1.3 OPERA neutrino anomaly solution

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Abstract

Implementation of tautological relation of light speed and gravity (*g=cd*) solved and explained the anomaly observed during the OPERA experiment. The observed disagreement with the predicted time has been calculated up to the level of tolerance of +3.375 ns, which is 4.236 times less than the specified tolerance. The only used data from the experiment was the length of a specific baseline. Because of the rigidity of the principle, the degree of approximation from the use of mean values of the Earth's radius and acceleration is irrelevant in the solution of the anomaly.

1.3.1 A brief description of OPERA experiment

Experiment settings, performance and the result are brief description of the article "Measurement of neutrino velocity with the OPERA detector in the CNGS beam", published on the internet address: http://arxiv.org/abs/1109.4897.
All settings and the results are quoted from specified article.

Using very precise methods, during the time between 2009 and 2011, OPERA neutrino experiment at Gran Sasso underground laboratory, performed successive measurement of the neutrinos speed emitted from CERN over the baseline length of 730 km through the Earth's crust. The experiment has measured 60.7 ± 6.9 (stat.) ± 7.4 (sys.) ns (nanoseconds) earlier arrival of muon neutrinos compared to the relative difference of their speed to velocity of light c; $(v-c)/c$ = (2..48 ± 0.28 (stat.) ± 0.30 (sys.)) × 10^{-5}. (Stat. and sys. are abbreviations for statistical and systematic scale of errors conditioned by very small time interval measurements, the physical distance of two laboratories whose clocks were synchronized over a clock on the shared satellite, and extremely complex settings of the experiment).

For a solution of the perceived anomaly, from the text that describes in detail the methods of measurement and data processing, we need the following data;

The result of analysis of raw data Δt (blind) = 1,048.5 ± 6.9 (stat.) ns
The sum of all corrections of raw analysis (stat.) = -987.8 ns
The sum of all systematic uncertainties in the measurement (sys.) = 7.4 ns
baseline length s = 731,278 m/$s_{s/c}$
speed of light c = 299,792,458 m/s

and the specific values of the measurement system, which are not mentioned in the cited article, and were used in the anomaly solution;

Earth's radius r = 6,378,135 m/$s_{r/c}$
Earth's surface acceleration a = 9.807 m

In the experiment, the result of raw data was subtracted by the sum of all corrections, and the obtained result was (1.3.1.1);

$$\Delta t = \mathrm{TOF_c} - \mathrm{TOF_v} = 1048.5\ \mathrm{ns} - 987.8\ \mathrm{ns} = (60.7 \pm 6.9\ (\mathrm{stat.}))\ \mathrm{ns} \qquad 1.3.1.1$$

(where the TOF stands for the "Time of Flight"), in which systematic uncertainties were calculated, so obtained result represented precise possible range of the measured difference in time (1.3.1.2);

$$\Delta t = \mathrm{TOF_c} - \mathrm{TOF_v} = (60.7 \pm 6.9\ (\mathrm{stat.}) \pm 7.4\ (\mathrm{sys.}))\ \mathrm{ns}. \qquad 1.3.1.2$$

Thus, the measured relative speed difference of muon neutrinos, compared to the speed of light is (1.3.1.3);

$$(v\text{-}c)/c = \Delta t\ /(\mathrm{TOF_c} - \Delta t) = (2.48 \pm 0.28\ (\mathrm{stat.}) \pm 0.30\ (\mathrm{sys.})) \times 10^{-5} \qquad 1.3.1.3$$

1.3.2 Solution

Because of the purity of the proof, used values are average (common average acceleration and the distance from the centre of the Earth, of emission and receiving signal points), whose more precise values do not significantly affect the validity of the proof which result reside deep within the predetermined tolerance scale of the experiment.

According to symmetric equalities (0.0.8, 0.0.18), gravity is the expansion of velocity c, i.e. the genesis of space g in time d, which in 1 s time manifests as a frequency c/a of speed c in space a (consequently, the unit for formulation c^2/a is m/s^2). Therefore, through the consequential phenomenon of free fall, we read it as a constant force towards centre of mass, i.e. force of gravity. In a case of synchronised time of approximately equal speed reference frame positions of sending and receiving signals, the signal which passes through different space-time frames, i.e. systems of different speed, records the consequent space-time disagreement with the prediction of the observer. Space-time positions of a signal that spreads and lasts in space-time of greater expansion, in less expandable space-time frame of an observer, in the expected area of the detector appears to be premature in time.

