

Single and double ratio of elastic vector meson production to inclusive hadron production cross section as a possible signal of saturation in UPCs

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We explore a new ratio of observables in ultra-peripheral $A + A$ and $A + p$ collisions as a potential signal of saturation physics. We consider the ratio R_1 of elastic vector meson photo-production cross section to the inclusive hadron or jet photo-production cross section. The ratio can be measured in the $\gamma + A$ and $\gamma + p$ collisions taking place in the UPCs. We label the ratios $R_1(A)$ and $R_1(p)$, respectively, with A the atomic number of the nucleus. Constructing the double ratio $R_2(A) = R_1(A)/R_1(p)$, and performing a small- x calculation both in the quasi-classical approximation and by including small- x evolution, we observe that $R_2(A)$ exhibits a markedly different A dependence inside and outside the saturation region. Whether we are probing the physics inside or outside the saturation region is determined by the transverse momentum p_T of the hadron or jet: for $p_T \lesssim Q_s$ the inclusive production cross section in the denominator of R_1 is largely probing the physics inside the saturation region, while for $p_T \gg Q_s$ it is probing the physics outside the saturation region, with Q_s the saturation scale. The size of the produced meson in the elastic cross section also affects whether saturation region is probed or not in the elastic cross section in the numerator of R_1 . In the case of a relatively compact meson production, for instance, for J/ψ , the double ratio $R_2(A)$ grows faster with A inside the saturation region ($p_T \lesssim Q_s$) than outside ($p_T > Q_s$). For a larger meson, like ρ , the double ratio $R_2(A)$ decreases with A outside the saturation region ($p_T > Q_s$), and remains relatively flat inside the saturation region ($p_T \lesssim Q_s$).

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