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Quark-Hadron Duality Violation and Higher Order $1/m_b$ corrections in inclusive $B \to X_c \ell \bar{\nu}$

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The Heavy Quark Expansion (HQE) has become the major tool to perform precision calculations for inclusive heavy hadron decays. With this method, V_{cb} has been extracted with percent-level precision from moments of $B \to X_c \ell \bar{\nu}$. The HQE is an expansion in $1/m_b$ and introduces nonperturbative HQE matrix elements which can be extracted from data.

To further increase the theoretical precision, we recently pushed the expansion to $1/m_b^5$. Specifically, at $1/m_b^5$, "intrinsic charm" (IC) contributions proportional to $1/(m_b^3 m_c^3)$ enter, which are numerically expected to be sizeable. % We focused on reparametrization invariant (RPI) observables, which depend on a reduced set of HQE parameters.

I will show how the $1/m_b^5$ contribute to the q^2 moments of $B \to X_c \ell \bar{\nu}$ decays. We found that the total $1/m_b^5$ contributions may not be as sizeable as expected. I will discuss how this may impact a future inclusive V_{cb} determination.

Notably, all theoretical calculations are done in terms of quarks and gluons, while experimentally they are never detected individually, only as hadrons. Under certain conditions, Quark-Hadron Duality allows us to connect theoretical predictions and experimentally observed quantities.

Motivated by the increased accuracy in inclusive $B \to X_c \ell \bar{\nu}$ predictions, we try to model the effects of Quark-Hadron Duality Violation (QHDV). In this talk, I will show how we define QHDV, derive a model for QHDV based on the known behaviour of $B \to X_c \ell \bar{\nu}$ decays up to $1/m_b^5$, and finally how it impacts different kinematic moments of $B \to X_c \ell \bar{\nu}$ decays.

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