Possible systematic error in OPERA neutrino experiment
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The OPERA experiment has reported measuring neutrino velocities that are faster than the speed of light. The neutrinos appeared to arrive 60 ns early after traversing 730 km from CERN to the OPERA neutrino detector at the Gran Sasso Laboratory. The measurements were made with great care, but there may be some systematic error that explains the surprising results. We suggest a possible source of such error.

Timing is established by determining the proton time distribution during each 10.5 μs beam extraction and comparing it with the neutrino time distribution. The time shift required to make the two distributions coincide is the travel time of the neutrinos.

The reliability of this comparison requires that the time distribution of neutrinos has the same shape as the time distribution of protons for each 10.5 μs (10500 ns) beam extraction. Any diminution of neutrinos in the detector per proton on the graphite target later in the beam extraction would result in the early arriving neutrinos being given excessive weight in determining the average travel time. Only a small change in the time distribution is needed to cause a 60 ns shift out of 10500 ns.

We suggest a possible mechanism. The graphite target must heat up during each proton pulse. The thermal expansion of the carbon causes the pions to be produced farther into the 2 m long target. The efficiency of the magnetic horn for focusing the pions into a beam is certainly not constant over the entire 2 m length of the target. It is not just the total number of focused pions, and therefore neutrinos, but also the degree of collimation. For a wider beam at the detector, the fraction of the neutrinos detected is smaller.

We suggest a simple method of checking on this possibility. Recalculate the shift in time after multiplying the proton time distribution by a linear function that is 1.03 at the beginning and 0.97 at the end of the extraction. Note the amount this shifts the time and then adjust the x in 1+x and 1-x until the 60 ns is eliminated and then check to see if the fit of the neutrino time distribution to the modified proton time distribution is better, or at least not significantly worse, than the original.

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