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V. D'Amico, G. Fazio, S. Iannelli, F. Mezzanares and R. Potenza:
 ${}^7\text{Li} + d \rightarrow 2\alpha + n$ REACTION: III) EXPERIMENTAL RESULTS AT
 $E_d = 0.8$ MeV AND $E_d = 1.2$ MeV.

V. D'Amico^(x), G. Fazio^(x), S. Iannelli^(x), F. Mezzanares^(x) and R. Potenza: ${}^7\text{Li}+d \rightarrow 2\alpha+n$ REACTION: III) EXPERIMENTAL RESULTS AT $E_d = 0.8$ MeV AND $E_d = 1.2$ MeV^(o).

ABSTRACT. -

The ${}^7\text{Li}+d$ reaction was analyzed by detection of the bidimensional spectra of the exit α -particles at $E_d = 0.8$ MeV and 1.2 MeV.

The α -n complexes produced in the reaction seem polarized, as at other energies. A comparison is made between the asymmetry in the angular α - α correlations and the asymmetry produced in the n- α scattering with polarized neutrons.

1. - INTRODUCTION. -

In a first paper on the ${}^7\text{Li}+d$ reaction⁽¹⁾ we suggested a method of analysis of the bidimensional spectra of the reaction, with the transformation to systems of the relative coordinates (RCS) of the three outgoing particles.

A second paper⁽²⁾ reported the experimental results at $E_d = 1.0$ MeV treated with the method. The data at that energy were consistent with the hypothesis that the α -n complex appearing in the reaction were polarized. The asymmetry in the emission of the α -particle from that complex could be put in connection, though in a first approximation, with the analysing power of the n- α scattering and the polarization of the α -n complex⁽²⁾.

To study the dependence of the polarization of the α -n complex from the incident energy we did other experiments at $E_d = 0.8$ MeV

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and $E_d = 1.2$ MeV. The collection of the experimental data was performed as explained in the cited references^(1,2). The results are reported in the subsequent sections.

2. - EXPERIMENTAL RESULTS. -

The first detector was placed at $\theta_1 = 88.4^\circ$ and $\phi_1 = 0^\circ$, the second one was allowed to rotate between $\theta_2 = 30^\circ$ and $\theta_2 = 110^\circ$ at $\phi_2 = 180^\circ$.

Fig. 1 reports the angular correlations of the two α -particles from the $\text{Li}+d \rightarrow 2\alpha + n$ reaction in the laboratory system (LS) at $E_d = 0.8$ MeV and $E_d = 1.2$ MeV. Figs. 2 and 3 report the number dN/ds of counts per unit length of kinematic curve in the LS at the various θ_2 angles at $E_d = 0.8$ MeV and 1.2 MeV respectively. The absolute values of the cross sections were obtained by the method reported in ref. (2). The errors are about 15% on the absolute values. The error bars in the figures refer only to the statistical errors.

The data obtained after the transformation to the RCS and the rough correction for the identity of the α -particles (see refs. (1) and (2)) are reported in Figs. 4 and 5 for $E_d = 0.8$ MeV in the form respectively of the α -n internal energy spectra and of the angular correlations between the α -n complex and the decaying particles. The data at $E_d = 1.2$ MeV are reported in the same forms in Figs. 6 and 7. The RCS energies and angles are those defined in ref. (1).

The symmetrized angular correlation $\sigma(\theta) = [\sigma(\theta, 0) + \sigma(\theta, \pi)] / 2$ is reported in Figs. 8 and 9 and the corresponding $A(\theta) = [\sigma(\theta, 0) - \sigma(\theta, \pi)] / [\sigma(\theta, 0) + \sigma(\theta, \pi)]$ is Figs. 10 and 11 for $E_d = 0.8$ MeV and 1.2 MeV.

As one can see, the qualitative features of the reaction are similar to those shown at $E_d = 1.0$ MeV⁽²⁾.

3. - DISCUSSIONS AND CONCLUSIONS. -

In the rough hypothesis⁽²⁾ that the asymmetry $A(\theta)$ is simply connected to the polarization $P_{\alpha-n}$ of the produced α -n complex and to the analysing power of the n- α scattering $P_n(\theta)$ by the formula

$$(1) \quad A(\theta) = P_{\alpha-n} (-P_n(\pi - \theta))$$

the form of the asymmetry is independent from the energy of the bombarding particle, since $P_n(\theta)$ depends only from the internal energy E_{j-3} of the α -n complex.

