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Higher-order QED×QCD Corrections To Semi-leptonic Decays

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A systematic treatment of electromagnetic and strong corrections to the semi-leptonic decays is needed in order to have a precise determination of phenomenological parameters of the Standard Model (SM), such as CKM matrix elements. Under the presence of QED, the matrix element associated to the effective semi-leptonic operator on the lattice has to be renormalised, thus requiring a matching to the continuum results. To this end, we calculate the corresponding pertubative matching coefficients up to $O(\alpha\alpha_s)$.
In our work, we emphasise the importance of appropriate choices of renormalisation conditions on the lattice and show how these impact the resulting perturbative matching. In particular, we find that the renormalization conditions defined and used in the literature thus far lead to extraneous and unnecessary QCD contributions that reflect in an artificial dependence on the lattice matching scale.
We suggest improvements to rectify this problem and present the complete expression for the Leading-Log (LL) and Next-to-Leading-Log (NLL) strong corrections to the electromagnetic contributions of the low-scale Wilson Coefficient.
Additional steps will also be discussed, including matching the full SM at the Electroweak scale and the 3-loop anomalous dimensions of the semi-leptonic operator necessary to achieve the NLL result.

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