Neutrino signal from CERN to OPERA was sent straight through the Earth's crust. Consequently, as at every point of its motion altered the distance from the centre of the Earth, the neutrino signal trajectory went through different gravitational surroundings. At every point of his journey, gravity was higher than at those in areas of emission and reception.

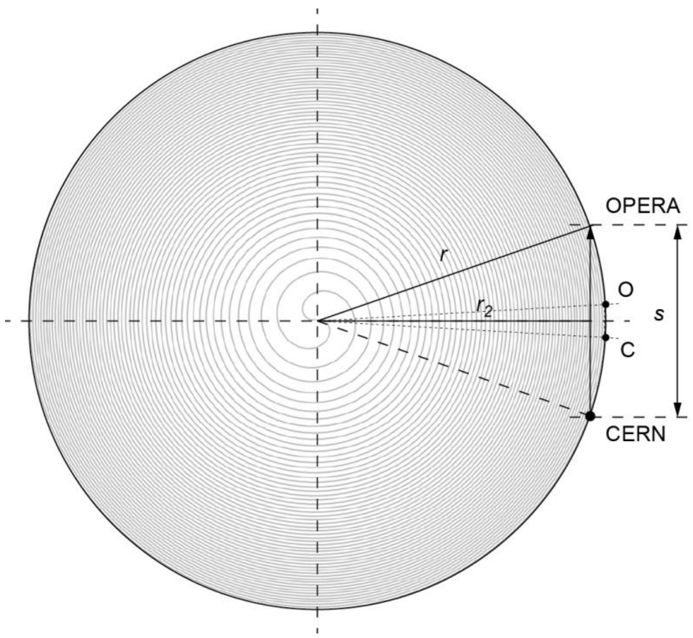

Figure 1.3.2.a

Because of better readability, the figure 1.3.2.a shows the exaggerated difference between Earth's radius r, from which surface the signal was sent and on which it was received, and the radius of the deepest position of the signal r_2 (the smaller triangle with points C and O shows approximately the appropriate relative distance in relation to the illustrated radius r). Both laboratories are underground, but as noted, a slight difference of their distances from the vortex centre of their space-time attractor, relative to its radius and their mutual distance, is ignored.
Therefore, the radius r_2 is equal to (1.3.2.1);

$$r_2 = \sqrt{r^2 - \left(\frac{s}{2}\right)^2} \qquad 1.3.2.1$$

Which amounts 6,367,645.8915 $m/s_{r2/c}$. Results, that the greatest depth of the signal passing through the Earth's crust, (r-r_2) is 10,489.1085 $m/s_{(r-r2)/c}$. According to a valid equality for acceleration a_n at any distance r_n from the centre of the space-time vortex of radius r (0.0.37) we derive (1.3.2.2);

$$a_{r_2} = \frac{ar^2}{{r_2}^2} \qquad 1.3.2.2$$

Accordingly, the acceleration a_{r2} at position r_2 is 9.8393358 m.

Variable speed system of signal trajectory is graphically shown in Figure 1.3.2.b. Acceleration of an observer located on the Earth's surface at its corresponding dilatation, measure constant speed of light. Thus, although the system is constantly accelerating, the observer measures the linear flow of time and linear space propagation. Also, higher acceleration a_2, by higher acceleration dilatation d_{a2}, at the surrounding area of the transmitted neutrino signal, measures unchanged speed of light ($c=a_2/d_{a2}$)

and physics within its system remains unchanged.

