The experimental data in this work are actually from quasi-elastic scattering including both elastic and inelastic contributions, since it is difficult to separate elastic scattering events from inelastic ones, due to the energy dispersion of secondary beams and energy resolution of silicon detectors. However, the contributions from the inelastic scattering channels are negligible in the present data within the angular range covered by our measurements[5, 6].

Experimentally measured elastic scattering angular distributions for ^{9}C (a), ^{8}B (b) and ^{7}Be (c) on the $^{\mathrm{nat}}$Pb target and the corresponding results from the optical model calculations with the systematic nucleus-nucleus potential of Xu and Pang[7].

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2 - 28 Charmonium Production from Two-photon Processes in Relativistic Heavy Ion Collisions*

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The two-photon interactions[1] for charmonium at unprecedentedly high energies can be studied in ultra-peripheral heavy ion collisions at Relativistic Heavy Ion Collider (RHIC), Large Hadron Collider (LHC), and Future Circular Collider (FCC) energies. We investigate the semi-coherent two-photon processes for large-p$_T$ charmonium (J/ψ) production in proton-proton and nucleus-nucleus collisions at RHIC, LHC, and FCC energies. If the transverse momenta of both photons are the same large (non-coherent) or small (coherent), the total transverse momentum would have a very small value, then the charmonium could not obtain large-p_{T} in the $\gamma\gamma \to \mathrm{H}$ interaction, where H is the charmonium. Indeed, the single track condition[2,3] leads to the weak contribution of non-coherent and coherent photon-photon processes for large-p_T charmonium production compared with the semi-coherent processes. Therefore we work in the semi-coherent two-photon approach that one photon is relatively hard and is incoherently emitted by participating projectile, while another can be soft enough to be in a coherent domain.

The cross-section for the charmonium produced by the semi-coherent two-photon interaction in ultra-peripheral collisions can be written as

$$\mathrm{d}\sigma = \widehat{\sigma}_{\gamma\gamma\to\mathrm{H}}(W)\mathrm{d}N_1\mathrm{d}N_2, \tag{1}$$

where the total cross section is given by $\hat{\sigma}_{\gamma\gamma\to\mathrm{H}}(W) = 8\pi^2(2J+1)\dfrac{\Gamma_{H\to\gamma\gamma}}{M_{\mathrm{H}}}\delta(W^2 - M_{\mathrm{H}}^2)$, and the decay width $\Gamma_{\mathrm{H}\to\gamma\gamma}$ for the charmonium can be taken from the experiment[4,5]. Furthermore, J and M_{H} are the spin and mass of the produced state, respectively.

The equivalent photon fluxes for the relativistic proton and nucleus can be obtained as

$$\mathrm{d}N_{1,2} = \frac{\alpha Z^2}{\pi^2}\frac{1-\omega/E+\omega^2/2E^2}{\omega/E}\frac{q_{\mathrm{T}}^2\left[F_{\mathrm{N}}\left(q_{\mathrm{T}}^2+\dfrac{\omega^2}{\gamma^2}\right)\right]^2}{\left(q_{\mathrm{T}}^2+\dfrac{\omega^2}{\gamma^2}\right)^2}, \tag{2}$$

where ω is the energy of the photon, γ is the relativistic factor, E is the energy for the projectiles, and $F(\mathrm{q}^2)$ is the proton and nuclear form factor of the equivalent photon source[6,7].

In Figs.1 and 2, we plot the differential cross section for large-p_{T}charmonium (J/ψ) in ultra-peripheral heavy ion collisions at RHIC, LHC, and FCC energies. Our calculations show that the large values of the differential cross sections for nucleus–nucleus and non-negligible values in proton–proton collisions can be obtained with the semi-coherent approach in ultra-peripheral heavy ion collisions at the RHIC, LHC, and FCC energies.

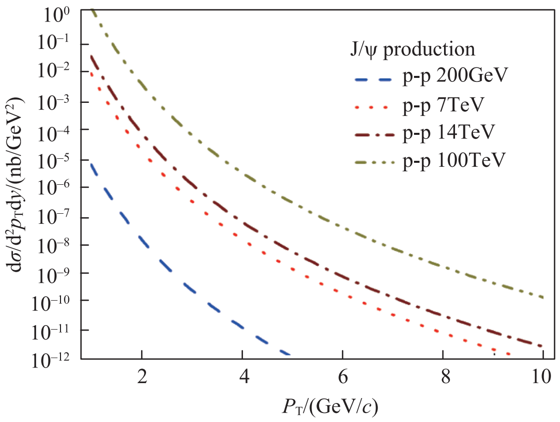

Fig. 1 (color online) The differential cross section for J/ψ production from the semi-coherent two-photon interaction in proton- proton collisions at RHIC, LHC, and FCC.

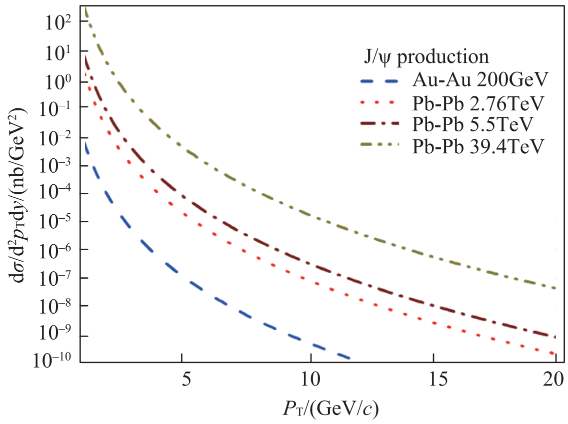

Fig. 2 (color online) The differential cross section for J/ψ production from the semi-coherent two-photon interaction in nucleus- nucleus collisions at RHIC, LHC, and FCC.

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2 - 29 Preparation of Uranium Monocarbide Powder by Carbothermic Reduction

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Uranium dioxide (UO_2) has become the basic fuel material for power reactor industry. It has many excellences such as high melting point, dimensional stability under irradiation and good mechanical property. Compared with UO_2, uranium monocarbide (UC) also has high fissionable material density and thermal conductivity, which can generate more power per kilogram. Therefore, uranium monocarbide (UC) is considered as a potential nuclear fuel in the fourth generation nuclear reactors, especially in accelerated driven systems.

UC can be synthesized by at least five different methods as shown below:

(a) Reaction of carbon with uranium metal or uranium hydride;

(b) Reaction of hydrocarbons with uranium metal or uranium hydride;

(c) Precipitation of uranium carbide from metal melts;

(d) Reduction of uranium halides;

(e) Carbothermal reduction of uranium oxide under vacuum or in an inert atmosphere.

The method chosen for this study is carbothermic reduction of uranium dioxide with graphite. In general, the carbothermic reduction of UO_2 may be represented by the following equation:

$$UO_2(s) + 3C(s) \rightarrow UC(s) + 2CO\,(g)\,.$$

The reaction rate between solid reactants are, among other factors, determined by particle size and how well the reactants are mixed. In addition, the partial pressure of gaseous product CO also affects the rate. The composition of the final product depends on the initial ratio UO_2/C, the reduction temperature and the effective CO pressure.

The starting materials were uranium dioxide powder and graphite powder, which were mixed manually with an agate mortar in glove box for approximately five minutes. After that, the powder was pressed into a pellet with