SPIN-DEPENDENT FORWARD SCATTERING AMPLITUDE OF THE Ω^--HYPERON AND DEUTERON ON AN UNPOLARIZED PROTON IN GLAUBER EIKONAL APPROXIMATION.

V. G. BARYSHEVSKY, K. G. BATRAKOV AND S. CHERKAS
Institute of Nuclear Problems, Bobruiskaya Str.11, Minsk, Belarus
E-mail: cherkas@inp.minsk.by

Spin-dependent forward scattering amplitude of the composite particles with spin $S \geq 1$ on an unpolarized target is discussed in terms of the Glauber multiscattering theory. It is shown that this amplitude is determined by the constituent rescattering, nonsphericity of the particle, spin-dependent constituents scattering amplitude.

1 Introduction

Forward scattering amplitude of the particles with spin can be measured by the spin dichroism, rotation and oscillation [1] observation . This effects can be described by the particle spin-dependent refractive index in a medium which is proportional to the forward scattering amplitude on target particle. For particles with spin $S \geq 1$ (Ω^--hyperon, deuteron) the effects above exist even in unpolarized target [2]. Forward scattering amplitude of particle with $S \geq 1$ on, for instance, an unpolarized proton has the form:

$$\hat{F}(0) = T_1 + T_2(\mathbf{Sn})^{\mathbf{2}} \quad ,$$

where $\mathbf{S}$ is particle spin operator and $\mathbf{n}$ is direction of the momentum. It is significant that in the frame of Glauber multiscattering theory [3] T_2 is determined only by the rescattering of the colliding particle constituents [4] i.e. first term of Glauber series does not contribute to the T_2. So one have unique possibility to observe nucleon rescattering in deuteron-proton collision and the constituent quarks rescattering in Ω^--hyperon proton collision. T_2 had been considered for Ω^--hyperon in terms of constituent quark collisions. We have calculated [4] that for 300 *Gev* Ω^- colliding with a proton

$$\left| \frac{F_{3/2} - F_{1/2}}{F_{3/2} + F_{1/2}} \right| \approx 1.5 \times 10^{-3} \ ,$$

where F_m is the forward scattering amplitude of the Ω^- with spin projection m to the direction of momentum.

It is very instructive that two different contributions to the T_2 term exists. First one is due to the nonsphericity of the $S \geq 1$ particle and second is due to spin-dependent elastic scattering amplitude of the constituents. Let us to illustrate this by the example of deuteron -proton collision.

2 Forward elastic scattering amplitude of the deuteron on a proton.

Glauber expresion for the elasitc scattering amplitude of the composite particles can be extended for case of spin particles.

For the nucleon deuteron scattering we have:

$$F(0) = \frac{i}{2\pi} \int Sp_{\sigma_1 \sigma_2} \Big\{ \Gamma_1(\boldsymbol{b} - \boldsymbol{b}_1) + \Gamma_2(\boldsymbol{b} - \boldsymbol{b}_2) - \Gamma_1(\boldsymbol{b} - \boldsymbol{b}_1)\Gamma_2(\boldsymbol{b} - \boldsymbol{b}_2) \times$$
$$\theta(z_1 - z_2) - \Gamma_2(\boldsymbol{b} - \boldsymbol{b}_2)\Gamma_1(\boldsymbol{b} - \boldsymbol{b}_1)\theta(z_2 - z_1) \Big\} \delta(\boldsymbol{r}_1 - \boldsymbol{r}_2)\rho(\boldsymbol{r}_1) d^3\boldsymbol{r}_1 d^3\boldsymbol{r}_2, \quad (1)$$

where $\boldsymbol{r} \equiv \{\boldsymbol{b}, z\}$, $\rho(\boldsymbol{r})$ is nucleon density in deuteron and spin density matrix of deuteron nucleons simultaneously. Now we use amplitudes normalized by the condition $\sigma_{tot} = 4\pi Im F(0)$. The expression (1) implies that, if the incident particle scatters with the nucleon 1 at first it wave function is acted by Γ_1 , and then by the Γ_2. If the first collision happens with nucleon 2 the Γ_2 acts firstly. Profile-function $\Gamma(\boldsymbol{b})$ connected with the $N - N$ nucleon scattering amplitude by the relation: $f(\boldsymbol{q}) = \frac{i}{2\pi} \int \Gamma(b) e^{-i\boldsymbol{q}\boldsymbol{b}} d^2\boldsymbol{b}$. Large deuteron radii allows one to use model profile-function for $N - N$ scattering:

$$\Gamma_\alpha(\boldsymbol{b}) = \frac{2\pi}{i} \Big\{ a_\alpha + v_\alpha(\boldsymbol{\sigma}\boldsymbol{\sigma}_\alpha) + e_\alpha(\boldsymbol{\sigma}_\alpha \boldsymbol{n})(\boldsymbol{\sigma}\boldsymbol{n}) - \frac{c_\alpha}{m}(\boldsymbol{\sigma} + \boldsymbol{\sigma}_\alpha) \times \boldsymbol{n} \frac{\partial}{\partial \boldsymbol{b}} -$$
$$\frac{d_\alpha}{m^2}(\boldsymbol{\sigma}_\alpha \frac{\partial}{\partial \boldsymbol{b}})(\boldsymbol{\sigma} \frac{\partial}{\partial \boldsymbol{b}}) \Big\} \delta^2(\boldsymbol{b}) \quad (2)$$

