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DETERMINATION OF DEUTERON SIX-QUARK COMPONENT PARAMETERS

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1. Our data on proton momentum spectra are presented in refs.[1,2]. The spectra have been measured at zero angles in the reaction of relativistic (8.9 GeV/c) deuteron fragmentation. The experiment was performed at the Dubna synchrophasotron; preliminary data were presented at the International Conferences [3].

The data allow one to find the nucleon momentum distribution in deuteron (NMDD) using the formula

$$E\, d^3\sigma / d\vec{p} = \frac{1}{8\pi}\, \sigma^{in}_{NA} \frac{\sigma^{in}_{dA}}{\sigma^{T}_{dA}} \sqrt{\frac{m^2}{4\alpha(1-\alpha)^3}}\, F(\alpha)\, |\psi(k^2)|^2 \qquad (1)$$

derived [4] under relativistic approach. Here σ^{in}_{dA}, σ^{in}_{NA} are the total inelastic dA and NA cross sections, σ^{T}_{dA} is the total dA cross section, $\psi(k^2)$ is the nonrelativistic wave function of deuteron (DWF), $k^2 = \frac{m^2 + p^{*2}_{\perp}}{4\alpha(1-\alpha)} - m^2$, α is the usual light cone variable: $\alpha > \frac{E^*_p + p^*_{\parallel}}{M_d}$. M_d and m are the deuteron and proton masses, and p^* is the proton-spectator momentum taken in the deuteron rest frame. Factor $F(\alpha)$ is used to take into account kinematical constraints on the reaction phase space. In determining NMDD we limit ourselves to the $k \lesssim 0.8$ GeV/c region, because in a $k > 0.8$ GeV/c region the factor $F(\alpha)$ rapidly reduces to zero when one approaches to the kinematical limit for the $dA \to pX$ reaction being studied. Besides, in this region, near $k \simeq 1.02$ GeV/c, contributions from other mechanisms, such as proton knockout reactions $dp \to pd$, $dp \to p(np)$, are possible.

Figure 1 presents the NMDD extracted from the data obtained on targets with different neutron and proton numbers (carbon and polyethylene).

One can see that the extracted NMDD are practically identical over the whole measurement interval despite different isospin contents of the targets. This fact suggests that the isospin-dependent effects of final state interactions (FSI) are small. As was noted in ref.[5], the effects of Δ-isobar excitation in the intermediate state decrease by a factor of 5 when a proton target is replaced by a neutron one. If one takes into account that the effective nucleon number in carbon is about 6, then the χ^2-criterion rules out the hypothesis of the presence of such FSI effects (the confidence level of the hypothesis is less than 1%).

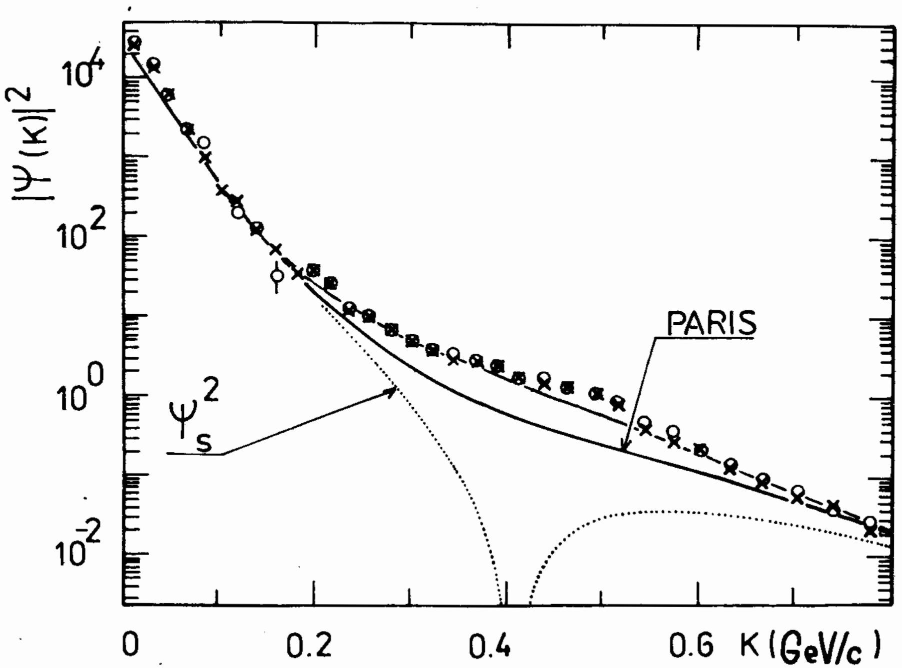

Fig.1. The nucleon momentum distributions in deuteron. × - carbon, o - polyethylene targets. Statistical errors are shown when they exceed the dimensions of the point symbols. PARIS - Paris DWF squared, ψ_S^2 - contribution of the S-wave Paris DWF component. The upper line represents our DWF with the parameters in the text. In determining their values, data in the region k from 0.36 to 0.53 GeV/c are omitted, because their excess over our DWF is possibly due to the diffraction production of dibaryon resonance /1,2/.

In going to the high momentum region with k from 0.2 up to 0.6 GeV/c, where $|\psi(k^2)|^2$ has fallen by 3÷5 orders of magnitude, an excess has been found of the measured $|\psi(k^2)|^2$ value over the expected one (from known DWFs including the recent Paris potential DWF /6/). Its magnitude is as large as (300-400%) (see fig.1).

