Physicists testing Nobel-winning theory

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(PhysOrg.com) -- Soeren Prell and a team of Iowa State University researchers are part of an international research team testing a theory that led to a share of the 2008 Nobel Prize in Physics for Japanese researchers Makoto Kobayashi and Toshihide Maskawa.

Prell, an Iowa State University associate professor of physics and astronomy, is part of the BaBar experiment at the U.S. Department of Energy's SLAC National Accelerator Laboratory in Menlo Park, Calif. Prell returned to Iowa State this summer after a year in California as BaBar's physics analysis coordinator.

The experiment is the work of nearly 500 collaborating physicists from 74 institutions and 10 countries. Other Iowa State researchers who have been part of the BaBar research team are James Cochran, an associate professor of physics and astronomy; H. Bert Crawley, a professor of physics and astronomy; W. Thomas Meyer, an adjunct research professor; and Eli Rosenberg, a professor of physics and astronomy who's currently on assignment with the U.S. Department of Energy.

"The central focus of the BaBar experiment is to study the differences between matter and antimatter," Prell said. "One of the big questions of the universe is, "Why is it made out of matter?"

At the time of the big bang, physicists say the explosion of energy should have created equal amounts of matter and antimatter. And they say whenever particles of matter and antimatter would have met they would have annihilated each other.

But the universe wasn't annihilated and it's full of matter. So how did matter come out so far ahead?

Physicists believe a small imbalance of matter over antimatter -- something like an extra particle of matter for every 10 billion antimatter particles -- led to our world. They call that imbalance an asymmetry.

In 1964 physicists discovered an asymmetry between matter and antimatter -- it's also known as a charge-parity violation -- in subatomic particles called kaons. Nobel-winners Kobayashi and Maskawa in 1972 developed a theory that attempted to explain those symmetry violations. Their idea called for the addition of three quarks to the Standard Model of particle physics, a theory that explains how subatomic particles interact via forces. Other researchers theorized that studies of B mesons (very short-lived subatomic particles) would help explain these broken symmetries.

The BaBar experiment in California, which completed operations earlier this year, has been called a "B factory" because the electron-positron collisions it produces are capable of creating more than a million B mesons every day. Since 1999 researchers have been studying the decay of those subatomic particles to confirm the Kobayashi-Maskawa theory.

They did and the presenters of the Nobel Prize took notice: "As late as 2001, the two particle detectors BaBar at Stanford, USA, and Belle at Tsukuba, Japan, both detected broken symmetries independently of each other," says the press release announcing the Nobel Prize in Physics. "The results were exactly as Kobayashi and Maskawa had predicted almost three decades earlier."

"We found a particle/anti-particle asymmetry," Prell said. "We found that B mesons and anti-B mesons behave differently."

But, Prell said the Kobayashi-Maskawa theory doesn't fully explain the existence of the universe. So, once data analysis of the BaBar experiment is concluded and another 100 or so scientific papers written (that's in addition to the 375 already written), Prell and other physicists will be moving to the higher-energy experiments made possible by the Large Hadron Collider at CERN, the European Organization for Nuclear Research near Geneva, Switzerland.

And what do these theories and tests of the subatomic world do for all of us?

"We're not solving the financial crisis or the energy crisis," Prell said. "But this will help us all to understand a little bit better where we come from. There are big questions behind this such as, 'Why is there a universe made of matter?'"

BaBar: www-public.slac.stanford.edu/babar/

Provided by Iowa State University