# ON THE DIFFRACTION ${}^{3}_{\Lambda}$Hp-SCATTERING

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We derive the analytic expression for the elastic diffraction ${}^{3}_{\Lambda}$Hp-scattering amplitude, which contains the interaction parameters of each hypertriton constituent with a proton in the explicit form. A necessity of taking the multiple cluster-nucleus scattering into account is shown. The strong dependence of the scattering differential cross-section on the binding energy $B_\Lambda$ of the Λ-hyperon in a hypernucleus ${}^{3}_{\Lambda}$H is discovered. This can be used as one more additional evaluation method to the existing ones and, possibly, as a refinement method for the binding energy of $B_\Lambda$.

## 1. Introduction

The physics of hypernuclei is separated into the individual field of nuclear physics, whose content consists of researches of the interaction of nucleons and atomic nuclei with strange baryons generated, for example, in the strangeness-exchange reaction $K^- + n \rightarrow \pi^- + \Lambda$ with a quark diagram depicted in Fig. 1 or in the reaction of associative origination of a pair of strange particles $(K^+\Lambda, K^+\Sigma)$ on nuclei, which is initiated by the particles (γ, e, p, ions) with zero strangeness [1]. The excited states of hypernuclei originated in $(K^-, \pi^-)$-reactions (π-meson spectroscopy), the discovered resonance states of Λ- and Σ-hypernuclei in these processes, γ-spectroscopy of the systems of nucleons and hyperons stable with respect to the strong interaction, and the dissociation of a ${}^{3}_{\Lambda}$H

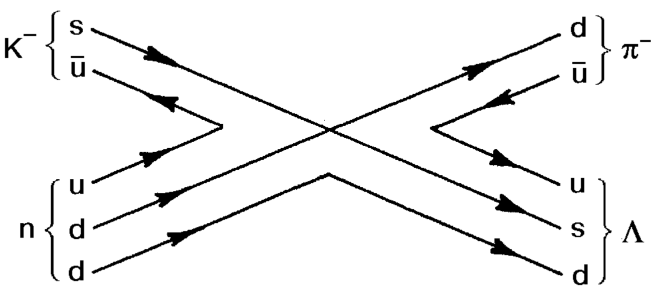


Fig. 1. Quark diagram of the strangeness-exchange $(K^-, \pi^-)$-reaction

hypernucleus to a Λ-hyperon and a deuteron are examples of the actual research themes in the hypernucleus physics.

The probability of the hypertriton dissociation increases with decrease in the Λ-hyperon separation energy (the Λ-binding energy in the hypernucleus) $B_\Lambda$ and with increase in the emission energy of the hypernucleus, which agrees with experimental data [2]. Experiments with the beams of exotic nuclei, particularly with those of ${}^{3}_{\Lambda}$H hypernuclei, are planned in various scientific centers [3—5]. The researches of the Coulomb dissociation of ${}^{3}_{\Lambda}$H hypernuclei are included to the program of the research of hypernuclei on the synchrophasotron—nucleotron acceleration complex in Dubna [3] and provide a possibility to determine $B_\Lambda$. In work [3], it is accented that the strong dependence of the dissociation cross-section on $B_\Lambda$ allows one to measure $B_\Lambda$ even in non-precision experiments and in the range of those values of $B_\Lambda$, where other methods appear to be improper. The discoverer of hypernuclei J. Pniewski [6] and other investigators [7] suppose that, upon the research of the $\Lambda N$-interaction, the Λ-binding energy in hypernuclei in the ground state is the main information which favors the correct choice of parameters of the $\Lambda N$-interaction and the adequate understanding of the structure of hypernuclei. The binding energy $B_\Lambda$ is closely related to the branching ratio $R_3$ [6], i.e. with the ratio of the number of two-particle $\pi^-$-decays to the total number of all pion decays of a ${}^{3}_{\Lambda}$H hypernucleus. It is assumed that the $\Lambda N$-interaction is by several times weaker than the $NN$-interaction. Therefore, the presence of a Λ-hyperon in a hypernucleus shouldn't essentially change the structure of the nucleus-core.

