

Hypothesis

Not peer-reviewed version

---

# Hypothesis: Electromagnetic Waves can be Represented as Continuous Long String Vibrations

---

[ZhaoYang Zhang](#)\*

Posted Date: 28 February 2024

doi: 10.20944/preprints202402.1583.v1

Keywords: Electromagnetic Waves; String Vibration; Dark Matter; Planck Constant



Preprints.org is a free multidiscipline platform providing preprint service that is dedicated to making early versions of research outputs permanently available and citable. Preprints posted at Preprints.org appear in Web of Science, Crossref, Google Scholar, Scilit, Europe PMC.

Copyright: This is an open access article distributed under the Creative Commons Attribution License which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Disclaimer/Publisher's Note: The statements, opinions, and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions, or products referred to in the content.

*Hypothesis*

# Hypothesis: Electromagnetic Waves Can Be Represented as Continuous Long String Vibrations

Zhang Zhaoyang

Department of Light Chemical Engineering, Nanjing Tech University, Nanjing 210000, China; zzy@stu.cup.edu.cn

**Abstract:** This study delves into the intricate relationships among the constituent elements, wave speed, and energy of both mechanical waves and electromagnetic waves. By establishing connections with the string vibration equation, a compelling revelation emerges. Upon equating the energy and constituent element mass of one wave cycle of a homogeneous string with those of a single wave cycle of electromagnetic waves, it is evident that the wave speed derived from the string vibration equation consistently matches the constant speed of light. From this, a hypothesis takes root: electromagnetic waves manifest as waves resulting from the vibration of a uniform, elongated string-like material. The phenomenon of superluminal speed further fortifies the validity of this conjecture.

**Keywords:** electromagnetic waves; string vibration; dark matter; Planck constant

---

## 1. Introduction

The concept of "ether" holds pivotal importance in classical physics, originally introduced by Descartes in the realm of natural science. Rejecting the notion of action at a distance and the existence of the so-called "vacuum," Descartes envisioned the universe as permeated by an invisible primitive substance – the ether. The historical progression from philosophical ether to mechanical, luminiferous, and electromagnetic ether centers around a fundamental idea: the refusal to accept that a vacuum is entirely devoid of substance. In light of the refutation of the existence of an absolute reference frame through the Michelson-Morley experiment and the subsequent evolution of special relativity, the concept of the ether underwent a gradual abandonment. Nevertheless, certain facets of the 'ether's essence'—specifically, the recognition of the absence of an absolute vacuum in a literal sense—have persevered [1]. The realms of dark matter and dark energy present enigmatic challenges in modern physics, their confirmed objective existence underscoring the notion that a vacuum is not devoid of substance [2].

Huygens proposed in the wave theory of light that light is a mechanical wave propagated by the continuous motion of a medium, grounded in the existence of 'ether' particles [3,4]. However, with the decline of the ether theory, which did not experience significant development, what underlying 'mechanism' guarantees the consistent speed of light for electromagnetic waves in a vacuum? This paper dispenses with certain concepts associated with the 'ether,' particularly the notion of an absolute reference frame, while retaining elements of the 'ether's essence'—specifically, the absence of an absolute vacuum in a literal sense. Departing from the premise that the propagation of electromagnetic waves necessitates a medium, the paper introduces a hypothesis: Electromagnetic waves arise from the vibrations of an extremely fine, continuous, homogeneous, and elongated string-like material (with no imposed restrictions on the movement of the material string itself), forming waves through the vibrations of the string. The validity of this hypothesis is validated through the correlation between electromagnetic waves and the string vibration equation, accompanied by an analysis of results obtained from experiments investigating superluminal phenomena. In contrast to Huygens' proposal of "ether" particles as a medium for mechanical wave propagation, this paper posits a continuous homogeneous long string material as the medium for

electromagnetic waves. Unlike string theory, which suggests photons are the transverse vibration of a small segment of an 'open string' [5], our hypothesis asserts that electromagnetic waves are formed through continuous long string vibrations. This discovery produces a fresh perspective for exploring the mysteries of dark matter and dark energy.

The subsequent sections of this paper unfold as follows: Section 2 outlines the process of deducing the constant speed of light for string vibration waves by analogizing one-dimensional mechanical waves to electromagnetic waves. This relies on the assumption that unbounded string vibration waves and electromagnetic waves share identical total energy and constituent element mass in one wave cycle. In Section 3, building upon the hypotheses proposed in this paper, further inferences are made, providing a theoretical foundation for the possibility of surpassing the speed of light in the lateral transmission of electromagnetic wave energy. The concluding section summarizes the overarching conclusions drawn from this study.

## 2. Deductive Process

Through theoretical derivation, formulas for the total energy of one wave cycle for mechanical waves, electromagnetic waves, and string vibration waves are obtained separately. Analogizing electromagnetic waves to mechanical waves allows the mass-energy equation to calculate constituent element mass of one wave cycle of electromagnetic waves. Through a thorough examination of energy formulas, it is observed that when the total energy and constituent element mass of a singular oscillation cycle in string vibrational waves align with those of electromagnetic waves, the speed of the string vibrational waves consistently maintains a constant value equivalent to the speed of light. This result provides substantiation for the theoretical derivations presented in this paper.

