Relativistic Physics of New Transforms of Special Relativity

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Abstract

In our previous paper in this series of "Rudiments of relativity revisited", the new transforms for special relativity were derived based on the alternative formulation of relativity. In this paper, we show that the new transforms can reproduce the so far proven results of special relativity like preserving the lightspeed, length contraction, time dilation, velocity addition and others without the need of relativity of simultaneity. But they can experimentally be distinguished on the lines of new proposed tests. Besides, they improve the understanding of a growing lightsphere and also predict some new interesting physics and phenomena, like anisotropic spatial warping, relativity of spatial concurrence, relativistic non-localization and possibility of superluminal travel. Lorentz transforms need reinterpretation in the light of the fourth axiom of Kishori developed in this paper.

1. Introduction

Mathematical elegance of Lorentz transforms (LT), which were first proposed by Lorentz, later explored as a group by Poincare and re-derived again by the genius of Einstein as transforms of special relativity [1,2], is unmatched. Their impact and achievements for more than a century are tremendous. However, the current relativity (CR) follows the relativistic physics based on classical localization, and assumes a particle like photon to exist at overlapped positions in different frames (OPDF) while mapping the events across the frames, leading to relativity of simultaneity (RoS) [3]. But, the new relativity (NR) invents the physics of relativistic non-localization (RNL) [4] i.e. a photon exists at different positions in different frames (DPDF) to successfully map a set of simultaneous events of one frame to a set of simultaneous events of the other [5]. The New transforms (NT) of special relativity have been derived from the same two postulates of relativity but guided by Kishori's axioms [5], reproduced below along with LT.

$$\text{NT:}\quad x' = em(x - vt)\ ,\ y' = em_{\perp}\, y\ ,\ z' = e\, m_{\perp} z \qquad (1)$$

$$t' = e\, t\ , \qquad (2)$$

$$\text{LT:}\quad x' = g(x - vt)\ ,\ y' = y\ ,\ z' = z \qquad (3)$$

$$t' = g(\, t - vx/c^2) \qquad (4)$$

where,

$$e = \sqrt{1 - v^2/c^2}\,, m = \frac{1}{1-(v/c^2)(x/t)}\,, m_{\perp} = em\,, e = \frac{1}{e}\ , \qquad (5)$$

v is the relative velocity between two frames, and c the lightspeed.

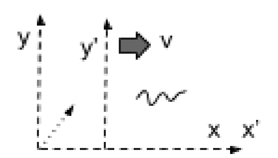

Fig 1. A moving particle observed from two frames whose origins met at t=t'=0, and having relative velocity v.

The temporal transform of the NT, unlike LT does not contain any x dependent synchronization term. The NT relates the unique times of the two frames without a trace of RoS. The factor m in the spatial transforms is responsible for anisotropic spatial warping (ASW) and the relativity of spatial concurrence (RSC). [3-9]. This paper explores NT in contrast with CR and LT, and then views CR and LT in the light of new relativistic physics of the NT. The physics of OPDF and RoS of CR is experimentally distinguishable from that of DPDF or RSC [7-9], and our papers [6-12] propose several experiments to differentiate between the CR and NR.

2. The Meeting Points of NR and CR

Despite drastically differing in terms of physics of relativity, the NT and LT do agree mathematically on a number of points if not in terms of the underlying physics.

2.1 Time Dilation

LT and NT both agree on the time dilation for a moving clock. Eq (2) of the NT explicitly states it.

2.2 Constancy of the lightspeed: LT and NT both preserve the constancy of lightspeed and the principle of relativity. However, the NT besides preserving the lightspeed also accepts RNL. For example, a growing lightsphere in the moving frame,

$$x'^2 + y'^2 + z'^2 = c^2t'^2 \quad (6)$$

readily transforms to

$$x^2 + y^2 + z^2 = c^2t^2 , \quad (7)$$

a growing lightsphere in the rest frame under NT. The lightsphere is assumed to start growing at the common origin coinciding at an instant $t=t'=0$. LT can also yield (7) from (6). However, as has been detailed in section 4.2, the NT preserves both the spatial and mathematical sphericity of a growing lightsphere in the two frames unlike LT which renders a mere mathematical but not the spatial sphericity in the other frame.

2.3 Lorentz Fitzgerald length contraction: Under the NT, a rigid sphere of radius R in the moving frame, $x'^2 + y'^2 + z'^2=R^2$, transforms in the rest frame to,

$$e^2(x-vt)^2/m^2R^2 + e^2y^2/m_\perp{}^2R^2 + e^2z^2/m_\perp{}^2R^2 = 1 .$$

Both e and m scale the moving rigid sphere, but e affects it isotropically. Anisotropy of contraction is due to m factors as expected. Using $x/t = v$ in the expressions of m, we get the final equation as,

$$(x-vt)^2 / R^2(1-v^2/c^2) + y^2 / R^2 + z^2 / R^2 = 1, \quad (8)$$

which is an ellipsoid moving with a velocity v in the rest frame having an axially reduced radius by a Lorentz contraction factor.

