A Comment on arXiv:1110.2685

Armando V.D.B. Assis
Departamento de Física, Universidade Federal de Santa Catarina – UFSC, Trindade 88040-900, Florianópolis, SC, Brazil
armando.assis@pgfsc.ufsc.br

This brief paper traces comments on the article [2]. This article, a preprint, has recently received an attention, raising errors related to the timing process within the OPERA Collaboration results in [1], that turns out to be a wrong route by which serious science should not be accomplished. A peer-reviewed status should be previously considered to assert that [2] claims a solution for the superluminal results in [1]. Within [2], it seems there is an intrinsical misconception within its claimed solution, since an intrinsical proper time reasoning leads to the assumption the OPERA collaboration interprets a time variation as a proper time when correcting time intervals between a GPS frame and the grounded baseline frame. Furthermore, the author of [2] seems to double radio signals, doubling the alleged half of the truly observed time of flight, since the Lorentz transformations do consider radio signals intrinsically by construction.

1 An intrinsical proper time reasoning? A misconception from the OPERA collaboration, or from the author of [2]? What is actually observed, τ_{clock}/γ?

The author of the article [2]* used, *ab initio*, the designation: *from the perspective of the clock...* Within the approach used by the author, via special relativity, the GPS frame of reference must use ***two*** distinct but synchronized clocks to tag the instants at A and B. The eq. (2) in [2] was, intrinsically, obtained via the Lorentz transformations for the neutrino events of departure from A and arrival to B, but this was not clearly specified within [2], being the construction of the Eq. (2) in [2] crudely accomplished under what would be being seen from the perspective of the clock, in the author of [2] words:

- ***From the perspective of the clock the detector at B moves towards location A at a speed v. And we find that the foton will reach the detector when the sum of the distances covered by the detector and the foton equals the original separation...***; [2].

This reasoning, *ab initio*, leads, as it very seems, to an intrinsical proper time reasoning under the perspective of what was being seen, locally, by the satellite at its very location. Let (x_A, t_A) and (x_B, t_B) be the spacetime events of departure and arrival of the neutrino in the baseline reference frame K, respectively. The time interval spent by the neutrino to accomplish the travel in the [2] GPS reference frame K' is:

$$\delta t' = \left(1 - v^2/c^2\right)^{-1/2} \left[(t_B - t_A) - \frac{v}{c^2}(x_B - x_A)\right], \qquad (1)$$

in virtue of the canonical Lorentz transformation for time in K' as a function of the spacetime coordinates in K, where v is the assumed boost of K' in relation to K in the baseline direction AB, c the speed of light in the empty space. With $\delta t = t_B - t_A$, $\delta x = x_B - x_A = S_{baseline}$, $\delta x = v_\nu \delta t$, where v_ν is the neutrino velocity along the AB direction, the eq. (1) reads:

$$\delta t' = \left(1 - v^2/c^2\right)^{-1/2} S_{baseline} \left(\frac{1}{v_\nu} - \frac{v}{c^2}\right). \qquad (2)$$

With $v_\nu = c$, $\gamma = \sqrt{1 - v^2/c^2}$, $\delta t' \stackrel{!}{=} \tau_{clock}$, as defined in [2], the eq. (2) here becomes the eq. (2) in [2]:

$$\tau_{clock} = \frac{\gamma S_{baseline}}{c + v} \Rightarrow c\tau_{clock} + v\tau_{clock} = \gamma S_{baseline}. \qquad (3)$$

But:

- $\delta t' \stackrel{!}{=} \tau_{clock}$ is not a proper time (it is a time interval measured by distinct clocks at different spatial positions in K'); hence: why would the OPERA collaboration correct $\delta t' \stackrel{!}{=} \tau_{clock}$ via $\delta t = \delta t'/\gamma$, as claimed via the eq. (5) in [2]?
- Such correction would be plausible if the events of departure and arrival of the neutrino had the same spatial coordinate $x'_A = x'_B$ in the GPS K' frame of reference, but it is not the case.

Hence, as asserted before, the claimed solution supposes an intrinsical proper time reasoning, but there is no reason for this, since the $\delta t'$ is not a proper time. Thus, the claimed solution turns out to be constructed on an erroneous correction. The correction that should be done by the OPERA Collaboration, if the [2] GPS reference frame was to be taken in consideration, would read:

$$\delta t = \left(1 - v^2/c^2\right)^{-1/2} \left[(t'_B - t'_A) + \frac{v}{c^2}(x'_B - x'_A)\right], \qquad (4)$$

and this correction would read: $\delta t = \delta t'/\gamma$, with the $\gamma = \sqrt{1 - v^2/c^2}$ defined in [2], ***if and only if***: $x'_B - x'_A = 0$, but it is not the case.

*The comments we raise here are related to the first version of [2], v1, uploaded to arXiv. Recently, the author uploaded an updated version, but the misconceptions seem to persist. The root of the arguments within [2] to obtain the alleged 64 ns seems to be flawed *ab initio*.

