Researchers identify two key characteristics never before measured of Lambda particle

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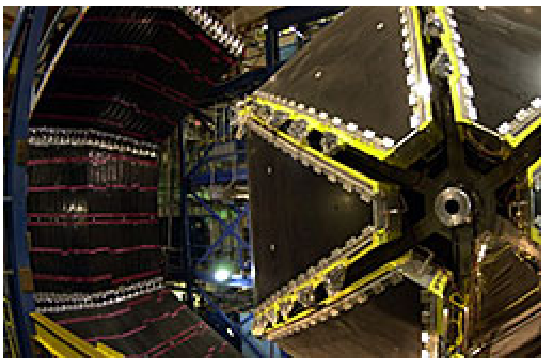

The detector system used in the experiment was the Jefferson Lab CEBAF Large Acceptance Spectrometer, shown open here. The CLAS detector was capable of measuring the momentum and angles of almost all of the particles produced in electon-proton collisions in Hall B.

(Phys.org) —It takes dedication and perseverance to solve a mystery that has been around for 50 years. Just ask Reinhard Schumacher, a professor of physics at Carnegie Mellon University. He and his colleagues analyzed data from an experiment conducted at DOE's Thomas Jefferson National Accelerator Facility to finally pin down two key characteristics that had never been measured before of an elusive particle, the Lambda(1405).

But that wasn't the original goal of the experiment, nor is it the first result to be announced from the data. Rather, this result was announced in the 18th paper to be published from this one experiment.

That doesn't bother Schumacher at all. In fact, it's a source of pride for how well he and his colleagues in the CLAS collaboration planned and carried out the measurements back in 2004 in Jefferson Lab's Experimental Hall B. The original experiment was the idea of researchers from the Istituto Nazionale di Fisica Nucleare in Italy who were pursuing different goals. The data from the experiment has been remarkably fertile, especially in terms of providing these first measurements of the Lambda(1405).

"We were able to get the world's best dataset for this thing, ever. And at some point, we realized that we could do this measurement," he says. "When I told my graduate student, Kei Moriya, about this, he latched onto it and spent six months of his life pursuing this to even show that we could make the measurement."

The result concerns key properties of the Lambda(1405) particle that had been theorized, but that had not yet been measured experimentally. It can be thought of in terms of providing a unique description of an object to help differentiate it from other things. For instance, you may refer to an object in terms of its physical properties, such as color, shape or size. In nuclear and particle physics, scientists do much the same, differentiating the hundreds of sub-atomic particles, such as protons, quarks and electrons, by their measurable properties.

"All sub-atomic particles have an array of properties - mass, spin, quark content, magnetic moment, a handful of things like that, and it is important to us to pin down all those properties," Schumacher says.

The Lambda(1405) was first identified in 1962 by its mass. However, because the particle is difficult to produce experimentally, many of its key properties remained a gap in our knowledge. Schumacher and his colleagues realized that their dataset may hold the keys to measuring two related properties: spin and parity.

Physicists refer to the first property as intrinsic angular momentum, which can be thought of as the amount of spin motion that a particle has.

"In the quantum world, that's one of the things that nature quantizes. No one has really measured how many units this thing spins with. And the options were half a unit, three-halves of a unit, or maybe five-halves of a unit," Schumacher explains.

For the Lambda(1405), that number turned out to be one-half, a quantity it has in common with electrons and protons.

The second property that Schumacher, Moriya and their colleagues measured is the Lambda(1405)'s parity, which is related to its spin. A particle's parity determines how that particle's spin behaves - whether the spin remains the same or whether it is flipped to the opposite state when the short-lived Lambda(1405) decays into other particles. They found that the particle has negative parity, unlike the proton.

"That's one of the fundamental properties that every subatomic particle has, it's like a personality characteristic. It's either positive parity or negative parity," Schumacher says.

Schumacher, Moriya and the rest of the collaboration are continuing to make the most of the data from this experiment, looking for other key findings that lie deep within the set. Moriya, now a postdoctoral research associate at Indiana University, is also working on related physics in Jefferson Lab's newest experimental area, Hall D, where he is interested in applying the method to other states.

More information: K. Moriya et al. (CLAS Collaboration). "Spin and parity measurement of the Λ(1405) baryon." *Phys. Rev. Lett.* 112, 082004 – Published 28 February 2014, journals.aps.org/prl/abstract/ … ysRevLett.112.082004

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