Λ_b baryon LCDAs in the short distance expansion

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Light-cone distribution amplitudes (LCDAs) enter in QCD factorization approaches as hadronic inputs. Figure 1 shows the LCDAs for the Λ_b and the Λ baryon that are depicted

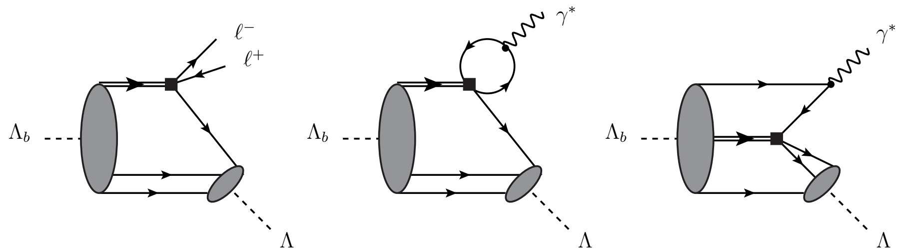

Figure 1: Possible diagrams containing baryon LCDAs in a sum rule calculation taken from arXiv:2312.14146.

as grey bubbles. They are genuinely non-perturbative quantities which describe the low-energy dynamics of the hadronic bound state. We obtain the full amplitude by combining them with the hard scattering kernel in between that mediates the interaction

The LCDA $\phi_2(\tau_1, \tau_2)$ is defined as the hadronic matrix element of a non-local operator in heavy quark effective theory (HQET)

$$\epsilon^{abc} \langle 0| \left(u^a(\tau_1 n)\, C\gamma_5 \not{n}\, d^b(\tau_2 n)\right) h_v^c(0)|\Lambda_b(v,s)\rangle = f_{\Lambda_b}^{(2)}\, \tilde{\phi}_2(\tau_1, \tau_2)\, u_{\Lambda_b}(v,s), \tag{1}$$

where the separations of the light quarks to the heavy quark are parametrized by τ_1 and τ_2. By calculating the short-distance expansion, we can relate the local hadronic elements to a few non-perturbative quantities. This limit corresponds to small separations $\tau_{1/2}$ and is also called the "radiative tail" in momentum space.

$$\begin{aligned} \tilde{\phi}_2(\tau_1, \tau_2) = {}& \left(1 - i(\tau_1+\tau_2)\frac{2\bar{\Lambda}}{3}\right)\left(1 - \frac{\alpha_s C_F}{4\pi}\left(L_1^2 + L_2^2 + L_1 + L_2 + \frac{5\pi^2}{12}\right)\right) \\ & + i\bar{\Lambda}\,\frac{\alpha_s C_F}{4\pi}\left(\tau_1\left(\frac{2L_1}{3} - \frac{3}{4}\right) + \tau_2\left(\frac{2L_2}{3} - \frac{3}{4}\right)\right) + \mathcal{O}(\tau_i^2)\,. \end{aligned} \tag{2}$$

We can use this constraint to improve the LCDA modelling. For long separations $\tau_{1/2}$, we have to assume a certain non-perturbative model and we extrapolate it with the help of the renormalization group equation (RGE) to the short-distance region, where we can adjust the parameters to fit our calculated result.

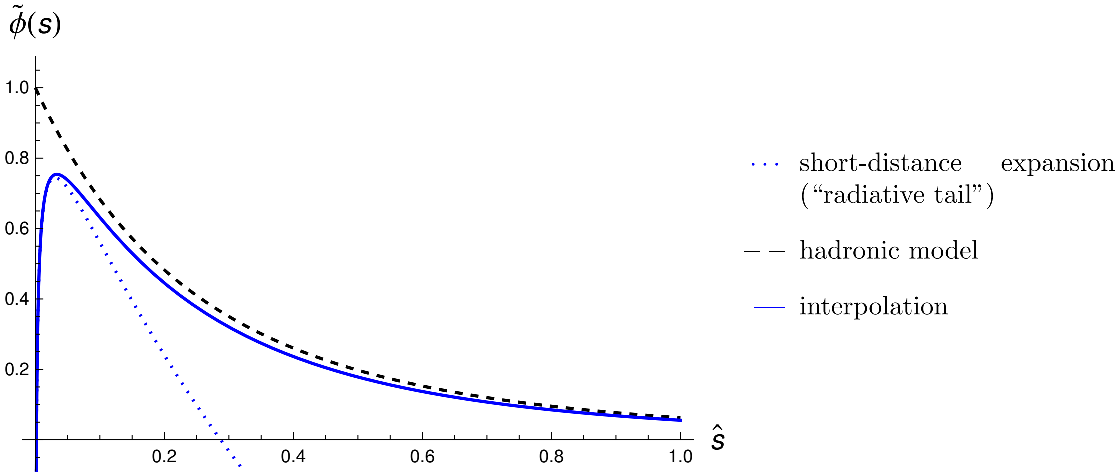

Figure 2: Model, "radiative tail" and interpolation for the Λ_b LCDA ϕ_2 plotted against the separation $\hat{s} \sim i\tau_{1/2}$.