with the constant a_α,v_α, e_α,c_α,d_α. $\delta^2(\boldsymbol{b})$ is two dimensional delta-function, m is nucleon mass. Let us represent $\rho(\boldsymbol{r})$ as:

$$\rho(\boldsymbol{r}) = \frac{1}{4}\{A_0 + A_1 \boldsymbol{S}\,(\boldsymbol{\sigma}_1 + \boldsymbol{\sigma}_2) + A_2(\boldsymbol{S}\boldsymbol{r})(\boldsymbol{\sigma}_1 + \boldsymbol{\sigma}_2) \cdot \boldsymbol{r} + A_3(\boldsymbol{S}\boldsymbol{r})^2$$
$$+A_4(\boldsymbol{\sigma}_1\boldsymbol{\sigma}_2) + A_5(\boldsymbol{\sigma}_1\boldsymbol{r})(\boldsymbol{\sigma}_2\boldsymbol{r}) + A_6((\boldsymbol{\sigma}_1\boldsymbol{S})(\boldsymbol{\sigma}_2\boldsymbol{S}) + (\boldsymbol{\sigma}_2\boldsymbol{S})(\boldsymbol{\sigma}_1\boldsymbol{S}))$$
$$+A_7(\boldsymbol{\sigma}_1\boldsymbol{r})(\boldsymbol{\sigma}_2\boldsymbol{r})(\boldsymbol{S}\boldsymbol{r})^2 + A_8(\boldsymbol{\sigma}_1\boldsymbol{\sigma}_2)(\boldsymbol{S}\boldsymbol{r})^2 + A_9((\boldsymbol{\sigma}_1 \times \boldsymbol{S} \cdot \boldsymbol{r})(\boldsymbol{\sigma}_2 \times \boldsymbol{S} \cdot \boldsymbol{r})$$
$$+(\boldsymbol{\sigma}_2 \times \boldsymbol{S} \cdot \boldsymbol{r})(\boldsymbol{\sigma}_1 \times \boldsymbol{S} \cdot \boldsymbol{r})) + +A_{10}((\boldsymbol{\sigma}_1\boldsymbol{r})(\boldsymbol{\sigma}_2\boldsymbol{S})(\boldsymbol{S}\boldsymbol{r}) + (\boldsymbol{\sigma}_1\boldsymbol{S})(\boldsymbol{\sigma}_2\boldsymbol{r})(\boldsymbol{S}\boldsymbol{r})$$
$$+(\boldsymbol{\sigma}_1\boldsymbol{r})(\boldsymbol{S}\boldsymbol{r})(\boldsymbol{\sigma}_2\boldsymbol{S}) + (\boldsymbol{S}\boldsymbol{r})(\boldsymbol{\sigma}_2\boldsymbol{r})(\boldsymbol{\sigma}_1\boldsymbol{S}))\}. \quad (3)$$

By substituting expressions for $\rho(\boldsymbol{r})$ and for the profile-function to the (1) it is possible to calculate forward scattering amplitude. Real functions $A_0 - A_{10}$ can be find from the deuteron wave function.

3 Summary

For the amplitudes a, b, c... had been taken from the SAID phase shift analyses and Nijmegen deuteron S- D- wave function results had been obtained are pictured on the figure. We may see that the main contribution is due to deuteron nonsphericity for the deuteron energy greater than 5 *Gev*. Measurements of

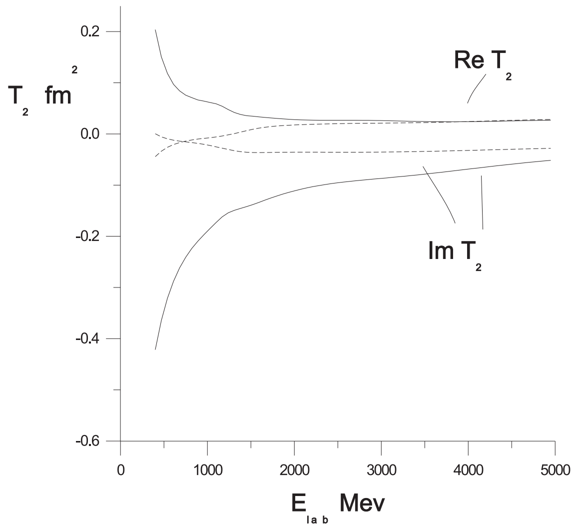

Figure 1: Spin-dependent amplitude of the deuteron on unpolarized proton. Dashed curve is the contribution of the deuteron nonsphericity.

the T_2 term of the elastic scattering amplitude of the high energy composite particles gives information about rescattering of the constituents, nonsphericity and spin-dependent scattering amplitude of the constituents.

References

1. V.G. Baryshevsky *Phys. Lett.* A **171**, 431 (1992),
2. V.G. Baryshevsky *J. Phys.* G **19**, 273 (1993)
3. W. Czyz and L.C. Maximon *Ann.Phys.* **52**, 59 (1969)
4. V.G. Baryshevsky, K.G. Batrakov and S. Cherkas Los Alamos Preprint hep-ph/9801371 (in press *J. Phys.* G)