Contribution ID : **88**   Type : **Oral talk**

Associated J/ψ and photon production in the Parton Reggeization Approach at high energy

Friday, 25 October 2024 10:00 (15)

The study of the associated production of J/ψ-mesons and photons is very impotent to verify perturbative quantum chromodynamics, factorization approaches, heavy quark to heavy quarkonium hadronization models and to extracting the Parton Distribution Function (PDF) of gluon in a proton from experimental data. In this paper, we study the associated production of J/ψ-mesons and photons at the energies of the Large Hadron Collider using the Parton Reggeization Approach (PRA) [1], which is based on Lipatov's effective field theory [2] and the modified Kimber-Martin-Ryskin model for unintegrated PDFs [3, 4]. We use two different heavy-quark to heavy quarkonium hadronization models: the non-relativistic quantum chromodynamics (NRQCD) [5] and the improved color evaporation model (ICEM) [6].

We have found that the PRA based predictions for production cross sections are higher than next-to-leading order collinear parton model results. We have shown that contributions of the direct production processes via the color-octet intermediate states in the NRQCD are suppressed relatively to the process via the color-singlet intermediate state, so the Color Singlet Model (CSM) can be used for predictions at the $p_{T J/\psi} < 40$ GeV. The long distance matrix elements of the NRQCD and ICEM parameter F_ψ in the calculations are taken as they have been obtained to describe experimental data of the J/ψ-meson prompt production at the LHC energies.

We have predicted various differential cross-sections for associated production of J/ψ-mesons and photons in the PRA at the center-of-mass energy $\sqrt{s} = 13$ TeV in the central rapidity region. We have obtained that the PRA using the CSM cross-sections strongly overestimate the results obtained in the PRA using the ICEM and this difference increases as more as the cutoff on the photon transverse momentum p_T becomes larger. The results of this study indicate that there are big difference between the ICEM based and the NRQCD based predictions for the associated $J/\psi + \gamma$ production that can be used for discrimination heavy quark to heavy quarkonium hadronization models.

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Session Classification : HEP Theory

Track Classification : High energy physics: theory