Forests might serve as enormous neutrino detectors

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Neutrino detectors don't grow on trees. Or do they? Forests could one day be used to spot ultra-high-energy neutrinos, a physicist proposes.

Trees could act as natural antennas that pick up radio waves produced by certain interactions of the difficult-to-detect subatomic particles, astroparticle physicist Steven Prohira proposes in a paper submitted January 25 at arXiv.org.

"It is a very exciting idea," says physicist Amy Connolly of the Ohio State University in Columbus, who was not involved with the study. "This could be … a natural solution that may have been sitting there under our noses."

Neutrinos typically demand large, sensitive detectors. That's especially true for detectors designed to snag the rarest, highest-energy neutrinos that shower down on Earth from space. Building such enormous detectors from scratch is a major hurdle.

But high-energy neutrino physicists are known for building inventive detectors in natural settings. The IceCube Neutrino Observatory searches for neutrino interactions using a cubic kilometer of Antarctic ice, and the Cubic Kilometre Neutrino Telescope, KM3NeT, currently under construction, will search for neutrinos interacting in the Mediterranean Sea (SN: 4/10/14). These detectors have large enough volumes to make catching rare high-energy neutrinos possible.

To study neutrinos of even higher energies, scientists aim to spot one particular neutrino variety, called a tau neutrino. When such a neutrino passes inside the Earth, it can interact and produce a particle called a tau lepton. If that tau lepton escapes from the ground into Earth's atmosphere, its decay can produce a shower of charged particles that generate radio waves. To detect these radio waves, scientists have proposed detectors such as the massive GRAND experiment, which would use a total of 200,000 antennas divided into 20 separate arrays around the world.

Given the enormous undertaking involved in building that type of detector, "it dawned on me that it'd be cool if the antennas were already there," says Prohira, of the University of Kansas in Lawrence. Previous research had shown that trees can pick up radio waves. Detecting those radio waves would require nailing a wire into each tree or wrapping a coil of wire around each tree's trunk and connecting that to electronics to read out the signals.

Many questions still need to be answered to determine if the technique is plausible, Prohira acknowledges. Scientists would need to study how the trees performed for very high frequency radio waves, the range in which neutrino detectors of this type operate. And traditional radio antennas can be precisely built, allowing a detailed understanding of how they respond to different types of radio signals. Trees, of course, can't be. For example, it's not clear how trees would respond to the polarization of the radio waves, the orientation of their wiggles. Plus, the effect of foliage and, for deciduous forests, the seasonal dropping of leaves, needs to be investigated.

Although the idea is inspiring, says physicist Eric Oberla of the University of Chicago, "it's unclear if supplanting manufactured antennas with trees will solve more problems than it might create, and these detector-design challenges would need to be further addressed."

Any impact the detector would have on the forest would also need to be understood. "Such a detector," Prohira writes in the paper, "must be built in harmony with, and with respect for, nature; otherwise, this idea is not worth trying."

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