DOUBLE INTERFERENCE IN NEUTRAL B-MESON DECAYS AND POSSIBILITY TO MEASURE THE SIGN OF Δm_B

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For neutral B-mesons (B_d and B_s), just as for neutral K-mesons, there exist transitions between particle and antiparticle. They lead to diagonalization of the effective Hamiltonian and produce a small difference Δm_B of masses of two diagonal states. Interference of these states in decays generates many interesting effects depending on $|\Delta m_B|$. One of them was used to find $|\Delta m_{Bd}|/\Gamma_{Bd} \approx 0.7$, while the sign of Δm_B stays unknown. For K-meson decays there was a similar situation, and only additional complicated experiments with regeneration of K_s in several plates allowed to determine the sign of Δm_K. Surely, such experiments are impossible for B-mesons because of too short lifetime.

The work, described here suggests another way realizable for B-mesons. It uses decays of the neutral B into neutral K and an accompanying hadron system having a definite CP-parity. Such decays demonstrate double coherent oscillations of both beauty and strangeness. Evolution of the initially produced B-meson up to a secondary (i.e., K-meson) decay reminds interference phenomena arising when the light propagates through two optically different substances, one after another, which gives two coherent contributions to the optical path. The most close analogue is the rotation of a polarization plane in two optically active substances.

As a result of double oscillations, the yield of K-meson decay products (e.g., of leptons with a definite sign of electric charge) contains contributions proportional to cos $(\Delta m_B t_B \pm \Delta m_K t_K)$, where $t_B(t_K)$ is the time interval from production to decay of the $B(K)$-meson. The relative sign of two terms in the cosine argument is determined by the CP-parity of a hadron system accompanying the neutral K in the neutral B decay. If it is fixed, the yield depends on the relative sign of Δm_B and Δm_K and allows one to measure it.

Additional effects arise when one accounts for CP-violation in decays. They suggest possibilities for physical identification of the two diagonal states of neutral B-mesons through their decay properties.

One more interesting point is that the evolution of the secondary K-meson system (obtained after integration over t_B) is sensitive to the sign of Δm_B by itself.

All the corresponding calculations and detailed discussions of the results obtained are published in papers [1—5].

References

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