A study of power corrections in gauge theories with SCET
Snowmass 2021 LOI

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Factorization and resummation are essential tools relevant for modern QCD collider studies. Large hierarchy of scales in a given process leads to the appearance of large logarithms of the ratios of these scales and the convergence of perturbative treatment is spoiled. These large corrections have to be summed to all orders in perturbation theory to obtain reliable predictions. This summation is typically achieved only for the leading term in the power expansion around a certain singular limit.

Recently, there has been significant progress in understanding of the next-to-leading power (NLP) corrections thanks to the application of the effective field theory approach. There are many objectives of the NLP studies. One of the most important goals is increasing the precision of theoretical predictions relevant to phenomenological studies. Simultaneously, NLP corrections allow us to understand the all-order structure of gauge theories better. Leading logarithmic resummation in QCD has been achieved for several different processes, including event shape observables [1–3] and threshold resummation [4, 5]. There has also been progress in understanding mass suppressed effects [6–9] and effects related to soft quark exchange [10, 11]. However, further studies are necessary to extend the validity of factorization theorems beyond leading logarithmic accuracy and merge NLP resummed results with their fixed order counterparts, as well as to perform resummation for a more general class of processes and observables. Existing results are the foundation for careful and methodical studies of NLP physics and its relevance for the next generation of experiments.

There are technical issues related to the factorization beyond leading power, which hinder the progress. For example, the problem of so-called endpoint divergences spoils the naïve factorization [12, 13]. The physical origin of the factorization breakdown should be investigated, and a proper scheme allowing for a systematic treatment of these endpoint contributions must be devised.

Power-suppressed effects naturally show up in studies of QED corrections in heavy quark decays. Soft-collinear effective field theory allows for a systematic treatment of QED effects in leptonic [14] and non-leptonic B-meson decays [15]. While QED effects are typically presumed to be small, in certain cases, the QED corrections receive power-enhancement [16]. As new experimental data become more accurate, it is of utmost importance to systematically scrutinize the treatment of QED effects in flavor physics and consistently include them in theoretical predictions. A study should be performed on the validity of the presently applied approximate treatment of QED in the experimental setup and a comparison of this approach with a more exact treatment in the effective field theory framework.

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