A Comment On arXiv:1110.2685

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This brief paper traces comments on the article arXiv:1110.2685. 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.

AN INTRINSICAL PROPER TIME REASONING, MISCONCEPTED BY THE OPERA COLLABORATION?

The author of the article arXiv:1110.2685 uses 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 arXiv:1110.2685 should be obtained via the Lorentz transformation for the neutrino events of departure from A and arrival to B. 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 arXiv:1110.2685 GPS reference frame K' is:

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

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:

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

With $v_\nu = c$, $\gamma = \sqrt{1 - v^2/c^2}$, $\delta t' \overset{!}{=} \tau_{clock}$, as defined in arXiv:1110.2685, the Eq. (2) here becomes the Eq. (2) in arXiv:1110.2685:

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

But:

- $\delta t' \overset{!}{=} \tau_{clock}$ 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 $\delta t' \overset{!}{=} \tau_{clock}$ via $\delta t = \delta t'/\gamma$, as claimed via the Eq. (5) in arXiv:1110.2685?
- 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, putting straightforwardly, as asserted before, the claimed solution within arXiv:1110.2685 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 arXiv:1110.2685 GPS reference frame was to be taken in consideration, would read:

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

and this correction would read: $\delta t = \delta t'/\gamma$, with the $\gamma = \sqrt{1 - v^2/c^2}$ defined in arXiv:1110.2685, ***if and only if***: $x'_B - x'_A = 0$, but it is not the case.

Furthermore, I would like to assert, respectfully, that, related to the K' reference frame, the frame the author of arXiv:1110.2685 takes 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 arXiv:1110.2685, K', are taken into consideration since the clocks at A and B in this reference frame tagging the events of departure and arrival are previously synchronized by the very radio signals the author refers at the final of the article arXiv:1110.2685. Hence, once the Lorentz transformations provide the τ_{clock}, one should not consider radio signals twice.

Concluding, it seems unlikely that the OPERA collaboration has misinterpreted a GPS time interval.

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[1] The OPERA collaboration: T. Adam et al. Measurement of the neutrino velocity with the OPERA detector in the CNGS beam http://arxiv.org/abs/1109.4897 *arXiv:1109.4897*, 2011.

[2] Ronald A.J. van Elburg. Times of Flight between a Source and a Detector observed from a GPS satelite http://arxiv.org/abs/1110.2685 *arXiv:1110.2685*, 2011.