Physicists develop first conclusive test to better understand high-energy particles correlations

March 26 2012

Researchers have devised a proposal for the first conclusive experimental test of a phenomenon known as "Bell's nonlocality." This test is designed to reveal correlations that are stronger than any classical correlations, and do so between high-energy particles that do not consist of ordinary matter and light. These results are relevant to the so-called 'CP violation' principle, which is used to explain the dominance of matter over antimatter. These findings by Beatrix Hiesmayr, a theoretical physicist at the University of Vienna, and her colleagues, a team of quantum information theory specialists, particle physicists and nuclear physicists, have been published in the *European Physical Journal C*.

According to the famous Einstein-Podolsky-Rosen Gedanken-Experiment, two particles that are measured independently obey the principle of locality, implying that an external influence on the first particle, such as measurement, has no direct influence on the second – in other words there is no "spooky action at distance," as Einstein would have described it. In an experimental setup, however, measurement results for one particle revealed a correlated measurement result for the other particle. Initially, these correlations could only be explained by referring to hidden parameters. In 1964, John Bell found that so-called local realistic hidden parameter theories imply that the relations between these correlations could be experimentally tested through so-called Bell tests. Since then many experiments have proven that local, realistic

hidden parameters cannot be used as an explanation for these correlations.

In this study, the authors have succeeded in devising a new Bell test, taking into account the decay property of high-energy particles systems, called kaon-antikaon systems. This procedure ensures that the test is conclusive – a goal that has never before been achieved – and simultaneously guarantees its experimental testability. Experimental testing requires equipment such as the KLOE detector at the accelerator facility DAPHNE in Italy.

Revealing "spooky action at distance" for kaon-antikaon pairs has fundamental implications for our understanding of such particles' correlations and could ultimately allow us to determine whether symmetries in particle physics and manifestations of particles correlations are linked.

More information: Hiesmayr B. C., Di Domenico A., Curceanu C., Gabriel A., Huber M., Larsson J.-Å., Moskal P. (2011). Revealing Bell's Nonlocality for Unstable Systems in High Energy Physics, *European Physical Journal C* (EPJ C) 72: 1856 DOI: 10.1140/epjc/s10052-012-1856-X

Provided by Springer