### 2.1. Mechanical Waves and Electromagnetic Waves

In the realm of unbounded conditions, one-dimensional mechanical waves reach an equilibrium where potential and kinetic energies are ultimately equal, resulting in the equal distribution of system energy [6]. To elaborate, the total energy within one wave cycle equals twice the kinetic energy of the constituent elements of the wave. In the context of wave propagation, when considering the entire constituent element of the wave collectively, it can be inferred that, given a constant wave speed, the total kinetic energy  $E_K$  in one wave cycle equals the kinetic energy of the entire constituent element moving in the direction of the wave. This relationship is expressed as follows:

$$E_K = \frac{1}{2}mv^2 \quad (1)$$

where  $m$  represents the total mass of constituent elements in one wave cycle, and  $v$  denotes the wave speed.

Consequently, when the wave speed remains constant, the total energy  $E=2E_K$  of one wave cycle of unbounded one-dimensional mechanical waves equals:

$$E = mv^2 \quad (2)$$

Now, let's consider the hypothesis that the individual electromagnetic waves require a medium for propagation and can be treated as one-dimensional mechanical waves. Due to the constant speed of electromagnetic waves in vacuum, which is the speed of light  $c$  (in the following chapters, only individual electromagnetic waves in vacuum were discussed), So the total energy  $E_1$  of an electromagnetic wave in one wave cycle is:

$$E_1 = m_1c^2 \quad (3)$$

By combining equation (2), it can be deduced that  $m_1$  in equation (3) corresponds to the constituent element mass of one wave cycle of electromagnetic waves.

Considering the energy  $\epsilon = hv$  of a photon, where  $h$  is the Planck constant, and  $v$  is the frequency of the electromagnetic wave [7], it is evident that the energy change of each photon is completely dependent on the frequency of the electromagnetic wave. Therefore, it can be inferred that the energy value of the Planck constant corresponds to the energy value of one wave cycle of a

single electromagnetic wave, denoted as  $E_h$ .  $E_h$  is also a constant.  $E_h$  is also the total energy of one wave cycle of electromagnetic waves. Following the mass-energy equation, we have:

$$E_h = m_h c^2 \quad (4)$$

where  $m_h$  corresponds to the relativistic mass linked to the energy value in the Planck constant.

Combining equation (3), it can be deduced that  $m_h$  corresponds to the constituent element mass of one wave cycle of a single electromagnetic wave.

## 2.2. String Vibration Waves and Electromagnetic Waves

The wave speed  $u$  of a homogeneous string is determined by

$$u = \sqrt{T/\mu} \quad (5)$$

where  $T$  is the tension in the string, and  $\mu$  is the linear density of the string.

In the derivation of the string vibration equation, several logical assumptions are made, with only those explicitly related to this paper listed:

1. The string is "uniform," indicating consistent material and cross-sectional density.
2. The string can bend arbitrarily without internal stress resisting bending but the tension resists stretching, adhering to Hooke's law. The tension at any point on the string is along the tangent direction.
3. The string undergoes "transverse vibration," all motion occurs in a single plane (indicating that the string vibrational wave is likewise a one-dimensional mechanical wave). An important conclusion is that during the vibration process, the tension at each point remains constant, always equal to the constant  $T$ , where  $T$  is the tension in the string when taut in the equilibrium position [8].

Rearranging equation (5) yields

$$u^2 = T/\mu, \quad (6)$$

Substituting  $\mu = m_L/L$  into equation (6) and simplifying gives

$$m_L u^2 = TL \quad (7)$$

where  $m_L$  is the mass of the string of length  $L$  for one wave cycle of string vibration, also the constituent element mass of one wave cycle of string vibration, and  $L$  is the length of the string for one wave cycle.

Since string vibration waves are one-dimensional mechanical waves, the total energy of one wave cycle with no boundaries is likewise equal to twice the total kinetic energy of the entire constituent element moving in the direction of the wave during one wave cycle. Due to the constant velocity of homogeneous chord waves of the same material. Additionally, due to the tension in the string being always tangent to the string and constant in magnitude during the string vibration process, the source of vibration consistently performs work against the tension, over a distance equal to the length of the string. Consequently, it can be deduced that, when the wave speed is constant, the total energy  $E_L$  of one wave cycle of the string vibrational wave is.

$$E_L = m_L u^2 = TL \quad (8)$$

When string vibration waves and electromagnetic waves have equal total energy for one wave cycle, and when the total mass of constituent elements for both waves,  $m_L$  and  $m_h$ , each representing one oscillation cycle, is equal:

$$E_h = E_L = m_h c^2 = m_L u^2 = TL \quad (9)$$

Simplifying equation (9) gives

$$u = c \quad (10)$$

This result suggests that if electromagnetic waves are formed by homogeneous string vibration, the wave speed in a vacuum is constant at the speed of light. The phenomenon of light bending in a vacuum aligns with the hypothesis that electromagnetic waves are formed by homogeneous string

vibration. When the string is distorted, the vibrational path of the light bends accordingly, in accordance with observed phenomena.