Figs. 10 and 11 report the $A(\theta)$ curves computed by means of eq. (1). The values of $P_{\alpha-n}$ are obtained fitting the curves by the least

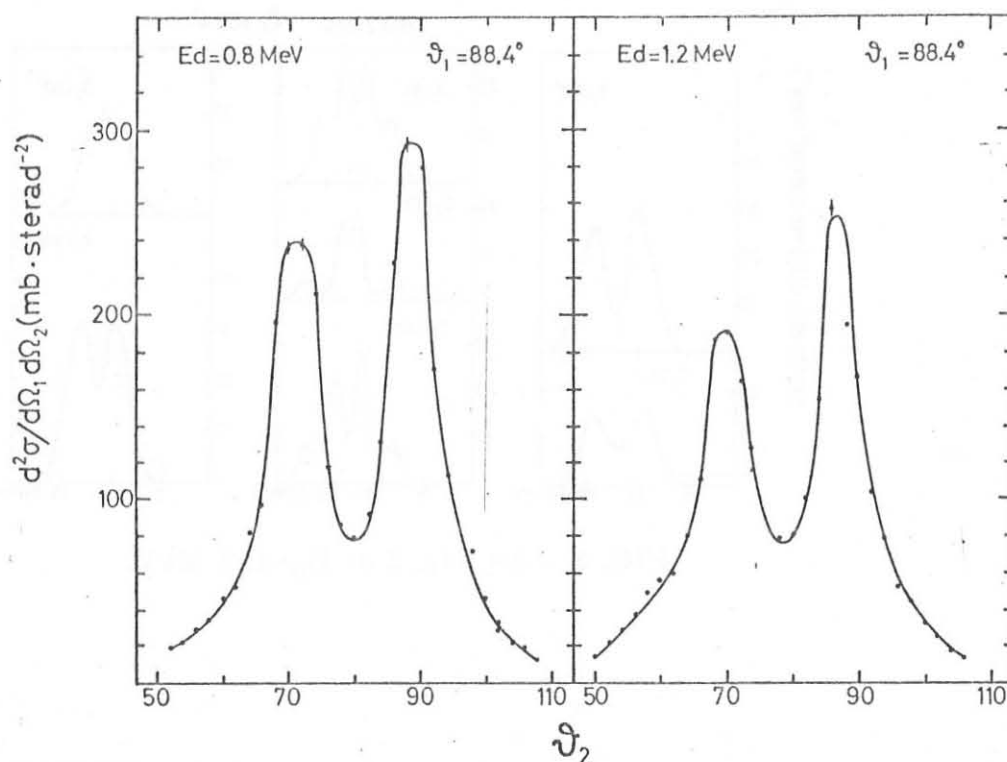


FIG. 1 - Integral α - α angular correlations in the LS for the ${}^7\text{Li}+d \rightarrow 2\alpha+n$ reaction at $E_d=0.8$ MeV and $E_d=1.2$ MeV.