The variational calculation [7] of the root-mean-square distance between the nucleons in a ${}^{3}_{\Lambda}$H hypernucleus determines its value to be only by 10—15 % less than that of a free deuteron. At the same time, the mean distance of a Λ-hyperon from the center of masses of nucleons approximately equals 10 fm, which is natural due to the anomalously low value of $B_\Lambda$ for this hypernucleus. It does not follow from the insufficient deformation of a deuteron in a ${}^{3}_{\Lambda}$H hypernucleus that the model of the hypertriton structure with a non-deformed deuteron is a good approximation for the calculation of $B_\Lambda$ [2]. The model with a deformed deuteron, where the wave function of a ${}^{3}_{\Lambda}$H hypernucleus is presented as the product of the wave functions of the relative motion of nucleons and the Λ-hyperon motion with respect to the center of masses of nucleons [7], appears to be a more effective one. A similar construction of the wave function (the product of the Λ-hyperon wave function and the shell wave function of the nucleus-core) of a ${}^{8}_{\Lambda}$Li hypernucleus was used in [2].

The most probable spatial configuration of nucleons and a Λ-hyperon in a ${}^{3}_{\Lambda}$H hypernucleus was determined in [8,9]. The calculations [8, 9] of the properties of a bound $\Lambda NN$-system by means of solving the Faddeev equations with various realistic $\Lambda N$- and $NN$-forces showed that a very small value of $B_\Lambda$ in the case of a hypertriton is related to its wave function with the structure which corresponds to the deuteron interacting with a remote Λ-hyperon. Starting from the requirement for the squared modulus of the wave function of a ${}^{3}_{\Lambda}$H hypernucleus to be maximum, it was revealed in [8] that the sought geometric configuration is an isosceles triangle, in which the Λ-hyperon is more distant from the nucleons than the nucleons from one another. In this case, the probability $P_d$ to find the nucleons of a ${}^{3}_{\Lambda}$H hypernucleus in the state which corresponds to a deuteron equals 0.987. It was shown [8] that such a configuration isn't evident enough. For example, in the $\Sigma NN$ system, a Σ-hyperon is localized on the line which connects two nucleons with equal probabilities in a direct proximity near one of them.

Contrary to the results of calculations given in [7], it may seem that the total probability of the undistorted deuteron state in a hypertriton found in [8], $P_d = 0.987$, gives the grounds to consider a ${}^{3}_{\Lambda}$H hypernucleus as a two-cluster object, whose constituents are an undistorted (or even point-like) deuteron and a Λ-hyperon. But our calculations also show that the structure of a deuteron cluster, which is also a weakly bound object, can influence $B_\Lambda$. In spite of the fact that the influence of the deuteron structure appears not always to be noticeable, we nevertheless consider it approximately, nevertheless, by representing the deuteron state by a model Gaussian function. In the future, a necessity to use the more realistic internal wave functions of a ${}^{3}_{\Lambda}$H hypernucleus will undoubtedly arise if the experimental information on ${}^{3}_{\Lambda}$Hp-scattering will be available. Thus, we consider a hypertriton as a three-cluster structure $\Lambda + \mathrm{n} + \mathrm{p}$ addressing also to its two-cluster representation $\Lambda + \mathrm{d}$ for comparison.

We calculated the differential cross-section (DCS) of a diffraction elastic scattering of hypertritons by protons. The condition for the applicability of the diffraction approximation holds true well if the energy of an incident compound particle (${}^{3}_{\Lambda}$H hypernucleus) exceeds 50 MeV per baryon. Properly saying, the present work is an approximate solution of one of the most difficult problems concerning four interacting particles, only three from which are bound.

