Cumhuriyet Üniversitesi Fen Fakültesi
Fen Bilimleri Dergisi (CFD), Cilt 37(2016)
ISSN: 1300-1949

Cumhuriyet University Faculty of Science
Science Journal (CSJ), Vol. 37 (2016)
ISSN: 1300-1949

http://dx.doi.org/10.17776/csj.85008

Polarization Effects in Adron-Nuclei Scattering at High Energy

R.A. AHMEDOV

Azerbaijan State University of Oil and Industry Baku/ Azerbaijan

Received: 30.09.2016; Accepted: 15.11.2016

Abstract: The available experimental data point to the absence of the energy interval of scattering. This makes a basis for the hypothesis about the existence of a non-zero polarization research on the future accelerators will provide information about the structure of the nucleon interaction at large distances. Using different hypotheses about the property of the nucleon interaction at large distances a number of model approaches lead to the nondisappearing polarization in high -energy processes at small transfer moment. In this investigation we regard the model results for the polarization effects of nucleon-nuclei scattering. In the framework of the hypothesis concerning the exis¬tence of quark bag in nuclei we managed to describe the behaviour of the formfactors of nuclei at large q and structure functions of nuclei. The parameters of quark distribution in the bag at k>>k0 (the parameter k0 may in principle be different for different bags) extracted from the data on formfactors and on deep inelastic scattering of nucleons on nuclei proved to be very close. This result allows us to suppose that the contribution of the nucleon to the main terms in the spin-flip amplitude. The hypothesis will be proved in this work. The analysis shows that when the preasymptotic corrections are absent, we have the zero polarisations. The parameters in the spin-flip amplitude determined from one reaction, for example nucleon-nuclei scattering, allow us to obtain a wide circle of results for the polarisation effects of elastic pp or meson-nucleon scattering at high energies.

Keywords: Polarization effect, pp scattering, meson-nucleon scattering

1. INTRODUCTION

The measurements of the angular distribution and polarization effects in the scattering of nucleons at high energies (E> 300 MeV) with nuclei, as well as their theoretical analysis clearly showed that in addition to the central and tensor interactions, there is also a spin-orbit interaction.

The spin dependence of forces between two nucleons, is the need for a large number of experiments to determine the interaction. If this dependence is absent, the scattering experiments could identify only a single value for each scattering angle and energy - the differential cross section.

As a result of the spin dependence of the interaction cross-section of scattering may depend on the polarization of the incident particle and the polarization of the target. The polarization of particles - a characteristic of the state of the particles associated with the presence of their own angular momentum - spin. microparticle system is called polarized if the spatial distribution of spin orientations of the particles in the system is non-isotropic. Using different hypotheses about the property of the nucleon interaction at large distances a number of model approaches lead to the nondisappearing polarization in high -energy processes at small transfer moment.

The analysis shows that when the preasymptotic corrections are absent, we have the zero polarizations. The parameters in the spin-flip amplitude determined from one reaction, for example nucleon-nuclei scattering, allow us to obtain a wide circle of results for the polarization effects of elastic, nucleon-nuclei, pp or meson-nucleon scattering at high energies.

Early, it was shown [1] that the calculated in the quark cluster model real and imaginary parts of the leading asymptotic term of the spin-flip amplitude of the charge exchange reactions agree sufficiently well with the amplitude reconstructed by the model independent approach from the experimental data.

* Corresponding author. *Email address:* rasim.a15@mail.ru

Sivas: IX. International Workshop on Nuclear Structure Properties (NSP2016), Sivas, Turkey, 1-3 September 2016

In the framework of the hypothesis concerning the existence of quark bag in nuclei we managed to describes the behavior of the formfactors of nuclei at large q and structure functions of nuclei

The purpose of this paper is to show that disagreement between the high energy Glauber-Sitenko multiple scattering theory [2] and the data disappears if the composite structure of nucleons is explicitly taken into account in the calculation of the differential cross section and polarization effects nucleon-9Be reaction according to the multiple scattering theory.

2. THE MODEL FORMALISM

If hadron interactions with nucleons of the target depend on the spin, the average cross-section of interaction with nucleons polarized target for hadrons, polarized parallel and antiparallel to the direction of polarization of the target will be different from each other. This means that the filtration of unpolarized beam through a polarized beam of the target will be relatively enriched hadrons with the polarization direction for which the interaction cross section of the smaller; there will be a polarization of the beam in this direction.

In the case of a spherically symmetric central field we have the following expression for the scattering amplitudes

$$f(k,\theta) = ik\int bdbJ_0(qb)\left[1 - e^{i\chi_c(b)}\right] \tag{1}$$

In terms of the transmitted momentum (1) is as follows

$$f(\mathbf{q}) = \frac{ik}{2\pi}\int \exp(i\mathbf{qb})\langle\Psi|\Gamma(\mathbf{b})|\Psi\rangle d\mathbf{b}\,, \tag{2}$$

$$\Gamma(\mathbf{b}) = 1 - \prod_{j=1}^{A}\left[1 - \gamma_j(\mathbf{b} - \mathbf{s_j})\right]. \tag{3}$$

Here $\mathbf{q}$ is the momentum transfer, k is the value of the wave vector of the nucleon, $\mathbf{b}$ is the impact-parameter vector, $\Psi(r_1, r_2,...,r_A)$ is the ground state wave function of the nuclei, $\Gamma(\mathbf{b})$ is the total nucleon–nuclei interaction profile function, $\gamma_j(\mathbf{b})$ is the profile function for the nucleon-nucleon interaction, brackets $\langle||\rangle$ mean interactions over the nucleon coordinates.

