Neutrino, Flying from CERN to LNGS, and Brachistochrone

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Abstract

The result of the OPERA neutrino experiment [1] at the underground Gran Sasso Laboratory (LNGS) is explained by the brachistochrone effect.

A particle, which flys from a point C to point L in the Earth gravitational field (Figure 1), should submit to the brachistochrone problem decision:

$$\begin{aligned} x &\simeq -\frac{v^6}{9g^3S^2}(\theta-\sin\theta)+\frac{S}{2}, \\ y &\simeq -\frac{v^6}{9g^3S^2}(1-\cos\theta)+\frac{v^2}{2g} \end{aligned}$$

for large value of v. Here v is the initial velosity, S is the distanse between points C and L by GPS.

In this case in point C: $\theta_C \simeq -3\frac{S}{v^2}g$, in point L: $\theta_L \simeq 3\frac{S}{v^2}g$, and the particle passes a way of cycloid CRL during

$$T_{CRL} \simeq 3\sqrt{\frac{2}{\pi}}\frac{\sqrt{g}}{v^2}\left(\sqrt{S}\right)^3.$$

Such time on stright line CL:

$$T_{CL} = \frac{1}{v}S.$$

Thus $T_{CRL} \geq T_{CL}$ only if

$$S \geq \frac{1}{18}\frac{\pi}{g}v^2.$$

But in the considerated case this condition isn't executed.

Therefore, value of distance by GPS is larger than value of this distance which is measured by direct method.

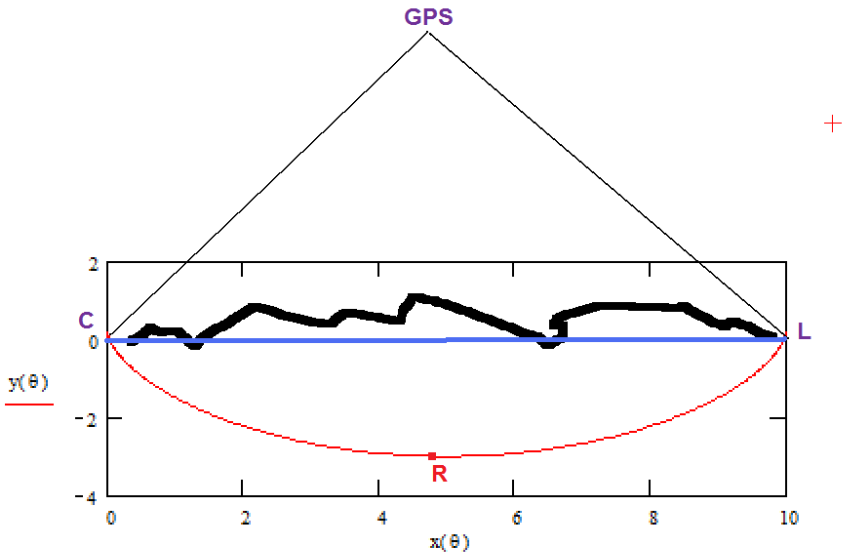

Figure 1:

References

[1] The OPERA Collaboraton, Measurement of the neutrino velocity with the OPERA detector in the CNGS beam. http://arxiv.org/abs/1109.4897