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Recent progress on inclusive quarkonium production and polarization

Quarkonium production and polarization serves as a vital testing ground for quantum chromodynamics (QCD), offering critical insights into both perturbative and nonperturbative dynamics. In the nonrelativistic QCD (NRQCD) factorization framework, inclusive production cross sections of quarkonia are expressed as products of perturbatively calculable short-distance coefficients (SDCs) and nonperturbative long-distance matrix elements (LDMEs), which are hypothesized to be universal across production processes. For three decades, the validation of LDME universality has been central to understanding quarkonium production mechanisms. However, different groups extracted dramatically different sets of the three color-octet LDMEs of J/\psi, and none of them can describe all the production and polarization data from LHC, HERA, LEP and Belle, challenging the universality of LDMEs. In this talk, we will report our recent progress on factorizing the LDMEs into products of wave functions and gluonic correlators based on the potential NRQCD (pNRQCD) effective theory and comprehensive phenomenogical study on inclusive quarkonium prduction and polarization. We show that most of the data can be well described in the framwork of NRQCD factorization and those still evade a consistent discription coincide with “extenstions” of endpoint regions.

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