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Lattice calculation of form factors for semi-leptonic decays B \to D^(\ast) using improved heavy quark action

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The semileptonic form factors, at zero and non-zero recoil, of $B \to D^{(*)}\ell\nu$ decays are needed to determine the V_{cb}, a Cabibbo-Kobayashi-Maskawa (CKM) matrix element. Typically in the Unitarity Triangle (UT) analysis for the quark flavor mixing angles and the CP violating phase, V_{cb} enters as a normalization of $|V_{ub}|/|V_{cb}|$ or with $\varepsilon_K \propto |V_{cb}|^4$. More precise determination of V_{cb} will make the UT constraints tighter and possibly can reveal a new physics. Other interesting quantity is the ratios of $R(D^{(*)}) = \Gamma(B \to D^{(*)}\tau\nu)/\Gamma(B \to D^{(*)}\ell\nu)$ which can provide a precision test of lepton-flavor universality. A lattice calculation with a non-zero recoils can be used to diagnose the current HQET parameterization of the form factors, which are argued by many of recent articles.

We will present a recent progress in a lattice calculation of these $B \to D^{(*)}\ell\nu$ decays form factors. The calculation has been carried out with the MILC HISQ ensemble which simulates 2+1+1-flavor of dynamical quarks. A preliminary results from two different lattice spacings $a = 0.12, 0.09$ fm with heavy pion mass 310 MeV will be presented. The valence charm and bottom quarks are simulated with the Oktay-Kronfeld (OK) action [1] by which a highly improved lattice heavy quark action reducing discretization errors with $\mathcal{O}(\lambda^3_{QCD}/m^3_{b,c})$ matching to continuum QCD at tree-level. Capturing the loop corrections with a tadpole prescription in a numerical simulation, we reported that this tree-level matched OK action, in practice, shows a significant improvement in the heavy quark discretization errors. [2] Anticipating improved measurements of the decay rates from Belle II experiment, our projected error on the V_{cb} is below 1%. Such an improvement will tighten the constraints on the UT analysis, and help resolve the approximate 3σ discrepancy between estimates using exclusive and inclusive B decays.

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