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Momentum transfer squared dependence of exclusive quarkonia photoproduction in UPCs

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In this work, the exclusive photoproduction of the ground and excited states of the heavy vector mesons $\psi(1S)$, $\psi(2S)$, $\Upsilon(1S)$ and $\Upsilon(2S)$ are discussed in ultraperipheral hadron collisions (UPCs) with proton and nucleus targets. Since we are interested in scatterings with the projectile being a virtual photon produced by the incoming hadron, we employ the color dipole model, which permits the factorization of the process in three steps. The first one is the splitting of the photon in a $q\bar{q}$ pair, which is described by a perturbatively calculated wave function. The second is the interaction of this pair with the target, this part is described by a parametrized dipole cross section, in order to account for the non-perturbative effects. In this work, we used two different b-dependent parametrizations for the evaluation of the t-dependent cross sections: one obtained by solving the Balitsky–Kovchegov equation with the collinearly improved kernel and the other with a Gaussian impact-parameter dependent profile. The third step is the transition of the $q\bar{q}$ pair into the vector meson, this part is obtained in the framework of the interquark potential model incorporating the Melosh spin transformation. With this formalism and the proton as a target, we compared our results with the available data from the HERA collaboration and found a good agreement between the both. For the nuclear case, we extended our calculations making use of the Glauber-Gribov theory and applied it to the coherent photoproduction of vector mesons in UPCs with the inclusion of the gluon shadowing effects fitted to data. We compared our results to the recently published ALICE data for the $\psi(1S)$ photoproduction as well as made predictions for other states: $\psi(2S)$, $\Upsilon(1S)$ and $\Upsilon(2S)$ at $s_{NN} = 5.02$ TeV, which can be useful in the future with new measurements on the large particle colliders.

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