Proc. Sixth Int. Symp. Polar. Phenom. in Nucl. Phys., Osaka, 1985
J. Phys. Soc. Jpn. 55 (1986) Suppl. p. 884-885

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Measurement of the Tensor Analyzing Power A_{xz} of d-α Elastic Scattering for Testing the Phase Shifts in the Energy Region between 20 and 40 MeV

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The analysis of d-α elastic scattering data, with the aim of obtaining the correct energy-dependent phase-shifts of this process and determining the corresponding level parameters of the ^{6}Li nucleus, has been the subject of intensive work in the last two decades[1]. While the phase shifts at energies up to about 20 MeV are considered to be uniquely determined, since complete or nearly complete sets of data are available, the situation in the energy range between 20 and 40 MeV is more uncertain. This is largely because these data are taken with a polarized deuteron beam from a cyclotron, where the spin direction in the beam is fixed and therefore no tensor analyzing power $A_{xz}=-\sqrt{3}T_{21}$ could be measured. In this energy region two or more different phase shift sets could be found which gave fits to all available data with similar quality. However, the prediction for the missing A_{xz} component was greatly different. Therefore it was suggested, that the measurement of this component could resolve the ambiguity in the present phase shift analysis.

Recently, at the SIN injector cyclotron a spin rotation solenoid was installed. With the additional aid of deflection magnets with a deflection angle of 170°, the spin of the tensor polarized deuterons could be brought into a convenient direction such that the beam contains also a t_{21} component[2].

Measurements at several deuteron energies were carried out to determine the tensor analyzing power A_{xz}. The results at 24.0 MeV and 38.2 MeV deuteron energy are presented in Fig. 1 and Fig. 2 together with the predictions of the different phase shift sets from ref. 1. The size of the data points are smaller than the combined statistical and systematic errors. At 24 MeV the data in the angular range between θ_{cm}=80° and 140° clearly agree with the solution A of ref. 1 and exclude the solution A'. At larger angles another maximum develops near 160°, which is not predicted by any phase shift solution.

At 38.2 MeV the structure of the new A_{xz} data agrees in the angular range θ_{cm}=60° to 140° with all three phase shift solutions, however, the magnitude is different in the first maximum around 90°. In this angular range the phase shift solution B of ref. 1 is favoured. However, as at lower energy, an additional maximum at angles larger than 140° is observed in the new A_{xz} data set, which is in disagreement with all phase shift solutions found so far. Instead of a predicted deep minimum a maximum is found. The angular width of this observed maximum is small and therefore stronger contributions of higher partial waves are suggested. On the other hand one should be aware, that in this extreme backward angular range also data for the components A_y, A_{yy} and A_{xx} are missing. In particular the two other tensor components cause a problem since the value at θ_{cm}=180° are not fixed to zero as in the case of A_y(180°). Therefore also these predicted values for these components in ref. 1 should be considered with some caution. For a final solution of the problem an improved phase shift analysis including the new A_{xz} data is required.

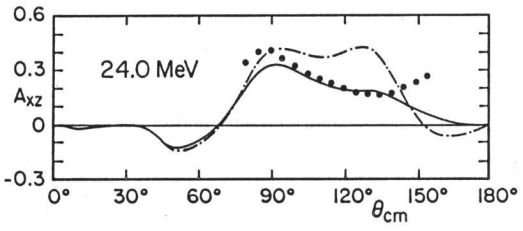

Fig. 1. Tensor analyzing power A_{xz} at E_d=24 MeV. The curves are phase shift predictions from ref. 1.

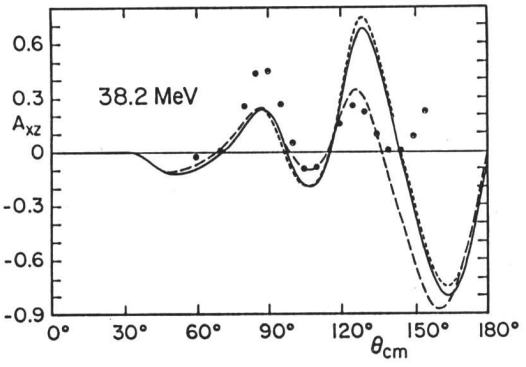

Fig. 2. Tensor analyzing power A_{xz} at E_d=38.2 MeV. The curves are phase shift predictions from ref. 1.

References

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2) V. König, W. Grüebler, P.A. Schmelzbach, Ch. Forstner, M. Bittcher, B. Vuaridel, D. Singy, R.E. White, J. Ulbricht and S. Jaccard: Contribution to this Symposium.