Antineutrino detectors could aid non-proliferation

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Patrick Huber

Physicists at the Large Hadron Collider in Switzerland and even in the fictional world of CBS' "The Big Bang Theory" look to subatomic particles called neutrinos to answer the big questions about the universe.

Now, a group of scientists led by a physics professor at Virginia Tech are asking whether the neutrino could provide the world with clues about nuclear proliferation in Iran and other political hotspots. Neutrinos are produced by the decay of radioactive elements, and nuclear reactors produce large amounts of neutrinos that cannot be shielded or disguised, which could help regulatory agencies monitor plutonium production.

Measuring neutrino emissions allows scientists to infer the plutonium content of a reactor from outside the building, according to a letter due to be released in the *Physical Letters Review* written by Patrick Huber, an associate professor of physics and a member of the Center for Neutrino Physics at Virginia Tech, with Thomas Shea, a 20-year veteran of the International Atomic Energy Agency, and graduate students Eric Christensen of Westminster, Maryland, a doctoral student in physics, and Patrick Jaffke of Arlington, Virginia, a doctoral student in physics and a master's student in nuclear engineering.

"By making moderate improvements in existing neutrino-detector technology, we can fit a detector system into a standard 20-foot shipping container to monitor the Iranian heavy water reactor at Arak as part of a non-proliferation measure," Huber said. "Neutrino monitoring is non-intrusive and doesn't rely on a continuous history of reactor operations."

Monitoring antineutrinos—subatomic particles akin to the neutrino, except they spin in a different direction—also could help distinguish varying levels of fuel enrichment.

The Iranian 40 megawatt heavy water reactor at Arak has a design which is ideal for plutonium production for nuclear weapons and the International Atomic Energy Agency needs to be able to verify whether operations at the facility are for peaceful purposes.

Antineutrino detectors can provide the agency with high-level monitoring not currently offered by any other technique, the researchers say. This monitoring is based on the spectrum of antineutrinos produced by fission of uranium-235, plutonium-239, uranium-238, and plutonium-241, where the plutonium isotopes produce neutrinos with a lower average energy.

The paper is the result of an interdisciplinary collaboration between Huber's group at Virginia Tech's College of Science and Shea, with funding from the U.S. Department of Energy and the Institute for Society, Culture, and Environment at Virginia Tech.

For being such tiny particles, neutrinos have made big headlines. They travel at about the speed of light, unimpeded by electromagnetism and strong nuclear forces that affect other particles. Studying them has provided insight into Albert Einstein's theory of the Standard Model of particle physics and has astronomical information from the far reaches of the universe.

Huber's recent interview on the subject is available at WVTF public radio.

Provided by Virginia Tech

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