Rare radiative B decay to the orbitally excited $K_2^*(1430)$ meson

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Rare radiative decays of B mesons represent an important test of the standard model of electroweak interactions. These transitions are induced by flavour changing neutral currents and thus they are sensitive probes of new physics beyond the standard model. The increased statistics of rare radiative B decays allowed a significantly more precise determination of exclusive and inclusive branching fractions. Recently the first observation of the rare B decay to the orbitally excited tensor strange meson $B \to K_2^*(1430)\gamma$ has been reported by CLEO. The branching fraction and the ratio of exclusive branching fractions to excited and ground state K mesons were measured. These new experimental data provide a challenge to the theory. Many theoretical approaches have been employed to predict the exclusive $B \to K^*(892)\gamma$ decay rate. Considerably less attention has been payed to rare radiative B decays to excited strange mesons and most of the theoretical approaches rely on the heavy quark limit both for the initial b and final s quark and the nonrelativistic quark model. However, it is necessary to point out that the s quark in the final K^* meson is not heavy enough, compared to the $\bar{\Lambda}$ parameter, which determines the scale of $1/m_Q$ corrections in heavy quark effective theory. Thus the $1/m_s$ expansion is not appropriate. Notwithstanding, the ideas of heavy quark expansion can be applied to the exclusive $B \to K^*(K_2^*)\gamma$ decays. From the kinematical analysis it follows that the final $K^*(K_2^*)$ meson bears a large relativistic recoil momentum $|\mathbf{\Delta}|$ of order of $m_b/2$ and an energy of the same order. So it is possible to expand the matrix element of the effective Hamiltonian both in inverse powers of the heavy b quark mass for the initial state and in inverse powers of the large recoil momentum $|\mathbf{\Delta}|$ for the final state. Such an expansion was realised in the framework of the relativistic quark model based on the quasipotential approach in quantum field theory [1]. All important relativistic effects including transformation properties of the wave function of a meson from the rest reference frame to the moving one were taken into account. We found a good agreement of the predictions for decay rates and the ratio r of branching fractions of $B \to K_2^*\gamma$ and $B \to K^*\gamma$ with experiment and the theoretical estimates of Ref.[2]. Other theoretical calculations substantially disagree with data either for $B \to K^*\gamma$ or for $B \to K_2^*\gamma$ decay rates, and as a result their predictions for the ratio r are several times larger than the experimental value. Despite the fact that the approach of Ref.[2] relies on the expansion in inverse powers of the s quark mass, it is effectively equivalent to the expansion in the inverse powers of the s quark energy $\epsilon_s(p+\Delta) = \sqrt{(\mathbf{p}+\mathbf{\Delta})^2 + m_s^2}$, which is large in our case due to the large recoil momentum $\mathbf{\Delta}$. Notice, that the analysis in Ref.[1] is, however, more consistent and reliable, since it does not use the ill-defined limit $m_s \to \infty$, and the proposed quark model consistently takes into account important relativistic effects.

References

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[2] S. Veseli and M. G. Olsson, Phys. Lett. **B 367** (1996) 309.