oduction of J/Ψ particles by 43-GeV/c π^- esons on the nuclei Be, Cu, and W

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The A-dependence of the cross section for the production of J/Ψ particles by 43-GeV/c π^- mesons is measured. It is found that $\sigma=(18\pm6)A^{0.92\pm0.06}$ nb/nucleus in the region $x>0$.

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To study the A-dependence of the inclusive production of J/Ψ particles we used a "Sigma" :trometer with four targets of Be, Cu, and W+Cu alloy with density 17.7 g/cm³. The targets knesses were 40 cm=0.55 λ_a (Be), 13.4 cm=0.58 λ_a (Cu-1), 40 cm=1.72 λ_a (Cu-2), 25 =1.84 λ_a (W+Cu). The targets Be, Cu-1 and Cu-2, W+Cu had pairwise approximately equal knesses in nuclear units λ_a. Consequently, they absorbed the beam and the secondary particles ıe same manner, and thus the background conditions in the experiments performed with them ɜ equivalent. To decrease the background due to the $\pi(K)\rightarrow\mu$ decays, a carbon absorber of kness 232 g/cm² was placed behind the target. The apparatus and the dimuon selection criteria described in[1].

For each target we obtained ~1500 $\mu^+\mu^-$ events with masses $M_{\mu\mu}>1.2$ GeV. The mass :tra for these events, without allowance for the dependence of the acceptance of the apparatus $M_{\mu\mu}$, are shown in Fig. 1. The weighted number of the J/Ψ particles, which is needed to nate the cross section, was obtained by approximating the mass spectrum, corrected for the :ptance, by the formulas:

$$\frac{dN}{dM_{\mu\mu}}=\frac{N_{J/\Psi}}{(2\pi\sigma^2)^{1/2}}e^{-\frac{(M_{\mu\mu}-M_{J/\Psi})^2}{2\sigma^2}}+\begin{cases}Ae^{-k_1M_{\mu\mu}} & (1)\\ BM_{\mu\mu}^{-k_2} & (2)\end{cases}$$

TABLE I. Free-parameter values obtained by fitting the mass spectra of the $\mu^+\mu^-$ pairs to formulas (1) and (2).

Target	Fit	$M_{J/\psi}$, GeV	$\Gamma_{J/\psi} = 2.35\sigma$ GeV	Weighted number of J/ψ particles	k_1 GeV^{-1}	k_2
Be	1	3.04 ± 0.02	0.30 ± 0.04	1632 ± 194	2.6 ± 0.1	–
	2	3.05 ± 0.02	0.25 ± 0.03	1284 ± 180	–	4.2 ± 0.2
Cu-1	1	3.03 ± 0.02	0.23 ± 0.03	1220 ± 182	2.6 ± 0.3	–
	2	3.03 ± 0.02	0.21 ± 0.03	1107 ± 195	–	4.6 ± 0.3
Cu-2	1	3.09 ± 0.02	0.39 ± 0.05	1479 ± 210	2.5 ± 0.2	–
	2	3.09 ± 0.02	0.36 ± 0.05	1358 ± 207	–	4.3 ± 0.3
W + Cu	1	3.03 ± 0.03	0.52 ± 0.06	2763 ± 346	2.3 ± 0.2	–
	2	3.04 ± 0.03	0.48 ± 0.06	2382 ± 345	–	3.9 ± 0.2

The difference between formulas (1) and (2) lies in the description of the continuum region. The acceptance of the spectrometer was calculated for each event under the assumption that the decay of the dimuon is isotropic in its rest system. In the region of the J/Ψ particle, the efficiency of the registration of the $\mu^+\mu^-$ pair was on the average 7% for $x = P_L/P_{max} > 0$. To improve the signal-

