# $A$-dependence of the inclusive distributions of the $J/\psi$ particles

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We measured the differential cross sections $d\sigma/dx$ and $d\sigma/dp_t^2$ of the inclusive production of $J/\psi$ particles by $\pi^-$ mesons with momentum 43 GeV/$c$ from the nuclei Be, Cu, and W. The dependence of the cross sections on the atomic weight $A$ of the nucleus was approximated by the function $A^{\alpha}$. The exponent $\alpha$ increases with increasing $p_t^2$ and is independent of $x$ within the limits of statistical errors.

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We have previously reported[1] measurements of the $A$ dependence of the cross section for the production of $J/\psi$ particles by $\pi^-$ mesons with momentum 43 GeV/$c$. In the present article we present the distributions of the $J/\psi$ particles with respect to

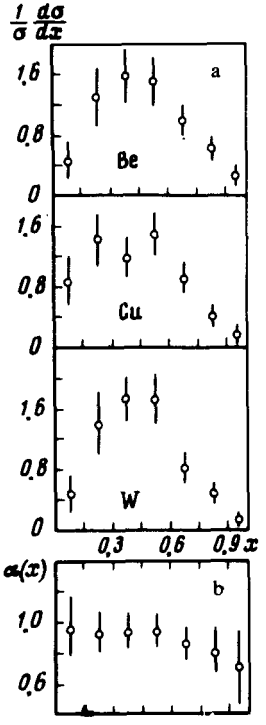


FIG. 1. a) Normalized inclusive cross sections $(1/\sigma)(d\sigma/dx)$ for the production of $J/\psi$ particles on the nuclei Be, Cu, and W; b) dependence of the exponent $\alpha$ on $x$ for the $J/\psi$ particles.

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the variables $x=pL^*/p^*_{max}$ and $p_t^2$, obtained from the nuclei Be, Cu, and W in the same experiment. The experimental setup (the "Sigma" spectrometer) and the reduction procedures are described in[1,2].

The reaction $\pi^- A \to J/\psi + \cdots$ was identified by the $J/\psi \to \mu^+\mu^-$ decay. To construct the inclusive distributions of the $J/\psi$ particles we selected events with effective pair mass $M_{\mu\mu}$ in the band $|M_{\mu\mu} - M_{J/\psi}| \leqslant \Gamma_{J/\psi}$, where $M_{J/\psi}$ and $\Gamma_{J/\psi}$ are the measured[1] mass and width of the $J/\psi$ peak in the effective-mass spectrum of the $\mu^+\mu^-$ pairs. The background under the $J/\psi$ peak was 5–20% in different targets.[1] It was assumed that this background has the same dependence on $x$ and $p_t^2$ as the cross section for the production of $J/\psi$ particles.

Figure 1a shows the normalized cross sections $(1/\sigma)(d\sigma/dx)$ for the production of $J/\psi$ particles from different nuclei. Their shapes are similar: the broad maximum at $x \approx 0.4$, observed for copper in[3,4], is present also in the spectra obtained for beryllium and tungsten. The results of the approximation of the different cross sections $d\sigma/dx$ by the power-law function $A^\alpha$ is shown in Fig. 1b. The parameter $\alpha$ is independent of $x$, within the limits of the statistical errors, and agrees with the value $\alpha = 0.92 \pm 0.06$ obtained by us earlier[1] for the total inclusive cross sections of $J/\psi$ particle production. Independence of $\alpha$ of $x$ was observed also in the production of $J/\psi$ particles in $nA$ interactions at 300 GeV/$c$.[5]

