

Search

Search

Filter by topic

Filter

[Home](#) [News](#) [Blog](#) [Multimedia](#) [In depth](#) [Jobs](#) [Events](#)
[Buyer's guide](#)

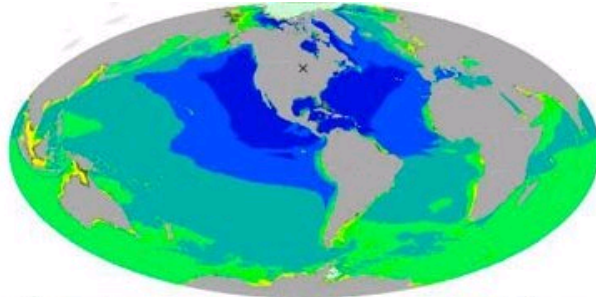
News archive

2009

- ▶ [September 2009](#)
- ▶ [August 2009](#)
- ▶ [July 2009](#)
- ▶ [June 2009](#)
- ▶ [May 2009](#)
- ▶ [April 2009](#)
- ▶ [March 2009](#)
- ▶ [February 2009](#)
- ▶ [January 2009](#)

- ▶ [2008](#)
- ▶ [2007](#)
- ▶ [2006](#)
- ▶ [2005](#)
- ▶ [2004](#)
- ▶ [2003](#)
- ▶ [2002](#)
- ▶ [2001](#)
- ▶ [2000](#)
- ▶ [1999](#)
- ▶ [1998](#)
- ▶ [1997](#)

Deep-sea communication with neutrinos

Oct 7, 2009 [8 comments](#)

Staying in touch with neutrinos

Communicating with nuclear-powered submarines – which can remain underwater essentially indefinitely – is a major challenge because seawater is opaque to most of the electromagnetic spectrum. Neutrinos have previously been proposed as a solution to this problem, because these subatomic particles can pass easily through all matter, but it was thought to be impossible to generate beams of sufficient intensity. However, a physicist in the US has now calculated that the extremely intense beams of a neutrino factory would do the job.

Nuclear-powered submarines can remain submerged for months at a time and only need to resurface to replenish food stocks or carry out maintenance. However, submarines' movements are restricted by the need to receive messages to direct their actions. Seawater is transparent only in part of the visible portion of the electromagnetic spectrum (blue and green wavelengths) and at frequencies below about 100 Hz. Using lasers in the visible is not practical and low-frequency radio transmissions result in extremely low data rates – around one bit per minute. As a result, nuclear submarines currently communicate by floating a wire antenna close to the surface of the ocean. While this supports data rates of about 50 bits per second, it restricts the depth and speed of operation of a vessel.

Sent through the Earth

Patrick Huber of Virginia Tech believes that these problems can be overcome by instead using neutrinos. Because neutrinos interact extremely weakly with other matter, a beam of such particles can be sent through the Earth with very little loss of intensity. So a submarine could in principle pick up information encoded in a neutrino beam sent from anywhere else on the planet by detecting the neutrinos that approach it from below.

Unfortunately, neutrinos interact very weakly with matter and, therefore, generating a measurable signal requires an extremely intense beam. There are currently a number of experiments around the world that involve the transmission and detection of neutrino beams in order to measure how neutrinos "oscillate" as they travel through space, an important area of study in fundamental physics. But such facilities would be unsuited for carrying out long-range communications. For example, a beam sent from **Fermilab** outside Chicago to a mine around 700 km away in Minnesota results on average in just one neutrino being registered in the detector every 12 hours. As Huber points out, this rate would need to improve by a factor of about one million if neutrinos were to be used to send

Sign up

To enjoy free access to all high-quality "In depth" content, including topical features, reviews and opinion [sign up](#)

Share this

- [E-mail to a friend](#)
- [Connotea](#)
- [CiteUlike](#)
- [Delicious](#)
- [Digg](#)
- [Facebook](#)
- [Twitter](#)

Related stories

- [US could beam neutrinos to Japan](#)
- [Could neutrinos destroy nuclear weapons?](#)
- [Neutrino messages from across the Universe](#)
- [Neutrinos for geophysics](#)

Related links

- [Fermilab](#)
- [arXiv 0909.4554](#)
- [Patrick Huber](#)

Related products

- [New Controller for Optical Path Control, Beam Steering & Image Stabilization,](#)
- [PI \(Physik Instrumente\)](#)
- [L.P. Piezo Nano Positioning](#)
- [Sep 1, 2009](#)
- [The spin on electronics!](#)
- [The Royal Society](#)
- [Jul 27, 2009](#)
- [Turnkey 18kV, 20A Power System](#)
- [TDK-Lambda Americas](#)
- [Mar 24, 2009](#)

Webinar series



Heat transfer and multiphysics modelling

Free registration

Key suppliers



Corporate partners



messages.

Huber, however, has worked out that a new kind of neutrino source that physicists hope to build within the next decade – a neutrino factory – would provide sufficient intensities. A neutrino factory would work by slamming high-energy protons into a target made of liquid mercury, with the collisions producing pions, which decay into muons, which in turn decay into muon neutrinos.

