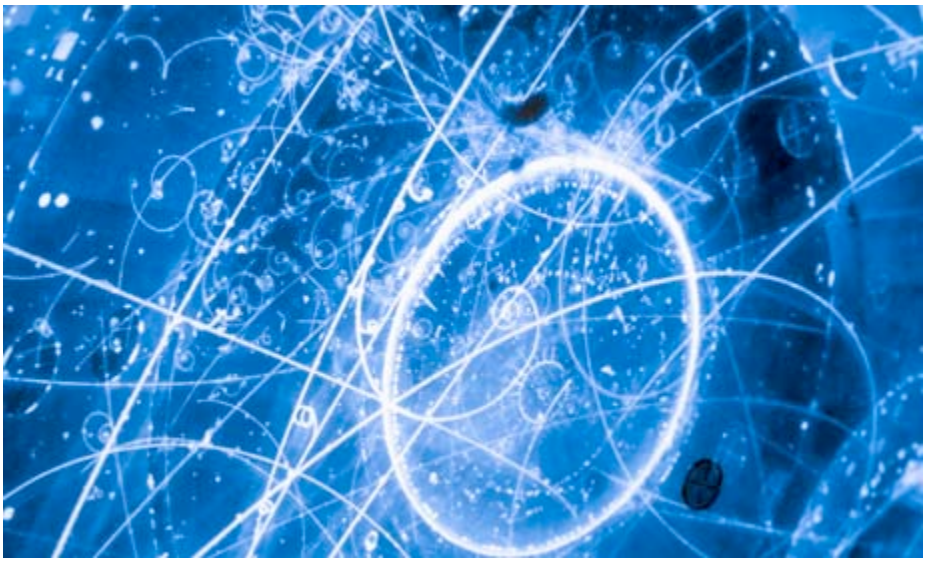
theguardian

Faster than light particles found, claim scientists

Particle physicists detect neutrinos travelling faster than light, a feat forbidden by Einstein's theory of special relativity

- Ian Sample, science correspondent

- guardian.co.uk, Thursday 22 September 2011 23.32 BST
- Article history



Neutrinos, like the ones above, have been detected travelling faster than light, say particle physicists. Photograph: Dan Mccoy /Corbis

It is a concept that forms a cornerstone of our understanding of the universe and the concept of time – nothing can travel faster than the speed of light.

But now it seems that researchers working in one of the world's largest physics laboratories, under a mountain in central Italy, have recorded particles travelling at a speed that is supposedly forbidden by Einstein's theory of special relativity.

Scientists at the Gran Sasso facility will unveil evidence on Friday that raises the troubling possibility of a way to send information back in time, blurring the line between past and present and wreaking havoc with the fundamental principle of cause and effect.

They will announce the result at a special seminar at Cern – the European particle physics laboratory – timed to coincide with the publication of a research paper describing the experiment.

Researchers on the Opera (Oscillation Project with Emulsion-tRacking Apparatus) experiment recorded the arrival times of ghostly subatomic particles called neutrinos sent from Cern on a 730km journey through the Earth to the Gran Sasso lab.

The trip would take a beam of light 2.4 milliseconds to complete, but after running the experiment for three years and timing the arrival of 15,000 neutrinos, the scientists discovered that the particles arrived at Gran Sasso sixty billionths of a second earlier, with an error margin of plus or minus 10 billionths of a second.

The measurement amounts to the neutrinos travelling faster than the speed of light by a fraction of 20 parts per million. Since the speed of light is 299,792,458 metres per second, the neutrinos were evidently travelling at 299,798,454 metres per second.

The result is so unlikely that even the research team is being cautious with its interpretation. Physicists said they would be sceptical of the finding until other laboratories confirmed the result.

Antonio Ereditato, coordinator of the Opera collaboration, told the Guardian: "We are very much astonished by this result, but a result is never a discovery until other people confirm it.

"When you get such a result you want to make sure you made no mistakes, that there are no nasty things going on you didn't think of. We spent months and months doing checks and we have not been able to find any errors.

"If there is a problem, it must be a tough, nasty effect, because trivial things we are clever enough to rule out."

The Opera group said it hoped the physics community would scrutinise the result and help uncover any flaws in the measurement, or verify it with their own experiments.

Subir Sarkar, head of particle theory at Oxford University, said: "If this is proved to be true it would be a massive, massive event. It is something nobody was expecting.

"The constancy of the speed of light essentially underpins our understanding of space and time and causality, which is the fact that cause comes before effect.

"Cause cannot come after effect and that is absolutely fundamental to our construction of the physical universe. If we do not have causality, we are buggered."

The Opera experiment detects neutrinos as they strike 150,000 "bricks" of photographic emulsion films interleaved with lead plates. The detector weighs a total of 1300 tonnes.

Despite the marginal increase on the speed of light observed by Ereditato's team, the result is intriguing because its statistical significance, the measure by which particle physics discoveries stand and fall, is so strong.

Physicists can claim a discovery if the chances of their result being a fluke of statistics are greater than five standard deviations, or less than one in a few million. The Gran Sasso team's result is six standard deviations.

Ereditato said the team would not claim a discovery because the result was so radical. "Whenever you touch something so fundamental, you have to be much more prudent," he said.

Alan Kostelecky, an expert in the possibility of faster-than-light processes at Indiana University, said that while physicists would await confirmation of the result, it was none the less exciting.

"It's such a dramatic result it would be difficult to accept without others replicating it, but there will be enormous interest in this," he told the Guardian.

One theory Kostelecky and his colleagues put forward in 1985 predicted that neutrinos could travel faster than the speed of light by interacting with an unknown field that lurks in the vacuum.

"With this kind of background, it is not necessarily the case that the limiting speed in nature is the speed of light," he said. "It might actually be the speed of neutrinos and light goes more slowly."

Neutrinos are mysterious particles. They have a minuscule mass, no electric charge, and pass through almost any material as though it was not there.

Kostelecky said that if the result was verified – a big if – it might pave the way to a grand theory that marries gravity with quantum mechanics, a puzzle that has defied physicists for nearly a century.

"If this is confirmed, this is the first evidence for a crack in the structure of physics as we know it that could provide a clue to constructing such a unified theory," Kostelecky said.

Heinrich Paes, a physicist at Dortmund University, has developed another theory that could explain the result. The neutrinos may be taking a shortcut through space-time, by travelling from Cern to Gran Sasso through extra dimensions. "That can make it look like a particle has gone faster than the speed of light when it hasn't," he said.

But Susan Cartwright, senior lecturer in particle astrophysics at Sheffield University, said: "Neutrino experimental results are not historically all that reliable, so the words 'don't hold your breath' do spring to mind when you hear very counter-intuitive results like this."

Teams at two experiments known as T2K in Japan and MINOS near Chicago in the US will now attempt to replicate the finding. The MINOS experiment saw hints of neutrinos moving at faster than the speed of light in 2007 but has yet to confirm them.