Neutrino research: Tracking a shapeshifter

October 6 2015, by Joshua Melvin

The portraits of the winners of the Nobel Prize in Physics 2015 Takaaki Kajita (L) and Arthur B McDonald are displayed on October 6, 2015 at the Swedish Academy of Sciences in Stockholm

For over eight decades, the neutrino—one of the most abundant yet elusive particles in the Universe, has been giving physicists the runaround, forever shape-shifting just out of reach.

Takaaki Kajita of Japan and Arthur McDonald of Canada were awarded the Nobel Physics Prize on Tuesday for uncovering the elementary

particle's duplicitous nature and revealing that it has mass—key to our understanding of the cosmos.

Here is a timeline of ongoing efforts to understand the neutrino:

1930: Austrian-born quantum physics pioneer Wolfgang Pauli hypothesises the existence of an as-yet-undetected, electrically-neutral particle, which Italian physicist Enrico Fermi later dubs the neutrino. But the particle is hard to track down as it does not interact strongly with any other matter in the Universe, shooting undeterred through our bodies and the Earth itself.

1956: Two American scientists, Frederick Reines and Clyde Cowan, report the first hard evidence of the existence of neutrinos.

1988: Two American researchers, Leon Lederman and Melvin Schwartz, as well as German-born scientist Jack Steinberger receive the Nobel Physics Prize for uncovering in the 1960s the existence of at least two kinds of neutrino. Their work was a key contribution to the Standard Model of particle physics, which seeks to explain how the Universe is put together.

1995: More than 20 years after Cowan's death, Reines is awarded the Nobel Physics Prize for their discovery, which used a fission reactor to pump out neutrinos and a sensitive detector to spot them. He shared the award with American Martin Perl who unearthed another type of particle which suggested the existence of a third neutrino form or "flavour".

This has since been confirmed—neutrinos, created in radioactive processes like those in the Sun or nuclear reactors, come in the form of electron, muon or tau neutrinos.

1998: Kajita and a team observe that neutrinos can switch from one type to another, in a process called "oscillation", as they travel between the atmosphere and the Super-Kamiokande underground particle detector in Japan. The change was drastic—like having "an orange in your hand which suddenly turns into an apple," Oxford University neutrino researcher Alfons Weber told AFP.

1999: McDonald announces that neutrinos from the Sun were not "disappearing", as long suspected, but changing form before they arrive at an observatory in Ontario, Canada.

2002: Raymond Davis Jr. of the United States and Masatoshi Koshiba of Japan receive the Nobel Physics Prize for the first detection of neutrinos from beyond Earth—originating in the Sun and an exploding star.

2011: European scientists cause a storm by publishing experimental results showing that neutrinos can travel faster than the speed of light—challenging Albert Einstein's 1905 theory of special relativity.

2012: The scientists admit their experiment was flawed and reaffirm that neutrinos—like everything else—are bound by the universal speed limit.

What next?

Scientists believe there may be a fourth type of neutrino, and the hunt is on. Measurements have yielded slightly fewer neutrinos than calculations say there should be, which might mean they are transforming into a fourth, as-yet-undetected flavour.