, it is at the highest level in modern terms, not simply backwards.

Table 2. Measurements of the speed of light from 1676 to 1862

Surveyor and publication time/year	Method of measurement	Measured values c (km/s)	System error	For note
O. Roemer, 1676	Benon observations	214000	- 30%	Visible light waves
J. Bradley, 1728	The star is out of alignment	301000	+ 0.4%	Visible light waves
A. Fizeau, 1849	Method of screw tooth	313000	+ 4.4%	The round-trip distance is 17.2km
J. Foucault, 1862	Rotating mirror method	298000	- 0.6%	One-way distance 20 m

There are currently three main options for the "new ether" : physical vacuum, gravitational field, and microwave background radiation. We think the new ether is better defined as a quantum physical vacuum. Historically, the master J. Maxwell [62] first connected the speed of light c in vacuum with the characteristic parameters(ε_0, μ_0) of vacuum as a medium. In recent years, I has made a profound discussion on the vacuum of quantum physics [63,64]. In 1865, Maxwell used two physical parameters of vacuum (ε_0, μ_0) to derive the wave equation of electromagnetic wave, and proved that the speed of light in vacuum is

$$c = \frac{1}{\sqrt{\varepsilon_0 \mu_0}} \tag{22}$$

This is a statement that light needs a medium to travel, and that medium is a vacuum. Maxwell was very clever. He put the known values (ε_0, μ_0) into the equation and got a speed of about 3×10^5km/s. It was so close to four existing measurements of the speed of light that he concluded `that the waves described by his electromagnetic wave equations were light waves. Here we give Table 2: The four measurements of the speed of light known to Maxwell in 1865 (and the only ones at that time), in which the so-called systematic error is calculated by comparing the measured values with the standard values (c =299792458m/s) stipulated by the International Bureau of Metrology.

Therefore, the author judges that Maxwell's academic thought is similar to Lorentz's later, but different from Einstein's later. Maxwell believed there was an ether, a vacuum. Of course, he couldn't have thought in terms of quantum theory, because QM wouldn't appear for another 60 years. Quantum field theory (QFT) holds that each quantum field in the vacuum state is still in motion, that is, each mode is still oscillating in the ground state, which is called vacuum zero oscillation. In vacuum, virtual particles are constantly produced, disappeared and transformed into each other, because of the interaction between the quantum fields. On March 25, 2013, the website of 《Science Daily》 reported that French and German scientists respectively proposed research results published in the European Journal of Physics, which said that the speed of light is a real characteristic constant, while quantum theory holds that vacuum is not empty. This results in the speed of light c not being fixed, but having fluctuating values.

In 2021, I published a long English paper abroad, the title was: "Two kinds of vacuum in Casimir effect" [64]. According to the Casimir effect, since its discovery in 1948 and the present situation, it is necessary to make a new discussion on the definition and characteristics of "physical vacuum". The fact that there is an attraction between two parallel metal plates in a Casimir structure, which was experimentally demonstrated in 1997, is not Newton's gravitational force, nor is it a Coulomb force because it has no charge. This peculiar phenomenon becomes apparent when the distance between the plates is small. Therefore, it can not be ignored in nanoscale scientific research. Since the interplate may be a negative-energy state, even if the outside of the plate is the usual physical vacuum state (called free vacuum), the interplate situation must be a further vacuum structure, which I call it negative-energy vacuum. The calculation shows that the refractive index n is less than 1, so the superluminal phenomenon will occur [65].

In short, the new ether is a physical vacuum medium with quantum properties. But it is still a

matter for discussion. For example, the "new ether" is a free vacuum, what role does the so-called "negative energy vacuum" play? Our view is that the empty space is indeed a medium, and only in this way can it be specially arranged to create local "emptier vacuums" in the medium — the nature is indeed more wonderful than we can imagine!

10. MAXWELL EQUATIONS (ME) COVARIATION PROBLEM AND EXPANDED ME

When discussing "covariation of ME to LT" in electromagnetics books, they always write the $\mathbf{E}$、$\mathbf{B}$、ρ、$\mathbf{J}$ transformation relation between and two reference frames. In fact, a premise has been used that ME covaries with LT, but not with GT. This derivation does not prove with whom ME covaries.