## 2. The Scattering Amplitude of a Three-cluster Hypernucleus by a Spherical Nucleus

The above-mentioned results in [8] are very important for us due to the fact that the configuration of baryons [8] in a ${}^{3}_{\Lambda}$H hypernucleus coincides with the scheme which underlies the construction of the amplitude of the diffraction elastic scattering of a weakly bound three-cluster hypernucleus by a spherical nucleus [10]

$$F(q) = \sum_{n=1}^{3} F_n(q). \tag{1}$$

Let us write the amplitudes of the $n$-fold ($n = 1, 2, 3$) scattering of clusters $F_n(q)$ by a spherical nucleus (by a proton, in our case) in the form [4, 10]

$$F_1(q) = ik[\Phi_0(\gamma_1 q)u_1(q) + \Phi_0(\alpha_1 q)\Phi(\gamma_3 q)u_2(q)+$$

$$+\Phi_0(\alpha_1 q)\Phi(\gamma_2 q)u_3(q)], \tag{2}$$

$$F_2(q) = \frac{k}{2\pi i}\int d^{(2)}\vec{q}\,'[\Phi_0(|\vec{q}\,' - \alpha_1\vec{q}\,|)\times$$

$$\times\Phi(\gamma_3|\vec{q}\,' - \vec{q}\,|)u_1(q')u_2(|\vec{q}\,' - \vec{q}\,|)+$$

$$+\Phi_0(|\vec{q}\,' - \alpha_1\vec{q}\,|)\Phi(\gamma_2|\vec{q}\,' - \vec{q}\,|)u_1(q')u_3(|\vec{q}\,' - \vec{q}\,|)+$$

$$+\Phi_0(\alpha_1 q)\Phi(|\vec{q}\,' - \gamma_2\vec{q}\,|)u_2(q')u_3(|\vec{q}\,' - \vec{q}\,|)], \tag{3}$$

$$F_3(q) = \frac{ik}{(2\pi)^2}\int d^{(2)}\vec{q}\,'\int d^{(2)}\vec{q}\,''\Phi_0(|\vec{q}\,' - \alpha_1\vec{q}\,|)\times$$

$$\times\Phi(|\vec{q}\,'' + \gamma_2(\vec{q}\,' - \vec{q}\,)|)u_1(q')u_2(q'')u_3(|\vec{q}\,' + \vec{q}\,'' - \vec{q}\,|), \tag{4}$$

where $\vec{k}$ is the wave vector of an incident three-cluster hypernucleus, whose kinetic energy is $E$, $\vec{q}$ is a transferred momentum, $\alpha_1 = 1 - \gamma_1$, $\gamma_1 = (m_2 + m_3)/(m_1 + m_2 + m_3)$, $\gamma_2 = m_2/(m_2 + m_3)$, $\gamma_3 = 1 - \gamma_2$, $m_j$ is the the mass $(j = 1, 2, 3)$ of a cluster $j$, where $m_1$ is the mass of a $\Lambda$-hyperon, $m_2$ and $m_3$ are, respectively, the masses of a proton and a neutron, and $\hbar = c = 1$. The integration over the variables $\vec{q}\,'$ and $\vec{q}\,''$ is carried out in a plane perpendicular to the vector $\vec{k}$. The functions $u_j(q)$ are related to the partial amplitudes $f_j(q)$ of the cluster-nucleus scattering

$$u_j(q) = \frac{f_j(q)}{ik_j} = \frac{1}{2\pi}\int d^{(2)}\vec{\rho}_j e^{i\vec{q}\vec{\rho}_j}\omega_j(\rho_j), \tag{5}$$

where $k_j$ is a momentum, $\rho_j$ is an impact parameter, and $\omega_j(\rho_j)$ is a function of the $j$-cluster profile. The radii-vectors of clusters in an incident hypernucleus are counted from the center-of-mass of the nucleus-target [5]. The Gaussians

$$\omega_j(\rho_j) = a_j \exp(-b_j\rho_j^2), \quad a_j = a_j^{(1)} - ia_j^{(2)},$$

$$a_j^{(1)} = \text{Re } a_j^{(1)}, \quad a_j^{(2)} = \text{Re } a_j^{(2)} \tag{6}$$

are used as profile functions in the calculations. The structure form-factors

$$\Phi_0(q) = \int d^{(3)}\vec{r}\ |\varphi_0(r)|^2 e^{-i\vec{q}\vec{r}},$$

$$\Phi(q) = \int d^{(3)}\vec{\eta}\ |\varphi(\eta)|^2 e^{-\vec{q}\vec{\eta}} \tag{7}$$

in (2)—(4) are determined by the wave functions of a relative motion $\varphi_0(r)$ of a $\Lambda$-hyperon and a deuteron and by those of the relative motion of nucleons $\varphi(\eta)$ in a deuteron. The substantiation of the choice of the total internal wave function of a ${}^3_\Lambda$H hypernucleus in a factorized form $\varphi_0(r)\varphi(\eta)$ was also discussed in [5].