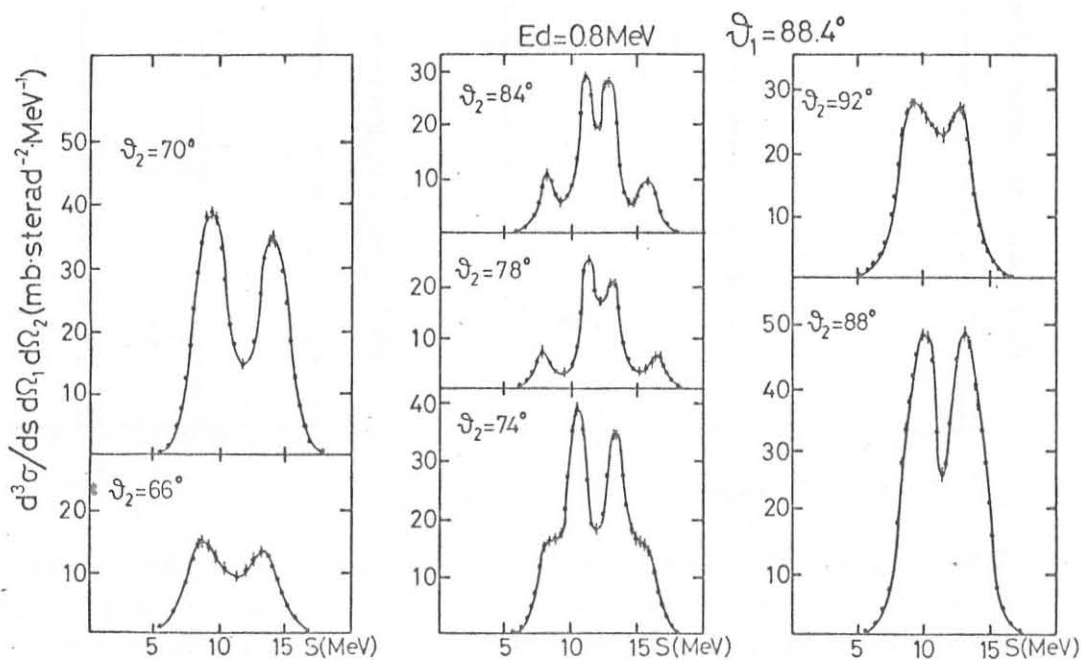


FIG. 2 - Distribution of counts along the kinematic curves in the LS for $E_d=0.8$ MeV, $\theta_1=88.4^\circ$, $\phi_2-\phi_1=180^\circ$ and various θ_2 .

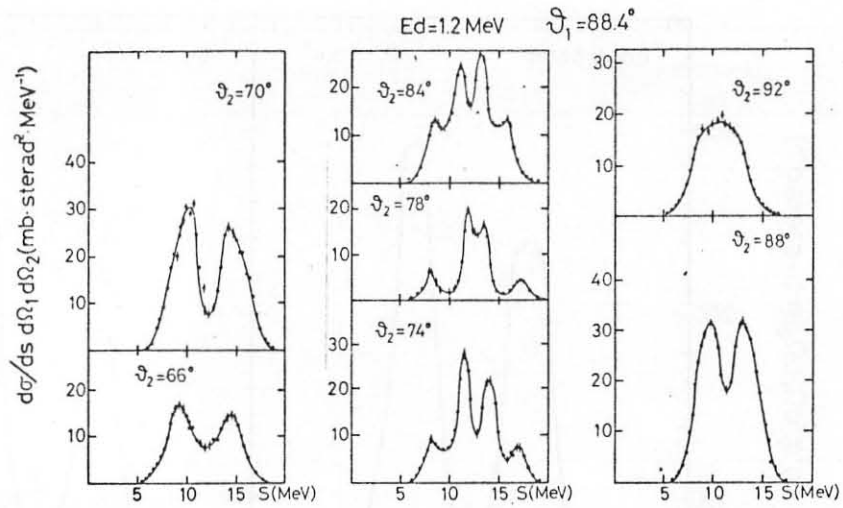


FIG. 3 - As Fig. 2 at $E_d = 1.2$ MeV.

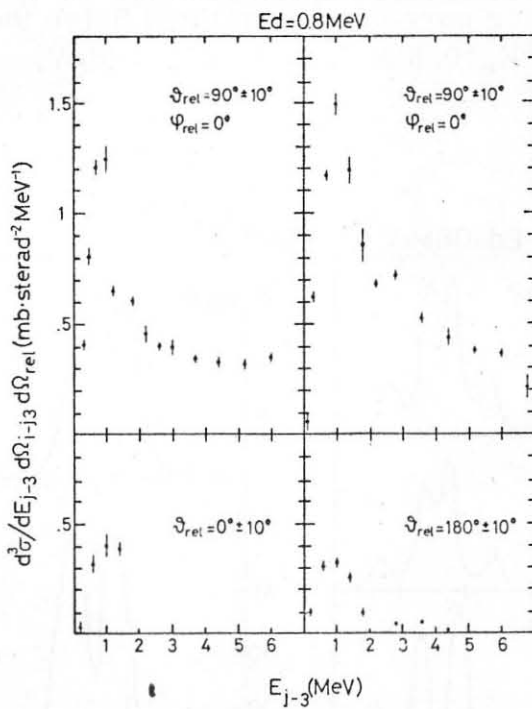


FIG. 4 - Internal energy spectra of the α -n systems seen at various angles θ_{rel} of the emitted α -particles with respect to the direction of the motion of the α -n centre of mass at $E_d = 0.8$ MeV.

