Report on CR10456D

This manuscript calculated the hadroproduction cross sections of the J/ψ, $\psi(2s)$ and χ_c mesons at QCD LO. These calculations have been performed 20 years ago in e.g. Ref. [1–4] and also in a recent paper [5]. Neither the inclusion of the LHC data in the fitting nor the prediction of $\sigma(\psi(2s))/\sigma(J/\psi)$ is new. Actually, they have been studied at QCD NLO level [6, 7]. Nevertheless, I believe that an updated QCD LO study on the charmonium hadroproduction is necessary for the convenience of some researchers who have not been equipped with the tools to do QCD NLO computation. But just these materials do not justify the publication in Physical Review D. I suggest that the authors could publish their paper in some lower-level journal. However, if they can make some major extensions, I can also recommend publication of their paper in Physical Review D.

In addition, I provide some comments regarding more specific issues of this paper as follows.

- 1. The authors should provide the complete definitions of the variables used in their manuscript, for example, the definition of M, σ, p_T, m_T, and m_H. The symbol $\otimes$ in Eq.(1) is confusing. According to my calculation, it should be simply "times".

- 2. The statement below Eq.(1), "... depends ... on the renormalization scale μ_R" is wrong. The PDF depends on μ_F, however, does not depend on μ_R.

- 3. The authors used $M_L(Q\bar{Q}(n) \to H)$ to denote the LDMEs. Although optional, I believe that using the generally used notations would improve the readability of their paper.

- 4. The relations between the LDMEs for ${}^3S_1^{[8]}$ and ${}^3P_J^{[8]}$ to J/ψ and $\psi(2s)$ in Eq.(10) and Eq.(11) are strange. Actuall, there is neither theoretical nor phenomenological evidence for these relations. More confusingly, even their own results in Eq.(14) and Eq.(15) do not support their relations.

- 5. Another optional suggestion is that the authors could include the RHIC data, which is also suitable for perturbative calculations.

- 6. I don't know why the authors ignored the copius χ_c data at the Tevatron and the LHC, namely Ref. [8–12]. The authors should at least address this, and compare there results with Ref. [13]. They should also notice that Ref. [14] only measured four

points, namly the ratio $\sigma(\chi_c)/\sigma(J/\psi)$. The differential cross section for χ_c production was obtained by extrapolation.

- 7. The presentation of the LDMEs, $M_L(^1S_0^{[8]}...) = M_L(^3P_0^{[8]}...)/m_{charm}^2$ in Eq.(14) and Eq.(15) seems strange to me. This equation has no foundation. So, I suggest they present their results following the form in Ref. [2] or Ref. [1]. Actually, they can use the η_c hadroproduction data to fix these LDMEs, as Ref. [15] did. It would be interesting to see whether this approach also applies at QCD LO.

- 8. The authors should compare their results with Ref. [1, 4, 5].

Once the authors can address all the issues raised above and make major extensions, I can recommend publication of this paper in Physical Review D.

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