The analytic expressions for the structure form-factors (7),

$$\Phi_0(q) = \exp\{-q^2/(8\alpha_0^2)\}, \quad \Phi(q) = \exp\{-q^2/(8\alpha^2)\}, \tag{8}$$

and DCS $\sigma_e(q) = |F(q)|^2$ are calculated with Gaussian functions $\varphi_0(r)$ and $\varphi(\eta)$, whose explicit form is shown for the determination of the parameters $\alpha_0$ and $\alpha$:

$$\varphi_0(r) = \{2\alpha_0^2/\pi\}^{3/4}\exp\{-\alpha_0^2 r^2\},$$

$$\varphi(\eta) = \{2\alpha^2/\pi\}^{3/4}\exp\{-\alpha^2\eta^2\}. \tag{9}$$

The results of calculations of the amplitudes $F_n(q)$, $n$ = 1,2,3, are as follows:

$$F_1(q) = ik\sum_{j=1}^{3} a_j c_j \exp\Big\{-\frac{1}{2}\Big[(\omega_{(j-1)3} - c_j)q^2 + c_j q_\perp^2\Big]\Big\}, \tag{10}$$

$$F_2(q) = -ik\sum_{j=1}^{3}\frac{\prod_{n=1}^{3} a_n c_n}{\mu_{j1}a_{(4-j)}c_{(4-j)}}\times$$

$$\times\exp\left\{-\frac{1}{2}\left[(\mu_{j3} - c_{(3-\epsilon_{j23})})q^2 + \left(c_{(3-\epsilon_{j23})} - \frac{\mu_{j2}^2}{\mu_{j1}}\right)q_\perp^2\right]\right\}, \tag{11}$$

$$F_3(q) = ik\frac{\prod_{n=1}^{3} a_n c_n}{(\mu_{21}\mu_{31} - \mu_{32}^2)}\exp\left\{-\frac{1}{2}\left[(\mu_{23} - c_3)q^2 + \right.\right.$$

$$\left.\left. + \frac{1}{\mu_{31}}\left[(c_3\mu_{31} - \mu_{32}^2) - \frac{(\mu_{22}\mu_{31} - \mu_{32}^2)^2}{(\mu_{21}\mu_{31} - \mu_{32}^2)}\right]q_\perp^2\right]\right\}. \tag{12}$$

Here, $c_j \equiv 1/(2b_j)$, $\epsilon_{jkl}$ is the completely antisymmetric pseudotensor of the third rank ($\epsilon_{123} = 1, \epsilon_{223} = \epsilon_{323} = 0$), $\mu_{03} \equiv \kappa_0^2\gamma_1^2 + c_1$, $\kappa_0 \equiv 1/(2\alpha_0)$, $\mu_{ij}$ are elements $(i, j = 1, 2, 3)$ of a square third-order matrix (the Gantmacher denotations [11]),

$$\|\mu_{ij}\|_1^3 = \left\|\begin{array}{ccc} \kappa_0^2 + \kappa^2\gamma_3^2 + c_1 + c_2 & \kappa_0^2\alpha_1 + \kappa^2\gamma_3^2 + c_2 & \kappa_0^2\alpha_1^2 + \kappa^2\gamma_3^2 + c_2 \\ \kappa_0^2 + \kappa^2\gamma_2^2 + c_1 + c_3 & \kappa_0^2\alpha_1 + \kappa^2\gamma_2^2 + c_3 & \kappa_0^2\alpha_1^2 + \kappa^2\gamma_2^2 + c_3 \\ \kappa^2 + c_2 + c_3 & \kappa^2\gamma_2 + c_3 & \kappa_0^2\alpha_1^2 + \kappa^2\gamma_2^2 + c_3 \end{array}\right\|, \tag{13}$$