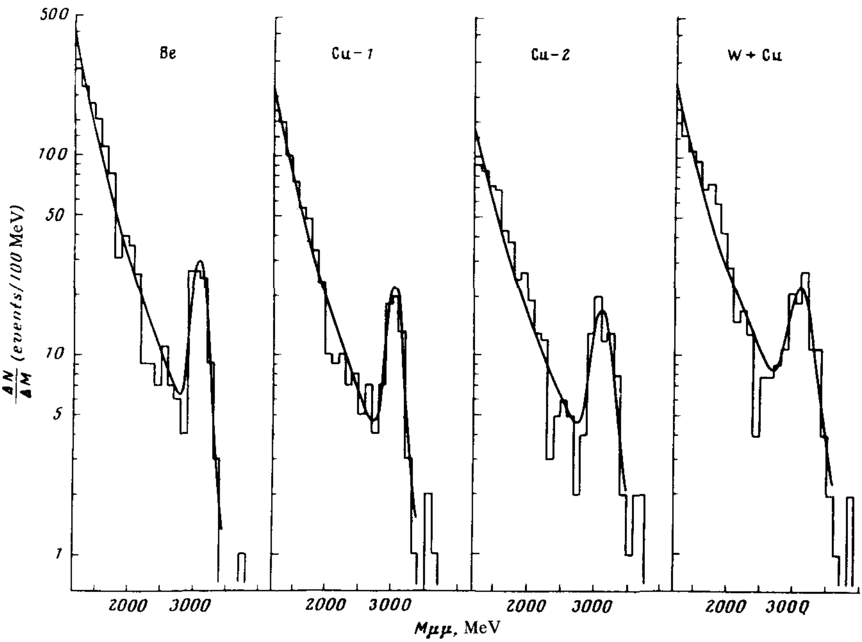

FIG. 1. Dependence of the number of $\mu^+\mu^-$ events on the dimuon mass. The curves are the results o the approximation of the spectra by formula (2).

TABLE II. J/Ψ particle production cross sections in the region $x > 0$.

Nucleus	$\sigma_{J/\Psi}$, nb/nucleus	
	fit 1	fit 2
Be	156 ± 19	123 ± 17
Cu	840 ± 90	773 ± 93
W	2504 ± 345	2152 ± 343

/noise ratio we discarded events whose registration efficiency was less than 1%. It turned out that both formulas (1) and (2) could be used to describe the mass spectra. The estimates of the free parameters obtained in this case are in agreement (see Table I).

The cross sections σ_a for the absorption of the primary beam by the target nuclei, which are needed to determine the cross sections for the production of the J/Ψ particles, were measured in a special experiment. We have defined σ_a as the sum of the cross sections for all the processes in which the π^- meson loses more than 7 GeV.[2] That is to say, it was assumed that the low energy losses (less than 7 GeV) do not influence the probability of production of the J/Ψ particle. We found that the value of σ_a determined in this manner is $(18.9 \pm 0.9)A^{0.8}$ mb. This is ~20% less than the cross sections[3] customarily used to correct for particle absorption in targets.

The measured values of the inclusive cross sections for the production of J/Ψ particles in the region $x > 0$ are given in Table II. The errors indicated there are statistical. The statistical error does not depend on the type of the approximated function and equals 25% for all targets. To describe the A-dependence of the cross sections for the production of the J/Ψ particles we used the formula $\sigma^A_{J/\Psi} = \sigma^N_{J/\Psi} A^\alpha$ (see Fig. 2). The results of fitting this formula to the experimental data in different regions of x are shown in Fig. 2. The statistical errors of the free parameters were

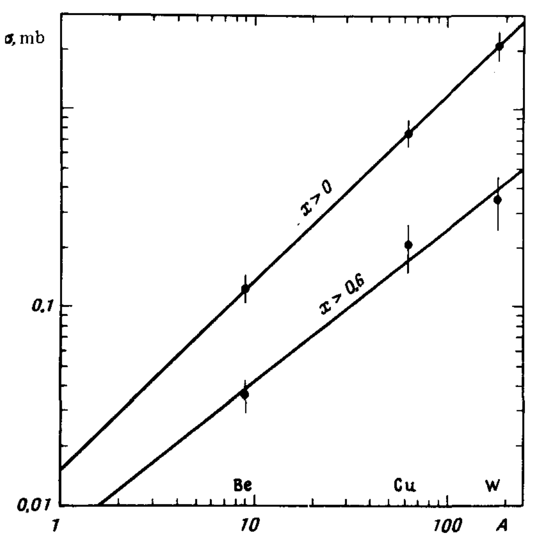

FIG. 2. A-dependence of the J/Ψ particle production cross section.

TABLE III. A-dependence of the J/Ψ particle production cross section.

x-Region	fit 1		fit 2	
	$\sigma^N_{J/\Psi}$, nb	α	$\sigma^N_{J/\Psi}$, nb	α
$x > 0$	21 ± 6	0,90 ± 0,06	15 ± 5	0,95 ± 0,07
$x > 0.3$	15 ± 5	0,89 ± 0,07	12 ± 4	0,91 ± 0,08
$x > 0.6$	7 ± 3	0,80 ± 0,09	7 ± 3	0,78 ± 0,11

estimated with the aid of the MINOS program.[4] The estimate of the values of $\sigma^N_{J/\Psi}$ and α obtain for the approximating functions (1) and (2) were the same within the limits of errors. The obtain value of the parameter α is close to that measured in experiments at higher energies.[5,6]

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