The One-Way Linear Effect (OWLE) Award

Our research group cordially offers the award of two thousand dollars ($2000) to the first person who provides the solution to the exercise described below, supporting the validity of the Lorentz transformations (LT) and light speed invariance. If there is a second solution, more rigorous than the first, the prize might be shared.

On this occasion, the participants must be professors or researchers of the ULA or CIDA.

We believe that the exercise is accessible and can be of interest even to students. In fact, should they not find a solution, they might still be able to conclude whether the light speed is invariant or not. Thus, students are quite welcome to participate with their approach endorsed by a professor. The deadline for submission of the PDF with the solution is April 15, 2025, with the possibility of an extension if requested by participants.

1- The winner is invited to use part of the award as help for a student thesis. If nobody provides a solution, part of the prize can still be awarded to student thesis on the subject.

2- In the absence of a solution, the research group will offer the award to researchers from other institutions, national or international, hopefully with higher amounts. Researchers and students are invited to send any original innovative interpretation, either in favor or against light speed invariance. The group is in contact with scientific journals where a "special issue" on this topic may be published. Depending on the quality of the interpretation, the group may recommend it for publication, provide help to cover the publication fees, or other incentives.

The whole process will follow the usual academic standards. Any correspondence can be sent to the research group through the contact (Professor Gianfranco Spavieri): telefono.c1100@gmail.com

Motivation for the OWLE Award: In relation to his famous optical effect, Sagnac (1913) and his followers believed that his experiment disproved the one-way light speed invariance, while physicists supporting the validity of the LT, instead claim light speed to be invariant. The controversy evolved after the realization of the linear Sagnac effect (Wang et al. 2003). According to Sagnac and his followers, it is physically impossible that light speed is invariant along the whole contour of the optical effect. **Thus, seeking the help of researchers to clarify whether light speed is invariant, the research group considered it convenient to offer the OWLE Award**.

Hopefully, the award may stimulate interest in research on the foundations of modern physics theories.

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The exercise: In the linear Sagnac effect of Fig. 1, an optical fiber (with refractive index $n = 1$) slides at speed v on the two pulleys A and B with AB $= L$. The device C* (a clock) is fixed to the fiber and may move with it from the lower to the upper section while an emitted counter-propagating photon performs the round trip in the invariant time interval T. For the counter-moving photon, the round-trip interval measured by C* co-moving with the fiber, is (Post 1967),

$$T = \frac{2L}{\gamma(c+v)} = \frac{2\gamma L}{\gamma^2(c+v)} = \frac{2\gamma L(1-v/c)}{c} \simeq \frac{2L(1-v/c)}{c}, \qquad (1)$$

which is independent of the initial position of C* and can be calculated (even in Newtonian physics) from any inertial frame where the one-way light speed is assumed to be c.

The challenge.

Demonstrate the following: Using the Lorentz transformations in the context of flat spacetime, show that, in the one-way linear effect discussed above, the photon traveling at the *local* speed c along each section of the optical fiber, covers the *whole* fiber length $\simeq 2L$ in the proper time interval T measured by the clock C*.

The fiber length $L_{loc} = c_{loc}T_{loc}$ traversed by the photon along any fiber section, corresponds to the length determined using the local (differential) speed c_{loc} and local clocks measuring the time interval T_{loc} while at rest with the fiber in that section.

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Additional comments and a hint to determine the distance traversed by the photon traveling at the "local" one-way light speed c along the lower and upper fiber sections.

To simplify the calculations, we assume (as in Fig. 1-b) that the interval η, taken by C* to move around the pulley of radius R, is negligible and much less than T, which implies $L >> R$.

Clock C* can be at any initial position. However, calculations are easier in the case when C* moves from the lower to the upper fiber section during the interval T. Let S$''$ be the inertial rest frame of C* when located on the lower fiber section and by S$'$ the rest frame when on the upper section and T''_{out} and T'_{ret} the intervals taken by the photon to traverse the lower and upper sections respectively. With $T = T''_{out} + T'_{ret}$, we may measure T''_{out} and T'_{ret} by means of two clocks in uniform motion: For the out trip on the lower section, the first clock is C*≡C$''$ co-moving with S$''$ and, for the photon return trip on the upper section, we use, as shown in Fig. 1-b, the second clock C*≡C$'$ co-moving with S$'$, where C$'$ is set at $t' = t'' = 0$ at point A when facing C$''$. [The LT (e.g., from the lab frame S to the frame S$'$) are $x' = \gamma(x - vt)$, $y' = y$, $z' = z$, $t' = \gamma(t - vx/c^2)$].