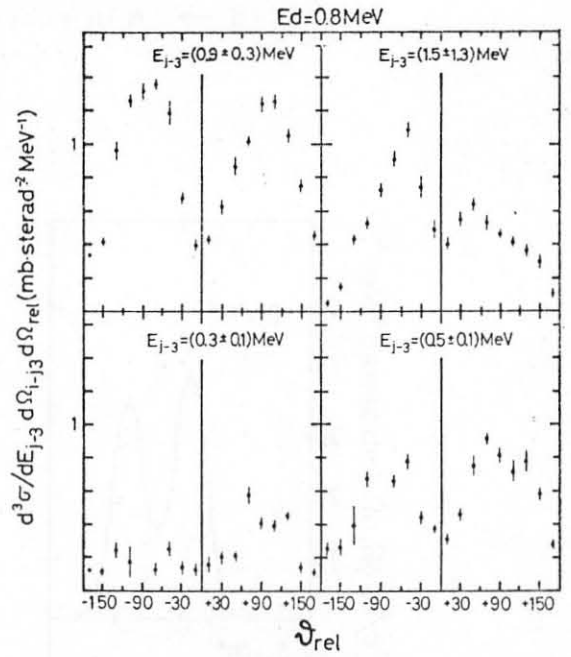
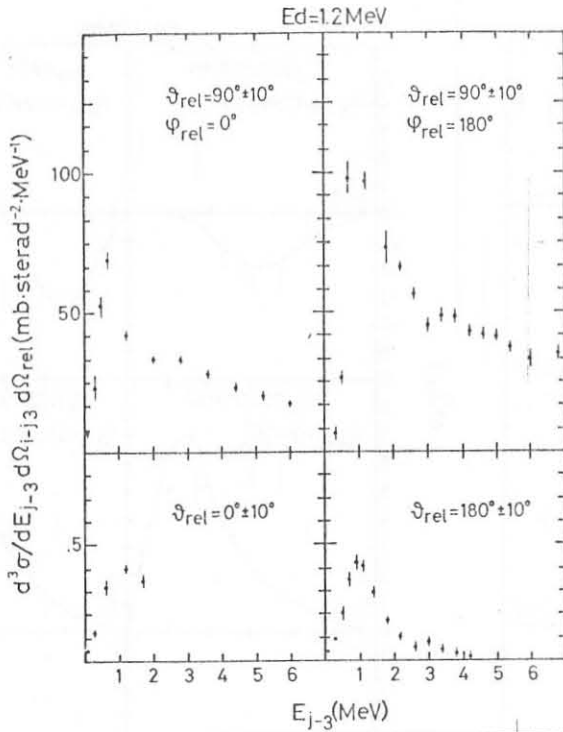
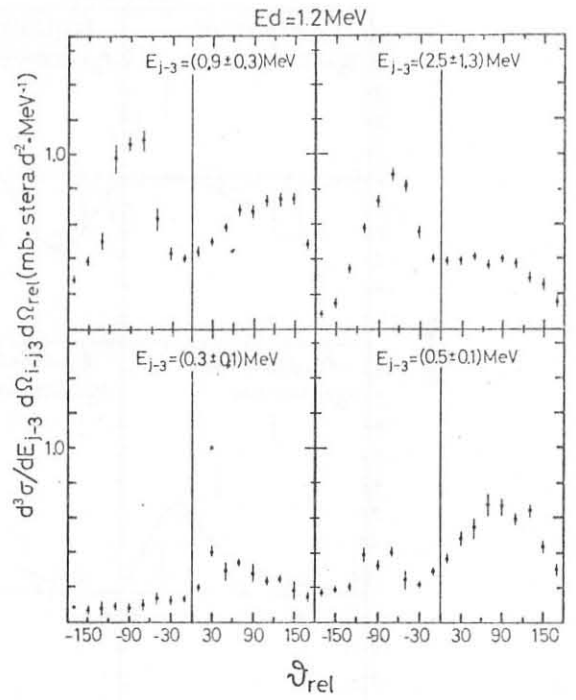
