Discovery

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A truly fundamental discovery does not happen very often. I was so lucky to witness one, when I attended the Neutrino 1998 conference in Takayama, Japan. One of our principal investigators, Takaaki Kajita, gave a presentation there. The advertised title of the talk was "Atmospheric neutrino results from Super-Kamiokande & Kamiokande." Doesn't sound very exciting. But when Takaaki took the podium and showed his first slide, he proclaimed "I am going to change the title of my talk today."

The new title was "Evidence for muon-neutrino oscillations," and he showed that the neutrinos have a little bit of mass. He demonstrated very convincingly that muon neutrinos morph into something else as they travel over a few hundred kilometers. It was truly a defining moment in neutrino physics. People have been looking for this kind of evidence all the way since the 1960s, but failed.

I stood up at the end of presentation. About a half of the audience followed, and gave Takaaki a standing ovation. This normally doesn't happen at a physics conference, where scientists are supposed to be critical, analytical, skeptical, and subdued. This was not that kind of moment. It was truly moving.

It was believed that the neutrinos don't have any mass at all, just like the photon that allows us to send signals from Japan to Hayabusa explorer that landed on an asteroid 20 light-minutes away and made its way back to the Earth. If so, the neutrinos must be travelling at the speed of light. Einstein told us if anything travels at light speed, its clock stops. But the neutrinos do experience time, because they morph *over time* from one species to another. They know time, and therefore they must be slower than the speed of light, which is possible only if they have a mass.

Read what Takaaki says about his major discovery. But we still do not know why the neutrinos have mass. We are trying to find the answer with a new experiment called KamLAND-ZEN. Hopefully we get to report what we find in the near future.