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$B_c \rightarrow \eta_c$ form factors at large recoil: interplay of soft-quark and soft-gluon double logarithms

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Exclusive B -decays provide valuable insights into physics beyond the Standard Model and measurements of Standard Model parameters. At large hadronic recoil Soft-Collinear Effective Theory is the appropriate theory to describe the QCD dynamics of heavy-to-light transitions and to resum logarithmic corrections to all orders in perturbation theory. However, since the relevant hadronic matrix elements are power suppressed, the factorisation of soft and collinear contributions is spoiled by endpoint divergences. We therefore resort to diagrammatic resummation techniques to derive the double-logarithmic series of the “soft-overlap” contribution to $B_c \rightarrow \eta_c$ transition form factors, assuming the scale hierarchy $m_b \gg m_c \gg \Lambda_{\text{QCD}}$. We find that the leading double logarithms arise from a peculiar interplay of soft-quark “endpoint logarithms” from ladder diagrams with energy-ordered spectator-quark propagators, as well as standard Sudakov-type soft-gluon corrections. We elucidate the all-order systematics, and show that their resummation proceeds via a novel type of integral equations.

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