Reduced Fermi-motion effect by kinematical corrections in diffractive leptoproduction of heavy quarkonium

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The diffractive J/ψ (photo-) lepto-productions at ep collider of HERA offer a unique opportunity to measure the gluon density in the proton, especially at small-x. In the framework of pQCD, a importance of employing the light-cone wave functions of photon and J/ψ has been emphasized for the more reliable prediction to such processes[1,2]. Ryskin *et al.*[1], actually assuming a Gaussian form for J/ψ light-cone wave function, suggested that Fermi-motion effects of $c\bar{c}$ system could strongly suppress the cross section of J/ψ production. Frankfurt *et al.*[2] calculated the cross section by constructing the J/ψ light-cone wave functions starting from realistic potential models, although they dealt with the approximate Fermi-motion correction. They also predicted larger suppression due to the Fermi motion than ref.[1]. In our work[3], systematic analysis for the kinematical correction of $c\bar{c}$-system is presented in the diffractive leptoproduction of charmonia ($1S$,$2S$) within the light-cone perturbation theory. Here the kinematical corrections related to the relative momentum $\boldsymbol{k}_\perp$ between c and $\bar{c}$ quarks with the mass m_c are systematically taken into account up to the order $O(\boldsymbol{k}_\perp^2/m_c^2)$. It arises from the convolution of the perturbative parts in the light-cone wave functions of the photon and the charmonia. We found the corrections to reduce effectively the large suppression by Fermi-motion effects predicted in Refs.[1,2] and strongly enhance the total cross sections of both J/ψ(Fig.1) and ψ'(Fig.2) productions. As shown in the figures the results seem to agree with recent data from HERA. We suggest that it gives a possibility to explain the Q^2 and $\sqrt{s}$-dependences of the data within the consistent treatment of the color-dipole picture based on the light-cone perturbation theory. We also discuss about Υ-family production.

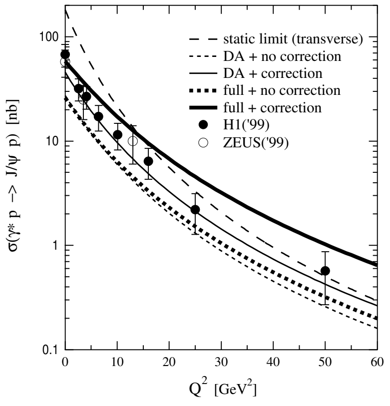

Figure 1: Total cross section of J/ψ.

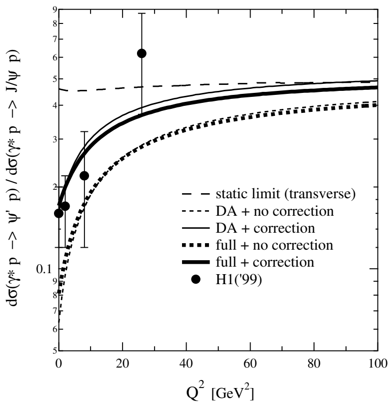

Figure 2: Ratio of ψ' to J/ψ.

References

[1] M.G. Ryskin *et al.*, Z. Phys. **C76**(1997) 231.
[2] L. Frankfurt *et al.*, Phys. Rev. **D54**(1996) 3194; ibid. **D57**(1998) 512.
[3] A. Hayashigaki, T. Hatsuda, K. Suzuki and K. Tanaka, preprint (2002).