A nucleus in the quark cluster model is described as a system of many clusters- completely anti summarized with respect to the quark variables. Non-antisymmetrized wave function for the ^9Be in the oscillator-cluster model can be written as

$$\Psi_{^9Be} = \phi_{N_1}(r_1, r_2, r_3)\cdots\phi_{N_9}(r_{25}, r_{26}, r_{27})\chi(R_1, R_2,..., R_9)\,, \tag{4}$$

where the nucleus is pictured as a bag with radius R_h, located at R_A enclosing A nucleons. Using the relations

$$R = \frac{r_{3i-2} + r_{3i-1} + r_{3i}}{3}\,, \quad \text{i=1,2,…,9} \tag{5}$$

and

$$\phi(r) = (\sqrt{\pi}R_h^2)\exp(-r^2 / R_h^2)\,, \tag{6}$$

we can write (3) in a factorised form

$$\Psi_{^9Be} = \prod_{j=1}^{9} \exp[\frac{r_{3j-2}^2 + r_{3j-1}^2 + r_{3j}^2}{R_h} - 2i\left(\frac{1}{R_A^2} - \frac{1}{R_h^2}\right)(\mathbf{s}_{3j-2} + \mathbf{s}_{3j-1} + \mathbf{s}_{3j})]P_n(r_j)Y_{lm}(\vartheta, \varphi) \tag{7}$$

Then scattering amplitude (1) may be written in the form

$$f(q) = (ik/2\pi)\int d\mathbf{b}\exp(i\mathbf{qb})(\delta_{mn}\delta_{MN}) - Det\left|\delta_{mn}\delta_{MN} - \left\langle M \mid \prod_{i=1}^{3}\prod_{j=1}^{3}(1-\gamma(\mathbf{b}-\mathbf{s}_i+\mathbf{r}_j)) \mid N\right\rangle\right| \tag{8}$$

The matrix element of the profile function between the single particle states described by the quantum numbers *M* and *N*.

Assume that the particle beam with the wave vector **k** is scattered by the nucleus *A* in the direction and the angle between the direction of the vector **k** and $\mathbf{k}'$ equal to θ_1. The scattered beam is polarized in the direction of $\mathbf{n}_1$, which is perpendicular to the plane $\mathbf{k}$ and $\mathbf{k}'$. Broken particle falls on the second core *B* in and dispersed in the direction $\mathrm{k}''(\theta_2, \varphi_{1,2})$, where θ_2 - the angle between the vectors $\mathbf{k}'$ and $\mathbf{k}''$, and $\varphi_{1,2}$ - the angle between the vectors n1 and n2, and perpendicular to the planes, respectively. Because after scattering on the target *A* the average spin of the particles is equal $\langle\sigma\rangle_1 = P_1\mathrm{n}_1$, then the target of the incident polarized beam of particles with $\langle\sigma\rangle_1$ spin. Therefore, the double scattering cross section can be expressed as:

$$\begin{aligned}\sigma(\theta_1,\theta_2,\varphi_{12}) &= \left(1 + P_2\mathbf{n}_2\langle\sigma\rangle_1\right)I_2(\theta_2)I_1(\theta_1) = \\ &= \left\{1 + P_2(\theta_2)P_1(\theta_1)\cos\varphi_{12}\right\}I_1(\theta_1)I_2(\theta_2)\end{aligned} \tag{9}$$

3. CONCLUSION

Use of the spin-non-flip amplitude of the *nucleon*-^{9}*Be* reaction, obtained from the formulae (8) permits us to calculate the correct picture of polarisation scattering nucleon. We consider the case where spin-flip is neglected. It is important to emphasise that the case of the nucleon-nuclei scattering the leading asymptotic terms of the spiral amplitudes is also determined by the contribution of the quark cluster with the evident replacement of $f(q)$ by the pion-nucleon scattering amplitudes. The model prediction for the polarisation of elastic *n*-^{9}*Be* scattering, corresponding to the experimental data [3] is shown in fig.1.

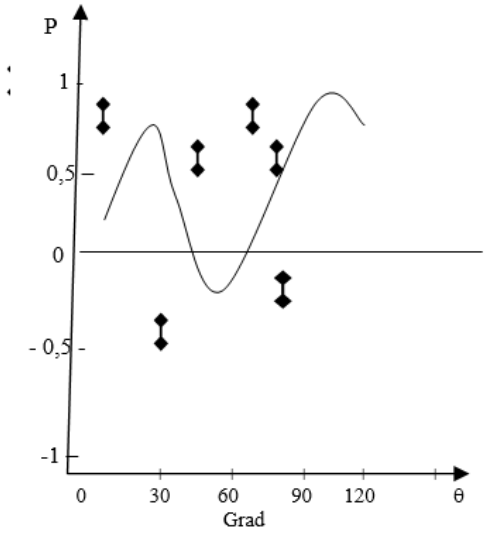

Fig. 1. The polarisation of the neutron in n-^9Be scattering.

Note that the model predicts a large polarisation at high energies in the range of the diffraction peak. The analysis shows that when the preasymptotic corrections are absent, we have the zero polarisations.

REFERENCES

1. S.V. Goloskokov, S.P. Kulishov// JINR, E2-96-40, 1996.
2. Ф.Г. Ситенко.ЭЧАЯ, 1973, Том 4, Вып. 2, стр 546.
3. А. Е. Дорохов, З.И. Конаков, А.М. Рахимов// Ядерная физика, 1989, Том 50. стр 790