

Reply to the unjustified comments by Justo Pastor Lambare in his work “Noninertial Reference Frames in Special Relativity”

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Abstract

We present a critical reply to the analysis of noninertial reference frames in special relativity recently put forward by Justo Pastor Lambare [1]. While Lambare explores the application of special relativity to accelerated systems via the hypothesis of locality, his discussion overlooks crucial foundational insights established in optical and relativistic physics over the past century. Specifically, he fails to notice that the linear Wang-Sagnac effect proves that Sagnac-type phenomena are fundamentally independent of noninertiality. Furthermore, contrary to Lambare’s claim, the local differential speed utilized in his derivations corresponds precisely to the variant Galilean speed (or Selleri/LTA transformations), confirming that the one-way speed of light is not invariant for a moving observer. Accounting for spacetime continuity breach under standard Lorentz transformations (LT) and incorporating advances from classical entanglement synchronization and alternative relativistic frameworks (LTA), we establish that a viable interpretation of relativistic paradoxes requires coordinate transformations based on absolute simultaneity and light-speed variance.

1 Introduction

In a recent study [1], Lambare discusses the application of special relativity (SR) to noninertial reference frames, addressing the common misconception among students and academics regarding whether SR can describe accelerated systems without resorting immediately to general relativity. Lambare emphasizes Einstein’s 1905 heuristic approach, the hypothesis of locality (HL), and the infinitesimal application of special relativity through momentarily comoving inertial frames.

While we acknowledge the pedagogical value of clarifying the local validity of special relativity in accelerated systems, Lambare’s framework does not address the central controversies regarding light speed invariance, clock synchronization, and spacetime topology

[2]-[71]. The purpose of this reply is to re-examine these issues in light of extensive theoretical and experimental developments spanning over a century [2]-[71].

A primary reason why the critical contributions of Sagnac, Selleri, Gift, and others [2]-[71] remain largely absent from mainstream discussions lies in the prevailing sociological and institutional dynamics of contemporary academia. Driven by "publish or perish" incentives and paradigm-preserving peer-review practices, researchers and editors naturally tend to favor mainstream-aligned topics while viewing fundamental, disruptive objections to established coordinate frameworks with institutional skepticism. Nevertheless, we see in the literature works like Lambare's attempting to disprove the validity of the use of a variant speed of light in the articles of Sagnac, Selleri, Gift, and others [2]-[71] while, contradictorily, the local differential speed—utilized by Lambare and other authors in their derivations—corresponds precisely to the variant Galilean speed (or Selleri/LTA transformations), confirming that the one-way speed of light is not invariant for a moving observer.

2 The Sagnac Effect and Noninertiality

Lambare applies special relativistic techniques to analyze rotating reference frames and the Sagnac effect [2]. However, in our opinion, Lambare's paper represents an exercise in applying transformations between noninertial reference frames to physical effects without recognizing that the correct interpretation of Sagnac-type effects has no relation to noninertiality.

This is most transparently demonstrated by the realization of the linear Wang-Sagnac effect [4]-[6], where the measuring device is situated entirely on an inertial frame [5]-[6]. Lambare neither mentions nor applies his techniques to this linear configuration, where rotational noninertiality plays no role [31]-[52]. Consequently, attributing the physical origin of Sagnac-type phenomena to noninertiality is a physically misleading interpretation with no ground [31]-[52].

3 Metric Tensor and Local Differential Speed

In his derivation, Lambare expresses the spacetime interval in noninertial coordinates as:

$$ds^2 = \sum_{\mu, \nu=0}^3 g_{\mu\nu} dx^\mu dx^\nu \quad (1)$$

and subsequently expands it for rotating systems, yielding Eq. (17) in his paper [1]:

$$ds^2 = (1 - \beta^2)c^2 dt^2 - dr^2 - r^2 d\phi^2 - dz^2 - 2\beta rc dt d\phi \quad (2)$$

where $\beta = v_0/c$. Lambare omits mentioning that this metric is precisely the Langevin-Lifshitz-Landau metric utilized extensively by numerous authors, including Spavieri and Haug [43]-[52].

More importantly, Lambare utilizes a local differential speed in his Eqs. (20) and (21) to solve for the propagation times of counter-propagating light beams:

$$dt^+ = +\frac{Rd\phi^+}{c(1-\beta)} \Rightarrow c(1-\beta) = +\frac{Rd\phi^+}{dt^+}, \quad (3)$$

$$dt^- = -\frac{Rd\phi^-}{c(1+\beta)} \Rightarrow c(1+\beta) = -\frac{Rd\phi^-}{dt^-} \quad (4)$$

Lambare is apparently unaware that the local differential speed he extracts and utilizes ($c(1-\beta)$ and $c(1+\beta)$) is precisely the variant speed predicted by the Selleri transformations (or Lorentz Transformations with Absolute Simultaneity, LTA) [31]-[52]. Thus, his own mathematical approach confirms that the speed of light is not invariant for a moving observer, fully supporting the claims of Sagnac, Selleri, Spavieri, Haug, Gift, and many others [31]-[54].

