New Results on Neutrino Mixing

August 8, 2016

Neutrinos—light, elusive particles—give up their secrets a little at a time. They captivate physicists because they are, in many ways, hidden in plain sight. If, for example, it took you three seconds to read that last sentence, three trillion or so neutrinos just passed through you. They're generated naturally from the sun or other galactic origins, but because they seldom interact with other particles they're difficult to detect. Experiments like NOνA, headquartered at the U.S. Department of Energy's Fermi National Accelerator Laboratory, are making strides to find out more about them.

Neutrinos are detected in three flavors: muon, tau, and electron. While they have no electric charge, they do exist in three mass states. Yet there is no hard and fast correlation between the flavors and the mass. They're related via a complex (and only partially understood) process called mixing. Connecting the dots between flavors and mass in these particles will help scientists understand more about them and by extension, the forces of nature.

Today at the International Conference of High-Energy Physics in Chicago, NOνA scientists present evidence that one of the three neutrino mass states might not include equal parts of muon and tau flavor, as previously thought. Scientists refer to this as "non-maximal mixing," and NOνA's preliminary result is the first hint that this may be the case for the third mass state.

"This is the first hint on the composition of this ghostly particle, which may be more complicated than initially thought," said UT Research Assistant Professor Athans Hatzikoutelis, who works on the experiment. "It seems that the race between scientists for the discovery of the nature of neutrinos and from that the big questions of the structure of the universe itself, is raging."

An illustration of the three neutrino mass states and the three flavors that make them up (electron, muon and tau), as they were previously though to mix. NOνA's new result shows that the third mass state may not have equal amounts of muon (yellow jellybeans) and tau (blue jellybeans) flavors. Image: Fermilab/Sandbox Studios

The NOvA experiment has been collecting data on neutrinos since February 2014. It uses the world's most powerful beam of muon neutrinos, generated at Fermilab, which travels through the earth 500 miles to a building-size detector (built with help from UT physicists) in northern Minnesota. UT scientists involved with the NOvA experiment are Hatzikoutelis, Professors Thomas Handler and Yuri Kamyshkov, and graduates Eric Flumerfelt (Ph.D., 2015) and Phil Mason (Ph.D., 2015). The collaboration includes more than 200 scientists from 39 institutions.

The above was adapted from ***Fermilab's press release (http://news.fnal.gov/2016/08/nova-shines-new-light-neutrinos-behave/)****. Learn more about the experiment at the* ***NOvA Website (http://www-nova.fnal.gov/ http://www-nova.fnal.gov/)****.*