

## Marking Time

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A theory for the observation of Lorentz transformations is derived from the Transactional Interpretation of Quantum Mechanics (TI). In this theory, time is measured as wave peak counting on TI four-vector standing waves. Light itself then becomes a space-time background.

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Key Words: special relativity; Lorentz transformations; Transactional Interpretation of Quantum Mechanics.

## **French interpretation**

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Une théorie pour l'observation des transformations de Lorentz a sa source dans l'Interprétation Transactionnelle de la Mécanique Quantique (IT). Dans cette théorie, on mesure le temps en comptant les pics d'ondes sur des ondes stationnaires à quatre vecteurs de la Mécanique Quantique. La lumière elle-même devient alors un fond espace-temps.

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## 1. Introduction:

A theory is developed which produces the Lorentz transformations from a TI four-vector standing wave. In developing this theory, the history of the ether is discussed.

This theory also contributes to the formation of a direct relationship between special theory of relativity (STR) and quantum mechanics (QM). Most previous attempts to relate the theories have used the Copenhagen Interpretation. The transactional interpretation of quantum mechanics (TI) [1] has not been investigated for advantages in this regard.

## 2. Special Relativity Investigation:

A review of the general developmental history of STR is worthwhile to determine which concepts/postulates are necessary to any relativistic theory. An investigational review includes the rejection of the concept of an ether as originally proposed.

Following the study of light by Fresnel, physicists of the 19<sup>th</sup> century conceived of a fluid medium, which was different from all material media. It permeated everything and existed in a vacuum. It served as a substrate for the propagation of light. It penetrated bodies as if they were sponges. One view held that very large bodies dragged the ether, which surrounded them. Another view had the earth moved by an ether wind. Einstein's theory rightly did away with this ether, which was not experimentally confirmed. The ether has one main characteristic relevant to this investigation:

- 1) Electromagnetic waves travel through it.

John Bell [2] in *Speakable and Unsayable in Quantum Mechanics* argues that using certain aspects of the Lorentz idea of a preferred frame is not inconsistent with the experimental evidence. He states, "it is not possible experimentally to determine which, if either, of two uniformly moving systems, is really at rest, and which is moving". Consequently, moving through a background is different than measuring against one.

This paper attempts to show that it is theoretically possible that a background exists, and the Lorentz transformations are observed. This background must have entirely different characteristics than the ether in order to satisfy Bells statement, and experimental evidence. Specifically:

- 1) Motion cannot run through a background, but must be measured relative to one.
- 2) A background must be uniform.

Backgrounds were generally disregarded by the physics community as they add unnecessary complexity to a stand-alone theory. There is strong sentiment among many physicists that a background is not only possible, but useful as a visualization aid.

### 3. TI Quantum Mechanical Investigation.

When describing most optical phenomena, one imagines a continuous electromagnetic wave traveling from point A to point B. This classical wave model was used during the development of the Einstein and the Lorentz theories. Present models contain both forward and reverse time Wheeler-Feynman waves [3].

This paper does not seek to give a complete review of TI, but rather to point out the pertinent concepts as they apply to this theory.

TI is derived from the Wheeler-Feynman description of a radiative process. This process is applied to the exchange of energy, momentum, etc. as a quantum, between a present emitter, and a single future absorber. This is achieved through what is defined as a transaction. A transaction occurs when the quantum value boundary conditions are met for a Wheeler-Feynman exchange of advanced waves:

$$\Psi^* = e^{-i(kx-wt)} \quad (1)$$

and retarded waves:

$$\Psi = e^{i(kx-wt)} \quad (2)$$

The retarded wave has eigenvalues characteristic of  $+\hbar\omega$  and momentum  $+\hbar k$  with the advanced wave having negative eigenvalues of energy and momentum.

A four-vector standing wave is established between emitter and absorber. This four-vector standing wave describes the transfer of photon energy from point A to point B.

Additionally, these Wheeler-Feynman forward and reverse waves allow for a direct development of the Born probability law with:

$$\langle x \rangle = \int_{dv} \Psi^* \mathbf{X} \Psi \quad (3)$$

In the Copenhagen Interpretation (CI), the Born probability law is stated as fact. TI has the advantage of the law being directly derived from the physical model.

