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POLARIZATION OF HIGH ENERGY PROTONS SCATTERED BY COMPLEX NUCLEI

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March 2, 1954

Berkeley, California

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When a nucleon of several hundred Mev collides with a nucleus, there is no a priori reason to believe that the force it feels is the force exerted on low energy particles as described, for example, by the shell model. However, it is interesting to attempt to describe the process in terms of elementary interactions with the individual nucleons. With the impulse approximation[1] one can indeed formulate such a scattering problem, provided the nucleon wave function is known. The lack of knowledge of detailed nuclear wave functions is what limits the applicability of such calculations to processes involving deuterons.

If one observes, however, that the entire dependence of the matrix element upon the nucleon wave function is contained in the "sticking factor" (overlap integral between the initial and final states), and that the polarization is essentially the ratio of two cross sections, then one is led to suspect that for nuclei possessing a sufficient degree of symmetry, the sticking factors cancel out and the polarization may be calculated without any knowledge of the nuclear wave function. It can be shown that the deuteron and all alpha-particle nuclei have this property. Furthermore on this model all alpha-particle nuclei should give the same polarization.

A method of constructing an S-matrix for the scattering from complex nuclei in terms of the n-p and p-p phase shifts has already been described[2]. Using the tensor force p-p phase shifts of Goldfarb and Feldman[3], and the n-p phase shifts of Swanson[4], polarizations have been calculated for incident protons of 240 Mev. The polarizations at various angles are given in Table I.

Note that the phase shifts used give qualitative agreement with the polarization effects found in nucleon-nucleon scattering. It is significant, then, that interference and spin-correlation effects work in such a way as to markedly increase the polarization, in agreement with recent experiments[5].

It is tempting to generalize the above results, arguing that most light nuclei consist of an alpha-particle-like core plus a few excess nucleons, so that most of the scattering is from the alpha-particle core. On the basis of this picture one may argue that all nuclei of $4 \leq z \leq 20$ should give about the same polarizations.

A more detailed paper will appear shortly.

This work was performed under the auspices of the Atomic Energy Commission.

TABLE I

θ	Percent polarization: p-d	p-α
30°	18%	43%
45°	35	79
60°	40	~~66~~ 92

Percentage polarizations for scattering of protons at various angles. θ is the scattering angle in the center of mass of the nucleon-nucleon system. Except for small relativistic effects this is twice the laboratory angle.

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