In my paper [7], I quoted famous theoretical physicist Ling-Jun Wang, who said:

"Maxwell's equations conform to the Lorentz transformation, which presupposes the theory of Relativity. Special relativity proposes a formula for the transformation of electric and magnetic fields in different coordinate systems, which is based on the formula for the transformation of forces in different coordinate systems in Relativity, and the strength of the electric field is simply the force per unit charge. So does the magnetic field strength. If Relativity does not hold, the relativistic field-strength transformation does not hold, and therefore ME does not conform to LT. People hope to use Lorentz covariation of ME to prove the correctness of Relativity, and borrow Maxwell's great achievements in electromagnetic field theory to "endorse" Relativity. They play the trick of logic cycle: according to the formula of relativistic field strength transformation, ME conforms to LT, and conversely, ME conforms to LT to prove the correctness of Relativity. Relativity's many logical contradictions and basic premises (including the principle that the speed of light does not change) have proved that Relativity is an impossible theory, and its logic cycle breaks down.

Even if we take a step back and admit that the relativistic formulation of field strength transformation can make ME obey LT, Lorentz covariation cannot be regarded as a universal physical law. The fact that an equation conforms to a certain covariation is only a mathematical characteristic of the equation, and therefore it cannot be regarded as an iron law requiring all physical theories to conform to the Lorentz covariation."

Another famous physicist Xiao-Chun Mei once pointed out that SR original paper introduced a transformation, called relativistic transformation of electromagnetic field in order to prove that the motion equation of electromagnetic field satisfies the relativistic principle.However, this apocryphal transformation contradicts the LT of the electromagnetic field itself and has no physical basis. In addition, the constitutive equation of dielectric electromagnetic field has no invariance originally, and the classical electromagnetic field motion equation does not satisfy LT invariance originally.

Professor Qing-Ping Ma. pointed out that ME obeys Lorentz covariation but not Galilei covariation because Lorentz et al. insist on the absolute rest of the ether in space, and on the other hand have to accept the optical and electromagnetic experiment results that appear when the ether is completely dragged by the earth. The LT is the result of a compromise between these two sides. By abandoning the view that the ether/light medium is absolutely stationary in space and accepting that the light medium is completely dragged by a massive object such as the Earth, ME obeys GT invariance completely and LT invariance not at all.

The analysis angles of the above three scholars are not completely the same, but the conclusions are consistent. This issue has also attracted the attention of other scholars. For example, Guo-Fu Ji [66] published an article on the Internet in 2021 entitled "On the Covariation of Maxwell's Equations under Galilei Transformation". In this paper, it is very interesting to transform the space-time coordinates with wave frequency and wave vector, and obtain the wave equation satisfying GT invariability. However, it is not proved that the classical electromagnetic field equation satisfies GT invariance. In 2022, Guo-Fu Ji [67] published "Rediscussing the Covariation Problem of Maxwell's Equations". Galilei coordinate transformation and Galilei velocity transformation in absolute space-time view are universal to both classical mechanics and electromagnetics. Secondly, it is proved that under the condition of giving up the principle of constant speed of light, it can be concluded that ME covaries under different inertial frames and obeys GT, and the transformation formula is

given. It is considered that the electromagnetic wave velocity (including the speed of light) in different inertial frames obey GT. The principle of constant speed of light of SR and LT are denied. Thus, the relativistic view of time and space was abandoned.

Now let's look at Expanded Maxwell's Equations; Prof. Zhong-Lin Wang said: [9,11]

"By 1905 it had been realized that Maxwell's equations could not keep their form under Galilei coordinate transformation. Galilei absolute time and space view, however, gives a very good approximation in many cases.... Based on Galilei space-time view, Extended Maxwell Equations do not necessarily maintain Lorentz covariation."

In addition, one should not ignore the time-space view based on Galilei transformation, which separates time and space from one another. This is when he uses a term: Relativistic Electrodynamics, in which ME remains covariant to LT. Galilei electromagnetics, "works only at low speeds and does not preserve LT covariation". As for his own theory, LT covariability is not maintained.