$\kappa \equiv 1/(2\alpha)$, $q^2 = q_\perp^2 + q_z^2 = 4k^2\sin^2\frac{\vartheta}{2}$, the component $q_\perp = k\sin\vartheta$ is normal to the vector $\vec{k}$ which is directed along the axis $z$, where $\vartheta$ is the scattering angle in the center-of-inertia system, and $q_z = q\sin(\vartheta/2)$.

To determine the relation between the parameter $\alpha_0$ of the wave function in (9) and the separation energy $B_\Lambda$ of a $\Lambda$-hyperon from the neutron-proton system, we demand the equality of the root-mean-square radii in the

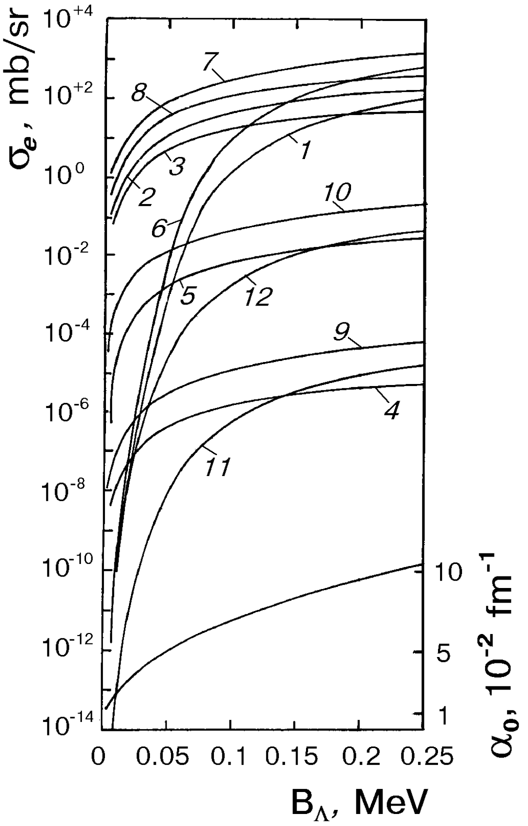


Fig. 2. DCSs of the elastic diffraction $^3_\Lambda$Hp-scattering (curves *1*–*12*) and the parameter $\alpha_0$ of the wave function (9) (the curve without a number, the right scale) versus the Λ-hyperon binding energy $B_\Lambda$ in a hypernucleus $^3_\Lambda$H. The notation of the curves and values of the parameters used in calculations are listed in the Table

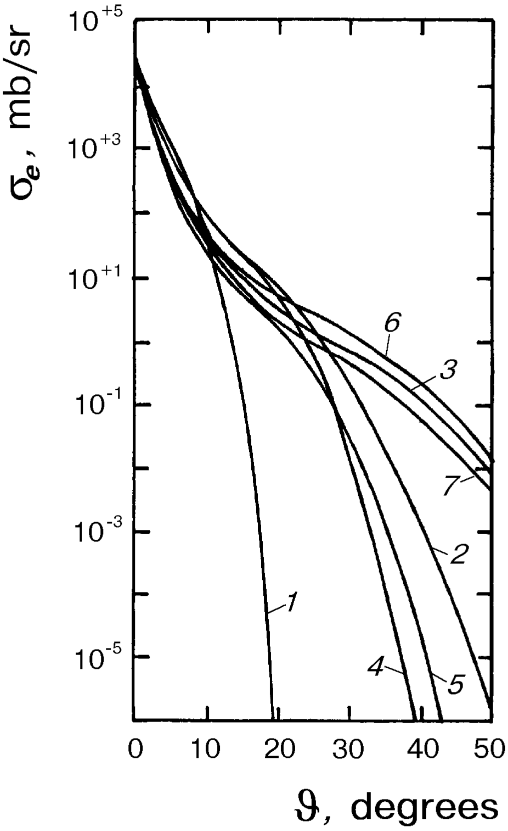


Fig. 3. Angular distributions of $^3_\Lambda$H hypernuclei upon the elastic diffraction $^3_\Lambda$Hp-scattering. The notation of the curves and values of the parameters used in calculations are listed in the Table

