BaBar researchers announce first evidence of predicted particle subtype

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Several SLAC members of the BaBar collaboration have been involved in bottomonium research, including (from left): Valentina Santoro, Veronique Ziegler, who led the data analysis for the hb study, Bryan Fulsom and (not pictured) Arafat Mokhtar. (Photo by Lori Ann White.)

(PhysOrg.com) -- Data collected by the BaBar experiment during its final months of operation in 2008 point to a new member of the "bottomonium" family of subatomic particles. BaBar collaboration member and SLAC physicist Valentina Santoro presented the results on behalf of the collaboration last month at the Lake Louise Winter Institute, a yearly conference held at Lake Louise, Alberta, Canada. The discovery adds another piece to physicists' model of the so-called "strong" force, which binds subatomic particles into larger chunks of matter.

In 2008, members of the BaBar collaboration announced they'd discovered the lowest-energy bottomonium particle, called η_b (pronounced eta-sub-b). A subsequent BaBar study confirmed the finding in 2009. Continued examination of the final BaBar data set has now revealed another particle of the bottomonium family, called the h_b (h-sub-b).

Several variants of bottomonium—a bottom quark bound to a bottom anti-quark—have been predicted and a number have now been observed, the first more than thirty years ago. But many of the predicted states remain unobserved. Each one discovered offers a valuable window into quantum chromodynamics, or QCD, explained BaBar Physics Analysis Coordinator Steve Robertson. QCD is the theory of the strong force that binds quarks into the protons and neutrons that make up atomic nuclei (and ultimately us). It's an important part of the Standard Model, currently the best theory physicists have to explain matter, energy, and how the two interact.

"Since [bottomonium particles] are held together by the strong force interactions, studying the particles is a good way to study the strong force," Robertson explained. However, studying them isn't easy. The strong force, though effectively limited in distance to lengths that span an atomic nucleus, is strong. Individual quarks have never been isolated, and all bottomonium particles are unstable and decay rapidly into lighter, less exotic particles. That means particle physicists must study them indirectly, by taking the final products of a particle collision, after any bottomonia have decayed away, and tracing back along the processes required to create these decay products. In this way, they can determine the nature of the particle at the beginning of that chain of particle decays. It's somewhat akin to running a film backward to watch shards of porcelain on the kitchen floor rise into the air and reassemble themselves into a tea cup on a table.

The BaBar researchers combed through data from more than 120 million electron–positron collisions to find their shards. They also narrowed the possibilities for how the hb particle is created, and confirmed theoretical predictions of its mass.

Less than two weeks after Santoro presented the results, a group of researchers from Belle, a collaboration based at the KEK facility in Japan, announced their observation of the hb particle while studying a completely different and somewhat unexpected decay process. Figuratively speaking, the Belle researchers watched the same pile of porcelain shards reassemble into a coffee mug.

Provided by SLAC National Accelerator Laboratory

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