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ELASTIC SCATTERING OF Li^6 ON C^{12} AND O^{16}

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Résumé. — La diffusion élastique des ions Li^6 sur C^{12} et O^{16} a été mesurée à une énergie incidente de 30 MeV. Les sections efficaces ont une structure prononcée aux grands angles et remontent fortement à l'arrière. Les résultats sont comparés à des calculs dans le cadre du modèle optique.

Abstract. — The elastic scattering of Li^6 ions on C^{12} and O^{16} was measured at an incident energy of 30 MeV. The cross sections have pronounced structure at large angles and strong backward peaking. The results are compared with the optical-model calculations.

The elastic scattering of Li^6 ions on C^{12} and O^{16} has been studied at $E_{Li} = 30$ MeV within c. m. angles from 15° to 175°. The carbon and Li_2O self-supporting foils were used as targets. The angular distributions obtained have a rather complicated diffraction picture (Fig. 1). Pronounced oscillations at the large scattering angles and strong backward peaking are observed. Deep and wide minima at the angle of about 100° exist as if dividing the differential cross section curves into two parts.

The angular distributions were analyzed in terms of the optical model. The nuclear potential was represented as the volume absorption potential without the spin-orbital term :

$$V(r) = V_0\left(1 + \exp\frac{r - r_{0v}A^{1/3}}{a_v}\right)^{-1} + iW_0\left(1 + \exp\frac{r - r_{0w}A^{1/3}}{a_w}\right)^{-1}.$$

The Coulomb potential was taken in the form of a uniform charged sphere of the radius $R_c = 1.4\ A^{1/3}$. First an attempt was made to explain the data using a four-parameter potential with the same geometry for real and imaginary parts ($r_{0v} = r_{0w}$, $a_v = a_w$). The optimum values of the potential were obtained : for C^{12} $V = 21.8$ MeV, $W = 13.2$ MeV, $a = 0.66$ f and for O^{16} $V = 25.2$ MeV, $W = 13.0$ MeV, $a = 0.69$ f. The interaction radius in both cases was taken in the form of $R = (1.2\ A^{1/3} + 2.2$ f). The curves calculated with the above parameters gave reasonable fits to the data in the range of angles from 20° to 80° and strong discrepancy for angles larger than 90° (Fig. 1*a*).

The calculations with independent real and imaginary potential geometries were performed at different starting values of the potential for C^{12} and O^{16}. The best fit to the experimental data (Fig. 1*b*) was obtained with approximately the same set of parameters as for heavier nuclei [1]. An important feature of this set is a deep real potential well, $V_0 \simeq 250$ MeV. No parameter set with the V_0 values from 20 to 150 MeV could describe the rise in the angular distributions of C^{12} and O^{16} for the backward hemisphere. The potential parameters chosen by a minimum of χ^2 are listed in the table I.

TABLE I

Nucleus	E MeV	V MeV	W MeV	r_{0v}, f	r_{0w}, f	a_v f	a_w, f	σ_r mbarn
C^{12}	30.6	245	12.5	1.2	1.75	0.8	1.0	1 410
O^{16}	29.8	252	13.0	1.3	1.75	0.7	1.2	1 700

The fits are surprisingly good. Indeed, for large angle region they are better than in the case of heavier nuclei [1]. This means, however, that the result obtained must be taken with caution.

An alternative explanation of the backward structure of the angular distributions can be proposed on the basis of the multinucleon transfer mechanism. In the case under consideration the Li^6-cluster exchange should occur. Though possible (the « effective number » of Li^6-cluster in the p-shell nuclei is about 0.1 [2]) this process seems very improbable due to the high binding energy of Li^6 in C^{12} and O^{16}. A similar situation takes place in the case of He^3 or triton scattering on Li^6 (the « effective number » of He^3-clusters or tritons in Li^6 is large, of order of unity, and the binding energies are high). The experiment on $He^3 + Li^6$ scattering [3], however, shows no structure or peaking at large angles contrary to the $Li^6 + C^{12}$ or $Li^6 + O^{16}$ scattering.

