The neutrinophone: It's not for you. (But it is cool)

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First of all, the neutrinophone isn't really a phone. It has the potential to be used for communication across immense distances—including into outer space—but even Jeff Nelson says the neutrinophone's debut was "little more than an outreach stunt."

Nelson is the Cornelia B. Talbot Term Distinguished Associate Professor of Physics at William & Mary. He explains that the neutrinophone demonstration was a side project stemming from neutrino research at the Fermi National Accelerator Laboratory. Nelson is one of a number of William & Mary scientists involved in a collaboration at Fermilab known as MINERvA.

Neutrinos are mysterious subatomic particles emitted in unimaginable numbers by nuclear reactions. Despite their high numbers, scientists are just now learning about the characteristics of neutrinos. William & Mary's physicists are involved in several large multinational collaborations aimed at learning about the properties of neutrinos. In addition to MINERvA and the other Fermilab experiments, William & Mary researchers are involved in other neutrino investigations, most notably the Daya Bay initiative in China.

Most neutrinos passing through earth come from the sun's nuclear furnaces, but they also are created by nuclear power plants and other such facilities. Neutrinos are hard to detect because they interact so rarely with anything. The Surry power plant across the river from Williamsburg emits neutrinos by the billions, but Nelson says you can live your whole life at William & Mary and the odds are against your body experiencing more than one single interaction from a Surry-generated neutrino.

Nelson explains that the neutrinophone used the tertiary beam from an accelerator at Fermilab. The accelerator, he says, is about two kilometers in circumference.

"It uses an intense proton beam," he said. "We take that proton beam and it hits a target and particles called mesons come out. The mesons decay into neutrinos."

The beam of neutrinos travels through hundreds of meters of rock on the way to the MINERvA detector, which Nelson explains is designed to study neutrino interactions in detail. For communication over the neutrinophone, the physicists used a simple 1-0 binary code.

"If you saw neutrinos, it was a zero; if there weren't any neutrinos, it was a one," he explained. "There are standard encoding patterns, ASCII is one of the ones that is used on the computer that tell you what letter corresponds to a series of so many digits of binary bits."

The first message sent by the neutrinophone, when decoded, was "neutrino." Nelson says the scientists aren't to blame for the lack of originality.

"It wasn't the neutrino physicists who picked that," he said. "We probably would've done something that we would've thought was more interesting and challenging but the communications guys think neutrinos are cool so that was what they wanted."

As a practical communications tool, the neutrinophone sits on the border of science and science fiction. Nelson notes that Star Trek characters use neutrino communications, but there are a number of scientific and engineering challenges to creating an interplanetary neutrinophone.

He said that one such challenge involves the difficulty in aiming the "gun barrel" of the neutrino beam. Another problem involves a flashlight-like effect, whereby the encoded neutrino beam widens and weakens as it travels through space, soon becoming lost in the stew of neutrinos coming from the sun and other natural sources of the particles.

Nelson says that earth-bound neutrino communications are a more realistic feasible in the future.

"Think of, say, a submarine," he said. "You could have a neutrino detector that's mostly liquid—a dedicated ballast tank with material that fluoresces and that would be much more sensitive. That would be feasible. You can imagine the submarine going to an area and accepting its secret message and then moving off again."

Provided by The College of William & Mary

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