### 3. Discussion and Prospects

Expanding upon the previously posited hypothesis that electromagnetic waves originate from the vibrational motion of a homogeneous string and integrating it with the intrinsic properties of electromagnetic waves, one can deduce that the energy associated with one oscillation cycle of an electromagnetic wave is a constant value. Considering equation (9), which represents the constant tension  $T$  in the string, it follows that the length of the string for one oscillation cycle, denoted as 'L,' is also constant. In the state of transverse vibration, the length of the string must surpass the wavelength. Consequently, when generating transverse vibrations for electromagnetic waves, the bending speed of the string must exceed the speed of light. With an escalating frequency of electromagnetic waves, the bending speed must also increase. As the frequency reaches a sufficiently high level, the transverse speed of constituent element on the vibrating string, perpendicular to the string, can surpass the speed of light. At this juncture, when the vibrating string intersects with other strings, energy transfer becomes possible, and the speed of energy transfer in the direction perpendicular or inclined to the string can exceed the speed of light.

In 1993, Ranfagni et al. conducted an open-space experiment between two horn antennas, utilizing amplitude-modulated microwave pulse signals. By intentionally displacing or tilting the receiving antenna relative to the transmitting antenna, particularly in instances where the separation between the two antennas was relatively small, they observed anomalous propagation of electromagnetic waves [9]. In a subsequent 1996 experiment by Ranfagni and Mugnai, a shift to one side of 16 cm relative to the transmitting antenna resulted in a measured speed 1.25 times the speed of light, corrected to twice the speed of light in air [10]. These observed superluminal results indicated the validity of the hypothesis.

The process of electromagnetic wave formation through homogeneous string vibration ensures the consistent propagation speed of light in a vacuum. Simultaneously, the speed of energy transfer perpendicular to the string direction can manifest superluminal phenomena. The distortion of the string can cause the propagation path of light to bend, aligning seamlessly with observational phenomena and providing additional support for the hypothesis's validity. Considering the nature of long-distance transmission, the constant speed of electromagnetic waves in a vacuum, and their capacity to bend in a vacuum, we conjecture that electromagnetic waves arise from continuous, long string vibrations. The Michelson-Morley experiment, which refuted the Earth's motion relative to the ether [11], led to the demise of the theory of ether particles. The underlying reason lies in the independence of ether particles from the Earth's existence, as they do not move with the Earth. In contrast, the long strings proposed in this paper, when connected to particles, move in synchrony with the Earth, adhering to the principle of the constancy of the speed of light. We reckon that elementary particles may arise from the entwining of multiple strings, extending outward, thereby establishing a cohesive link between the strings and particles. Due to the limited scope of this study, we will not discuss it for now. The tension in the strings can serve as a repulsive force driving the accelerated expansion of the universe. Additionally, the energy embedded in the bending of the strings can potentially be understood as dark energy, while the strings themselves warrant investigation as potentially representing dark matter.

### 4. Conclusion

Suggesting the hypothesis that electromagnetic waves derive from the vibrational motion of an exceptionally fine, continuous, homogeneous, and elongated string-like material, this discovery provides a fresh perspective for investigating the fundamental characteristics of electromagnetic waves, as well as the realms of dark matter and dark energy.

## References

1. de Andrade E M P, Faber J, Pinguelli Rosa L. "A spontaneous physics philosophy on the concept of ether throughout the history of science: birth, death and revival." *Foundations of science* 18 (2013): 559-577.
2. Spergel D N. "The dark side of cosmology: Dark matter and dark energy." *Science* 347.6226 (2015): 1100-1102.
3. Huygens C. *Treatise on Light: In which are Explained the Causes of that which Occurs in Reflection, & in Refraction. And Particularly in the Strange Refraction of Iceland Crystal.* MacMillan and Company, limited, 1912.
4. Shapiro A E. "Huygens' *Traité de la lumière* and Newton's *Opticks*: Pursuing and eschewing hypotheses." *Notes and Records of the Royal Society of London* 43.2 (1989): 223-247.
5. Schwarz J H. "Introduction to superstring theory." *Techniques and Concepts of High-Energy Physics.* Dordrecht: Springer Netherlands, 2001. 143-187.
6. Dassios G. "Equipartition of energy in elastic wave propagation." *Mechanics Research Communications* 6.1 (1979): 45-50.
7. Franklin A. "Millikan's measurement of Planck's constant." *The European Physical Journal H* 38.5 (2013): 573-594.
8. Tikhonov A N, Samarskii A A. *Equations of mathematical physics.* Courier Corporation, 2013.
9. Ranfagni A, Fabeni P, Pazzi G P, et al. "Anomalous pulse delay in microwave propagation: A plausible connection to the tunneling time." *Physical Review E* 48.2 (1993): 1453.
10. Ranfagni A, Mugnai D. "Anomalous pulse delay in microwave propagation: A case of superluminal behavior." *Physical Review E* 54.5 (1996): 5692.
11. Consoli M, Pluchino A. *Michelson-Morley Experiments: An Enigma for Physics and the History of Science.* World Scientific, 2018.

**Disclaimer/Publisher's Note:** The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.