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Weak radiative decay $\Lambda_b \to \Lambda\gamma$ in the heavy quark effective theory

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Abstract. The weak radiative decay $\Lambda_b \to \Lambda\gamma$ is studied in the heavy quark effective theory treating s-quark as heavy. This rare decay is induced by the short distance electromagnetic penguins. Including corrections of the order of $(1/m_Q)$, we obtain the transition matrix element and the corresponding decay width. The Isgur–Wise function is evaluated in the large N_c limit and the branching ratio obtained is 1.48×10^{-5}.

Keywords. Heavy quark effective theory; $1/m_Q$ corrections; Isgur–Wise function.

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1. Introduction

The weak radiative decays (flavor changing radiative decays) of hyperons have proven to be a challenge to both theorists and experimentalists. Experimental difficulties result from small branching ratios of these decays and their copious photon background. These transitions require the joint occurence of weak and electromagnetic interactions. Their theoretical treatment requires the inclusion of separate short distance (SD) and long distance (LD) contributions [1, 2]. The relative size of the two types of processes is an issue to be determined for every specific process. At the quark level there are three types of processes which contribute to the weak radiative decays of baryons classified as single, two and three quark transitions. The two quark transition corresponds to W exchange with the photon radiated by the participating quarks. The three quark transition, where the quark not participating in W exchange, radiates the photon, which is strongly suppressed. The single quark transition involves a (SD) contribution due to electromagnetic penguin diagrams [2, 3]. The weak radiative decay $\Lambda_b \to \Lambda\gamma$ is described by the single quark transition and is dominated by the short distance electromagnetic penguin transition $b \to s\gamma$. The recent measurement by CLEO of $B \to K^*\gamma$ [4] and $B \to X\gamma$ [5] processes confirm that this mode is indeed dominated by the electromagnetic penguins.

After knowing the fact that the decay process $\Lambda_b \to \Lambda\gamma$ is dominated by the short distance electromagnetic penguin, we use heavy quark effective theory to study this decay process. Important progress in the theoretical description of hadrons containing one heavy quark has been achieved due to the development of the heavy quark effective