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Color-allowed Bottom Baryon to s -wave and p -wave Charmed Baryon non-leptonic Decays

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We study color allowed $\Lambda_b \rightarrow \Lambda_c^{(**)} M^-$, $\Xi_b \rightarrow \Xi_c^{(**)} M^-$ and $\Omega_b \rightarrow \Omega_c^{(**)} M^-$ decays with $M = \pi, K, D, D_s, \rho, K^*, D^*, D_s^*, a_1$ and s -wave and p -wave charmed baryons, including $\Lambda_c^{(**)} = \Lambda_c, \Lambda_c(2595), \Lambda_c(2625), \Lambda_c(2765), \Lambda_c(2815), \Xi_c, \Xi_c(2815), \Xi_c(2790)$ and $\Omega_c^{(**)} = \Omega_c, \Omega_c(2770), \Omega_c(3050), \Omega_c(3090), \Omega_c(3120)$, in this work. There are six types of transitions, namely (i) $calB_b(\mathbf{3}_f, 1/2^+) \rightarrow calB_c(\mathbf{3}_f, 1/2^+)$, (ii) $calB_b(\mathbf{6}_f, 1/2^+) \rightarrow calB_c(\mathbf{6}_f, 1/2^+)$, (iii) $calB_b(\mathbf{6}_f, 1/2^+) \rightarrow calB_c(\mathbf{6}_f, 3/2^+)$, (iv) $calB_b(\mathbf{6}_f, 1/2^+) \rightarrow calB_c(\mathbf{6}_f, 3/2^-)$, (v) $calB_b(\mathbf{3}_f, 1/2^+) \rightarrow calB_c(\mathbf{3}_f, 1/2^-)$, and (vi) $calB_b(\mathbf{3}_f, 1/2^+) \rightarrow calB_c(\mathbf{6}_f, 3/2^-)$ transitions. The light diquarks are spectating in these transitions.

The bottom baryon to charmed baryon form factors are calculated using the light-front quark model. All of the form factors in the $1/2 \rightarrow 1/2$ and $1/2 \rightarrow 3/2$ transitions are extracted. They are found to reasonably satisfy the relations obtained in the heavy quark limit, as we are using heavy but finite m_b and m_c . Decay rates and up-down asymmetries are predicted using naive factorization and can be checked experimentally. The study on these decay modes may shed light on the quantum numbers of some of the charmed baryons.

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