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Sensitivity study for a measurement of decay-time-dependent CP-violation using $B^0 \to \pi^0\pi^0$ at Belle II

CP-asymmetry is expected to explain the huge imbalance between matter and antimatter in our universe. The CP-asymmetry observed so far at particle or nuclear physics experiments is too small to explain this imbalance. We therefore expect new, yet-unknown sources of CP-violation to exist. One way to find hints for these new sources is to precisely measure differences in the decay rates of B^0 and anti-B^0 ($\bar{B}^0$) particles decaying to specific final states. One important parameter quantifying CP violation —the CKM angle α —is poorly known. Constraints on this angle can be set by measuring the difference between the decay rates of $B^0 \to \pi^0\pi^0$ and $\bar{B}^0 \to \pi^0\pi^0$, as a function of the B^0 decay time. This measurement should be possible in the future using pairs of B^0 mesons produced in e^+e^- collisions at the Belle II experiment situated in Tsukuba, Japan. However, due to the difficulty of measuring the decay-time of the B^0 when it decays to $\pi^0\pi^0$, a very large dataset is needed, which might not be collected before the next decade.

The goal of the proposed summer student project is to try a new technique to measure the angle alpha using only information from the decay time of the other B0 produced in the e^+e^- collision. This is made possible thanks to the very small size of the e^+e^- collision point at Belle II, from which the displacement of the other B^0 can be measured to extract its lifetime. This technique has not been tried before, so the student will use simulated decays to assess whether it would allow to measure α with much less data than needed with usual techniques. If results are promising and if time permits, i.e. if a measurement is possible within the coming years, the technique can be further validated using control B^0 decays reconstructed in the real Belle II data.

Group

BELLE

Project Category

B1. Physics Data Analysis and Performance (software-oriented)

Special Qualifications

Some coding experience

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