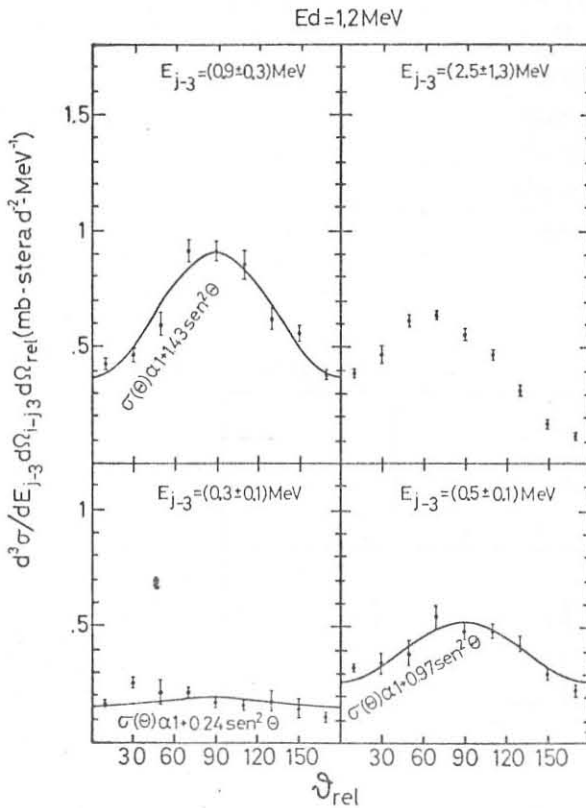
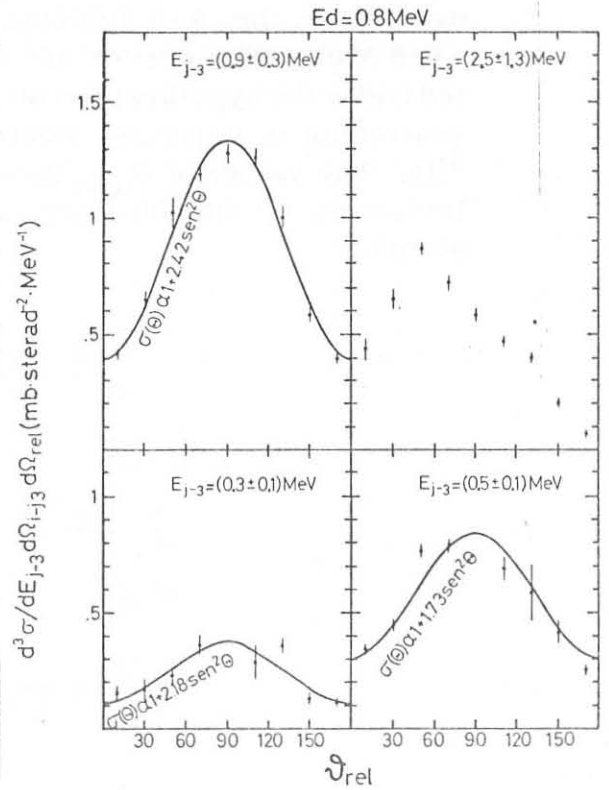