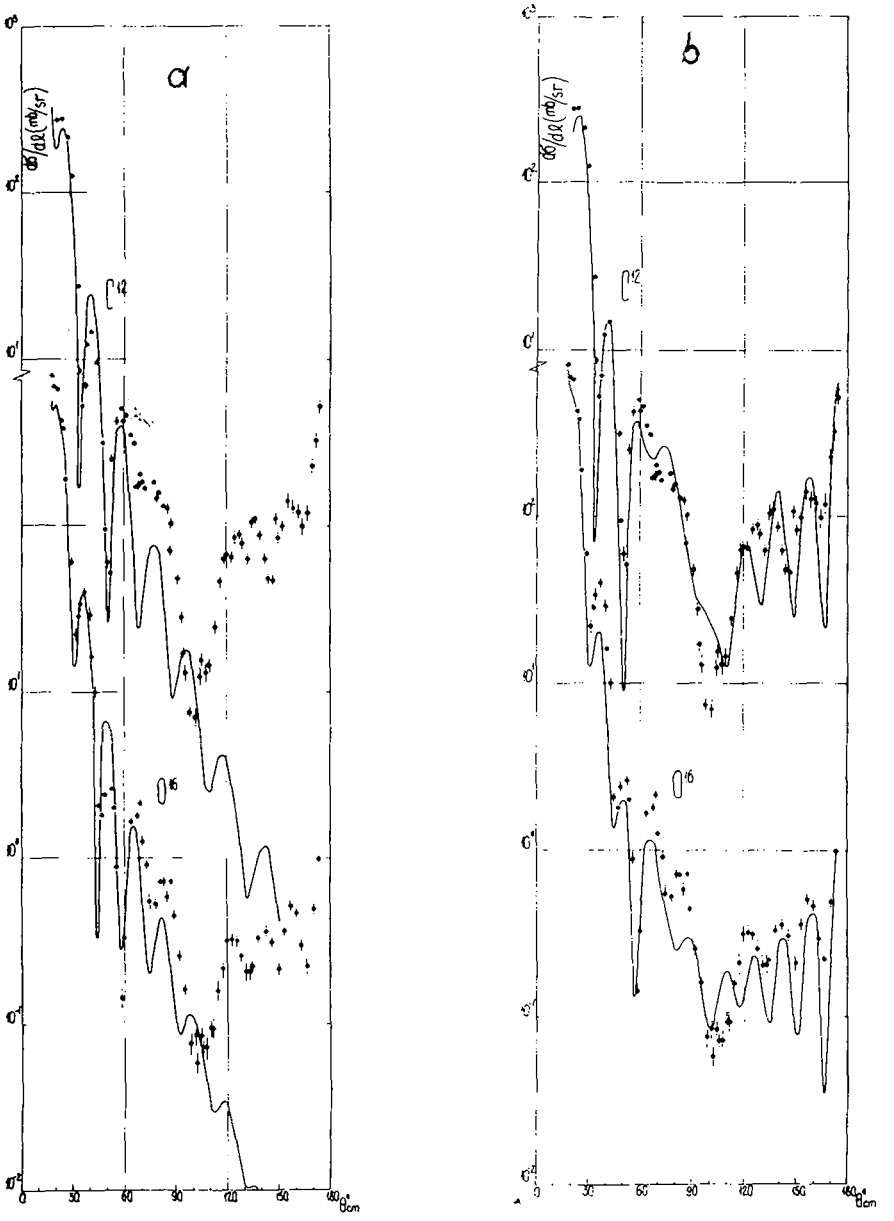

FIG. 1. — Differential cross sections of $Li^6 + C^{12}$ and $Li^6 + O^{16}$ elastic scattering.

a) Comparison with four-parameter optical-model calculations (the parameters are given in the text).

b) Comparison with six-parameter optical-model calculations (parameters are given in Table I).

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