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The photon energy spectrum in B$X_s\gamma$ at N^{3}LL'

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The smallest element of the CKM matrix, $|V_{ub}|$, can be extracted from measurements of semileptonic B meson decay $B \to X_u l \bar{\nu}$. However, the experimental signal of this process is obscured by large backgrounds, which are absent only at the edge of the phasespace. Resummation of perturbative series is essential in this kinematic region. Furthermore, this region is sensitive to Fermi motion of the b-quark inside the B-meson. Factorization theorems derived in Soft-Collinear Effective Theory are used to separate dynamics at different energy scales. The factorization also isolates nonperturbative effects in a so-called shape function. The shape function cannot be calculated perturbatively, but it can be measured in $B \to X_s\gamma$ decay.

I will present our preliminary predictions of $B \to X_s\gamma$ spectrum at $\mathrm{N^3LL'}$+$\mathrm{N^3LO}$. We parameterize the few unknown 3-loop perturbative ingredients, - a hard function coefficient and nonsingular contributions - using nuisance parameters. The variation of these nuisance parameters provides a robust estimate of the uncertainty that arises from our ignorance of these 3-loop terms.

In order to arrive at stable predictions it is essential to use a short-distance scheme for the b-quark mass. It is well-known that the pole mass scheme suffers from a renormalon problem, which leads to very poor convergence. We demonstrate that predictions in 1S mass scheme, which has been used for this process in the past, start to break down at $\mathrm{N^3LO}$ due to a mismatch between the 1S scale and the soft scale of this process. I will show that the MSR mass scheme yields much more stable results.

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