Beam energy dependence of the ($\gamma,\rho\rightarrow e^+e^-$) reaction on a nucleus

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Recent past, CLAS Collaboration measured the rho meson mass distribution spectrum in the ($\gamma,\rho\rightarrow e^+e^-$) reaction on nuclei [1]. In this measurement (done at Jefferson Laboratory), the tagged photon beam was used and the rho meson was detected for its momentum k_ρ (in GeV/c) = 0.8–3. It could be mentioned that the energy of the incoming beam can be weighted into six bins to simulate the beam profile function used in this experiment. Therefore, it is necessary to investigate the contribution to the cross section arising from different beam energies. The cross section can be written as

$$\frac{d\sigma}{dm}=\sum_{i=1}^{6}W(E_{\gamma,i})\frac{d\sigma(E_{\gamma,i})}{dm}, \qquad (1)$$

where $\frac{d\sigma(E_{\gamma,i})}{dm}$ denotes the differential cross section for the rho meson mass m distribution at the γ beam energy $E_{\gamma,i}$. The values of $E_{\gamma,i}$ (in GeV) are 1.0, 1.5, 2.0, 2.5, 3.0 and 3.5 with relative weights $W(E_{\gamma,i})$ of 13.7%, 23.5%, 19.3%, 20.1%, 12.6% and 10.9% respectively. $\frac{d\sigma(E_{\gamma,i})}{dm}$ can be written as

$$\frac{d\sigma(E_{\gamma,i})}{dm}=\int d\Omega_\rho K_F \Gamma_{\rho\rightarrow e^+e^-}\,|F_\rho|^2, \qquad (2)$$

where K_F is the kinematical factor associated with the reaction. $\Gamma_{\rho\rightarrow e^+e^-}$ denotes width of the rho meson of mass m decaying at rest into dielectron. It is given by

$$\Gamma_{\rho\rightarrow e^+e^-}(m)=C_\rho m, \qquad (3)$$

with $C_\rho\cong 8.8\times10^{-6}$.

The factor F_ρ appearing in Eq.(2) describes the photoproduction of the rho meson as well as the propagation of this meson through the nucleus. The rho meson production is described by the elementary rho meson photoproduction amplitude $f_{\gamma N\rightarrow\rho N}$ and its interaction with the nucleus is accounted by the elementary rho meson nucleon scattering amplitude $f_{\rho N}$. The experimentally determined energy dependent values of these amplitudes are used in this calculation. The detail of it is discussed in somewhere else [2].

We report the calculated differential cross section for the rho meson mass distribution in the ($\gamma,\rho\rightarrow e^+e^-$) reaction on ^{12}C nucleus for the rho meson momentum: k_ρ (in GeV/c) = 0.8–3. In Fig.1, we plot $W(E_{\gamma,i})\frac{d\sigma(E_{\gamma,i})}{dm}$ for various $E_{\gamma,i}$ to show the contribution to the cross section arising from different beam energy. The solid curve shows the cross section is maximum at 2.5 GeV beam energy. The cross section sections for the beam energies equal to 2 GeV (dashed curve) and 3 GeV (dot-dashed curve) are also significant. At 3.5 GeV beam energy, the rho meson momentum is larger than 3 GeV/c. Because of the kinematical constrain, i.e., k_ρ (in GeV/c) = 0.8–3, the cross section at 3.5 GeV is not calculated.

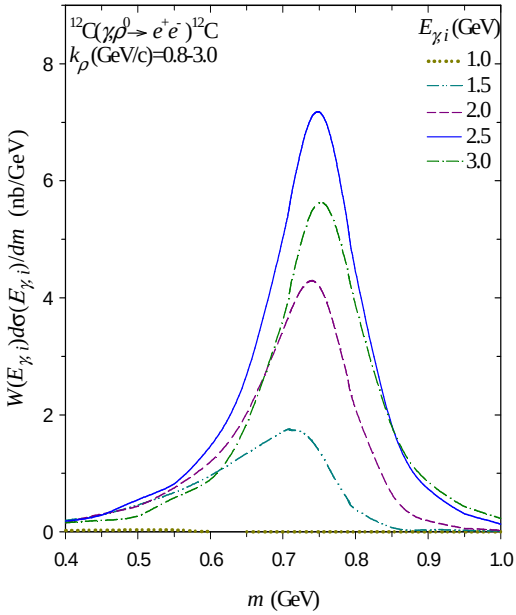

Fig.1 The calculated rho meson mass distribution at various beam energies.

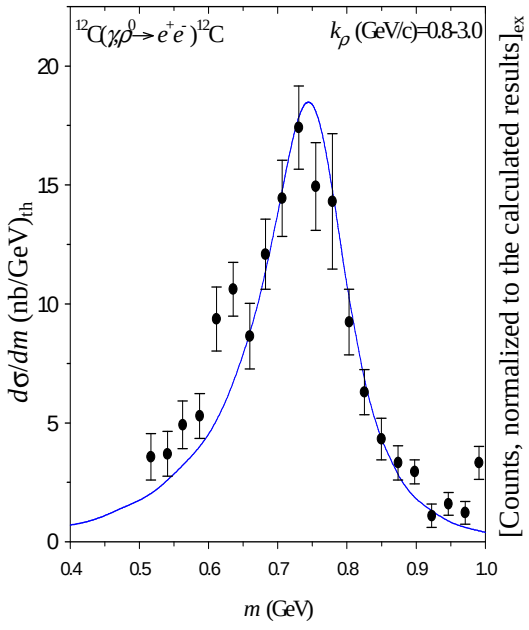

Fig2. The calculated rho meson mass distribution is compared with data.

We compare in Fig.2 the calculated results for ^{12}C nucleus with the rho meson mass distribution spectrum measured at Jefferson Laboratory [1]. The solid curve represents the summed cross section, as described in Eq.(1). The experimental counts are scaled to the calculated results at the peak. This figure shows the calculated results reproduce the measured spectrum reasonably well.

References

[1] R. Nasseripour et al., (CLAS Collaboration) Phys. Rev. Lett. **99** 262302 (2007); M. H. Wood et al., (CLAS Collaboration) Phys. Rev. C **78** 015201 (2008).
[2] Swapan Das, in preparation.