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ЛАБОРАТОРИЯ ЯДЕРНЫХ ПРОБЛЕМ

ON THE POSSIBILITY OF INVESTIGATING THE INTERACTION OF LONGITUDINALLY POLARIZED V^0-MESONS WITH NUCLEONS IN THE $\pi^- A \to V^0 A'$ REACTION

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О возможности определения сечения продольно-поляризованных V° - мезонов в $\pi^- A \to V^\circ A'$

Для процесса перезарядки на ядре ($\pi^- A \to V^\circ A'$) рассчитано сечение с учетом того, что в этом процессе рождаются как поперечно- так и продольно-поляризованные V° - мезоны.

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On the Possibility of Investigating the Interaction of Longitudinally Polarized V° -Mesons with Nucleons in the $\pi^- A \to V^\circ A'$ Reaction

It is reported that the investigation of the $\pi^- A \to V^\circ A'$ reaction is useful for the determination of the σ_L -total cross section of longitudinally-polarized V° -meson interaction with nucleons. This reaction is complementary to the V° -coherent photoproduction from the analysis of which the σ_T -total cross section of transversally polarized V° on nucleons is extracted.

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The analysis of data on unstable particle production from atomic nuclei permits to obtain information about unstable particle-nucleon forward scattering amplitudes averaged over nuclear spin. In the case of $V^\circ N$ -scattering (the V° -vector meson) such an averaged quantity is characterized by two complex numbers $\sigma'_T(V^\circ) = \sigma_T(1 - i a_T)$ and $\sigma'_L(V^\circ) = \sigma_L(1 - i a_L)$ where $\sigma_{T(L)}$ is the total transversally (longitudinally)-polarized V°-meson-nucleon cross section and $a_{T(L)}$ is the ratio of real-to-imaginary parts of the forward $V^\circ N$ -scattering amplitude. In the coherent V° photoproduction on nuclei investigated intensively recently /1/ according to the well known reasons, practically only the transversally-polarized V° -s may be produced and thus only σ'_T may be extracted from the analysis of the suitable experimental data. To determine σ'_L it is necessary to investigate such V° production processes from nuclei in which longitudinally polarized V° -s are produced predominantly. One of the processes of this kind the most available for the experimental investigation and the simplest for the theoretical analysis is V° production in π^- -nuclear collisions ($\pi^- A \to V^\circ A'$)[x/] . Using the standard technique for calculating the incoherent charge-exchange processes on nuclei /3/ , it is easy to obtain the following relation between the observable quantities of the $\pi^- A \to V^\circ A'$ and $\pi^- p \to V^\circ n$ reactions:

$$\frac{d\sigma^A}{dt}\rho^A_{\lambda\lambda'} = \frac{d\sigma^p}{dt}\rho^p_{\lambda\lambda'}\frac{Z}{A}N[\sigma(\pi), \frac{\sigma'_\lambda + \sigma'^*_{\lambda'}}{2}] . \qquad (1)$$

[x/] This process has been studied in /2/ under the assumption that $\sigma'_L = \sigma'_T$.

Here $\frac{d\sigma}{dt}^{A(p)}$ are differential cross sections under consideration on nuclei and nucleons, respectively (summed over all final nuclear states in the case of pruduction on nuclei), $\rho_{\lambda\lambda'}$ (λ, λ'= -I, 0, I) are elements of the density matrix through which the angular distributions of the unstable particle decay-products are expressed in a well-known way /4/ , the $Z(A)$-charge (the atomic number) of the nuclear target. The "effective number of nucleons" $N(\sigma_1, \sigma_2)$ (which are in general complex quantities, if σ_1 ; σ_2 are such ones) are expressed in the terms of nuclear density $\rho(\vec{r}) = \rho(z, \vec{\beta})$ normalized to the full number of the nucleon A and σ_1, σ_2 by /5/

$$N(\sigma_1, \sigma_2) = \int d^2B\,[\exp(-\sigma_1 \int_{-\infty}^{\infty} \rho(B,z)\,dz) - \exp(-\sigma_2 \int_{-\infty}^{\infty} \rho(B,z)\,dz)] \cdot /(\sigma_2 - \sigma_1) \tag{2}$$

and $\sigma'_{\lambda(\lambda')} = \sigma'_T$ $\lambda, \lambda' = \pm 1$

and $\sigma'_{\lambda(\lambda')} = \sigma'_L$ $\lambda ; \lambda' = 0$.

From (I) and the above definitions we have:

$$\frac{\frac{d\sigma^A}{dt}\rho_{11}}{\frac{d\sigma^p}{dt}\rho^p_{11}} = \frac{\frac{d\sigma^A}{dt}\rho_{1-1}}{\frac{d\sigma^p}{dt}\rho_{1-1}} = \frac{Z}{A} N(\sigma(\pi), \sigma_T(V^\circ)), \tag{3}$$

where the effective number of nucleons $N(\sigma(\pi), \sigma_T(V^\circ))$ in the right-hand side of these equalities is the function of the σ_T -transversally-polarized $V^\circ N$ cross section which may be determined independently from V°-s coherent photoproduction data. The checking of these equalities is the checking of selfconsistency of the scheme, describing particle-nuclear reactions, in whose framework such reactions are considered usually. (Practically this is the checking of the optical model). If such checking gives positive results, then the following step, is the determination of σ'_L by analyzing the longitudinal V° -production by means of

$$\frac{\frac{d\sigma^A}{dt}\rho^A_{00}}{\frac{d\sigma^p}{dt}\rho^p_{00}} = \frac{Z}{A} N(\sigma(\pi), \sigma_L(V^\circ)) .$$

The last step is the determination of α_L from:

$$\frac{d\sigma^A}{dt} Re\, \rho^A_{10} = \frac{d\sigma^p}{dt} Re \{ \rho^p_{10} N(\sigma(\pi), \frac{\sigma'_T + \sigma'^*_L}{2}) \}$$

(we do not write the analogous expression for the imaginary part because it does not enter into the angular distribution of decay products) either putting $Im\, \rho^p_{10} = 0$ as it follows from the Regge pole model /6/ or supposing that $Im\, \rho^p_{10}$ is a free parameter to be determined. Such is the scheme for σ'_L determination from nuclear data. The authors are grateful to Yu.M. Zaitsev, L.I. Lapidus, G.A. Leksin and S.G. Matinian for valuable discussions.

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