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The $^2H(d,p)^3H$ reaction has been studied at energies up to 12 MeV by a number of groups[1]. Grüebler et al. in particular have measured the differential cross sections and the deuteron analyzing powers at 9 energies between 3.0 and 11.5 MeV, and they have analyzed their data in terms of possible resonances in ^4He. Their analysis of the coefficients in a Legendre expansion fit to the data showed that no simple isolated state of this system exists between 24 and 30 MeV excitation of ^4He since relatively strong interference effects were observed.

The present experiment was undertaken at E_d = 30 MeV in order to study the $^2H(d,p)^3H$ reaction in a region of considerably higher excitation of ^4He. Also, it is to be expected that the direct nucleon transfer mode should be enhanced with respect to the compound-nucleus reaction mechanism at this higher energy. Measurements were made of the differential cross-section and the vector analyzing power iT_{11}. The iT_{11} results are shown in fig. 1, and the surprising feature is the approximate antisymmetry of the data with respect to $\theta_{cm} = 90^o$. The degree of symmetry observed is quite remarkable because the iT_{11} data at E_d = 11.5 MeV show little symmetry of any kind and are almost uniformly positive in sign.

The entrance channel particle identity requires that $\sigma(\theta) = \sigma(\pi-\theta)$, and in the inverse $^3H(\vec{p},d)^2H$ reaction the exit-channel particle identity requires that $A_y(\theta) = -A_y(\pi-\theta)$ for the proton analyzing power[2]. There is, *a priori*, no such symmetry condition imposed on the analyzing powers in the $^2H(\vec{d},p)^3H$ reaction. However, it can be shown that if the reaction mechanism is entirely that of direct nucleon transfer, the indistinguishability of the neutron transfers between the two deuterons results in exact symmetries in the deuteron analyzing powers[3]. In particular for our purposes

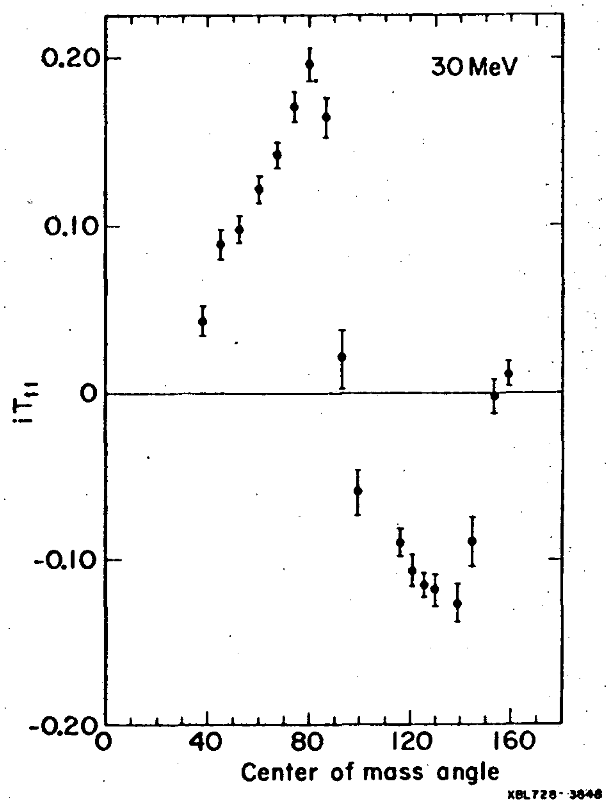
$$iT_{11}(\theta) = -\, iT_{11}(\pi-\theta), \qquad (1)$$

so the near antisymmetry of our data is clear evidence of a predominantly direct nucleon-transfer reaction mode at this higher energy. Of course, the *certain* conclusion is that deviations from eq. (1) show that other than the direct nucleon-transfer process is contributing to the reaction. It is possible, in principle, for the compound-nucleus reaction mechanism to give the result (1) if the reaction should proceed entirely through a single state or through states of the same parity so that only the even-L terms would contribute in the Legendre expansion

$$\sigma(\theta) iT_{11}(\theta) = \sum a_L\, P_L^1\, (\cos\theta).$$

In view of the data and analysis of Grüebler et al.[1], this circumstance is most unlikely in this reaction.

In summary, we have found in the $^2H(\vec{d},p)^3H$ reaction that the entrance-channel particle identity imposes definite symmetries on the polarization observables that are clear signatures of the direct-reaction process. We know of no other example of a condition by which this process can be identified so clearly.



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3) H. E. Conzett, J. S. C. McKee, R. M. Larimer, and Ch. Leemann, to be published.

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