bound states with the relative motion of cluster *1* with respect to two other clusters, whose state is determined by the wave function $\varphi_0(r)$, and in the same state with the Hulthen wave function $\varphi_{0h}(r)$. We present the last function

$$\varphi_{0h}(r) = \left\{ \frac{\alpha_{0h}\beta_{0h}(\alpha_{0h}+\beta_{0h})}{2\pi(\beta_{0h}-\alpha_{0h})} \right\}^{1/2} \frac{e^{-\alpha_{0h}r} - e^{-\beta_{0h}r}}{r} \tag{14}$$

in order to use it in the determination of the parameters $\alpha_{0h}$, $\beta_{0h}$ [4]. Here, the parameter $\alpha_{0h} = (2\gamma_1 m_1 B_\Lambda)^{1/2}$ depends on $B_\Lambda$. The connection of the parameters $\alpha_0$ and $B_\Lambda$ is determined by the relation

$$\kappa_0^2 = \frac{1}{6}\frac{(\alpha_{0h}+\beta_{0h})}{(\alpha_{0h}-\beta_{0h})^2}\alpha_{0h}\beta_{0h}\times$$
$$\times\left\{ \frac{1}{\alpha_{0h}^3} + \frac{1}{\beta_{0h}^3} - \frac{16}{(\alpha_{0h}+\beta_{0h})^3} \right\}, \tag{15}$$

which allows us to calculate the DCS $\sigma_e$ as a function of $B_\Lambda$ within the scope of the accepted assumption. The value of the parameter $\beta_{0h} = 1.45$ fm$^{-1}$ is defined in [12].

## 3. Discussion of the Results of Calculations

The curves that follow from the calculations of DCS for $E = 156$ MeV and 1 GeV are shown in Figs. 2 and 3 which together with the Table contain the full information about the obtained results. All the curves are built with the parameters $a_1 = a_2 = a_3 = 2.65 - i1.95$, $b_1 = b_2 = b_3 = 0.372$ fm$^{-2}$ [13]. The parameter $\alpha$ of the function $\varphi(\eta)$ is common for all the curves and equals $\alpha = 0.267$ fm$^{-1}$ [14]. The calculation performed with the use of the parameter $a_1 = a_3/2$ (where $a_3$ is the parameter of the neutron-proton profile function) decreases the DCS value $\sigma_e$ by

15—20 %, which allows one to investigate, in principle, the $\Lambda N$-interaction by comparing the cross-sections of the scattering, for example, of ${}^3_\Lambda$H, ${}^3$H, and ${}^3$He nuclei by protons. Moreover, the calculations carried out within the two-cluster model of a ${}^3_\Lambda$H hypernucleus showed that the DCS can increase or decrease by 10—20 % upon the transition to a three-cluster model, i.e. the two-cluster model is sometimes a rough enough approximation. Its inadequacy in some cases is conditioned by the impossibility to represent a deuteron as a point object in the composition of a hypertriton.

