Special relativity may answer faster-than-light neutrino mystery

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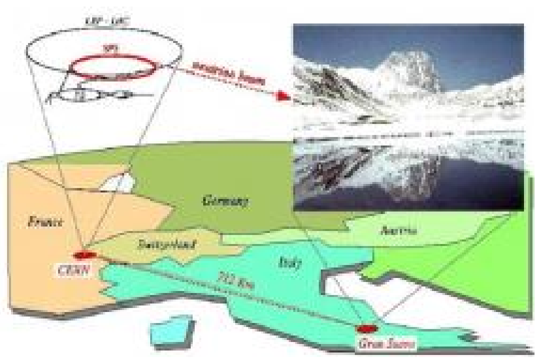

The relativistic motion of clocks on board GPS satellites exactly accounts for the superluminal effect, says physicist. Credit: axirv

Oh, yeah. Moving faster than the speed of light has been the hot topic in the news and OPERA has been the key player. In case you didn't know, the experiment unleashed some particles at CERN, close to Geneva. It wasn't the production that caused the buzz, it was the revelation they arrived at the Gran Sasso Laboratory in Italy around 60 nanoseconds sooner than they should have. Sooner than the speed of light allows!

Since the announcement, the physics world has been on fire, producing more than 80 papers – each with their own opinion. While some tried to explain the effect, others discredited it. The overpowering concensus was the OPERA team simply must have forgotten one critical element. On October 14, 2011, Ronald van Elburg at the University of Groningen in the Netherlands put forth his own statement – one that provides a persuasive point that he may have found the error in the calculations.

To get a clearer picture, the distance the neutrinos traveled is straightforward. They began in CERN and were measured via global positioning systems. However, the Gran Sasso Laboratory is located beneath the Earth under a kilometre-high mountain. Regardless, the OPERA team took this into account and provided an accurate distance measurement of 730 km to within tolerances of 20 cm. The neutrino flight time is then measured by using clocks at the opposing ends, with the team knowing exactly when the particles left and when they landed.

But were the clocks perfectly synchronized?

Keeping time is again the domain of the GPS satellites which each broadcasting a highly accurate time signal from orbit some 20,000km overhead. But is it possible the team overlooked the amount of time it took for the satellite signals to return to Earth? In his statement, van Elburg says there is one effect that the OPERA team seems to have overlooked: the relativistic motion of the GPS clocks.

Sure, radio waves travel at the speed of light, so what difference does the satellite position make? The truth is, it doesn't... but the time of flight does. Here we have a scenario where one clock is on the ground while the other is orbiting. If they are moving relative to one another, this calculation needs to be included in the findings. The orbiting probes are positioned from West to East in a plane inclined at 55 degrees to the equator… almost directly in line with the neutrino flight path. This means the clock on the GPS is seeing the neutrino source and detector as changing.

"From the perspective of the clock, the detector is moving towards the source and consequently the distance travelled by the particles as observed from the clock is shorter," says van Elburg.

According to the news source, he means shorter than the distance measured in the reference frame on the ground and the OPERA team overlooks this because it thinks of the clocks as on the ground not in orbit. Van Elburg calculates that it should cause the neutrinos to arrive 32 nanoseconds early. But this must be doubled because the same error occurs at each end of the experiment. So the total correction is 64 nanoseconds, almost exactly what the OPERA team observes.

Is this the final answer for traveling faster than the speed of light? No. It's just another possible answer to explain a new riddle... and a confirmation of a new revelation.

More information: Time-of-flight between a Source and a Detector observed from a Satellite, arXiv:1110.2685v2 [physics.gen-ph] arxiv.org/abs/1110.2685

Abstract
The Michelson-Morley experiment shows that the experimental outcome of an interference experiment does not depend on the constant velocity of the setup with respect to an inertial frame of reference. From this one can conclude the existence of an invariant velocity of light. However it does not follow from their experiment that a time-of-flight is reference frame independent. In fact the theory of special relativity predicts that the distance between the production location of a particle and the detection location will be changed in all reference frames which have a velocity component parallel to the baseline separating source and detector in a foton time-of-flight experiment. For the OPERA experiment we find that the associated correction is in the order of 32 ns. Because, judging from the information provided, the correction needs to be applied twice in the OPERA experiment the total correction to the final results is in the order of 64 ns. Thus bringing the apparent

velocities of neutrino's back to a value not significantly different from the speed of light. We end this short letter by suggesting an analysis of the experimental data which would illustrate the effects described.

via Technology Review

Source: Universe Today

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