SUPERLUMINAL NEUTRINOS

Loose Cable May Unravel Faster-Than-Light Result

Anomalous data suggesting that neutrinos can travel faster than light probably resulted from a faulty connection in a GPS timing system, physicists from the OPERA collaboration revealed last week. Scientists who wish not to be identified say a few persistent OPERA researchers spotted the problem during tests the collaboration’s leaders at first opposed.

OPERA, or Oscillation Project with Emulsion Tracking Apparatus, is a particle detector housed under the Gran Sasso mountain in central Italy. In September 2011, 171 scientists from the international collaboration announced that thousands of measurements made between 2009 and 2011 seemed to show that neutrinos from the CERN laboratory near Geneva, Switzerland, were reaching Gran Sasso some 60 billionths of a second (60 nanoseconds) earlier than light would—a finding at odds with Einstein’s special theory of relativity (Science, 30 September 2011, p. 1809). In November, measurements with shorter, easier-to-time pulses confirmed the anomaly, but many physicists remained skeptical (Science, 2 December 2011, p. 1200).

That skepticism has grown with the latest announcement. From December 2011 until a couple of weeks ago, a small group of OPERA researchers carefully measured how much time it takes light pulses to travel along an 8-kilometer optical fiber that connects an external GPS receiver to the Gran Sasso laboratory. The “time stamps” encoded by these pulses are also sent to CERN to synchronize timing at the two labs, but the time that the pulses take to travel along the fiber must be added to the time stamp to ensure that the neutrinos’ arrival times are recorded accurately.

The investigators discovered that the pulses’ transit time varied by several tens of nanoseconds depending on how tightly the coaxial fiber cable was plugged into a socket attached to a card inside the experiment’s master-clock computer. The card converts the light pulses into electronic signals. Any loose connection was supposed to stop the pulses from being registered, but instead it appears that the card allowed the delayed pulses to get through. So a loose connection during the experiment would have stamped neutrino pulses with arrival times suggesting faster-than-light travel. Although researchers can’t be sure the cable was loose during the experiment, the size of the delays involved is highly suggestive.

The travel times of pulses along the fiber had been measured in 2008 by collaboration member Dario Autiero of the University of Lyon in France. A source familiar with the experiment says some researchers thought the measurement should have been rechecked before the neutrino velocity results were submitted to a journal in November, but OPERA’s scientific management resisted carrying out such a check. (Autiero and collaboration spokesman Antonio Ereditato of the University of Bern in Switzerland were unavailable for comment before this story went to press.)

In December, the researchers finally got the go-ahead to test the fiber. Last week, OPERA issued a written statement confirming that the possible fiber delay, combined with a second potential source of error, could “substantially influence” the velocity results. This other potential error—an electronic card in the oscillator used to provide the fine-grain timing for individual neutrino events between GPS pulses—would cause the stamp to show a later time than it should. But Lucia Voltano, director of the Gran Sasso lab, says researchers consider the connection problem more significant. “This is the main suspicion because it is in the right direction for explaining the anomaly and is also bigger than the other effect,” she says.

A technical report on these two possible sources of error is being prepared for discussion at a forthcoming collaboration meeting. But the final word should come in May, when CERN will send a high-precision pulsed neutrino beam to OPERA and three other Gran Sasso detectors. The test will use two independent timing systems. “If none of these experiments detected the anomaly, then that would be definite proof that neutrinos can’t travel faster than light,” Voltano says. Meanwhile, physicists in the United States will be measuring the speed of neutrinos sent from Fermilab near Chicago to the MINOS detector in a mine in northern Minnesota.

David Wark of Imperial College London, a physicist who works on the T2K neutrino experiment in Japan, says it was “reasonable” for OPERA to release its results when it did. “If they sit on it for [too] long, inevitably it will come out on someone’s blog, and they will have no control over that,” he says.

“Instead, they said to the scientific community, ‘Look, we have something weird. Can you explain it?’ ”

But one OPERA scientist believes the error should have been caught. “What’s happened here is an accident, something unexpected, but identifying these things is part of the scientific procedure,” the researcher says. “In recent years, there has been too much pressure in science to be first. This has made us go faster than we should have done.”

—EDWIN CARTLIDGE

Edwin Cartlidge is a writer based in Rome.