The table contains information about the other variables, which were used for the construction of a curve with the certain number that reproduces the DCS $\sigma_1 \equiv |F_1(q)|^2$, or $\sigma_2 \equiv |F_1(q) + F_2(q)|^2$, or $\sigma_3 \equiv \sigma_e = |F_1(q) + F_2(q) + F_3(q)|^2$. Let us mark the dominant contribution of the amplitudes $F_2(q)$ and $F_3(q)$ in the DCS $\sigma_e$, which can be verified by comparing curves *1, 2, 3*. The largest contribution of these amplitudes is observed at small values of $B_\Lambda$, where the difference of the DCS $\sigma_2$ and $\sigma_3$ from the DCS in the impulse approximation $\sigma_1$ can reach several orders of magnitude. This agrees, in particular, also with the conclusion drawn in [4] about the impossibility to use the impulse approximation even for rough estimations of the DCS of the elastic diffraction scattering of hypertritons by nuclei. Moreover, the inadequacy of the impulse approximation is also revealed in the inelastic scattering. The relations (depending on the accounted $n$-fold amplitudes) valid for the elastic diffraction ${}^3_\Lambda$Hp-scattering also hold, for example, for the DCSs $d^6\sigma/d\Omega_p d\Omega_n dE_p dE_n$ and $d^5\sigma/d\Omega_p d\Omega_n dE_p$ of both the two-particle and three-particle [15] diffraction breakup of a ${}^3$H nucleus by protons. The processes of multiple scattering have the determining influence also on the total cross-sections of the diffraction interaction of ${}^3_\Lambda$H hypernuclei with nuclei [4]. The contribution of the scattering amplitudes of higher orders quickly increases with the value of $q$, which is seen from curves *4,5* for $q = 4.16$ fm$^{-1}$ and for the same value of $k$. The DCS $\sigma_1$ is so small in this case that it is impossible to show it on the scale of Fig. 2. If, at $q = 1$ fm$^{-1}$, $\sigma_2 > \sigma_3$ takes place everywhere, then, at $q = 4.16$ fm$^{-1}$, on the contrary, the relation $\sigma_3 > \sigma_2$ holds.

Curves *6, 7, 8* are distinguished form curves *1, 2, 3*, and curves *9, 10* from curves *4, 5* only by values of the energy $E$. Moreover, curves *11, 12* are distinguished form curves *9, 10* by the fact that $q_z \neq 0$ ($q_z = 0$ corresponds to curves *1—10*). The quantity $q_z \neq 0$ determines by the formula $q_z = q\sin(\vartheta/2)$, and the angle $\vartheta$ is determined by values of $E$ and $q$. It is worth noting the essential dependence of the DCS on $q_z$, especially at small values of $B_\Lambda$. The curve without a number in Fig. 2 illustrates dependence (15) of the parameter $\alpha_0$ of the wave function in expression (9) on the binding energy $B_\Lambda$. The range of the variation of $B_\Lambda$ is determined by using the data available in the literature [16], namely $B_\Lambda = (0.13 \pm 0.05)$ MeV. We also took into the account the assumption advanced in [3, 4, 17] about a systematic error made in [16], which establishes the uncertainty region $0.01 \leq B_\Lambda \leq 0.25$ MeV.

The totality of curves in Fig. 2 testifies to the strong dependence of the DCS $\sigma_e$ on $B_\Lambda$ like the case of the dissociation of a ${}^3_\Lambda$H hypernucleus in the Coulomb field of nuclei. This suggests one to use the measurement of the DCS of the elastic ${}^3_\Lambda$Hp-scattering, $\sigma_e$, as an additional method for the determination of the binding energy $B_\Lambda$. The certain advantage of the method proposed by us can be the absence of complications connected with the account of the structure of many-nucleon nuclei of a target. We will not count how many experimental methods of determination of $B_\Lambda$ exist and what accuracy they have. But, as was noted by I.M. Frank (with reference to the use of transition radiation for the determination of optical parameters of a substance), each new possibility of a measurement can turn out to be useful as one more independent method [18].

Fig. 3 shows the angular distributions of ${}^3_\Lambda$H hypernuclei upon the elastic diffraction ${}^3_\Lambda$Hp-scattering

**Calculated quantities and the parameters for the curves depicted in Fig. 2, 3**

| Parameter | Curve in Fig. 2 | | | | | | | | | | | | Curve in Fig. 3 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *1* | *2* | *3* | *4* | *5* | *6* | *7* |
| $\sigma_1$, mb/sr | * | | | | | * | | | | | | | * | | | | | | |
| $\sigma_2$, mb/sr | | * | | * | | | * | | * | | * | | | * | | * | | | |
| $\sigma_3$, mb/sr | | | * | | * | | | * | | * | | * | | | * | | * | * | * |
| $E = 156$ MeV | * | * | * | * | * | | | | | | | | * | * | * | * | * | * | * |
| $E = 1$ GeV | | | | | | * | * | * | * | * | * | * | | | | | | | |
| $q = 1.0$ fm$^{-1}$ | * | * | * | | | * | * | * | | | | | | | | | | | |
| $q = 4.16$ fm$^{-1}$ | | | | * | * | | | | * | * | * | * | | | | | | | |
| $q_z = 0$ | * | * | * | * | * | * | * | * | * | * | | | * | * | * | | | * | * |
| $q_z \neq 0$ | | | | | | | | | | | * | * | | | | * | * | | |

