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POSSIBLE OBSERVATION OF DIBARYON RESONANCE IN PROCESSES OF RELATIVISTIC DEUTERON FRAGMENTATION

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In studies of the reaction

$$d + A \rightarrow p + X \qquad (1)$$

on the C target with protons emitted in the forward direction ($\theta_p \leq 0.4°$) for a deuteron momentum of 8.9 GeV/c, a peak was observed in the proton spectrum over the range 6.10 GeV/c $\leq p_p \leq$ 6.72 GeV/c (295 MeV/c $\leq p^*_p \leq$ 391 MeV/c in the deuteron rest frame)/1/. To clarify the nature of this peak, the material obtained in an exposure of the CH_2 target in this experiment was analysed.

The measured invariant cross sections of the proton yield for reaction (1) on the C and CH_2 targets are presented in fig.1.

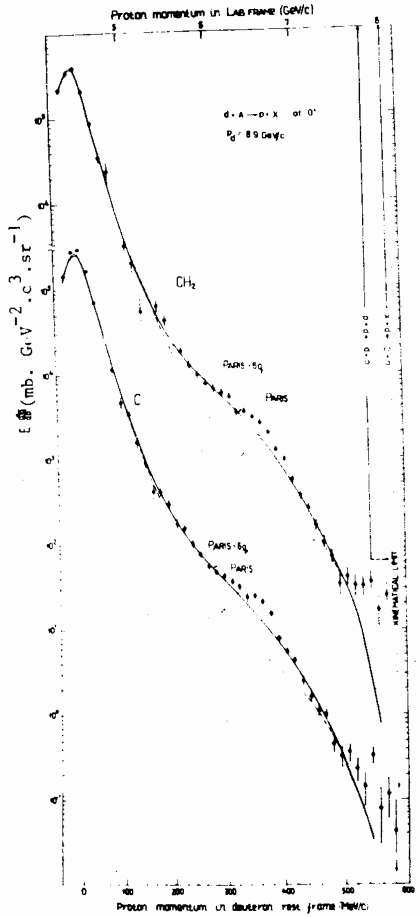

Fig.1. Invariant cross section of the proton yield for reaction (1) on the C and CH_2 targets. Solid lines - the result of calculation by the model/5/ with the parameters presented in Table 2, dashed lines - the calculation without taking into account 6q - admixture in the deuteron.

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The experimental data were compared to theoretical calculations by formula (2.10) taken from ref. [2] with relativistic deuteron wave function (DWF) written in terms of light cone variables [1,3,4]. The DWF of the hybrid model [5] with oscillator potential for interquark interaction was used. The wave function for the Paris potential (PARIS) was chosen as a two-nucleon wave function [6]. The NA and Np elastic scattering differential cross sections were approximated by the dependence $d\sigma_{NA}/dq_T^2 = (A/\pi)\exp(-Bq_T^2)$. Table 1 presents the values of A, slope parameters B and other values used in the calculation.

Table 1.

Parameters used to calculate the cross sections

Nucleus	$\sigma^{in}_{NA}/\sigma^{T}_{dA}$	σ^{T}_{NA} (mbn)	A mbn(GeV/c)$^{-2}$	B (GeV/c)$^{-2}$
^{12}C	0.54	380	7500	65
H	0.74	41	80	7

Free parameters of the model were the following: r is the RMS radius of 6-quark system (it is related to parameter w of the oscillator interquark potential by relation $r^2_{6q}=5/(4w)$; β^2 is the value of 6q-admixture in the deuteron; $\mathcal{H}$ is a relative phase of np and 6q components in the deuteron. These parameters were found by fitting the calculation to the data for the region 113 MeV/c $\le p^*_{\parallel} \le$ 494 MeV/c. In this case the region 295 MeV/c $\le p^*_{\parallel} \le$ 404 MeV/c, where a sharp anomaly is observed in the behaviour of the cross section, was excluded from the fit. The estimates of the parameters are presented in Table 2. The value of 6q-admixture agrees with the estimates obtained previously [7].

Table 2.

Parameters of 6q-admixture in the deuteron

Target	Probability of 6q-admixture β^2	r_{6q} (fm)	$\mathcal{H}$-phase of np and 6q incoherence	χ^2/degree of freedom
CH_2	(5.4±0.6)%	0.99±0.04	95°±7°	1.6
C	(4.3±0.4)%	0.95±0.05	82°±6°	1.9

As is seen from Table 2, the approximation of the cross sections on both targets gives the estimates of the parameters which agree within the errors. The value of $\mathcal{H} \sim 90°$ indicates orthogonality of the np and 6q components in the deuteron.

