tions 1, 2, and 3. These have been measured at a pion energy of of about 40 Mev.[7,8] We have now obtained a value of $(1.7\pm0.4)\times10^{-27}$ cm^2/sterad for the differential cross section at a laboratory angle of 45° for reaction 2 at 40 Mev. Together with the three total cross sections and the five differential points for reaction (1),[5] and under the assumption that α_{11}, α_{13}, and α_{31} are negligible, this determines the following ranges of values for the other phases:

$$\alpha_1=+9.7°\pm1.2°;\quad \alpha_3=-2.6°\pm1.4°;\quad \alpha_{33}=+5.7°\pm1.2°.$$

No solution exists with reversed signs.

The phases shifts so obtained are consistent with the strong backward maximum found recently at this energy for reaction 3.[9]

Figures 1 and 2 give the experimental points along with the curves calculated from the above three phase shifts.

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Nuclear Configurations Inferred from High-Energy Pickup-Deuteron Distributions*

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THE production of high-energy pickup deuterons, first observed by York,[1,2] using 90-Mev neutrons, has been examined theoretically[3] as a means of determining nucleon momentum distributions inside nuclei. In experiments now in progress here, the pickup process is being studied with the improved resolution available with a proton beam—the external proton beam of the Harvard cyclotron has an energy of about 95 Mev, with an energy spread, in the work so far, of about 3 percent. Deuterons are identified by simultaneous measurement of range and specific ionization.

Some of the early results are shown in Figs. 1 and 2. Figure 1 shows the sharp energy peak obtained from carbon. Although there is some production of higher excited states of the residual nucleus, it is seen that, as was roughly indicated by the earlier work, quite predominantly only one type of neutron state in carbon enters into the pickup process. This may be regarded as rather strong evidence for an alpha-particle structure for carbon. One can readily estimate that if the six neutrons of carbon were distributed in a shell-type structure, with two in s states and four in p states, then the energy separation of these two types of levels should be of the order of 6 to 8 Mev, an easily observable separation.

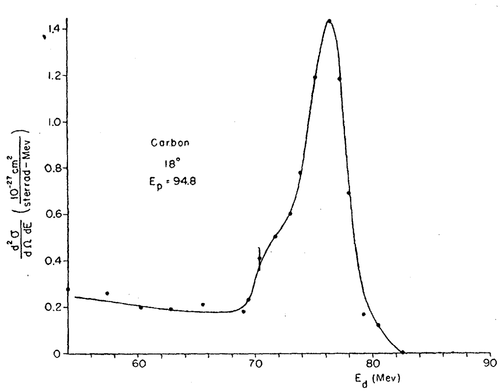

FIG. 1. Pickup-deuteron cross sections for carbon. The statistical accuracy of the points is indicated for a representative point.

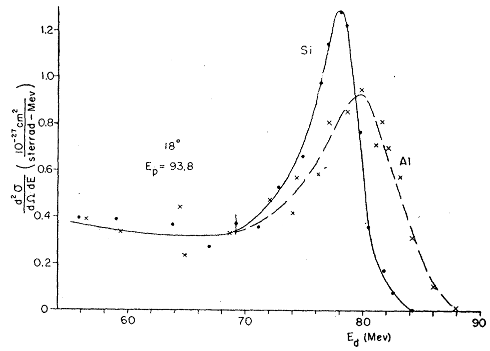

FIG. 2. Pickup-deuteron cross sections for aluminum and silicon. The accuracy of the points is indicated for a representative point.

The peak in carbon is still quite distinct at 60°, where the differential cross section is down by a factor of about 150 from its value in the forward direction. However, it is no longer so prominent relative to the continuum of deuterons (which presumably come from more complicated collisions), and so the separation of the "pickup" part of the cross section is uncertain to within a factor of perhaps two. Analysis of the angular distribution by the Born-approximation method of Chew and Goldberger[3] indicates a Gaussian momentum distribution for the picked up neutron.

In addition to carbon, other elements studied are beryllium, aluminum, silicon, copper, and lead; work is in process also on deuterium and helium. The heavier elements show less pronounced pickup peaks. All of the light elements show evidence of alpha-particle structure in "$4n$" nuclei. Beryllium shows the anticipated two peaks, one corresponding to a Q close to the $-16\frac{1}{2}$-Mev value found for carbon, the other to a Q near zero. Figure 2 shows the pickup deuterons from aluminum and silicon. Si^{28} (=89.6 percent of normal silicon) is expected to be a tightly bound structure on either the alpha-particle or the shell model. Al^{27} has the same number of neutrons as Si^{28}, and one proton less. Now to the extent to which the pickup process can be regarded as involving only the two nucleons concerned, with no interaction with the other nucleons in the target nucleus, the (p, d) pickup reaction samples the neutron distribution inside the target nucleus. On this basis, the results of Fig. 2 can be interpreted as showing that the neutron distribution present in the ground state of Si^{28} is considerably affected by the removal of one *proton*. This is a strong indication of alpha-particle structure in Si^{28}, particularly as compared to an individual-particle model having the neutron distribution relatively independent of the proton distribution.

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The Energy Levels of Be^{10}†

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THE proton spectrum from the reaction $Be^9(d, p)Be^{10}$ has been observed using a high-resolution magnetic spectrometer.[1] A thin (0.30 mb/cm^2) Be^9 foil was bombarded by a collimated beam of 14.5-Mev deuterons. After magnetic analysis the outgoing particles were detected by a scintillating crystal and identified both by their ranges in foils and by pulse-height analysis. Observations were made at ten laboratory angles.