Reply to Comment on "Coherent ρ 0 photoproduction in bulk matter at high energies" by T. C. Rogers and M. Strikman

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In their interesting comment [1] on "Coherent $\rho 0$ photoproduction in bulk matter at high energies" [2], Rogers and Strikman point out that, at high energies, $q\overline{q}$ dipoles with small separations (d) become more important, and that most of the growth of the cross-section is "driven by the increasingly large contributions from small size (high mass) configurations" [3]; at photon energies of 10^{20} eV, over half of the total cross-section is due to dipoles smaller than 0.25 fm. They state that charm production will increase, and may be as much as 30% of the cross-section.

The coherent photoproduction of heavier states requires higher energies than coherent ρ photoproduction, because the formation length scales as $1/M^2$. For the J/ψ, the required photon energy is 14 times higher than for the ρ. We agree that higher-mass states become important at higher energies. However, at this point, additional factors come into play; as we note after Eq. (7) [2], our calculation is only properly normalized when the conversion probability is relatively small. At the energies where coherent production of high mass states is possible, the coherent ρ production probability is large, and it is necessary to consider reverse reactions such as vector meson 'back-propagation' into real photons. The diagonal transitions found in generalized vector meson dominance, such as from a ρ to a ϕ or J/ψ may also become important, and a recursive technique appears needed to solve the problem [4].

To the extent that the higher mass states limit the growth of the low-mass cross-section, coherent ρ photoproduction will be smaller than we calculated. However, the high-mass fractions quoted by Rogers and Strikman are considerably smaller than the fractional difference between the two hadronic models we considered: the Glauber model [5] and the ERR calculations [6]. The presence of higher mass states in our Glauber calculation would not significantly alter the incoherent photonuclear cross-section in our Fig. 1. However, the subsequent ρ coherent cross-section would be lower, between the Glauber and ERR curves.

In the near future, it should be possible to measure the ρ and J/ψ photoproduction cross-section up to quite high energies (PeV photons in the target frame) using ultra-peripheral ion collisions at the LHC [7], thus reducing these uncertainties, and, more generally, search for signs of a rise in the coherent charm cross-section.

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