The anomalous behaviour of the cross section in the region 295 MeV/c $\le p^*_{\parallel} \le$ 404 MeV/c can be explained by the production of dibaryon resonance (fig.2) in the reaction

$$d + N \rightarrow d^* + N \quad \hookrightarrow p + N. \qquad (2)$$

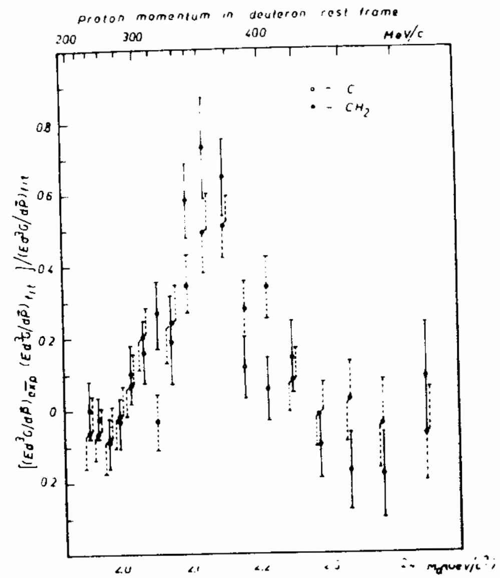

Fig.2. Peak in the proton spectra for reaction (1) on the C and CH_2 targets. The lower scale corresponds to the effective mass of the d^* system produced at a zero angle.

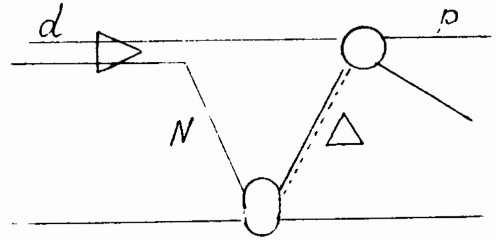

Fig.3. Triangular diagram with Δ-isobar in the intermediate state.

One could attempt to explain this peak by the contribution from the triangular diagram (fig.3) with Δ-isobar in the intermediate state. However, a combined analysis of the momentum spectra, obtained on the C and CH_2 targets, allows the second possibility to be excluded if isotopic relations are taken into account. The excess of the experimental cross section over the background curve with the parameters given in Table 2 is written as

$$R = \frac{\sum[(\sigma_{exp})_i - (\sigma_{t.c})_i]}{\sum(\sigma_{t.c})_i}.$$

The ratio of these values for the CH_2 and C targets is

$$R(CH_2)/R(C) = 1.00 \pm 0.07. \qquad (3)$$

As it follows from isotopic invariance, the process of Δ-isobar production in the intermediate state proceeds 5 times weaker on neutron than on proton, and the expected value of $R(CH_2)/R(C)$ is undoubtedly larger than 1.3 and equals ~ 2 for the effective number of nucleons in carbon ~ 4.

If the observed peak is interpreted as a contribution from process (2), from relation (3) it follows that isospin I of the observed resonance is 0. The parameters of the resonance obtained using Monte-Carlo simulation of the production process, are $M = (2.14 \pm 0.01)$ GeV/c^2 and $\Gamma = (80 \pm 10)$ Mev/c^2 on the assumption of diffractive production mechanism (fig.2).

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Возможное проявление дибарионного резонанса в процессах фрагментации релятивистских дейтронов

Приводятся и обсуждаются полученные на синхрофазотроне ОИЯИ результаты измерений фрагментаций дейтронов с импульсом 8,9 ГэВ/с на С и CH_2 мишенях. Для их описания использована модель с гибридной волновой функцией дейтрона $\psi_d = \psi_{np} + \psi_{6q}$; определены ее параметры.

Обнаружена особенность в импульсных спектрах протонов, испущенных под углом $\theta \leq 0{,}4°$. Она интерпретируется, как проявление дибарионного резонанса с изоспином ноль, массой $M = (2{,}14 \pm 0{,}01)$ ГэВ/с^2 и $\Gamma = (80 \pm 10)$ МэВ/с^2.

Работа выполнена в Лаборатории высоких энергий ОИЯИ.

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Ableev V.G. et al. E1-82-516

Possible Observation of Dibaryon Resonance in Processes of Relativistic Deuteron Fragmentation

Results of measurements of the fragmentations of 8,9 GeV/c deuterons on C and CH_2 targets obtained at the Dubna synchrophasotron are presented and discussed. The hybrid model of deuteron wave function $\psi_d = \psi_{np} + \psi_{6q}$ is used for their description; its parameters are determined.

A peak is observed in the momentum spectra of protons emitted at an angle of $\theta_p \leq 0.4°$. It is interpreted as an evidence for dibaryon resonance with isospin $I = 0$, $M = (2.14 \pm 0.01)$ GeV/c^2 and $\Gamma = (80 \pm 10)$ Mev/c^2 .

The investigation has been performed at the Laboratory of High Energies, JINR.

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