TI has recently gained experimental support. CI's definition of complementarity has recently been called into question [4,5,6]. This is demonstrated when one considers the double right angle prism beam splitter experiment by Mizobuchi and Ohtake[5]. At

the time of this writing, complementarity violation has been experimentally investigated and presented by Shahriar Afshar [6], and the results are awaiting journal publication. Dr. Afshar has presented the results, which show TI to be preferable to the Copenhagen, and the Many-Worlds interpretations.

#### 4. A TI Mechanism for a Lorentz transformation.

There are two postulates to STR that require a description to derive any merging theory. First, the speed of light is the same for all inertial observers and does not depend on the velocity of the source. Second, in all inertial laboratories the laws of nature are the same, they do not depend on the position and orientation of the laboratory in space, and there is no experiment which can tell whether the laboratory is moving or at rest. [7] Both of these have been shown to be addressed by the Lorentz transformations:

$$x_1' = x_1 \quad (4)$$

$$y_2' = y_2 \quad (5)$$

$$z_3' = (z_3 + i\beta t)/(1 - \beta)^{1/2} \quad (6)$$

$$t' = (t + i\beta t)/(1 - \beta)^{1/2} \quad (7)$$

Time dilation is the direct experimental proof of STR. These experiments include but are not limited to:

- 1) The lifetime of the  $\mu$ - meson at rest vs. the lifetime of the  $\mu$ - meson in motion [8]
- 2) The Ives-Stillwell experiment. [9]
- 3) The experiments of Hay, Schiffer, Cranshaw, and Eglestaff. [10]

Presently, the standard time clock is the NIST-F1. It is a laser-cooled fountain Cesium wave clock. A second is defined as 9,192,631,770 wave peaks of microwave energy, at the resonance frequency of cesium, passing a given point.

In TI, the Electromagnetic wave being counted is considered a four-vector standing wave established on the light path along  $45^\circ$  angles in Minkowski space-time. In this theory, the four-vector standing wave acts as the background that is used to measure time.

Figure 1 shows two clocks traveling at different speeds against a TI four-vector standing wave background. The clock paths are the arrowed lines. The waves represent maxima and minima of TI four-vector standing waves and act as a background. They are always at a  $45^\circ$  angle. They were arbitrarily chosen to emanate from the right hand side, and not all waves were drawn on the figure for clarity. S1 is the simultaneous events line for clock 1( $C_1$ ), or the clock at rest, and S2 is the simultaneous events line for clock 2 ( $C_2$ ), or the moving clock.

The different path angle of the faster clock ( $C_2$ ) will cause fewer wave peaks to be counted. This will result in a time dilation in agreement with the Lorentz transformations if the vertical axis is in units of  $ict$ .

The necessary conditions for observing the Lorentz transformations in this theory are then:

- 1) The background consists of TI four-vector standing wave peaks.
- 2) The four-vector standing wave has no distinguishable peaks.
- 3) The clocks motions are relative to these wave peaks and do not run through them.

Under these conditions, the TI four-vector standing wave can serve as a background for the Lorentz transformations. This is very different from the fluid background that Einstein proved invalid. In other words, light itself is the space-time background.

## **5. Conclusion:**

In this paper, insights gained from TI have been investigated to determine a potential background for the Lorentz transformations. Experimental evidence is presented that supports TI and a possible Lorentz background. Just as the visualization of the fluid-like ether gave way, the concept of a four-vector standing wave requires visualizing light in a different way. According to TI, light waves do not propagate, but are represented by a standing wave. It is shown here that this standing wave allows one to create a background that is consistent with the Lorentzian transformations. Regrettably, no experiment was identified that would determine this theory's validity over current theory. This theory does, however, demonstrate that a background is possible which is consistent with both the Lorentz transformations and experimental results. It also serves to aid in the merging of STR with quantum mechanics.

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### **Caption List**

Figure 1. Two clocks at center of their respective light cones.