2.4 Relativistic Velocity Addition: Consider a particle going with a velocity $x/t=u$ in the rest frame, The rest frame observer wishes to calculate its velocity w.r.to the moving frame. Put it in the first eq. of (9) and divide the same by (10) to get,

$$v' = (u-v)/(1-uv/c^2) \quad (9)$$

Similarly, we can also derive convincing results for aberration angle, relativistic doppler effect, sagnac effect and the Fresnel drag from the NT.

2.5 Common form: For cases when $x/t=v$ i.e. when the moving physical entity under observation is moving with the moving frame (at rest in the moving frame) or vice versa, then both the NT and LT reduce to the same common form:

$$x' = (x-vt)/e\,,\ y' = y\,,\ z' = z\,,\ t' = et \quad (10)$$

This equation can also be called the equation of agreed overlap of two frames. Thus, whenever LT is applied in the above form its results match with the NT. But for cases of x/t other than v, CR or LT most likely mislead and exhibit a confusing physics of illusory time and RoS. So, the mathematical elegance of LT comes at a cost of physical elegance. From (10) it is notable that LT for this case contains a temporal transform free from odd terms in v or x, which is in agreement not only with the physics of Kishori's second axiom but also with the temporal transform of the NT both agreeing on the unique time of moving frame.

3. Points of Difference

Despite the above similarities, the NR and CR represent quite a different physics of relativity but the good news is that these differences are experimentally verifiable to close on the right theory of relativity.

3.1 Mapping the events

The NT and LT follow very different criteria to map an event of one frame to the other [5]. CR assumes that a particle like photon exists at an OPDF given by (10), and therefore location of an event in one frame is mapped to the other frame using (10), resulting in mapping of a set of simultaneous events in one frame to a set of non-simultaneous events in the other. The NR asserts the photon exists at DPDF owing to the relativistic non localization (RNL), and thus a set of simultaneous events is mapped to a set of simultaneous events. The NT and LT map the same input set to two different sets of events in the other frame [5]. However, OPDF based RoS and DPDF based RSC can be experimentally distinguished [7-10].

3.2 Relativity of simultaneity: Let us reproduce temporal transform (2) of the NT,

$$t' = \sqrt{1 - v^2/c^2}\, t, \qquad (2)$$

which shows the moving frame time is the time shown by the clock stationed in the moving frame. Unlike LT, the NT contains no x dependent synchronisation term, and thus it is free from RoS. It is also free from any odd-order terms in v/c, so unlike LT, the direction of relative motion of the observer does not alter the time t'. Yet second order time dilation of CR is faithfully reproduced.

According to NR, RoS is a fallacy of CR that results from three others [3,4]: 1. Allowing undesirable effects (UE) of finite signal speed (FSS) to creep into the framework of their relativistic physics. 2. Ignorance of ASW and RNL and their role in cross frame detection 3. Finally the OPDF, overlapped position syndrome (OPS) of CR. In [7,8] experiments to directly test RoS and RSC have been proposed. In [8] the outcome of the famous train embankment thought experiment [2], is scrutinized under the NR, and an experimental setup is detailed to put them to test.

3.3 Spatial sphericity of a growing lightsphere

In section 2.1 the equation (7) of a growing lightsphere can be derived from (6) by both the NT and LT. The NT renders spatially an actual geometric shape of a sphere in the other frame whereas the LT-transformed renders a sphere in spacetime that preserves the lightspeed but not the spatial sphericity about the moving frame's origin.

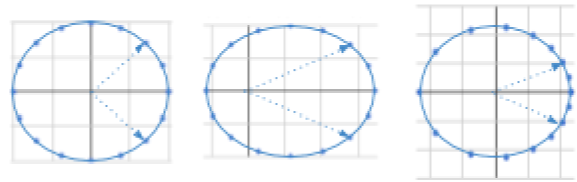

Fig. 2. (a) A lightsphere in the moving frame (b) The same transformed to the rest frame using LT (c) and finally using NT.

Not only its spatial shape is ellipsoidal but the origin is located asymmetrically as shown in panel (b) fig 2. Panel (a) gives the original untransformed lightsphere in the rest frame. The results of LT transformed lightsphere are drawn in panel (b) of Fig 2, whereas the panel (c) is the transformed lightsphere using the NT. Transformation of two representative rays has also been shown in the above.