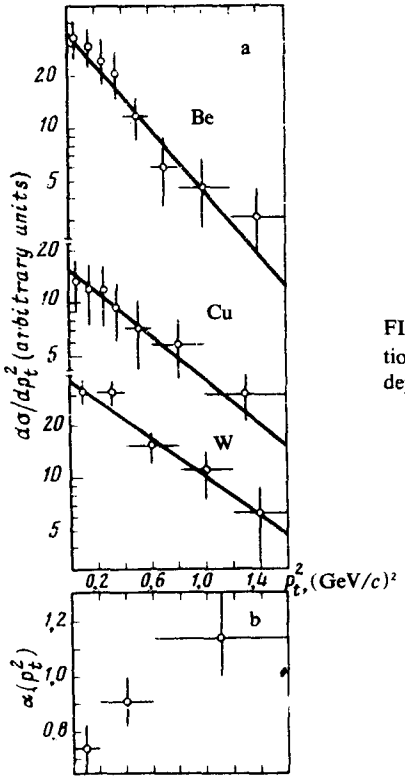


FIG. 2. a) Inclusive cross sections $d\sigma/dp_t^2$ for the production of $J/\psi$ particles from the nuclei Be, Cu, and W; b) dependence the exponent $\alpha$ on $p_t^2$ for the $J/\psi$ particles.

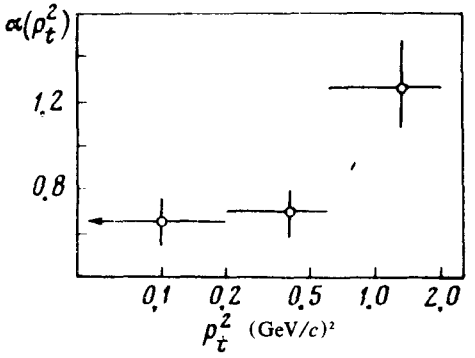


FIG. 3. The same as in Fig. 2b, but with a different subtraction of the background (see the text).

Figure 2a shows the cross sections $d\sigma/dp_t^2$ for the production of $J/\psi$ particles from different nuclei. The straight lines are the results of fitting to the exponential $\exp(-bp_t^2)$. The values obtained for the slope parameter $b$ are $b_{Cu}=1.45\pm0.25$; $b_W=1.3\pm0.3$ (GeV/$c$)$^{-2}$. The value of $b_{Be}$ agrees within the limits of errors with the one obtained by us earlier,[2] while $b_{Cu}$ agrees with the value obtained in[3,4]. Attention is called to the fact that with increasing atomic number of the target the slope $b$ decreases. Figure 2b shows a plot of $\alpha(p_t^2)$ obtained by approximating the cross section $d\sigma/dp_t^2$ by the power-law function $A^\alpha$. It is seen that $\alpha$ increases from $0.74\pm0.09$ at $p_t^2=0.1$ to $1.14\pm0.14$ at $p_t^2=1.1$ (GeV/$c$)$^2$. Since the dependence of the cross section for the production of $J/\psi$ particles on $p_t^2$ can differ from the dependence of the cross section of the production of the $\mu^+\mu^-$ pairs with the same effective mass, we have carried out the following additional analysis. All the events of $\mu^+\mu^-$ pair production were divided into three intervals with respect to $p_t^2$ and the cross section for the production of the $J/\psi$ particles was determined for each of the intervals by fitting the $M_{\mu\mu}$ mass spectrum in the manner described in[1]. The resultant function $\alpha(p_t^2)$ is shown in Fig. 3 and is similar to that obtained in Fig. 2b. The exponent $\alpha$ determined from the mass band 2500–2800 MeV adjacent to $J/\psi$ amounts to $\sim0.7$ and is independent of $p_t^2$ within the limits of errors. Thus, the observed increase of $\alpha$ with increase of $p_t^2$ is due to the production of the $J/\psi$ particle.

A similar behavior of $\alpha(p_t^2)$ was observed in the reactions for the inclusive production $\pi^\pm$, $K^\pm$, $p$ and $\bar{p}$ at 28,[6] 50–275,[7] 300,[8] and 200–400[9] GeV/$c$ and of $K^0$ at 10 GeV/$c$.[10] It should be noted that no variation of $\alpha$ with $p_t^2$ was observed in the reaction $nA\to J/\psi+\cdots$ at 300 GeV/$c$.[5]

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