Furthermore, I would like to assert that, related to the K' reference frame, the frame taken by the author of [2] to explain the relevance of the GPS reference frame in terms of special relativity: the radio signals turn out to be irrelevant to be taken into consideration once the clocks within K' are synchronized, viz., the Lorentz transformations for events do consider radio signals intrinsically under the synchronization of clocks in a given reference frame. This said, the factor 2 the author uses to reach 64 ns seems misconcepted. Remembering, the τ_{clock} is the time interval in K', it is not a proper time interval, and this time interval totally accounts for the entire process of emission and detection of the neutrino at A and B, respectively, departure and arrival, from which there are not two corrections to be accomplished at the points A and B related to radio signals. The radio signals related to the events at A and B in the GPS reference frame in [2], K', were taken into consideration *ab initio*, in [2], since the clocks at A and B in this reference frame tagging the events of departure and arrival were previously synchronized by the very radio signals the author of [2] refers at the end of his article, due to the intrinsical use of the Lorentz transformations, *ab initio*, within the eq. (2) in [2], albeit the author of [2] had not written down his eq. (2) in [2] under a Lorentzian reasoning. Hence, once the Lorentz transformations provided the τ_{clock}, the radio signals should not be considered twice.

I would like to furtherly comment the root of misconceptions, by which the author of [2] seems to have carried his reasonings to raise his arguments. Related to my previous comments, as asseverated before (see footnote 1), these ones are related to the first version of the mentioned article uploaded to arXiv. The author uploaded an updated version, but the root of misconceptions persists within his primordial reasoning related to the Lorentz transformations. It very seems the author had in mind that the time interval to be corrected $\delta t' = \tau_{clock}$ (here, we continue to consider the notations within the first version of [2], since there are not substantial modifications throughout the updated version to avoid the criticisms raised) was a proper interval. Constructing his arguments, the author refers to what is observed in the satellite reference frame. Suppose, following the author of [2] reasonings, the satellite sends a radio signal to the event at A to see the departure of the neutrino when this radio signal is sent back to the satellite. Be t'_{ESA} (E denotes emission, S denotes satellite, and A denotes the location of the CERN at the instant, read in the satellite local clock, the neutrino starts the travel to Gran Sasso) the instant this signal is sent to reach the event of the neutrino departure; t'_{RSA} (R detotes reception) the instant the signal comes back to the satellite, read in the satellite local clock. These instants are related by:

$$t'_{RSA} = t'_{ESA} + 2d'_{SA}(t'_A)/c, \tag{5}$$

where $d'_{SA}(t'_A)$ is the distance between the satellite and the CERN location at A, at the instant the signal (radio signal) reaches A, viz., $d'_{SA}(t'_A)$ is the distance between the satellite and the CERN location at A at the instant t'_A the neutrino is sent to Gran Sasso in the satellite frame. Analogous reasoning related to the neutrino arrival at Gran Sasso, at B, leads to:

$$t'_{RSB} = t'_{ESB} + 2d'_{SB}(t'_B)/c, \tag{6}$$

where $d'_{SB}(t'_B)$ is the distance between the satellite and the Gran Sasso location at B, at the instant another signal previously sent by the satellite at instant t'_{ESB} read in the satellite local clock (another radio signal) reaches B, viz., $d'_{SB}(t'_B)$ is the distance between the satellite and the Gran Sasso location at B at the instant t'_B the neutrino arrives to Gran Sasso in the satellite frame. The instants t'_A and t'_B are respectively given by:

$$t'_A = \frac{t'_{ESA} + t'_{RSA}}{2}, \tag{7}$$

and:

$$t'_B = \frac{t'_{ESB} + t'_{RSB}}{2}. \tag{8}$$

From these relations, the proper time interval between the instants the satellite ***sees*** the events of departure and arrival, $t'_{RSB} - t'_{RSA}$, is given by:

$$t'_{RSB} - t'_{RSA} = t'_B - t'_A + \frac{d'_{SB}(t'_B)}{c} - \frac{d'_{SA}(t'_A)}{c}, \tag{9}$$

therefore, since $t'_B - t'_A = \delta t' = \tau_{clock}$, see my previous comments:

$$\tau_{clock} = t'_{RSB} - t'_{RSA} - \left(\frac{d'_{SB}(t'_B)}{c} - \frac{d'_{SA}(t'_A)}{c}\right), \tag{10}$$

from which: τ_{clock} ***does take into consideration*** the radio signals travelling, encapsulated within the time intervals within:

$$\tau_{signals} = \frac{d'_{SB}(t'_B)}{c} - \frac{d'_{SA}(t'_A)}{c}. \tag{11}$$

The problem within the reasonings of the author of [2] seems to be this author was thinking that τ_{clock} would be the proper interval related to what was being seen by the satellite, $t'_{RSB} - t'_{RSA}$. Hence, at the end of his article, this author applies a correction related to radio signals to account for the time interval $t'_B - t'_A$, but this process was already done when the author obtained $\delta t' = t'_B - t'_A$, viz., as said before within my previous comments, the Lorentz transformations have got radio signals intrinsically, by construction, to deal with events in spacetime. Thus, when the author of [2] applies the factor 2, this author seems to erroneously account for radio signals twice, and the factor 2 seems misconcepted. Even if the OPERA Collaboration had done the correction the author of [2] refers to, such discrepancy would be 32 ns, but not this value twice. The factor 2 seems to have not got logical explanation within the [2] reasoning, mostly being putted a fortiori.

2 Conclusions

Respectfully, the reasoning that led the author of [2] to the factor 2 is not clear. I think this reasoning should be putted under a fairly crystalline terms, as far as possible, in virtue of the importance given to this article, in virtue of the importance given to the subject. Furthermore, what would be being observed, $\delta t'/\gamma$ (this gamma is the original one used by the author of [2]), or this value twice? Why does not the author of [2] provide spacetime diagrams showing the process related to the radio signals that doubles the alleged half of the truly observed time of flight?

Concluding, it seems unlikely that the OPERA collaboration has misinterpreted a GPS time interval within the terms of [2].

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References

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