Published online 22 September 2011 | Nature | doi:10.1038/news.2011.554
Updated online: 23 September 2011

News

Particles break light-speed limit

Neutrino results challenge cornerstone of modern physics.

Geoff Brumfiel

Has OPERA found super-speedy neutrinos?
CERN

An Italian experiment has unveiled evidence that fundamental particles known as neutrinos can travel faster than light. Other researchers are cautious about the result, but if it stands further scrutiny, the finding would overturn the most fundamental rule of modern physics — that nothing travels faster than 299,792,458 metres per second.

The experiment is called OPERA (Oscillation Project with Emulsion-tRacking Apparatus), and lies 1,400 metres underground in the Gran Sasso National Laboratory in Italy. It is designed to study a beam of neutrinos coming from CERN, Europe's premier high-energy physics laboratory located 730 kilometres away near Geneva, Switzerland. Neutrinos are fundamental particles that are electrically neutral, rarely interact with other matter, and have a vanishingly small mass. But they are all around us — the Sun produces so many neutrinos as a by-product of nuclear reactions that many billions pass through your eye every second.

The 1,800-tonne OPERA detector is a complex array of electronics and photographic emulsion plates, but the new result is simple — the neutrinos are arriving 60 nanoseconds faster than the speed of light allows. "We are shocked," says Antonio Ereditato, a physicist at the University of Bern in Switzerland and OPERA's spokesman.

Breaking the law

The idea that nothing can travel faster than light in a vacuum is the cornerstone of Albert Einstein's special theory of relativity, which itself forms the foundation of modern physics. If neutrinos are travelling faster than light speed, then one of the most fundamental assumptions of science — that the rules of physics are the same for all observers — would be invalidated. "If it's true, then it's truly extraordinary," says John Ellis, a theoretical physicist at CERN.

Ereditato says that he is confident enough in the new result to make it public. The researchers claim to have measured the 730-kilometre trip between CERN and its detector to within 20 centimetres. They can measure the time of the trip to within 10 nanoseconds, and they have seen the effect in more than 16,000 events measured over the past two years. Given all this, they believe the result has a significance of six-sigma — the physicists' way of saying it is certainly correct. The group will present their results tomorrow at CERN, and a preprint of their results will be posted on the physics website ArXiv.org.

At least one other experiment has seen a similar effect before, albeit with a much lower confidence level. In 2007, the Main Injector Neutrino Oscillation Search (MINOS) experiment in Minnesota saw neutrinos from the particle-physics facility Fermilab in Illinois arriving slightly ahead of schedule. At the time, the MINOS team downplayed the result, in part because there was too much uncertainty in the detector's exact position to be sure of its significance, says Jenny Thomas, a spokeswoman for the experiment. Thomas says that MINOS was already planning more accurate follow-up experiments before the latest OPERA result. "I'm hoping that we could get that going and make a measurement in a year or two," she says.

Reasonable doubt

If MINOS were to confirm OPERA's find, the consequences would be enormous. "If you give up the speed of light, then the construction of special relativity falls down," says Antonino Zichichi, a theoretical physicist and emeritus professor at the University of Bologna, Italy. Zichichi speculates that the 'superluminal' neutrinos detected by OPERA could be slipping through extra dimensions in space, as predicted by theories such as string theory.

Ellis, however, remains sceptical. Many experiments have looked for particles travelling faster than light speed in the past and have come up empty-handed, he says. Most troubling for OPERA is a separate analysis of a pulse of neutrinos from a nearby supernova known as 1987a. If the speeds seen by OPERA were achievable by all neutrinos, then the pulse from the supernova would have shown up years earlier than the exploding star's flash of light; instead, they arrived within hours of each other. "It's difficult to reconcile with what OPERA is seeing," Ellis says.

Ereditato says that he welcomes scepticism from outsiders, but adds that the researchers have been unable to find any other explanation for their remarkable result. "Whenever you are in these conditions, then you have to go to the community," he says.

UPDATED: *The OPERA collaboration has posted* ***a paper*** *describing their result.*

Comments

If you find something abusive or inappropriate or which does not otherwise comply with our ***Terms*** *or* ***Community Guidelines****, please select the relevant 'Report this comment' link.*

Comments on this thread are vetted after posting.

#59818

I like this article and it makes me think about it more seriously and now i would like to sahre my ideas and opinion with other people also. thank you so much for this article **Biltmore homes for sale**

Report this comment

Posted by: **Alicia Collien** | 2013-08-26 08:24:15 AM

A physicist at the front line takes us through the fall-out when an international team of physicists announced certain particles had broken light speed. #60292
FM radio online":http://www.radiostime.com/

Report this comment Posted by: **heena sharma** | 2013-10-09 07:33:59 AM

The speed of light is widely held to be the Universe's ultimate speed limit, and much of modern physics – as laid out in part by Albert Einstein in his theory of special relativity – depends on the idea that nothing can exceed it. #60572
gold

Report this comment Posted by: **kitty gibson** | 2013-10-31 04:06:59 AM

The speed of light is widely held to be the Universe's ultimate speed limit, and much of modern physics – as laid out in part by Albert Einstein in his theory of special relativity – depends on the idea that nothing can exceed it. #61018
divorce in texas

Report this comment Posted by: **kitty gibson** | 2013-11-10 11:44:29 PM

Its important to make people feel comfort near us. We are need other people in our life. We cant live alone in this life. That is why we need to make a good relation to all the people around us. #61029
medical travel

Report this comment Posted by: **cheena wilson** | 2013-11-12 12:30:17 AM

In breaking news, physicists reported Thursday that sub-atomic particles called neutrinos can travel faster than light, a finding that – if verified – would blast a hole in Einstein's theory of relativity. #62409
foamposite

Report this comment Posted by: **suyash Sharma** | 2013-12-12 01:45:19 AM

Commenting is now closed.

Nature ISSN 0028-0836 EISSN 1476-4687