BABAR searches for a new matter-antimatter asymmetry

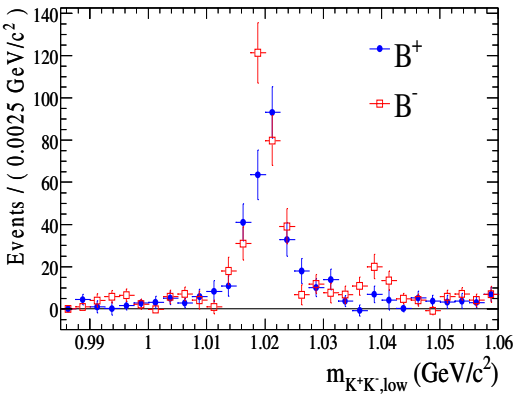
In a recent publication, the BABAR collaboration extends the hunt for new sources of matter-antimatter asymmetry in rare decays of the B meson.

The *BABAR* experiment at SLAC was designed to explore subtle differences in the behavior of matter particles compared to antimatter particles. *BABAR* discovered matter-antimatter asymmetries in decays of the B meson, first in its decay into a J/Psi and a neutral K, and later in a wide range of different decay processes. Remarkably, nearly all these measurements could be quantitatively explained by a single, complex, parameter of the standard model. These discoveries by *BABAR*, along with Belle, a competing experiment in Japan, led to the awarding of the 2008 Nobel Prize to Kobayashi and Maskawa.

However, *BABAR*'s search for matter-antimatter asymmetries did not end there; the current picture of particle physics, the Standard Model, cannot be complete, and there is very good reason to expect other sources of matter-antimatter asymmetries. After all, the universe itself has just such an asymmetry, since everything we observe is matter, and there is virtually no antimatter to be found. But the Standard Model vastly underestimates the universe's asymmetry, so some new source of asymmetry in particle interactions or decays must exist.

In a new paper just submitted by the *BABAR* collaboration to Physical Review D, Stanford graduate student Brian Lindquist, SLAC staff scientist Mathew Graham and Professor Aaron Roodman report the intriguing results of a search for just such a new matter-antimatter asymmetry. They studied the decay of both the neutral and charged B mesons into three K mesons, taking care to analyze the complex structure of the decay kinematics that occur when a B decays into three particles. These decays are particularly promising in the search for new asymmetries because they occur via a higher-order process known as a penguin diagram. Many models predict that signs of new asymmetries in B decays will appear most readily in penguin diagrams.

In this new result, matter-antimatter asymmetries were measured in both the decays $B^0 \to K^+K^-K^0$ and $B^+ \to K^+K^-K^+$. Within the experimental uncertainties, the asymmetries in the decay $B^0 \to K^+K^-K^0$ agreed with the expectations from the standard model; the same asymmetry was observed here as in other B meson decays. However, in a particularly interesting region of the decay $B^+ \to K^+K^-K^+$, a rather unexpected asymmetry of $12.8 \pm 4.6\%$ was observed. In this decay, the standard model predicts no appreciable asymmetry. The figure on the right shows the number of B^+ and B^- decays detected as a function of the mass of the K^+K^- system. The asymmetry was observed when the decay proceeded via an intermediate ϕ meson, which has a mass of 1.02 GeV. This asymmetry differs from zero by 2.8 standard deviations, not enough to claim a discovery, but definitely a tantalizing result warranting further study.



All of the data collected by BABAR have been analyzed in this measurement, but our colleagues at BELLE and at the LHCb experiment at CERN should be able to shed further light on our result.