Since, as seen from C$''$ co-moving with frame S$''$, the speed v of A and the local light speed $c'' = c$ are known, the initial position of C$''$ relative to A (Fig. 1-a), can be chosen in such a way (AC$'' = (v/c)L/\gamma$) that the counter-propagating photon leaving C$''$ reaches B when, simultaneously in S", C$''$ reaches A, as shown in Fig. 1-b (lower fiber section). Then, the photon reaches B in the interval,

$$T''_{out} = T_{out} = \frac{L''}{c''} = \frac{L}{\gamma c}. \tag{2}$$

As measured by clock C$''$, the fiber length covered at the local speed $c'' = c$ by the photon on the out trip T_{out} from C$''$ to B, is

$$L'' = cT''_{out} = \gamma^{-1} L \simeq L. \tag{3}$$

The return-trip interval, measured by clock C$'$ on the upper section where the photon travels at the local speed $c' = c$, is,

$$T'_{ret} = T_{ret} = T - T_{out} = \frac{\gamma L(1 - v/c)^2}{c}. \tag{4}$$

Result (4) implies that in the interval T'_{ret} ($t'' > 0$) and at the local speed $c' = c$, the photon covers the fiber length,

$$L' = cT'_{ret} = \gamma L(1 - v/c)^2 \simeq L - 2(v/c)L < L. \tag{5}$$

The total path covered at the local speed c by the photon, L'' on S$''$ and L' on S$'$, is exactly,

$$L'' + L' = \gamma^{-1} L + \gamma L(1 - v/c)^2 = 2\gamma L - c\delta t' < 2L, \tag{6}$$

where the term $\delta t' = 2\gamma v L/c^2$ represents the "time gap" from S$'$ to S$''$ due to the relative simultaneity foreseen by the time transformation of the LT.

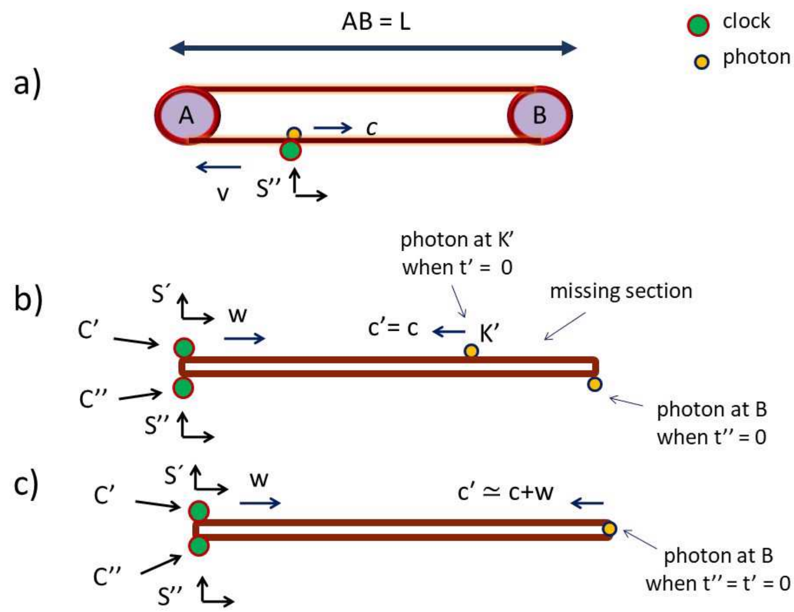

Figure 1: *a*) In the linear Sagnac effect, light propagates along an optical fiber sliding at speed v on the two pulleys A and B. The frames S$'$ and S$''$ are co-moving with the upper and lower fiber sections, respectively, possessing opposite velocities v relative to the lab frame AB. *b*) After being emitted by the clock C$''$, co-moving with the lower fiber section at $t'' < 0$, the photon reaches B when A reaches C$''$ at $t' = t'' = 0$ and the origins of S$''$ and S$'$ coincide at point A. As observed from C$''$ in frame S$''$, the photon has covered the distance L/γ in the interval $T_{out} = L/(\gamma c)$. According to the LT and with $w \simeq 2v$ the relative velocity between S$'$ and S$''$, in the return trip on the upper section the photon is at K$'$ at $t' = 0$ and covers the shorter distance $\gamma L(1-v/c)^2$ in the interval $T_{ret} = \gamma L(1-v/c)^2/c$ measured by clock C$'$. The "missing" section K$'$B $= c\delta t' = 2\gamma(v/c)L$ has not been covered for $t' > 0$ in the observed interval T'_{ret}. *c*) According to transformations conserving simultaneity, in the return trip on the upper section, the photon is at B at $t' = 0$ and covers the distance $c'T'_{ret} \simeq L$ in the interval T'_{ret} measured by clock C$'$, traveling at the speed $c' \simeq c+2v$. Spacetime continuity is conserved with these transformations.

Result (6) explains why Sagnac and his supporters (Selleri 1997, Gift 2015, Kipreos 2016, Lundberg 2019-21, etc.) claim that, at the local speed c, the photon cannot cover the whole fiber length $2\gamma L$ in the round-trip interval T. If the LT are used, there is a "missing" section $2\gamma vL/c = c\delta t'$ that has not been covered in the interval $T = T_{out} + T_{ret}$, in agreement with the last term of (1). Hence, the LT fail because do not provide a consistent interpretation of the Sagnac effects. In fact, to cover the whole length $2\gamma L$ in the interval T, the local light speed cannot be the invariant c but must be greater than c, consistently with the average speed $c + v$ of the first and second terms of (1).

As shown in Fig. 1-c, according to relativistic transformations conserving simultaneity (Selleri 1997, Kassner 2012, Lee 2020, Spavieri et al. 2019-2024), in the return trip on the upper section the photon is at B at $t' = 0$ and covers the distance $c'T'_{ret} \simeq L$ in the interval $T'_{ret} \simeq L/(c+2v)$ measured by clock C$'$, traveling at the local speed $c' \simeq c+2v$. Spacetime continuity is conserved with these transformations, which are currently used also by physicists supporting standard special relativity (Kassner 2012, Lee 2020).