4 Conventionalism, Spacetime Continuity, and the LTA

Lambare's discussion fails to engage with the advances made by conventionalism in interpreting these effects, where the one-way speed of light is treated as conventional and coordinated via Einstein synchronization (see, e.g., Lee [11]). Conventionalism represents the standard mainstream interpretation: the noninertiality plays no role. However, conventionalism assumes that the Lorentz transformations (LT) based on relative simultaneity are empirically indistinguishable from the LTA based on absolute simultaneity [3].

We have rigorously shown in several papers that assuming the local one-way speed of light to be c under the standard LT leads to a severe spacetime continuity breach in closed or moving topologies [31]-[52]. Specifically, when integrating light propagation around a closed contour of length $2\gamma L$, the standard LT force a coordinate step or discontinuity at the closure point [31]-[52]. For conventionalism, this is simply a nonobservable artifact of the theory.

Nevertheless, advances have been made in the issue of clock synchronization: To overcome the limitations of conventionalism, we have introduced synchronization procedures independent of light transport, such as rotating rod synchronization based on classical entanglement [52]. This non-Einsteinian synchronization procedure is operationally distinct and proves that not all internal synchronizations are equivalent to Einstein's [31]-[52].

Furthermore, the nonequivalence between the LT and LTA becomes evident in investigating physical scenarios such as:

- **The reciprocal linear Sagnac effect:** In the standard linear effect, the measuring device moves back and forth along a stationary optical contour, whereas in the reciprocal effect, the measuring device is stationary and the contour moves back and forth [44]-[49]. Spavieri and Haug demonstrated that while the invariant round-trip time T is independent of the initial distance X in the standard configuration, the LT predict that $T = T(X)$ becomes X -dependent in the reciprocal effect [49]. In contrast, under the LTA, T remains completely invariant and X -independent [49].

Because reciprocity—the principle that exchanging the roles of moving and stationary frames should yield equivalent physical descriptions—is a cornerstone of the relativity principle, its full preservation under the LTA and failure under the LT highlights a major conceptual advantage for the LTA framework [49].

- **Faraday induction from moving electrified bodies:** According to the LT, an electrified body in motion (such as a small charged sphere at rest in frame S) produces a time-varying magnetic field in a relatively moving frame S'. The space-time mixing of the LT ($t' = \gamma(t - vx/c^2)$) transforms the electrostatic field into a configuration where its curl no longer vanishes ($\nabla' \times \mathbf{E}' \neq 0$), thereby predicting a non-zero magnetic induction field $\mathbf{B}'$ and an induced electromotive force in a conducting wire at rest in S'. Conversely, under the LTA ($t' = t/\gamma$), space and time are not mixed; following Puccini and Bonaura [62], [63], calculations yield $\nabla' \times \mathbf{E}' = 0$ and $\mathbf{B}' = 0$, meaning no induction field or current appears. Although historical experiments (such as Rowland's disk) are inconclusive, the differing predictions confirm that the LT and LTA represent distinct physical realities.
- **The resolution of relativistic equilibrium paradoxes:** Standard special relativity based on the LT faces persistent equilibrium paradoxes, such as the Tolman-Lewis right-angle lever paradox, where force transformations introduce an unintended external torque in a moving frame S' that makes the lever appear to rotate. To solve this, standard relativistic mechanics must be complemented by an auxiliary stress tensor $S^{\mu\nu}$ alongside Maxwell's tensor $\Theta^{\mu\nu}$, rendering standard relativistic electromagnetism incomplete without it [66]. However, when the LTA are utilized instead of the LT, the force transformations introduce no extra external torque, allowing systems like the lever to remain naturally in equilibrium across every inertial frame without requiring any additional stress tensors.

Together with other physical situations—such as the different symmetry of the LT and LTA—suggesting that conventionalism has no universal validity, the possibility that the one-way light speed is observable and not conventional becomes viable and testable. In this case, the LT and LTA are no longer equivalent and predict different physical realities.

5 Conclusions

In conclusion, Lambare's analysis of noninertial reference frames in special relativity highlights the local applicability of SR through the hypothesis of locality. However, it bypasses the core controversies regarding one-way light speed invariance [31]-[52].

The physical reality revealed by Sagnac-type optical effects, the linear and reciprocal Wang-Sagnac configurations, and the necessity of preserving spacetime continuity, all point to the validity of transformations based on the conservation of simultaneity and light-speed variance (such as the Selleri or LTA transformations) as viable and superior alternatives to the LT in non-simply connected topologies [31]-[52].

We invite Lambare and other physicists to join in further developing and clarifying these foundational issues.

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