computed for the energy $E = 156$ MeV. The optimal value $B_\Lambda = 0.13$ MeV corresponds to curves $\sigma_e(\vartheta)$ with numbers *1—5*, and $B_\Lambda = 0.18$ and 0.08 MeV correspond to curves *6* and *7*. The DCSs $\sigma_1$ for $q_z = 0$ and $q_z \neq 0$ coincide in the impulse approximation (curve *1*). We indicate that the difference (at $\vartheta > 10°$) of the DCSs $\sigma_1$ and $\sigma_2$, $\sigma_3$ is too large. Therefore, we cannot neglect the contribution of high-order terms to the DCS. As seen from the comparison of curves *2, 3* and *4, 5* of Fig. 3, the account of the longitudinal component $q_z$ essentially influences the results of calculations of the DCS. Like Fig. 2, the influence of $B_\Lambda$ on the DCS $\sigma_e(\vartheta)$ is quite considerable (curves *3, 6, 7* in Fig. 3) in order to use of the angular dependences of the measured DCSs for the estimation of $B_\Lambda$.

## Conclusions

1. It is shown that the theoretical calculations of the DCS of the hypertriton-proton elastic diffraction scattering can assist in the estimation of the most important structural characteristic of a ${}^{3}_{\Lambda}$H hypernucleus, namely the separation energy $B_\Lambda$ of a $\Lambda$-hyperon (the binding energy of the $\Lambda$-hyperon in the hypernucleus ${}^{3}_{\Lambda}$H). The method of estimation of $B_\Lambda$ proposed by us can complement and, may be, make more precise the results, which are foreseen in the investigations of the dissociation of a ${}^{3}_{\Lambda}$H hypernucleus in the Coulomb field of nuclei. This process is a part of the program of investigations of hypernuclei on the synchrophasotron-nucleotron accelerating complex in Dubna.

2. We have derive the analytic expression for the amplitude of the elastic diffraction ${}^{3}_{\Lambda}$Hp-scattering, which is a function of the parameters $a_j$ and $b_j$ ($j = 1,2,3$) of the interaction (parameters of the profile functions $\omega_j$) of each constituent of a ${}^{3}_{\Lambda}$H hypernucleus with a proton. This allows one, in the scope of our simple model, to take explicitly into the account the differences of the $\Lambda$p-, np-, and pp-interactions. For example, a variation of the parameters of the $\Lambda$p-interaction, as was shown above, noticeably influences the results of calculations of DCSs.

3. The necessity to consider the multiple cluster-nucleus scattering and the inadequacy of the impulse approximation, which accounts only the first-order scattering of clusters by a nucleus, is emphasized.


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ПРО ДИФРАКЦІЙНЕ ${}^{3}_{\Lambda}$Hp-РОЗСІЯННЯ

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Р е з ю м е

Одержано аналітичний вираз для амплітуди пружного дифракційного ${}^{3}_{\Lambda}$Hp-розсіяння, який містить у явному вигляді параметри взаємодії кожного конституента гіпертритона з протоном. Показана необхідність урахування багаторазового кластер-ядерного розсіяння. Виявлено сильну залежність диференціального перерізу (ДП) розсіяння від енергії зв'язку $\Lambda$-гіперона $B_\Lambda$ у гіпер'ядрі ${}^{3}_{\Lambda}$H. Запропоновано використання вимірювання ДП пружного дифракційного ${}^{3}_{\Lambda}$Hp-розсіяння як ще один, додатковий до існуючих, метод оцінки і, можливо, уточнення енергії зв'язку $B_\Lambda$.