3.4 Anisotropic spatial warping: Spatial asphericity of the transformed lightsphere is due to the fact that CR or LT ignores the ASW experienced by the differently directed photons in the other frame. In section 3 of [2], Kishori's second axiom (KSA) predicts ASW that reveals to the particle actually traversing the space-segment of the cross frame depending on its speed and direction. ASW is the phenomenon behind preserving the shape of the light sphere in all frames as in fig 2 (c). Unaware of ASW and RNL, CR suffers from three pitfalls: 1. LT transforms a spatial lightsphere to an spatially elongated lightsphere. 2. Elongation here is different from Lorentz Fitzgerald length contraction of section 2.2 above. 3. The source of the diverging light rays in the other frame is not the centre of the elongated lightsphere but an axially off-centered point. This linear order offset is the result of OPS or OPDF of CR 4. Equal lengths traversed by lightrays in the rest frame of the source render unequal lengths under CR in the other frame; similarly equal traversal-times for all rays render unequal traversal times, leading to RoS. With the acknowledgement of ASW and DPDF all these discrepancies disappear under the NT, wherein both the frames see light diverging from a point-source at the very centre of their perfect light-spheres, all the rays traversing the equal lengths in the given frame, as is evident from Fig 2 (b). However, due to symmetric even order warping of e-factors, the lightsphere in the other frame is symmetrically conspanded.

3.5 Interpretation and experimentation: The lightsphere growth of fig 2 can be used to experimentally differentiate between CR and NR. The spatial sphericity of the transformed lightsphere pulse is guaranteed by the NT in panel (c) but not by LT, see panel (b), which renders a sphere in spacetime, not in space. Spatial sphericity means that a perfectly circular array of synchronised detectors about the origins of the two frames must receive the photons simultaneously. Thus both simultaneity and spatial sphericity are preserved by strict NR. Next take the case of CR in panel (b): It preserves neither simultaneity nor the spatial shericity, but for non-simultaneity to happen for the other frame, it demands to arrange the detectors along an elongated ellipse, not a circle. Thus, the non-simultaneity of LT is artificially achieved by distorting the circular symmetry of the array of detectors about *O* to receive the otherwise spherically growing pulse in both the frames, as predicted by the NR [10]. Why does CR map a spherical lightsphere to an aspherical shape in the second frame? Because of its belief in OPDF. Circular detectors in the first frame can only be accessed if they are on the asymmetrically placed ellipsoid in the second one, and so it deduces non-simultaneity for the simultaneous detection done in the original frame, without realising that due to DPDF of NR when photon touched the circular ring in the first frame they also formed a circle in the second, not an off-set ellipsoid.

3.5 Relativistic non localization

How can the photon have two different positions in the two frames to justify DPDF of NR? It is due to relativistic non localization (RNL) i.e. a particle in motion exists in an RNL superstate, which collapses at detection such that the motion state of the detector affects the position of detection such as to preserve the lightspeed. This quantum like attribute called RNL if true provides a way to manipulate lightspeed through vacuum [11]. Besides, further investigation on RNL may reveal more on the nature of spacetime fabric. The expression for RNL of shift eq (15) below can be derived in many ways from the NT [4,5].

4. Two oppositely moving photons

Kishori's first axiom (KFA) [3,4] encourages to consider every frame to be intrinsically fitted with signal detectors and synchronized clocks virtually at every point to eliminate the UE of FSS [3]. Every such synched clock of the frame represents a unique *time of frame* (ToF), which can be read by any observer from a clock next to it. At a given instant, there can only be a single or unique ToF for a given frame, with all intrinsic synchronized clocks of the frame agreeing to it. However, we shall quantitatively show here that the definition of moving frame time of LT is incompatible with the physics of a unique ToF and it is impossible to attach the time of LT with any real clock or ToF without accepting RSC or DPDF, but then RoS has to disappear.

Consider a photon originating at the common origin of the two frames at $t'=t=0$ and reaching a point x' at t'. Here t and t' are the respective ToF of the rest and moving frame, which means when intrinsic clocks of the moving frame (MF) display t', the intrinsic clocks of the rest frame (RF) display t and vice versa, both related by eq (10). At time t, let the photon be detected at x in the rest frame (RF). We wish to know (t', x') from (t, x) using both the NT and LT respectively:

$$t' = et,\ x' = ec(x - vt)/(c - v) \quad (11)$$

$$T' = (c - v)t/ec,\ X' = (x - vt)/e \quad (12)$$

$$t' = et,\ x' = -ec(x + vt)/(c + v) \quad (13)$$

$$T' = (c + v)t/ec,\ X' = -(x + vt)/e \quad (14)$$

where capitalized T' and X' have been used for primed coordinates of LT, thus (11) uses the NT and (12) uses LT. Equation (13) and (14) are equivalent to (11) and (12) but for a photon which originates with the previous photon at the same place same time but traverses to the left to be detected at $-x$ at t in the RF. We shall see eqn (11) and (13) are the statements of RNL or RSC for respective photons involved here. Following four conclusions in four subsections are due from (11-14).

