Elastic d-p Scattering at 190 Mev

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AS a result of recent theoretical interest, a comprehensive program has come into being, the purpose of which is to deduce some properties of the neutron-neutron interaction at high energies.

So far, p-p experiments have been carried out by Birge[1] at 100 Mev, and by Chamberlain, Segrè, and Wiegand[2] at (among other energies) 120 Mev. Professor Wilson M. Powell[3] is engaged in the study of n-d scattering using 90-Mev neutrons. We are measuring the scattering on protons, both elastic and inelastic, of the 190-Mev deuterons of the Berkeley 184-in. cyclotron. In all these experiments the relative velocities are comparable.

In this letter, we present our results to date on the elastic d-p scattering, first reported by one of us (A.L.B) at a recent meeting[4] of the American Physical Society. A more complete report, giving the details of the experiment, and possibly extending the data to larger and smaller angles, will be published in the near future.

The experimental arrangement was akin to that used by Chamberlain and Wiegand.[5] Deuterons scattered out of the cyclotron were collimated and made to impinge on a target. Coincidences between protons and deuterons were observed by means of stilbene crystals. Either one crystal, or two in coincidence, detected the scattered protons; another crystal, in coincidence with the former, the deuterons. Suitable tests were performed to convince us that only the desired events were being observed.

Carbon and polyethylene targets were used alternately to obtain the scattering cross section by subtraction. The data accumulated so far are shown in Fig. 1. The differential scattering cross section, in 10^{-27} cm^2 sterad^{-1} in the center-of-mass system, is shown as a function of the angle of deflection of either particle in that system. Table I gives the weighted averages of the cross sections for a given angle. The slight relativistic correction has been taken into account.

The solid curve of Fig. 1 shows the theoretical cross section as given by Chew.[6] Evidently, the fit is excellent from 60° to 110°, but at larger angles the measured cross section is lower than Chew's; this means that at this energy the pick-up process which causes a rise in the cross section in this region is less important than the Born approximation with Serber potentials for the n-p and p-p interaction would lead one to expect.

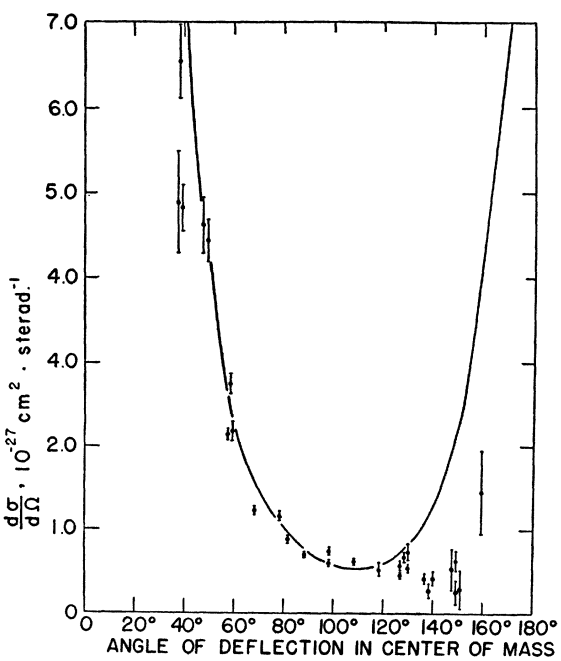

FIG. 1.

TABLE I. Differential scattering cross sections in the center-of-mass system, in 10^{-27} cm^2 sterad^{-1}, averaged over all data for a given angle, as a function of the angle of deflection in the center-of-mass system.

Angle	Cross section	Angle	Cross section
38°	5.4 ±0.4	98°	0.65±0.05
48°	4.5 ±0.4	108°	0.61±0.05
58°	2.3 ±0.2	118°	0.52±0.09
68°	1.22±0.09	128°	0.55±0.05
78°	1.16±0.10	138°	0.40±0.05
82°	0.89±0.08	149°	0.44±0.09
88°	0.70±0.06	159°	1.5 ±0.5

The errors shown in Fig. 1 are compounded of the standard deviations due to counting statistics and the estimated uncertainties in the factor which determines how much of the carbon count must be subtracted from that of the CH_2 target to yield the hydrogen effect. In addition, certain systematic errors, due to the uncertainties in the voltage plateaus, beam integration, and steadiness of the beam, etc., may occur. These have been estimated to amount to no more than 7 percent standard deviation, and have been taken into account in the errors quoted in Table I.

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[2] Chamberlain, Segrè, and Wiegand, Phys. Rev. **81**, 284 (1951).
[3] W. M. Powell (to be published).
[4] A. L. Bloom and M. O. Stern, Phys. Rev. **81**, 660 (A) (1951).
[5] O. Chamberlain and C. Wiegand, Phys. Rev. **79**, 81 (1950).
[6] G. F. Chew, Phys. Rev. **74**, 809 (1948).

Nuclear Compressibility and Fission

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AS is well known, many features of the fission phenomenon find a simple explanation in the theory of the compound nucleus; and, in particular, it has been possible to arrive at an approximate estimate of the critical fission energy for heavy nuclei. So far, however, no simple explanation has been found for the pronounced asymmetry of the nuclear division in fission.[1] In a search for an explanation of this phenomenon we have examined the effects of nuclear compressibility and of the polarizability of nuclear matter (separability of neutrons and protons), and it seems that these effects may play an important part in fission.

The reason is that the deformation energy of a nucleus is a small difference between large changes in electrostatic and surface energies, and that consequently even relatively small corrections to the estimate of these energies may have a decisive influence.

As a model of the nucleus we used a drop of a classical, compressible, polarizable neutron-proton fluid whose density distribution is constantly changing as the fission proceeds. Only the "adiabatic" approximation was considered, in which the density distribution at any instant is given by the equilibrium distribution corresponding to the instantaneous deformation. The total energy of the nucleus was taken to be the sum of volume, coulomb, and surface energies in the absence of compressibility plus a (negative) correction ΔE due to compressibility. That there is in general a factor in ΔE which favors asymmetric fission can be seen as follows: if the volume of the nucleus which is undergoing fission is divided conceptually into two regions corresponding to the nascent