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The effect of mass on the QCD-improved parton model factorization theorem

Ali Baradaran, and Seyed Mohammad Moosavi Nejad

Faculty of Physics, Yazd University, University Blvd. - Safayieh – Yazd

E-mail: mmoosavi@yazd.ac.ir

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Abstract

Many decay or scattering processes in particle physics involve the production of partons in the final state. Except for the Top quark, which decays rapidly due to its very short lifetime, all other partons are converted into observable hadrons through a non-perturbative process. The factorization theorem in Quantum Chromodynamics (QCD) enables us to separate the perturbative and nonperturbative sectors of a hadronic process at a hard energy scale. This factorization makes it possible to theoretically calculate some experimental quantities such as cross sections and decay rates. In conventional factorization theorems, the masses of quarks as well as those of final-state hadrons are commonly neglected. In the present work, we intend to prove a generalized form of this theorem in the presence of quark and hadron masses for hadron production in a decay process. Then, as an applied example, we study the effect of mass on the energy distribution of the produced mesons resulting from the decay of the Higgs boson. We will show that the effect of meson mass is very important at low energies and can change the results by up to 45%.

Keywords: Quantum Chromodynamics (QCD), Factorization theorem, Higgs boson, Meson mass

For full article, refer to the Persian section