What is commendable is that Prof. Wang affirms the value of Galilei space-time view and GT in both papers, and also flatly admits that his theory has no LT covariant.However, he believes that the ME ontology is covariant on LT, and he emphasizes the "approximation" of electromagnetic theory with GT covariant, arguing that as long as the non-relativistic equation is "only used at low speed". The Schrödinger equation (SE) is used as an example to illustrate why this view is wrong.... To sum up, Prof. Wang actually believes that there are three types of electromagnetics:

— Galilei Electromagnetism, based on GT;
— Electromagnetism based on LT, namely Relativistic Electromagnetism;
—Wang's Electromagnetism (WE), based on GT.

However, we believes that it is impossible to discuss the theory of Relativity without clarifying its attitude.

11. CONCLUSION

The covariation between ME and LT is closely related to the space-time view in physics. In 1904, Lorentz first proposed the time transformation relation from the electromagnetic theory, which met the covariation requirement of ME for LT.However, the Michelson-Morley experiment was not explained, so length contraction was proposed. However, Lorentz insisted on the existence of ether, that is, on the existence of absolute coordinate system, which was fundamentally different from SR. Lorentz's theory of length reduction states that there is a relationship between the length of an object stationary in the ether and the length of an object moving relative to the ether. Similarly, Lorentz believed that the time delay was caused by the absolute motion of the moving body; A clock with a high absolute speed slows down relative to a stationary clock. But in SR, Einstein explains length reduction and time delay by replacing the relationship between the observer and the ether with the relative motion of the reference frames of different observers. This creates a series of paradox.

But Lorentz's ideas about relativity today, some of them are wrong. For example, "length shortens in the direction of motion" has never been verified by experiments;"Mass-velocity formula" for neutral particles, neutral matter has no experimental proof. But his "motion clock slows down" formula is here to stay; The formula of mass-speed should be changed to the formula of force-speed. Especially, in the framework of Lorentz theory, superluminal phenomena can be explained, unlike SR.

Poinocarè summarized Lorentz's work in 1904 and pointed out that it could be a transformation group, and named it after Lorentz Transformation (LT). Einstein felt that SR needed LT and independently derived the same formula as LT without mentioning Lorentz's name. The results were unsuccessful. From today's point of view, LT has its place in the history of science, but it is not an absolute necessity. Therefore, it is a mistake to require LT covariability in any new physical theory. It should be emphasized here that although Einstein became a worldwide celebrity, both H. Poincarè (who died in 1912) and H. Lorentz (who died in 1928) expressed objections to Relativity in their later years — "tacit naysayers," according to Ohanian, a historian of science. That means "refuse to consent" [20].

From Galilei to Newton, this view of time and space is both correct and important. Therefore, Galilei transform (GT) cannot be denied. The generalized GT(or GGT) theory has special value today. We stress that Galilei's view of space-time

remains correct and needs to be refined to explain contemporary experiments.

Therefore, Maxwell's equations (ME) can be covariant with GT under certain theoretical conditions. It makes no sense for relativists to self-promote SR and deny the value of some new theories on the grounds of "covariation of ME to LT". In addition, this paper rejects the terms "relativistic electromagnetic field" and "relativistic electromagnetism".

Einstein's attempt to correct Newton's mechanics led in the wrong direction. QM, with a new way of thinking, inherits Newton mechanics in the view of time and space, and corrects Newton mechanics in the aspect of certainty and probability thinking — this is the beneficial guidance. Importantly, both Newton mechanics and QM don't put an upper limit on the speed of the immovable body, allowing for superluminal motion. This draws the line off SR and makes them a useful theory to explain many new experiments. At the same time, this paper shows that it is necessary and meaningful for Chinese scientists to put forward the concept of "Superluminal Light Physics". This paper emphasizes that quantum non-locality is a non-relativistic view of time and space in nature, Bell inequality theory is an important part of the history of physical thought, and the theoretical and experimental confirmation and development of quantum entanglement state is an excellent supplement to the study of FTL.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/94317