Extraction of the CKM phase γ using charmless 3-body decays of B mesons

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Abstract

In this study [3], we extract the the weak phase γ from three-body charmless B meson decays under an assumption of SU(3) flavour symmetry, following a method proposed in Ref. [4]. We use BABAR amplitude analysis results for the processes $B^+ \to K^+\pi^+\pi^-$ [1], $B^0 \to K_S\pi^+\pi^-$ [2], $B^0 \to K^+\pi^-\pi^0$ [6], $B^0 \to K_SK_SK_S$ [7] and $B^0 \to K_SK^+K^-$ [8], to reconstruct the amplitudes of the different decay modes over the Dalitz plane and extract γ with its uncertainty. By combining several hundred sets of points on the Dalitz plane, and taking into account the correlations among the different points, we obtain six possible solutions

$$\begin{aligned}
\gamma_1 &= [\ 12.9\,^{+8.4}_{-4.3}\ \text{(stat)} \pm 1.3\ \text{(syst)}]^\circ,\\
\gamma_2 &= [\ 36.6\,^{+6.6}_{-6.1}\ \text{(stat)} \pm 2.6\ \text{(syst)}]^\circ,\\
\gamma_3 &= [\ 68.9\,^{+8.6}_{-8.6}\ \text{(stat)} \pm 2.4\ \text{(syst)}]^\circ,\\
\gamma_4 &= [223.2\,^{+10.9}_{-7.5}\ \text{(stat)} \pm 1.0\ \text{(syst)}]^\circ,\\
\gamma_5 &= [266.4\,^{+9.2}_{-10.8}\ \text{(stat)} \pm 1.9\ \text{(syst)}]^\circ,\\
\gamma_6 &= [307.5\,^{+6.9}_{-8.1}\ \text{(stat)} \pm 1.1\ \text{(syst)}]^\circ.
\end{aligned}$$

One solution, γ_3, is consistent with the world average value while the other ones are not. The central values and statistical uncertainties are obtained neglecting flavour SU(3) breaking effects while systematic uncertainties take into account the effect of non well-resolved minima as well as flavour SU(3) breaking. The statistical uncertainties are dominant and are smaller than 11°, which is comparable with many measurements of γ from decays including loops processes and allow for comparison with the world average from measurements obtained with tree decays [5].

Two different tests of flavour SU(3) breaking are performed and show that, in this study, when averaging over a large number of points on the Dalitz plane, the breaking effects are less than 10%, which reinforce the validity of this hypothesis.

The present study only takes into account fully symmetric amplitudes, where, by construction, the resonances of spin 1 disappear. Including other symmetrisations, such as totally anti-symmetric states or mixed states would add information and may help to decrease the statistical uncertainties and reduce the number of solutions.

An interesting prospect for this method would be to perform a dedicated analysis in a single experiment (such as LHCb or BelleII) where γ is extracted directly from a simultaneous fit.

References

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