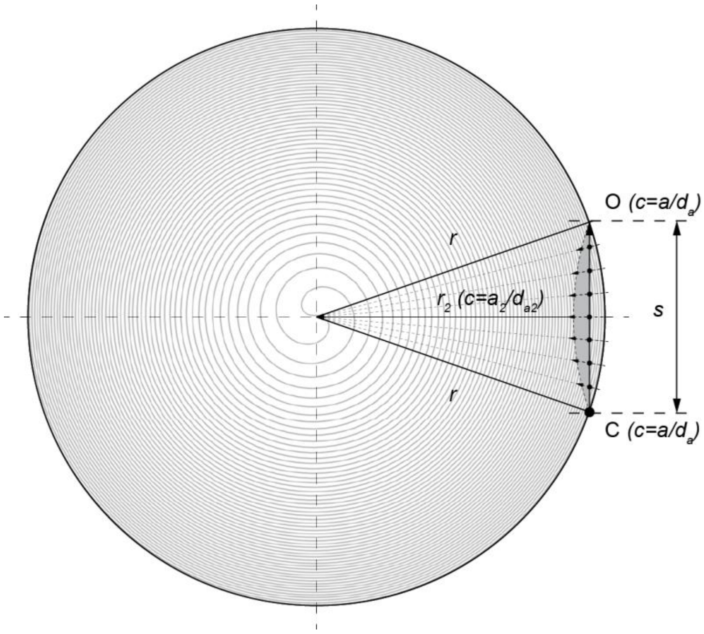

Figure 1.3.2.b

However, as higher acceleration means more stretching of space-time, i.e. greater expansion of velocity *c*, the observer in an unaltered accelerating environment records premature arrival of the signal, which leads to conclusion that the theoretically universally fixed, light speed limit was broken. Speed of light is a space-time scalar of time vector and its cross product space (0.0.9), (dilatation and gravity, in this case the acceleration dilatation and acceleration), so its measured value in any accelerating frame of reference remains unchanged. Its persistence within each accelerating system and the variability among the systems is the nature of the OPERA neutrino experiment anomaly solution.

Due to the variable depth of neutrino signal trajectory positions, the mean acceleration a_m, of the environment which the signal passes through, is calculated as a ratio of the circle sector area VCO, P_1, and the corresponding inscribed triangle VCO, P_2 (Fig. 1.3.2.c);

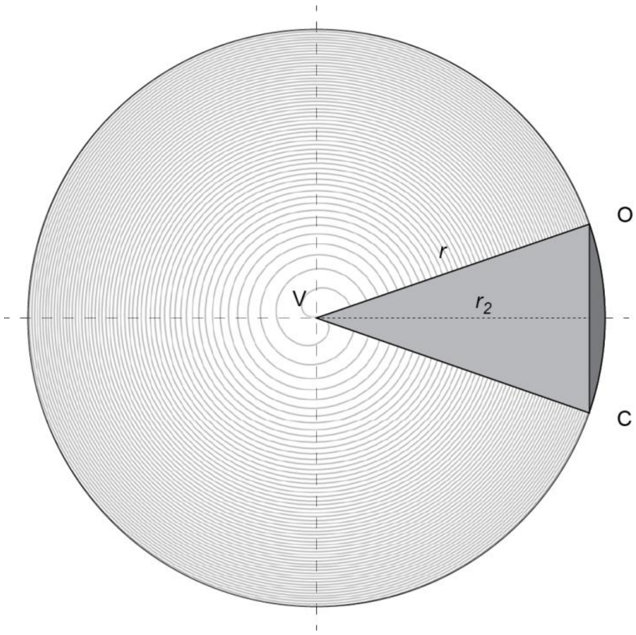

Figure 1.3.2.c

Follows from the above we have the relation (1.3.2.3);

$$a_m = a_2 \frac{P_2}{P_1} \qquad 1.3.2.3$$

By including the obtained result (9.8177691338003 m), in relation (1.3.2.2), we obtain the mean depth of the trajectory signal (r-r_m), which is 3,499.05535 m/$s_{r\text{-}rm/c}$. Consequently, the signal system at trajectory of the base line s is treated as if it spent the whole time at this depth, i.e. in the system of acceleration (light speed expansion) a_m.

It follows that the system of the expansion of velocity c, i.e. the acceleration of signal trajectory system a_m, is 0.0107691338002951 m (Δa) greater than the acceleration of system at points C, and O (1.3.2.4).

$$\Delta a = a_m - a \qquad 1.3.2.4$$

In other words, one meter of that system, in relation to the meter of the observer, in one second of the observer, stretches by the amount Δm (1.3.2.5), (Δm=0.00000000003592196372 m).

$$\Delta m = \frac{\Delta a}{c} \qquad 1.3.2.5$$

Since the same amount, expressed in seconds, is the time Δd needed for speed of light to pass Δa (1.3.2.6);

$$\Delta d = \frac{\Delta a}{c} \qquad 1.3.2.6$$

the second stretched for the same amount and the system of the signal measures unchanged, constant speed of light. Due to described, the signal is not overtaking the speed *c*, measured within its system.

The amount of one meter expansion *Δm*, multiplied by the number of meters consisted in a baseline *s*, is the amount of the expansion of velocity *v*, in described case *c*, i.e. the space-time expansion of signal trajectory (*Δms*=0.00002626891869490010 m) at time 1s (1.3.2.7);

$$\Delta c = \Delta ms \tag{1.3.2.7}$$

Deviation of the above amount, from the results obtained in OPERA experiment (1.3.1.3) is 0.13×10^{-5}, which is 4.45 times less than the assumed tolerance.

