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Probing quantum decoherence using data from B meson decays

The time evolution of neutral B mesons plays a fundamental role in determining key parameters of flavor physics. While their behavior is typically analyzed under the assumption of perfect quantum coherence, interactions with the surrounding environment can induce $decoherence$. Such environmental effects on neutral meson systems can be effectively described within the framework of open quantum systems. Decoherence can obscure the precise extraction of crucial parameters, such as the oscillation frequency Δm and the CP-violating parameter $\sin 2\beta$.

Using the available experimental data, we present the first combined analysis of mixing asymmetry and CP-asymmetry measurements for B_d mesons, demonstrating that decoherence parameter λ_d is nonzero with a significance of approximately 6 σ. Furthermore, we establish the first experimental constraints on the decoherence parameter λ_s for B_s mesons, confirming its nonzero value at a significance level of 3 σ.

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