Detecting Cerenkov radiation

Huber calculates that data encoded in beams of such neutrinos could be picked up by detectors wrapped around the hull of a submarine at rates of between 1 and 100 bits per second. These detectors would either pick up the muons produced when muon neutrinos interact with the water or, more indirectly, measure the Cerenkov radiation generated by the passage of such muons through the water. Data would be encoded by chopping time up into many different slots and then sending a pulse of neutrinos within a particular slot, so that one second divided up into 16,000 slots, for example, would be equivalent to transmitting one letter out of a 16,000 letter alphabet or 14 bits (2^{14}).

A neutrino factory would not come cheap – it would cost several billion dollars. And adapting it for telecommunications might, says Huber, roughly double this price; the extra expense required to make the device rotatable so that it could point to wherever a submarine is located. But Huber believes that this price should be seen in the context of the money already spent on nuclear submarines by the US, with the 14 Trident vessels, including missiles, costing some \$150bn. "There are many things I would not have thought a government would spend very large amounts of money on," he adds. "So I would not expect anyone to actually build such a system. But I would not be surprised if someone wanted to do more research on it."

The work is described on the *arXiv* preprint server.

About the author

Edwin Cartlidge is a science writer based in Rome

8 comments

[Add your comments on this article](#)

-
- 1 **kasuha** Oct 7, 2009 4:00 PM Prague, Czech Republic
Wouldn't the Cherenkov radiation be there not only around the submarine but all the way along the neutrino beam? If the effect was strong enough to pass so much data, it should not be big problem to trace it from surface or even from orbit...
- [▶ Reply to this comment](#) [▶ Offensive? Unsuitable? Notify Editor](#)
-
- 2 **Oliver K. Manuel** Oct 8, 2009 1:49 AM United States
Can Information Be Encoded in A Neutrino Beam?
I can imagine a Yes/No neutrino beam, but I am unaware of a method to encode a detailed message onto a neutrino beam.

What am I missing in the suggestion that "... a submarine could in principle pick up information encoded in a neutrino beam"?
- With kind regards,
Oliver K. Manuel
- [▶ Reply to this comment](#) [▶ Offensive? Unsuitable? Notify Editor](#)
-
- 3 **roybass** Oct 8, 2009 11:08 AM
It is similar to binary encoding of bits :
A series of Yes/No beams over a time frame is similar to a 011001100111 presentation
Edited by roybass on Oct 8, 2009 11:11 AM.
- [▶ Reply to this comment](#) [▶ Offensive? Unsuitable? Notify Editor](#)
-
- 4 **s501100kross** Oct 8, 2009 7:18 AM santa barbara, United States
"As Huber points out, this rate would need to improve by a factor of about one million if neutrinos were to be used to send messages."

More "pie in the sky"!
- [▶ Reply to this comment](#) [▶ Offensive? Unsuitable? Notify Editor](#)

5

ChrisAtUpwOct 9, 2009 11:31 AM
PETWORTH, United Kingdom

Quote:

Originally posted by s501100kross

"As Huber points out, this rate would need to improve by a factor of about one million if neutrinos were to be used to send messages."

More "pie in the sky"!

More like a yank trying to find a pot of personal research gold! The sun generates huge neutrino fluxes, but even large solvent tanks only pick up a few per day. There are other ways of increasing data rates which wouldn't break the government research bank.

[Reply to this comment](#) [Offensive? Unsuitable? Notify Editor](#)

6

Oliver K. ManuelOct 8, 2009 12:08 PM
United States**How Big Is A Neutrino Detector??**

The neutrino detectors at the Homestake Mine and at Sudbury were massive, because a neutrino can, figuratively, "pass through a light year of lead".

A submarine with such a neutrino detector on board would probably never surface again!

Has this technical problem been solved?

With kind regards,
Oliver K. Manuel

[Reply to this comment](#) [Offensive? Unsuitable? Notify Editor](#)

7

NeeyikOct 9, 2009 9:02 AM
Workington, United Kingdom

Quote:

Originally posted by Oliver K. Manuel

Has this technical problem been solved?

Current neutrino detectors are the size that they are because the flux they're detecting is very low; the article makes it clear that the flux for a communication system would need to be massively higher (and suggests a mechanism for generating such a flux). The detectors on the submarine would be looking for the muons or Cherenkov radiation; again, the article makes it clear that neither the detectors nor the submarine would form part of the system required to generate the muons or radiation - that role is taken by the ocean.

Quote:

Originally posted by kasuha

Wouldn't the Cherenkov radiation be there not only around the submarine but all the way along the neutrino beam? If the effect was strong enough to pass so much data, it should not be big problem to trace it from surface or even from orbit.

Correct but that's no different to communication systems used now (e.g. radio, microwave, IR) - such transmissions can easily be intercepted but decoding them is the difficult part. However, subs can only really communicate near the surface, which as the article points out, restricts its movements; a neutrino-based transmission system offers a signal that can penetrate water to depths that allow the sub to remain well hidden. So although the comms could be intercepted, the sub can remain hidden and therefore safe.

[Reply to this comment](#) [Offensive? Unsuitable? Notify Editor](#)

8

waro

Oct 9, 2009 2:37 AM

Neutrino communication.

Is that not just typical?

The first preference for Neutrino communications is for purposes of invasion and war.

It would be too much to expect these creatures to look for peaceful reasons for it's use, something to benefit the communities of the world.

Ofcourse it will(if successful) be imeadiately patented and that will be the last you will ever hear of it.

[Reply to this comment](#) [Offensive? Unsuitable? Notify Editor](#)