4.1 Unique time of frame

The NT indeed succeeds to provide a unique time of the moving frame t' corresponding to instant t of the RF, whereas LT fails to do so. Had there been n photons going in n different directions LT would have generated n-different times, one for each ray. Further, T' of LT as time of the MF corresponding to t contradicts its own notion of eq (10) where clock in the moving frame reads $t'=et$ when clock in the RF reads t. But t' of NT is fully compatible with it. To hold its OPDF, CR splits the time.

4.2 RSC and RNL

The prediction of ASW, RSC and RNL is a salient feature of the NT. At an instant denoted by t in the RF and t' in the MF, the point x of the RF overlaps or coincides with point $X'=(x-vt)/e$ of the MF given by (10), on which both the NT and LT agree. LT in (12) predicts that if a photon is at x in the RF, then in the MF it is at mutually agreed overlapped position X'. However, the NT in eq (11) predicts a very different position x' for the photon in the MF, quite different from mutually agreeable overlapped position X'. While the two frames agree on the mutual concurrence of points x and X', the picture of concurrence is very different for the photon as it concurs with x in the rest frame and at x' of eq (11) in the MF, giving an RSC shift,

$$x' - X' = evx/c \,. \tag{15}$$

This presence of the photon at different positions in different frames (DPDF) gives rise to RNL [4].

4.3 What is the MF time of LT?

Thus, the NT relates the two frames and their times at an instant giving a unique ToF for two frames, whereas LTs fail to do so. Then what does the T' in LT relate to? How should it be interpreted? Surely the synched clocks located at different axial positions of MF can not be out of synchronisation for the MFO itself. A conventional relativist may say that the time shown by frame's clocks at the instance t is $t'=et$ only as given by NT, but the clocks at $+/-x'$ are seen by RFO as not synchronized or vice-versa and hence the more than one T' exist in LT. However, for detection of photons in the MF, MFO has just to be concerned with his own frame's intrinsic clocks and detectors. How an observer in the RF sees MF's clock or vice-versa is immaterial and therefore such apparent effects are termed as UE of FSS by Kishori. Others may say that it is the photon that seems to lose or gain time depending on whether its motion is in $+x$ or in $-x$. But again the time for the photon's frame must be defined by (10) with v replaced by c, yielding infinitely slowed or eternal time.

4.4 The fourth axiom

Thus, the only way left ahead is not to assume T' of equation (12) as the unique time of the MF t' corresponding to instant t of the RF. This means when the RF observer saw the intrinsic clocks of the MF ticking T', its own ones were ticking $T=T'/e$. Thus, the instant T' or T, when the photon was at X' in the MF, is unrelated to the instant t or t' when the photon was at x in the RF. In other words, it is to indirectly accept DPDF i.e. at the instant t', the photon was at a very different position in the MF, different from X' and hence this is to conceptually accept the RSC and RNL of the NT once and forever. This discussion takes us to the fourth axiom of Kishori:

It is impossible to assign time T' of LT to any real physical clock without accepting the tenets of NR like ASW, RSC and RNL. This Kishori's quaternary axiom (KQA) is another way to discard the age-old premises of relativity of synchronisation and simultaneity as unessential and redundant. The LT involves different instants of time to retain its mathematical elegance and symmetry, but by assuming those instants related by LT to be the same, CR falsely declares RoS. For example a photon being at *x* in the RF and being at *X'* in the MF are two very different instants of time for clocks of both the frames. Discovering a relation between two different instants does not tantamount to RoS or linear order warping of time or MF time's dependence on *x* or even non-synchronization of clocks.

5. Conclusion

It is shown that both the NT and LT reproduce the results of relativity that are proven so far. However they follow a very different criterions of mapping, the OPDF used by CR, and the DPDF by NR. OPDF gives rise to RoS and DPDF to RSC, but they can be experimentally distinguished [6-10]. This study on NR opens an arena of new interesting relativistic phenomena unexplored so far like ASW, RSC, RNL, the possibility of discovering inherent quantum physical tenets in relativity and relativistic tenets in quantum physics. RNL might be exploited for superluminal travel, and the possibility of manipulating RNL for superluminal travel. This all makes NR and NT worth exploring further [6-15]. This paper also lays the foundation for re-interpreting LT devoid of RoS in the light of the NT and NR [14].

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