FIG. 5 - Angular correlations of the decaying α -particles from the α -n complex with respect to the α -n centre of mass motion at $E_d = 0.8$ MeV.

FIG. 6 - As Fig. 4 at $E_d=1.2$ MeV.FIG. 7 - As Fig. 5 at $E_d=1.2$ MeV.FIG. 8 - Simmetrized angular correlations in the RCS at $E_d=0.8$ MeV.FIG. 9 - As Fig. 8 at $E_d=1.2$ MeV.

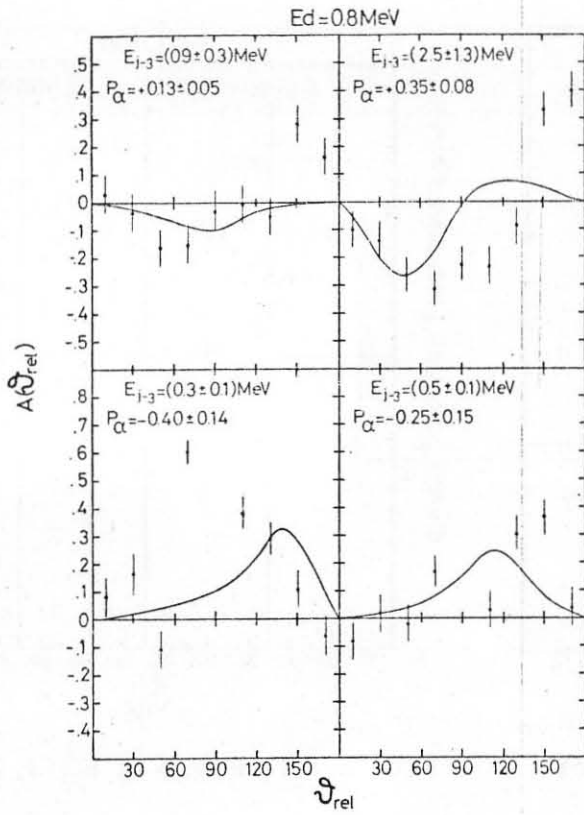


FIG. 10 - Asymmetry in the angular correlations for various internal energies of the α -n systems at $E_d = 0.8$ MeV. The curves are computed under the hypothesis of an elastic scattering of polarized neutrons on ${}^4\text{He}$. The values of $P_{\alpha-n}$ give the polarization of the decaying α -n systems.

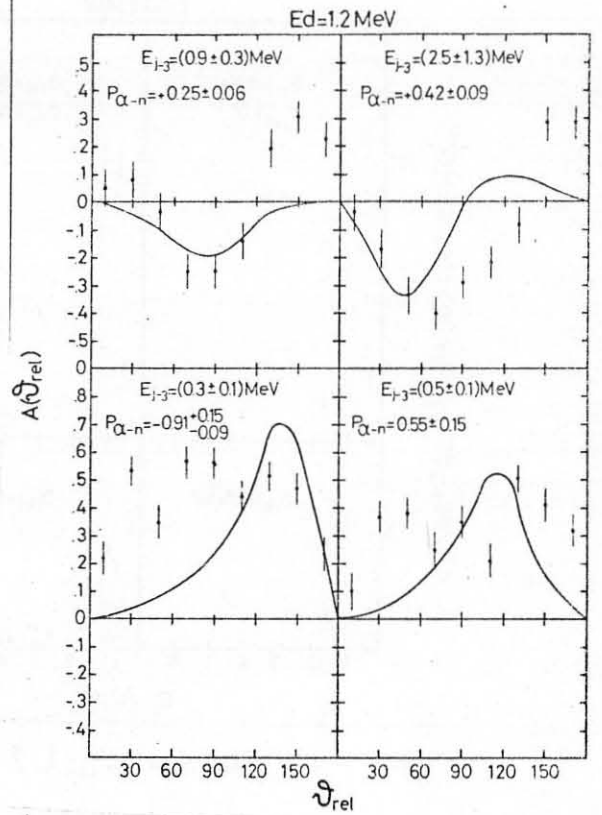


FIG. 11 - As Fig. 10 at $E_d = 1.2$ MeV.

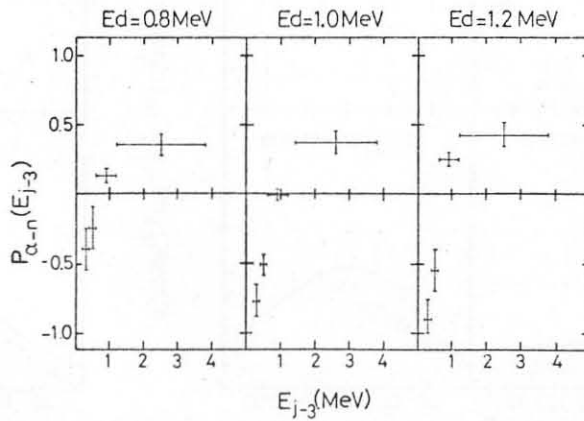


FIG. 12 - Polarization of the α -n systems vs. internal energy E_{j-3} at various incident deuteron energies.

square method. The fit is as good as at $E_d = 1.0 \text{ MeV}$ ⁽²⁾.

Taking into account the data obtained also at that energy, Fig. 12 reports the values of $P_{\alpha-n}$ at the various deuteron energies.

As is seen, the trend of the polarization of the α -n complex so deduced depends slightly from the incident energy in the explored range.

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