To obtain result for space-time expansion, determined by altered time *Δt*, in propagation time of velocity c at the described path of a baseline *s*, the obtained result is multiplied by its time of flight (TOFc=s/c). Accordingly, we have the relation (1.3.2.8);

$$\Delta t = \Delta c TOF_c \tag{1.3.2.8}$$

which is equivalent to (1.3.2.9, 1.3.2.10);

$$\Delta t = \frac{\Delta m s^2}{c} \tag{1.3.2.9}$$

$$\Delta t = \frac{\Delta c s}{c} \tag{1.3.2.10}$$

Therefore, measured from the reference frame of constant speed of light of an observer, it is true that the change of time *Δt* equivalents to change of space *Δs* (1.3.2.11);

$$\Delta t = \Delta s \tag{1.3.2.11}$$

It is the nature of space-time dynamics of propagation and duration, of all accelerating frames that consequently measure a constant speed of light.

Expansion of time *Δt* and space *Δs* of a signal trajectory, the observer notes as its premature arrival. Information of space-time stretch is measured with time. Calculated *Δt* amounts 0.00000006407572827191 s i.e. 64.076 ns. Deviation of the obtained result from the result measured and processed in the experiment (1.3.1.2) is 4.236 times less than the assumed tolerance.

The recorded anomaly is not a consequence of specific nature of neutrinos. If it could travel at the neutrino trajectory, the same disagreement would be recorded with the light signal. Also, if the signal went at deeper trajectory, or if it spent more time at measured depth, the category of "faster than the speed of light" would also apply for heavier space-time positions, i.e. protons and pions, which did not record the above anomaly in described experiment.

In specified case, the orbital positions of CERN and Gran Sasso are the top, while the variable orbit of the base line is the bottom of the tower in Pound-Rebka experiment.

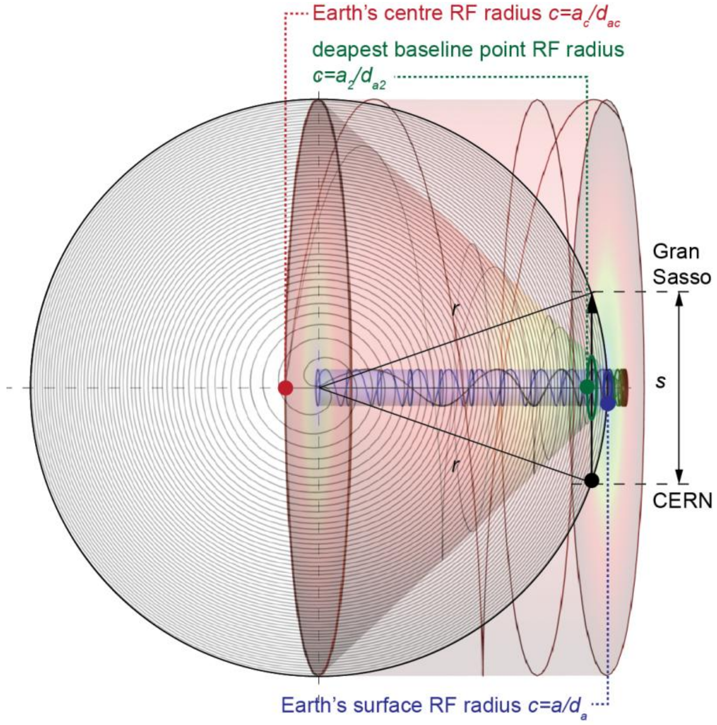

Figure. 1.3.2.d *Graphical presentation of space-time relations among different gravity fields in the OPERA experiment.*

The OPERA neutrino experiment measured the nature of gravitational wave.

1.3.3 Conclusion

The only data used from cited article is the length of the baseline specific for the OPERA experiment. All results of the experiment were used solely for comparison with results obtained by implementing the described tautological principle (0.0.8, 0.0.18). Therefore, the principle predicts the result of OPERA neutrino experiment. The solution of its perceived anomaly is its implication and, as such, proof of a principle. In the table attached (OPERA_neutrino_anomaly_solution.xlsx), beside OPERA's, presented are the results of three possible replicas of the same experiment: Fermilab - Gran Sasso, CERN - Kamiokande, Fermilab - Kamiokande. As the baseline of selected locations passes significantly deeper, provided time fractions of premature signal arrivals are in the range of milliseconds. Thus, these experiments are much more resistant to scale of possible systematic and statistical errors and uncertainties, which eliminate the possibility of their manipulation.