Because of the argument against a dominant role of the FSI isospin-dependent effects, this excess has been interpreted in our papers /1-3/ using the hypothesis on the presence of the S-wave six-quark state of the deuteron (6q-state):

$$\psi_{6q}(k^2) = 1{,}3574(8r_{6q}^2/15\pi)^{3/4}\exp(-4r_{6q}^2\ k^2/15). \qquad (2)$$

Taking this part of the total DWF into account (the hybrid model /7/)

$$\psi(k^2) = \sqrt{1-\beta^2}\,\psi_{np}(k^2) + \beta\exp(i\chi)\psi_{6q}(k^2), \qquad (3)$$

we have obtained an equally good description (fig.1) of the data /1,2/. The estimates of the 6q-component parameters found in ref. /1/ are the following: $r_{6q} = (0.95 \pm 0.05)$ Fm, $\beta^2 = 0.043 \pm 0.004$, $\chi = 82° \pm 6°$ with $\chi^2/\mathrm{DOF} \simeq 1.9$. (The χ^2/DOF grows up to 16 when the 6q-component is neglected). These estimations coincide, within the errors, with the ones obtained from the data of ref. /2/. In the analysis, the Paris DWF was taken as $\psi_{np}(k^2)$; the relativistic Glauber theory was used.

2. The possibility of comparing our results with the deuteron electrodesintegration data has arisen in the very last months, when the SLAC group published the new analysis /8/ of their old data and data of other groups, in particular those from Kharkov /9/. The aim of the analysis was to extract the NMDD as well. The authors of ref. /8/ have presented their results in terms of the k-variable interpreted as a fragment-spectator momentum (They do coincide in the nonrelativistic limit).

Figure 2 displays results of this analysis. As we do, the authors of ref. /8/ point to a deviation of the measured NMDD

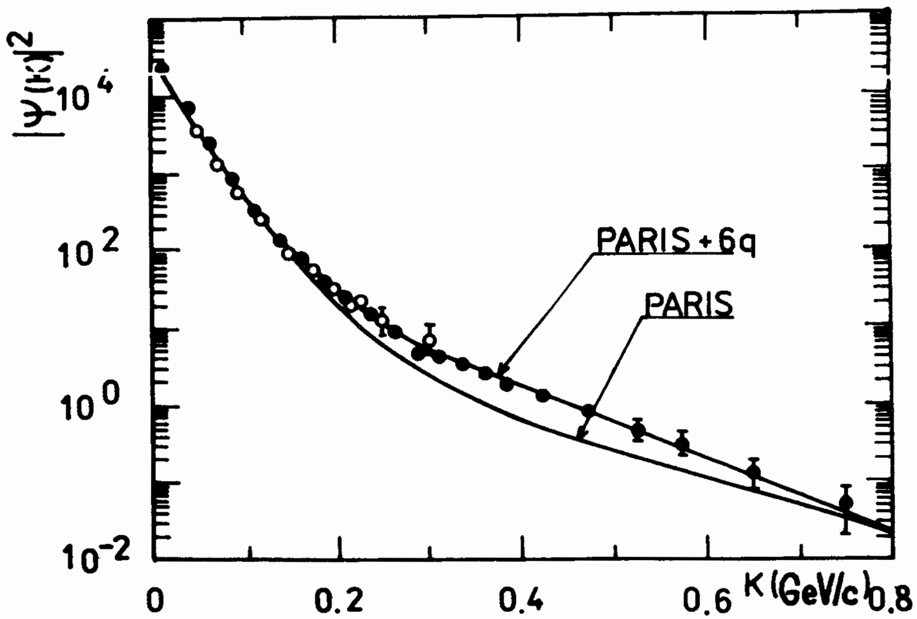

Fig.2. The nucleon momentum distribution in deuteron found in paper /8/. • - SLAC data, o - Kharkov data /9/. PARIS+6q - our DWF /1,2/.

from the Paris DWF and claim the impossibility of interpreting this deviation by the FSI effects.

In fig.2 we present also our DWF taken in the form (3) with the above parameters. It perfectly reproduces the SLAC data without any additional fit.

3. We conclude that the obtained nucleon momentum distributions in the deuteron do not differ despite the difference in the measurement methods (deuteron electrodesintegration at electron energies from 6 to 21 GeV and values of Q^2 from 0.8 to 10 GeV^2/c^2 or deuteron fragmentation on nuclear targets with different numbers of protons and neutrons, when nucleon is emitted at zero angle). Therefore the measured NMDD are actually the DWF squared: $|\psi(k^2)|^2$.

It is natural, within the present-day notions of hadron and nuclear structure[7,10], to interpret the obtained deviation of the measured NMDD from usual DWFs as a manifestation of the deuteron multiquark component.

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Аблеев В.Г. и др. E1-82-919
Определение параметров шестикварковой компоненты дейтрона

Получены новые данные об импульсном распределении нуклонов в дейтроне и определены параметры шестикварковой компоненты дейтрона. С ее учетом хорошо описываются прецизионные данные по стриппингу дейтронов на ядрах /Дубна/ и по электродезинтеграции дейтронов /Стенфорд/.

Работа выполнена в Лаборатории высоких энергий ОИЯИ.

Препринт Объединенного института ядерных исследований. Дубна 1982

Ableev V.G. et al. E1-82-919
Determination of Deuteron Six-Quark Component Parameters

New data on the nucleon momentum distribution in deuteron have been obtained, and parameters of the 6q-component of deuteron have been determined. Taking the 6q-component into account, the precision data on deuteron stripping by nuclei (Dubna) and deuteron electrodesintegration (Stanford) can be well described.

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

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